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Revealing key links between components in the circular economy

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Abstract: The circular economy (CE) has proven to be an effective solution for sustainable development in the last two decades, especially in the context of multiple crises. As a long-term strategy, business managers are seeking a sustainable business model that harmoniously and efficiently integrates prosperity, social security, and resource conservation. This research highlights the essential role of components such as green logistics (GL) and green human capital (GHC) in sustainable production (SP), which is necessary for the successful implementation of CE. The study, based on data collected from 117 companies in the Romanian food industry, uses partial structural equation modelling to explore the causal relationships between these variables. The results show that both green logistics and green human capital are important factors for circular economy, and sustainable production significantly mediates the relationships between green human capital, and circular economy, but not significantly for green logistics. Thus, it is concluded that sustainable production has a determining positive effect on circular economy. Although the research is limited by the geographical and sectoral context, it contributes theoretically and practically by analysing the relationships between these concepts and the relevant managerial implications.

Keywords: competitiveness; food industry; green logistics; green human capital; sustainable production

In the current context of the multiple global crises facing contemporary society, the promotion and implementation of circular economy (CE) practices is becoming increasingly important, especially in key sectors such as the food industry. The topic of this research focuses on the impact of green components on the implementation of the CE in food businesses. This topic is particularly relevant as businesses in this sector must find sustainable ways to operate in an unstable economic environment with limited resources (Jolink and Niesten 2015; Rabadán et al. 2019; Niu et al. 2021).

The food industry and the agricultural sector are closely interconnected, together forming a value chain essential for food security and economic development. The agricultural sector provides the raw material needed for the food industry, thus providing the basis to produce processed foods, finished products and other consumable goods. At the same time, the food

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industry contributes to the development of the agricultural sector through its constant demand for agricultural products, influencing agricultural practices and orienting farmers to crops and techniques that meet market requirements (Henson and Reardon 2005; FAO 2017). This symbiotic relationship stimulates innovation and sustainable development, for example by promoting organic farming and short supply chains, which reduce ecological impact and support the rural economy. Thus, the connection between these two sectors is crucial to ensure a constant and safe flow of food to consumers, while maintaining sustainability and economic competitiveness.

This theme is closely related to the objectives and strategy of the Green Deal proposed by the European Union. The Green Deal is an ambitious plan to make the European economy greener and more sustainable. The implementation of the CE in the food business aligns with these goals, as it promotes the efficient use of resources, the reduction of carbon emissions, and the elimination of waste in the production and consumption cycles (Rowan and Galanakis 2020).

Academic literature reveals that other EU countries have already adopted CE principles and practices in various sectors, including the food industry. CE principles, which include resource regeneration, sustainable design, and recycling, are considered essential for effective resource management in the context of sustainability (Kirchherr et al. 2017). Also, sustainable manufacturing practices and green logistics (GL) have been successfully implemented in other EU countries, helping to reduce the ecological footprint of businesses and promoting more responsible and efficient supply chains (Pietrobelli and Rabellotti 2011).

Romania's progress toward adopting CE principles presents as fragmented and faces substantial challenges. The country has made strides in reducing waste generation and improving construction and demolition waste recovery, yet recycling rates for municipal and packaging waste remain critically low, reflecting inconsistencies in implementation. The food industry, a key sector in the CE transition, highlights inefficiencies in addressing food waste, with significant losses across the supply chain exacerbated by outdated technologies and limited public awareness. Surveys reveal that while familiarity with the green economy concept is high, only 52.94% of organisations have incorporated CE strategies into their plans, hindered by operational costs, inefficient recycling systems, and insufficient incentives (Vermeşan et al. 2020; Dumitru et al. 2021; Topliceanu et al. 2023). Addressing these gaps requires systemic reforms, including enhanced education, robust recycling infrastructure, and strengthened public-private partnerships, to foster a more consistent and effective transition to a circular economy.

Currently, companies are under pressure to take responsibility for the negative effects of their economic activity, so they are looking for ways to integrate environmental objectives into their strategic planning. Logistics has a significant impact on emissions and energy consumption, and green solutions are becoming increasingly important. GL encourages environmental awareness and seeks a balance between economic, environmental, and social considerations. Previous research has particularly focused on the impact of GL management on environmental sustainability, but there is limited information available on its influence on the overall CE practices of companies (Khan et al. 2021; Seetharaman et al. 2022).

To achieve corporate sustainability and adopt the CE, human resource factors, including the human capital of managers, play a critical role. Recent research emphasises the need for organisations to develop dynamic capabilities such as green human capital (GHC) to support green innovation and environmental sustainability (Abrudan et al. 2022). This approach stimulates the use of environmental management strategies, such as green supply chain management, to achieve sustainability. However, there is still a dearth of information on the influence of GL management on companies' CE practices (Lee and Klassen 2008; Marrucci et al. 2021).

In addition, in countries such as China, the US, and the UK, more attention has been paid to green supply chain management than GL. In the context of these countries, there is still limited research on the impact of GL on the performance of organisations in the CE. There is also a knowledge gap regarding the GHC impact on CE practices or organisational sustainability initiatives in European countries (Dhull and Narwal 2016; Tseng et al. 2019; Shetty and Bhat 2022).

