GREEN LOGISTICS IN BIHOR COUNTY

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ABSTRACT
With the advent of green logistics and green practices in supply chains, it is an opportune time to identify the green logistics' practices in supply chains. This research employs a transversal analysis using a local dataset of Romanian Companies, analyzing the impact of green logistics' practices on environmental performance. Present research employes structural equation analysis using SmartPLS statistical software. We have documented that, while reverse logistics, green purchasing, eco-labels and cooperation with suppliers have a positive influence on environmental practices, further investment is needed in environmental innovation and collaboration with customers for improving environmental performance. Results shows are encouraging insofar as they show that green practices in supply chains do have the potential to reduce pollution and thus contribute to the objectives set by the European Green Deal Strategy.

KEYWORDS: *environmental performance, European Green Deal, green logistics, green supply chains, structural equations.*

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1. INTRODUCTION

With the war in Ukraine and the subsequent gas crisis, the progresses towards the goals set by the European Green Deal are being challenged, as the switch from coal to gas for power generation has been considered previously a driver of the greenhouse gas reduction in EU (EEA, 2021). Generalized disruptions of the economies in the aftermath of COVID-19 crisis (Dodescu et al., 2021) and an unprecedented global energy crisis as reveled by the annual report of the International Energy Agency (EEA, 2021) provides additional motivation to reconsider the link between logistics and environmental protection in Romania. The present study contributes to the literature in the field, filling the gap concerning the green logistics practices in Bihor County and their contribution to environmental performance. Although important contributions have been made by existing studies in the field, we are striving to augment the empirical studies in the filed by proposing a structural equations model of environmental performances as a function of green logistics practices implemented by organizations in Bihor County. Present research is, to the best of our knowledge, the first one to investigate the impact of the European long-term strategy for decarbonization on logistics practices of companies. Although the working dataset used in this study employs local organizations, policy implication of present research extends beyond boundaries, as documenting the difficulties facing by organizations in a less developed EU member state better informs the

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sustainability dimension of the European Green Deal decarbonization strategy laid down at EU level for all member states.

This research is structured as follows: Section 2 presents the existing literature in the field. After overviewing the European Green Deal strategy, section 2 continues with a review of green logistics practices as depicted in the literature in the field. Section 3 considers the research framework, hypotheses, method and data. Section 4 presents the results of our empirical estimation. Section 5 discusses the results and presents clues for further research.

2. LITERATURE REVIEW

2.1 Logistics and European Green Deal

According to the European Environment Agency, reducing greenhouse gas emissions alleviates the negative impact of climate change. Consequently, the EU has put forward an ambitious environmental agenda. The greenhouse gas emission targets set under the Paris agreement have been revises in 2021, when the European Green Deal committed to at least 55% reduction by 2030 and climate neutrality by 2050 (European Commission, n.d.).

European Environment Agency shows that EU is one of the biggest greenhouse gases pollutants in the world (EEA, 2021). Climate change is impacting Europe, affecting people's health, inflicting losses to biodiversity while carbon losses to agriculture are ranging from wildfires to floodings (Gillingham and Stock, 2018). However, data on greenhouse gas emission at EU level shows encouraging results, with greenhouse gas emission reaching 66% of the1990' level (EEA, 2021).

Neagu & Teodoru (2019) argue that the main contributor to decreasing pollution in EU is the restructuring in the EU economies. A switch from coal to gas for power generation and improvements in energy efficiency are also considered the main drivers of greenhouse gas reduction in EU (EEA, 2021).

The objectives set by the European Green strategy are achievable; although requiring high investments, a net-zero Europe is foreseeable, provided that the costs are paid by the population (McKinsey Company, 2019). The same report shows that the transportation sector is the second largest contributor to CO2 emissions within the EU (3600 MtCO2 2017), with passenger cars accounting for approximately 60% of sector' emissions, followed by truck with 35% and railways and aviation with 5%. McKinsey Company, (2019) estimates that the transportation sector is expected to approach the long-term objective of carbon neutrality by 2045 (McKinsey Company, 2019). Replacing petroleum-based cars with EV lies at the heart of EU' strategy to achieve decarbonization in the transportation sector. The main challenge to this goal would be setting up the supply chains required for getting the row material, production of batteries and assembly of EV's. However, the same report acknowledges that transportation for commodities will still rely on traditional combustion-based engines to power up larger vehicles, aircrafts and maritime carriers. Consequently, increasing the energy efficiency in commodity transportation is considered paramount for decarbonization of the overall transportation sector.