In what follows, we will review the literature on CE, sustainable production (SP), GL, and GHC to develop a deeper understanding of these concepts and how they can be applied in the context of food businesses in Romania.

The current study makes several significant contributions to assessing the connections between managing GL, GHC, SP, and circular economy practices in the food industry. The conceptual framework builds on previous research in the garment manufacturing sector (Singh et al. 2020; Cheng et al. 2023), hospitality industry (Ogiemwonyi et al. 2023), HR management

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(Cabral and Dhar 2019; Singh et al. 2020; Ogbeibu et al. 2021; Rubel et al. 2021) and automotive sector (Khan et al. 2022). First, this study emphasises the importance of the natural resource based theory (NRBV) and the dynamic capability theory (DCT) in researching the fields of GL and GHC in emerging economies. GHC is analysed from the perspective of DCT, while GL is approached from the perspective of NRBV. Second, by analysing the essential role of GL and GHC in enhancing the economic and environmental performance of enterprises, this study contributes to the development of the literature on GL, GHC, and CE. Third, this study makes a novel contribution by highlighting the mediating role of SP in the relationships between GL–CE and GHC–CE, which, to our knowledge, has not been previously demonstrated by existing research focusing on the food industry in the European context.

This study enriches the existing knowledge by examining how SP influences the interaction between GL and CE, as well as between GHC and CE. Finally, our research enhances the understanding of the role of SP in achieving CE and sustainability goals, providing a solid foundation for future studies.

MATERIAL AND METHODS

The natural resource-based view (NRBV). The natural resource-based view (NRBV) was formulated by Hart to extend the classical perspective of resource-based view (RBV) by including the external natural environment of the organisation as a resource (Hart 1995). RBV focuses on using an organisation's internal resources to gain a competitive advantage. In this sense, Barney (1986) argues that the RBV provides a framework for understanding how businesses use various resources to gain competitive advantage. The NRBV aims to emphasise the importance of the natural environment, seen as an essential component of a company's competitive advantage.

The NRBV approach integrates three interdependent environmental policies: 'pollution prevention', 'product management' and 'sustainable development'. The pollution prevention strategy aims to reduce pollution and waste, with a positive impact on the environment and operational costs. Product management involves the inclusion of diverse stakeholder views in the design of products and processes, contributing to a competitive advantage and strengthening the company's green reputation. At the same time, the sustainable development plan aims to minimise the negative impact of business on the environment, contributing to increasing sustainability and organisational performance (Ma 2000).

Green supply chain strategies are considered valuable business assets, and difficult for competitors to imitate due to the time and organisational capacity required for implementation. Thus, green approaches such as GL management and SP reveal great potential of generating a competitive advantage for businesses in the green market. In this paper, we use the NRBV to examine how GL can contribute to improving SP and CE practices performance within businesses (Hart and Dowell 2011).

Dynamic capabilities theory. Dynamic capabilities reflect a company's ability to react and adapt to changes in its environment by effectively integrating and reorganising its resources. These capabilities contribute to successfully running an agile and flexible company throughout a complex business environment. Through the dynamic capabilities theory (DCT) new skills can be acquired and developed with the potential to increase organisational performance (Wamba et al. 2020). In specialised literature, there are various perspectives on this concept, the most relevant of which is the framework proposed by Teece (2014), which includes three main components: 'perception', 'capability' and 'transformation'. Perception refers to a company's ability to identify and evaluate technical opportunities that can be used to meet consumer needs and strategic objectives. Capability involves the effective use of resources and procedures to obtain value from these identified opportunities. Transformational power, or the ability to reconfigure, refers to the company's ability to quickly reorganise its standard resources and capabilities to respond to market changes (Del Giudice 2021; Raut et al. 2021). We used the theory of dynamic capabilities in order to demonstrate the potential of GHC and GL, as organisational capabilities, to contribute to the improvement of CE and sustainability practices.

Circular economy: current approach. The transition to a CE requires establishing a solid foundation for SP and consumption. The CE includes the efficient use of resources and waste management, being integrated into a more complex green economy model that also aims at the well-being of the population and the resilience of ecosystems (Ghisellini and Ulgiati 2020). The concept of 'circular economy' was originally described by Stahel and Reday-Mulvey (1977) as an economic system that creates jobs, increases economic competitiveness, saves resources, and prevents waste. Geng et al. (2009) presented it as a system that minimises the flow of matter and energy without limiting economic growth. Later, the Ellen MacArthur Foundation (2015) expanded the vision, defining the CE as a renewable industrial system by design and intent, and Singh and Ordonez (2016)

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clarified that it transforms the linear consumption system into a circular one, achieving economic sustainability and significant material savings.

The CE is an economic model that is based on the judicious use of resources, reducing waste to a minimum and maintaining the value of resources as long as possible. For example, using compost for soil fertilisation or using food by-products in animal feed. It closes the circuits of products and materials according to environmental protection standards and socioeconomic benefits. While reducing environmental degradation and resource use, the CE has the potential to contribute to economic growth with minimal negative consequences, leading to sustainable development. Material reuse and recycling reduce waste and natural resource consumption, having sustainable effects on resource conservation and pollution reduction (Kirchherr et al. 2017; Xie et al. 2021).

Repair and reconditioning of products extend their life, reducing the need to produce new goods and the impact on the environment and the economy (Ghisellini et al. 2016; Geissdoerfer et al. 2017). Governments and public organisations play a crucial role in promoting the CE through green procurement, stimulating the market for sustainable and innovative solutions (Cheng et al. 2018; Letunovska et al. 2023). Thus, the CE protects the environment and contributes to sustainable economic and social development.

Hypotheses argumentation. We will start from the most influential variable in this analysis, as in many others, namely human capital:

H_1: Green human capital enhances the adoption of circular economy practices in companies.

and

H_2: Green human capital enhances the sustainable production process of companies.

In this sense, GHC integrates knowledge, skills and competencies of employees regarding environmental and sustainability practices. This type of human capital is crucial for the development and implementation of sustainable innovations, including CE practices.

Regarding the link between GHC and innovation, studies show that employees with sustainability knowledge and skills are more likely to innovate and implement sustainable solutions. GHC can stimulate creativity and innovation within firms, facilitating the adoption of CE practices (Singh et al. 2020; Micheli et al. 2020). To adapt to regulations and market requirements, employees trained in sustainability principles are better able to understand and navigate the complexity of environmental regulations and customer expectations regarding green products. This is essential for companies that want to comply and take advantage of new market opportunities (Maskuroh et al. 2023). At the same time, GHC is formed and contributes to the formation of an organisational culture that values sustainability and ecological responsibility. A firm commitment to these values is crucial to the success of implementing CE practices, as it requires changes at the level of processes, products, and business models (Aftab et al. 2023; Aggarwal and Agarwala 2023). Firms with strong GHC are better prepared to respond to pressure from stakeholders (including customers, suppliers, governments, and NGOs) demanding more sustainable practices. This not only helps maintain a positive public image but can also open up new business opportunities (Ahmad et al. 2015).

In the sense of what has been presented, we can say that the academic literature suggests that there is a strong and positive link between GHC and the ability of companies to successfully implement CE practices, this information is supporting H_1. By investing in the training and development of GHC, firms can improve their ability to innovate, adapt to market changes, and build a sustainable organisational culture, all of which are essential for long-term success in an increasingly CE.

To support the hypothesis (H_2) that GHC positively influences the SP process of companies, we will present a series of arguments from specialised literature.

Studies have shown that employees with skills in the field of sustainability and environmental management are essential for promoting SP. For example, Cabral and Dhar (2019) show that employees with knowledge in the field of natural resource management and energy efficiency are able to identify opportunities to improve production processes and implement innovative solutions to reduce environmental impact.

Another study (Ogbeibu et al. 2021) emphasises the importance of employee commitment and awareness in promoting SP practices. Employees who are motivated and actively involved in environmental initiatives are more likely to adopt responsible behaviours and practices within the production process.

GHC can stimulate innovation and creativity in the production process as employees with sustainability knowledge can contribute to the development and implementation of innovative technologies and practices to reduce resource consumption and waste generation in production processes (Ababneh 2021).

The active involvement of managers and leaders in promoting a sustainability-oriented organisational culture can positively influence the SP process. Several

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studies emphasise the essential role of leadership in facilitating cultural change and implementing SP practices within organisations (Gerard et al. 2017; Iqbal et al. 2020).

These sources highlight the crucial role of GHC in positively influencing the SP process of firms, emphasising the importance of skills, commitment, innovation, and leadership in promoting sustainable development within organisations.

As the CE gains momentum, companies are integrating these principles into their sustainability strategies. CE aims to maintain the economic value of goods and natural resources, reducing waste and minimising environmental impact through the efficient use of resources throughout the life cycle of products. Thus, reusing resources and maintaining their economic value as long as possible become central objectives.

The definition of CE can vary significantly, but a widely accepted perspective is that proposed by Kirchherr et al. (2017), who describe CE as an economic system that eliminates the concept of 'end of life' for products and materials used, promoting their reduction, reuse, recycling, and recovery at micro, meso, and macro levels. The goal is to achieve sustainable development that improves environmental quality, supports economic prosperity, and ensures social equity for present and future generations. Currently, especially against the background of the pandemic that has emphasised the importance of optimising supply chains and reducing waste, the concept of CE is increasingly supported by competent authorities globally. Increasing production capacity and maximising recycling become essential to ensure long-term sustainability. We believe that GL management plays a crucial role in promoting circular CE practices within organisations. GL combines innovative ideas and promotes sustainable development by integrating environmental concerns into logistics processes, such as waste flow management, ecology, reverse logistics, ecological logistics, and recycling logistics. GL can be viewed as a green supply chain management process that integrates the company's environmental concerns with those of suppliers and customers. GL aims to assess the ecological impact of distribution techniques, reduce energy consumption during logistics operations, and efficiently manage waste. Therefore, we can state that:

H_3: GL enhances the adoption of circular economy practices within companies.