2.2 Green supply chain management

Environmental considerations have been paramount to the entire logistics sector (Constăngioară & Florian, 2022; Murphy & Poist, 2003). Starting with Handfield et al. (1997), Green supply chain management (GSCM) and green logistics emerged, targeting not only transportation but all logistics activities. Hervani, Helms and Sarkis (2005) explicitly considers that Green Supply Chain Management focuses on green purchasing, production, material management distribution and marketing. Sheu et al. (2005) add to traditional supply chain processes those specific to inverse logistics. Srivastava (2007) considers that GSCM should consider the entire life span of products. Albino, Balice and Dangelico (2009) and Gavronski et al. (2011) focus on the strategic issues of GSCM. Srivastava (2007) points out that GSCM focuses on the management of logistics flows at supply chain level. Parmigiani, Klassen and Russo (2011) underline that literature in the field focuses on minimizing the negative impact of logistics on the environment while still striving for economic performance. Nevertheless, slowly the balance is shifting toward environmental protection, as noted by Andiç, Yurt and Baltacioğlu (2012).

Islam et al. (2017) summarize the green practices specific to GSCM, which they are grouping in 11 categories, depicting three organizational dimensions (organizational performances, operations management and technological innovation).

In the paper we propose an empirical study using a dataset of companies with operations in Bihor County, Romania. After identifying the green logistics' practices of companies in the sample, we focus on analyzing the relationship between them and organizational performance. To this extent we are using a structural equation approach, underlining the benefits of each category of green logistics' practices on organizational performance.

3. METHOD

3.1 Research framework

We rely on research of Islam et al. (2017) to build the questionnaire used to identify the green logistics' practices employed by companies in Bihor County. Out of the eleven categories proposed by the above-mentioned research, we have chosen seven categories:

(a) Green purchasing
(b) Reverse logistics
(c) Eco-design
(d) Environmental innovation
(e) Cooperation with customers
(f) Cooperation with suppliers
(g) Environmental performance

Internal environmental management (Environmental management systems - ISO 14001 certification, TQM centered on environmental protection, environmentally correct inputs, ecolabels), Investment recovery (recovery of company equipment at end of lifecycle, sale of scrap and leftovers), green compliance and green marketing have not been investigated in present research.

Thus, we propose a structural equations model with six first order latent constructs used to measure the green logistics practices. Additionally, a first order latent variable was used to measure the environmental performance. According to the proposed conceptual model (Figure 1), green logistics' practices do have a direct impact on environmental performance.