Green logistics (GL) and sustainable production (SP). At the time of its emergence, the concept of SP focused on those strategies aimed at protecting the efficiency of natural resources, promoting their responsible use (Repetto 1987). At that time, policy improvements were suggested that would encourage resource conservation, reduce environmental degradation, stimulate economic growth and combat rural poverty. Nowadays, the implementation of SP practices is considered an effective strategy for supply chain management, based on the need for foodservice operators to adapt less harmful compounds to meet consumer demands and minimise negative environmental impact. These practices improve operational efficiency, protect the community and the environment, and generate additional economic benefits. It is argued that GL management is essential for the promotion of SP within manufacturing enterprises, including initiatives to help reduce global environmental impact and promote more responsible and sustainable practices. Therefore, we postulate:

H_4: Green logistics enhances the sustainable production of enterprises.

The implementation of CE practices within companies is positively influenced by SP, as the latter promotes the efficient use of resources, waste reduction, and recycling. SP involves the adoption of innovative technologies and ecological practices that minimise environmental impact and optimise the life cycle of products. By fostering a mindset oriented towards sustainability and environmental responsibility, companies become better able to integrate CE principles such as reuse and recycling into their daily operations, which contributes to a more regenerative economic system. In this sense:

H_5: Sustainable production enhances the adoption of companies' circular economy practices.

Research design. The purpose of this research is to determine the factors that influence the successful implementation of CE practices in Romanian food industry businesses. The general research hypothesis consists of the idea that the successful development of CE practices in the business environment of this country, in the food field, depends on the extent to which a series of approaches are adopted in this process (at the level of the organisation) such as SP, GL and GHC. Based on the theoretical arguments, we adapted a model to capture the impact these approaches have on the development of the CE in the analysed business ecosystem. The investigated conceptual model integrates SP, GL, GHC, and CE practices to explore causal relationships and their level of mutual influence according to the formulated hypotheses H_1–H_5.

Sampling and data collection. For the conduct of this research, we used the empirical investigation based on a quantitative study through the administration of an online questionnaire between February 2023 and

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December 2023. We chose a convenience sample such as contacts from the food business environment, professional associations such as the Association of Entrepreneurs from Romania, and the InBusiness Professional Association, Afaceri.ro, Chambers of Commerce and Industry in the country, expert collaborators but also business owners, and social groups specialised in the analysed field, to which we sent emails to distribute the questionnaire and to persuade the collection of valid answers.

Questionnaire design. The present research design is based on the theory of NRBV and on the model developed by Cheng et al. (2023). We believe that translating and testing a circular economy influence model across industry sectors is logical and strategically justifiable. The basic principles – green human capital formation, sustainable production processes, green logistics and circular vision – can be contextualised according to the specifics of each industry, providing a robust framework for sustainable development and economic resilience (Geissdoerfer et al. 2017; Kirchherr et al. 2017; Ogiemwonyi et al. 2023). Given the differences between Bangladesh's economy and ours, we aimed to assess the model's relevance for an emerging European economy like Romania.

We employed a five-point Likert scale ranging from 1 (indicating minimal extent) to 5 (indicating maximal extent) and adjusted these scales to suit the context of our study, which focused on CE practices. Four main constructs were delineated, namely, green logistics (reflective construct made up of five elements), green human capital (reflective construct made up of five elements), sustainable production (reflective construct made up of four elements), and circular economy practices (construct formative consisting of five elements). These constructs, as shown in Table 1, were included as items in the questionnaire. It was applied online, in Google forms, throughout professional networks in the food industry in Romania.

RESULTS AND DISCUSSION

Evaluation of measurement models. We collected 117 valid responses from company managers from all over the country (M = 31–50 y.o., SD = 11.73). 53.4% of the responding managers have a business experience of over 10 years, 20.7% have a business experience of over 5 years, 12.1% have an experience of over 3 years, 7.8% have a business experience of over 1 year and 6% have less than a year of experience in the food business. 53% of the respondents work in micro-enterprises with fewer than 10 employees. However, respondents from companies with more than 250 employees rank second (17.4%) and 0.9% have over 1 000 employees. The companies with less than 50 employees were classified with a lower percentage, namely 13%, and the remaining 15.7% are companies with 51–249 employees.

Recent methodologies in the field indicate that a medium-sized sample, such as the one analysed (117 companies), may be sufficient for partial least squares structural equation modelling (PLS-SEM) analysis, especially for models with moderate complexity and medium to large effects (e.g. Kock and Hadaya 2018; Hair et al. 2024). This validity depends on factors such as effect size and model complexity, which we calculated to ensure the robustness of the analysis.

Model and hypotheses assessment, as designed in Figure 1, was developed through structural equation modelling using the PLS-SEM method implemented with SmartPLS 3.0 software (SmartPLS GmbH, Germany). We opted for

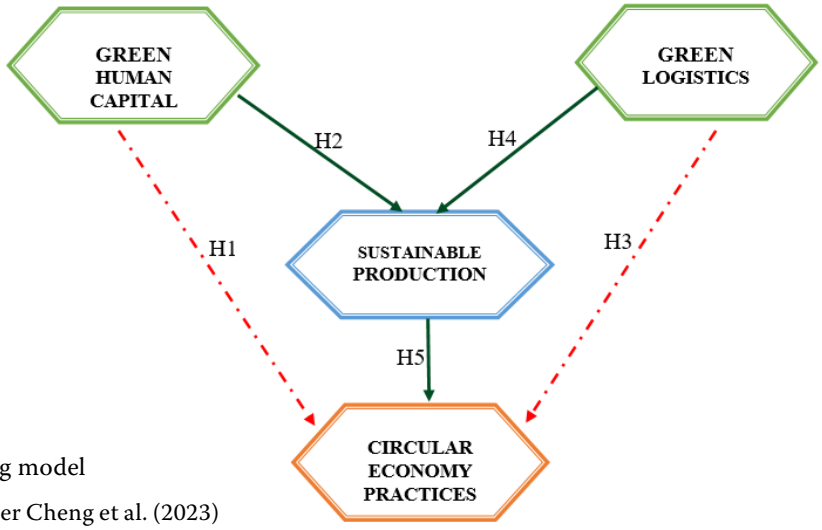

Figure 1. Mediating model

Source: Adapted after Cheng et al. (2023)

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PLS-SEM because of its suitability for analysing models that include both composite and reflective variables.

The hypotheses developed and the proposed model (Figure 1) were analysed using PLS-SEM by means of SmartPLS 3.0. As previously argued, this method was chosen because it is appropriate for structural models that include both composite and reflective constructs, according to the present context (Henseler et al. 2016).

Table 1. Construct reliability and validity

Construct	Item	Measure	Factor loadings	Cronbach's Alpha	*CR*	*AVE*	Sources
Circular economy (CE)	CE1	the company is dedicated to reducing manual labour per product	0.823	0.788	0.855	0.546	Kirchherr et al. 2017; Ghisellini and Ulgiati, 2020; Singh and Ordonez 2016; Cheng et al. 2023; Xie et al. 2021; Ghisellini et al. 2016; Geissdoerfer et al. 2017
	CE2	the company is dedicated to reducing the consumption of raw materials and energy	0.829	–	–	–	
	CE3	product packaging materials are used repeatedly	0.577	–	–	–	
	CE4	the remaining material is used repeatedly to make other products	0.649	–	–	–	
	CE5	the waste produced in the manufacturing process is recycled	0.782	–	–	–	
Sustainable production (SP)	SP1	we use cleaner energy during production processes	0.706	0.837	0.889	0.667	Cabral and Dhar 2019; Ogbeibu et al. 2021; Ababneh, 2021; Gerard et al. 2017; Iqbal et al. 2020; Cheng et al. 2023
	SP2	production technology and environmentally friendly production processes are a priority	0.836	–	–	–	
	SP3	we ensure energy efficiency during the production process	0.866	–	–	–	
	SP4	the company designs/optimises ways to recycle waste and spare parts	0.851	–	–	–	
Green logistics (GL)	GL1	environmental education, monitoring and evaluation	0.833	0.893	0.921	0.701	Liu et al. 2018; Seroka-Stolka and Ociepa-Kubicka 2019; Agrawal et al. 2023; Cheng et al. 2023; Maskuroh et al. 2023; Micheli et al. 2020
	GL2	ecological transport and distribution	0.878	–	–	–	
	GL3	ecological storage and ecological packaging	0.841	–	–	–	
	GL4	waste management and recycling	0.821	–	–	–	
	GL5	sustainable logistics information system	0.811	–	–	–	
Green human capital (GHC)	GHC1	contribution to environmental protection of employees	0.896	0.925	0.944	0.771	Maskuroh et al. 2023; Cheng et al. 2023; Singh et al. 2020; Micheli et al. 2020; Ahmad et al. 2015; Shoaib et al. 2021
	GHC2	competence of employees regarding environmental protection	0.881	–	–	–	
	GHC3	the qualities of the environmental protection product and/or service offered by our employees	0.874	–	–	–	
	GHC4	the amount of collaborative work in the team	0.919	–	–	–	
	GHC5	leadership supports employees to achieve their environmental protection goals	0.816	–	–	–	

Factor loading > 0.7; Cronbach's alpha > 0.7; *AVE* > 0.5; *CR* > 0.7; *AVE* – average variance extracted;
Source: Author's elaboration

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Table 1 presents item loading values, average variance extracted (AVE), reliability indicators, and discriminant validity, to verify the validity and internal consistency of all reflective constructs. Loading values exceed the minimum threshold of 0.70, indicating convergent validity of all measured items. In this study, the values range between 0.706 and 0.919, meeting the established criteria. The reliability of the model was confirmed by Cronbach's alpha coefficient, with all values above 0.7, which makes them acceptable for confirmatory purposes (Henseler et al. 2016). AVE values are greater than 0.5, indicating an adequate model (Chin 1998) and supporting the convergent validity of the constructs. Therefore, the reliability of the constructs was confirmed by composite reliability (CR), with all composite values exceeding the threshold of 0.7 (Hair et al. 2024).

The Fornell–Larcker and the Heterotrait–Monotrait (HTMT) criteria were used to assess the discriminant validity of each construct, the results being shown in Tables 2 and 3. To avoid confusion between similar constructs, we applied the HTMT criteria, and the AVE value for each latent variable must exceed the coefficient of correlation between that variable and all other distinct variables, according to the Fornell-Larcker criterion. Discriminant validity was confirmed in this study, with all construct values below the 0.9 threshold (Table 3), according to the HTMT criteria (Henseler et al. 2016). At this stage, we also evaluated the collinearity of the data. The maximum value of 4.328 for the GHC4 element indicates the absence of multicollinearity in the data set, and the variance inflation factor (VIF) values for all indicators are below 5, a threshold considered acceptable for collinearity analysis (Sarstedt et al. 2019). To test hypotheses and relationships between latent variables, we used a bootstrap procedure with 5 000 subsamples (Hair et al. 2024). Based on the value obtained for the *t*-statistic, we can state that a significant and positive relationship is demonstrated, and four hypotheses are confirmed.

Evaluation of structural model. To comprehensively evaluate the structural model, we analysed the collinearity of the constructs. The root mean square residual (SRMR) value of 0.081 meets the recommended criterion of < 0.010, indicating an acceptable goodness of fit for the model. Additionally, the highest variance inflation factor (VIF) value within the internal model is 2.615 (GHC → SP), which is below the indicated threshold. This confirms that there is no multicollinearity between the constructs.

As shown by the numbers in Figure 2, GL, GHC, and SP explain 61.6% of the variation in CE (R^2 = 0.616), while GHC explains 39.4% of the variation in SP (R^2 = 0.394). Table 5 contains the arguments for the statistical validation of four out of the five hypotheses, representing the results of testing the inferred relationships between the constructs of the analysed model.

Table 2. Discriminant validity analyses (Fornell-Larcker)

Construct	CE	GHC	GL	SP
Fornell-Larcker				
CE	0.739	–	–	–
GHC	0.626	0.878	–	–
GL	0.594	0.791	0.837	–
SP	0.729	0.627	0.486	0.817

CE – circular economy; GHC – green human capital; GL – green logistics; SP – sustainable production
Source: Author's elaboration

Table 3. Discriminant validity analyses – Heterotrait-Monotrait (HTMT)

Construct	CE	GHC	GL	SP
Heterotrait-Monotrait (HTMT)				
CE	–	–	–	–
GHC	0.720	–	–	–
GL	0.690	0.872	–	–
SP	0.859	0.667	0.522	–

CE – circular economy; GHC – green human capital; GL – green logistics; SP – sustainable production
Source: Author's elaboration

The Q^2 statistic illustrates the predictive relevance of the endogenous components, where a value exceeding 0 signifies their predictive importance. The values, specifically Q^2 SP = 0.236 and Q^2 CE = 0.286, indicate significant predictive relevance for the components examined in this study (Table 5). Additionally, model fit was assessed through SRMR PLS-SEM, revealing an SRMR value of 0.081. This value is under the 0.10 threshold, indicating an acceptable model fit.

Table 4 shows a moderate positive effect between GHC and CE, indicates employees' motivation to support circular economy practices (β = 0.045; *t*-value = 0.266;

Table 5. Predictive power of the model

Predictive power of the model		
Constructs	R^2	Q^2
Sustainable production	0.394	0.236
Circular economy	0.616	0.286

Source: Author's elaboration

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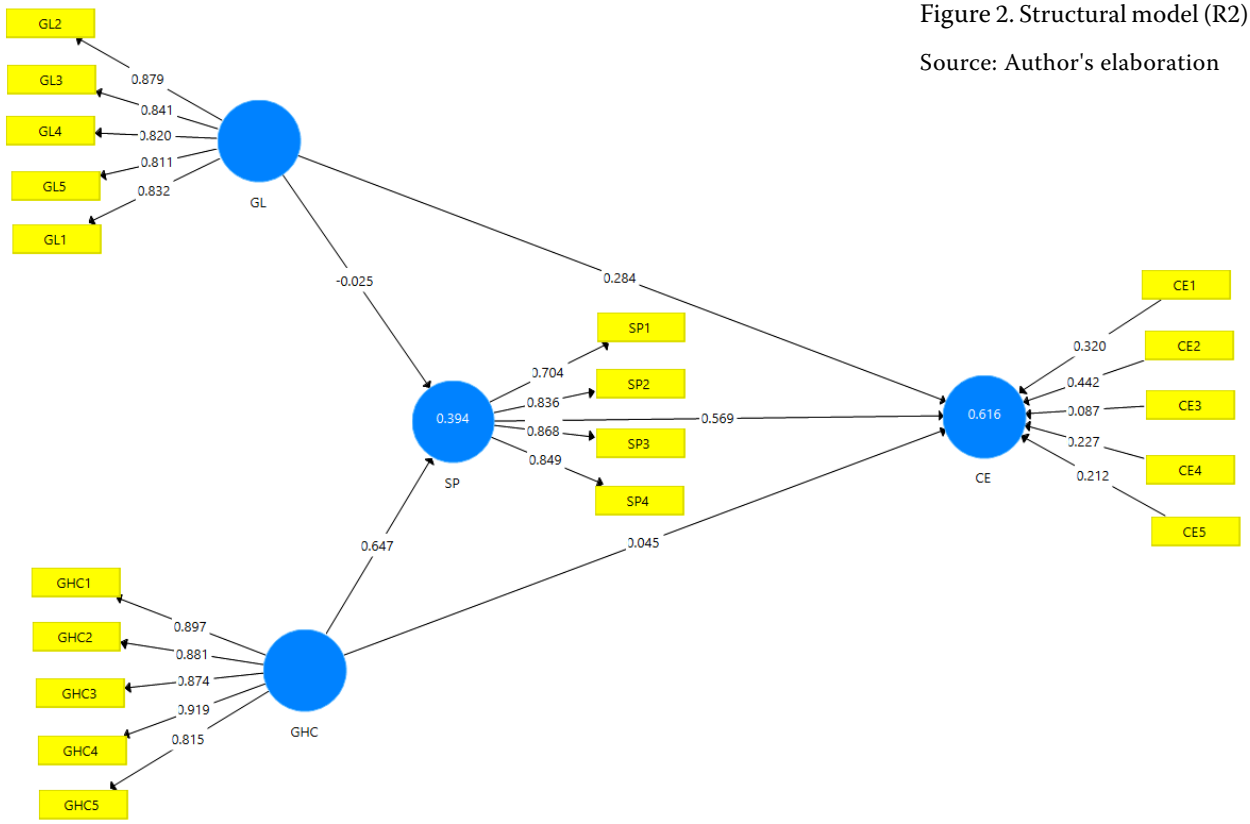

Figure 2. Structural model (R2)

Source: Author's elaboration

P < 0.001), thus H_1 is supported. For H_2, which posits a strong positive influence of GHC on circular economy implementation, the results confirm a significant relationship (β = 0.647; t-value = 5.921; P < 0.001), validating this hypothesis. H_3 reveals a positive effect of GL on CE. The findings (β = 0.284; t-value = 2.162; P < 0.031) confirm this relationship, showing that GL significantly enhances the adoption of circular economy practices, supporting H_3.

Regarding H_4, it assumed that GL influences SP practices. In this case, the results (β = –0.025; t-value = 0.197; P = 0.846) show that there is no relevant relationship between these constructs; therefore, H_4 is rejected. Finally, H_5 assumed that SP enhances the adoption of companies' circular economy practices. The results (β = 0.569; t-value = 6.298; P < 0.001) demonstrate a positive and strongly significant relationship, so we can accept H_5.

Interpretation of hypotheses. Companies need to improve their sustainability practices and performance to achieve national sustainable development goals (SDGs). To support the CE, many companies are implementing green and sustainable methods, including integrating green supply chain management into their operations. An essential role in accelerating the CE is played by GL management.

For the success of green and sustainability programs, human resources are also crucial. Our study explores the impact of managing GL and GHC for the implementation of CE practices through SP using natural resource theory (NRBV) and dynamic capabilities theory (DCT). PLS-SEM analysis reveals direct and mediating relationships between these elements, providing valuable insights for the literature in the framework of emerging economies.

Recent studies also support de validation of H_1 – that GHC management, such as recruitment, selection, training, and rewards (to motivate green behaviour), have a positive impact on the implementation of circular economy practices (Cvijović 2023). In the same sense, perspective of Punia et al. (2023) shows that investment in green human capital is crucial for the promotion and successful implementation of circular economy practices within companies.

Through H_2 we analysed the relationship between GHC and SP in the model and found that this hypothesis is confirmed, showing impressive results. Theoretically, the link between GHC and SP is supported by human resource theory, which emphasises the role of employees' skills and knowledge in the adoption of innovative and sustainable practices (Singh

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Table 4. Path coefficients of the structural equation model

Paths	Path coefficients β	SD	*t*-value	CI	*P*-value	Hypotheses
GHC → CE	0.045	0.169	0.266	0.295–0.367	0.790	H_1 – supported
GHC → SP	0.647	0.109	5.921	0.427–0.855	0.000***	H_2 – supported
GL → CE	0.284	0.131	2.162	0.052–0.556	0.031**	H_3 – supported
GL → SP	–0.025	–0.128	0.195	–0.262–0.246	0.846 n.s.	H_4 – not supported
SP → CE	0.569	0.090	6.298	0.390–0.748	0.000***	H_5 – supported

** and ***significance at 0.01 and 0.001 levels, respectively; CI: confidence interval (2.5%–97.5%)
CE – circular economy; GHC – green human capital; GL – green logistics; n.s. – not significant; SP – sustainable production
Source: Author's elaboration

et al. 2020). For example, companies like IKEA and Etsy have demonstrated how investing in employee training on sustainability topics can lead to the effective implementation of circular economy practices, such as waste reduction and resource efficiency (Edvardsson and Enquist 2008; Lingenfelter and Cohen 2019). These cases practically illustrate the positive influence of GHC on SP, confirming the hypothesis and demonstrating its applicability in real business contexts. Thus, we can deduce that the organisational strategies that potentiate the relationship between GHC and SP include the development of sustainability skills, investment in continuous employee training, encouraging green innovation, and adopting ecological work practices. These strategies can drive increased commitment to sustainability goals, improve operational efficiency, and drive manufacturing innovation. The successful implementation of these strategies requires a holistic approach, integrating sustainability into the organisational culture and business processes (Ahmad 2015; Singh et al. 2020; Aftab et al. 2023; Aggarwal and Agarwala 2023).

In the first instance, the research emphasises the significant impact of GL on the improvement of companies' practices towards a CE, aligning with the 3R principle (reduce, reuse, recycle) (Liu et al. 2018; Seroka-Stolka and Ociepa-Kubicka 2019). Key components such as green transport, packaging, and storage play crucial roles in minimising material use and promoting recycling (Letunovska et al. 2023). Moreover, the study emphasises that GL management predicts the transition of firms towards SP, emphasising the importance of integrating green practices in logistics to favour SP (Micheli et al. 2020; Agrawal et al. 2023; Maskuroh et al. 2023). This is consistent with previous research linking GL management to sustainable manufacturing outcomes thus supporting hypothesis H_3.

On hypothesis H_4, the literature highlights mixed perspectives on the influence GL on SP in enterprises. In one of these studies, on the organic production industry (Setyadi et al. 2023) the results showed that GL does not have a significant impact on SP, suggesting that the implementation of green logistics practices does not necessarily lead to improvements in sustainable production. Meghișan-Toma et al. (2022) emphasise that green performance has a positive impact on green production and digitalisation in Romanian companies, without mentioning the influence of green logistics on these aspects. These findings indicate that although green logistics aims to reduce the environmental impact of logistics activities, it does not directly influence the sustainable production practices of enterprises.

Hypothesis H_5, according to which SP improves the adoption of CE practices in companies, is supported by recent publications throughout arguments like the integration of circular economy principles and sustainability metrics in modern production is crucial (Cheng et al. 2023; Shaikh et al. 2024). Another perspective highlights that the transformation from a linear to a circular economy reduces waste and improves resource efficiency by implementing recycling, reuse, and repair cycles, demonstrating the positive impact of sustainable production on circular economy practices (Saari et al. 2024). For example, an analysis of Taiwan Sugar Company's efforts to redesign its production process-

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es, develop closed-loop systems, and promote resource efficiency demonstrated a close link between sustainable production and the adoption of circular economy practices (Sah and Hong 2024). These studies demonstrate that sustainable production plays a crucial role in facilitating and improving the adoption of circular economy practices within companies, thus supporting the validity of hypothesis H_5.

CONCLUSION

Theoretical contributions. This study addresses some important gaps in the literature, exploring the relationships between ecological practices and the CE in the context of developing countries, such as Romania. The results underline the universal applicability of NRBV theory and emphasise the crucial role of GHC in facilitating CE activities. By identifying a mediating relationship between SP and CE, the research contributes to the understanding of how SP practices can amplify the positive effects of GL and GHC on the CE.

Throughout this empirical research the theoretical model explains 61.6% of the variability of CE according to the analysed components (R^2 = 0.616), providing a robust theoretical framework for future research examining the synergistic interactions between green supply chain factors and human resources in the context of sustainable and circular practices. These findings suggest that GL, although moderately influential on CE, requires more rigorous integration to effectively contribute to SP, thus underscoring the need for a holistic and integrated approach to achieve CE goals. The research adds significant value to the literature by providing a different perspective on the synergistic impact of GL, GHC, and SP components in achieving circular economy practices, especially in the context of emerging economies.

Practical contributions. The results of this study have significant practical implications, particularly for the European food sector, where global companies are leaders in adopting sustainable practices. The research reveals key links between the components of the circular economy, in Romanian food industry, like integrating green supply chain management initiatives and green HR practices into daily operations can enhance organisations' competitiveness and facilitate effective CE implementation. Although the study indicates that GL has a moderate influence on CE, highlighting the need for better-integrated strategies, GHC demonstrates a strong and significant influence on CE and SP. This highlights the importance of developing green human skills for the long-term success of organisations in a CE.

The practical implementation of the study results is exemplified by the sustainability initiatives of renowned companies, such as the reduction of the carbon footprint through biodegradable packaging and the efficient management of resources. The study recommends the adoption of green practices by stakeholders and the development of dynamic capabilities such as GHC to improve resource efficiency and support the transition to a circular economy. The examples provided by famous global companies in terms of reducing food waste and using recyclable packaging highlight the need to integrate social responsibility into daily operations, thus advancing the goals of the circular economy.

In conclusion, the study highlights that the adoption of sustainable practices in food and other industries can bring substantial benefits, contributing to corporate sustainability and resource efficiency. This approach provides a cost-effective method for transforming linear economic models into circular ones, addressing resource scarcity issues, and increasing firm value. While the findings provide valuable insights into the Romanian context, situated within Southeast Europe, they remain specific to the study's scope and cannot be generalised. The research findings encourage foodservice operators to integrate more GL and develop dynamic capabilities such as GHC to ensure success in the CE.

Future research perspectives. Future extensions of this research theme can be made in the direction of exploring the relationships between GL, GHC, SP and CE in different types of companies, especially global companies, with the aim of comparing them with the findings based mainly on SMEs in this research.

A considerably broader research perspective that would bring additional knowledge would be comparative studies between countries with different economic, cultural and regulatory environments that could provide deeper insights into how regional factors influence the integration of GHC and GL into CE practices. Such investigations would provide a broader understanding of the dynamics and scalability of these sustainable strategies in various contexts.

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