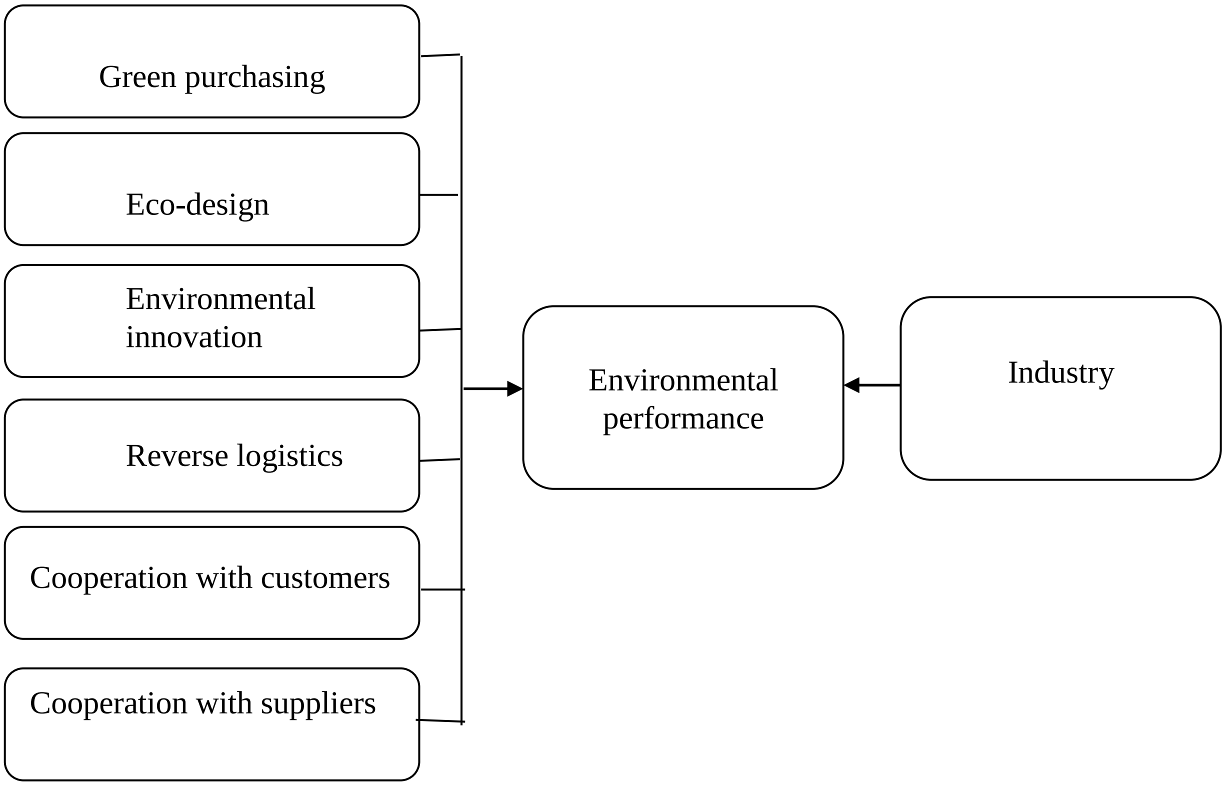

Figure 1. Proposed research framework

Based on Islam et al. (2017) we formulate our research hypothesis: *The green practices do have a positive impact on environmental performance.*

3.2 Data and methodology

The proposed empirical research uses a Romanian dataset concerning the green logistics' practices of companies in Bihor County. Data was collected through a questionnaire administered in the autumn of 2022. Analysis was conducted with SmartPLS statistical package. Our survey targeted senior level executives. The working sample consists of 50 observations. The latent constructs used in this research are based on Islam et al. (2017). A total of six items were employed to measure green practices of organizations in Bihor County. One construct was used to measure environmental performance.

The items used to measure green purchasing (GP) practices were:

- Using environmentally friendly row materials (GP1);
- Informing customers on minimizing the environmental impact (GP2);
- Quality standards for row materials (GP3);
- Green purchasing (GP4),

For measuring the Eco-design (ED) practices, we have employed the following indicator variables:

- Optimizing design of products to reduce energy consumption (ED1);
- Recycling (ED2);
- Optimizing design of products to eliminate dangerous components (ED3);
- Design of environmentally friendly products (ED4).

For measuring environmental innovation (EI), we have used the following items:
- R&D to achieve environmental objectives (EI1);
- Investment to achieve the environmental requirements of customers (EI2);
- Use green energy (EI3);
- Promote environmental awareness (EI4).

Reverse logistics (RL) practices were measured using the following items:
- Reverse logistic (RL1);
- Recycling practices (RL2);
- Dispose products at end-of-life cycle (RL3);
- Reverse logistics for packaging (RL4);

Cooperation with customers (CC) was measured using four items suggested also by Islam et al. (2017):
- Cooperation with customers for developing environmentally friendly products (CC1);
- Cooperation with customers for using clean energy in production (CC2) ;
- Cooperation with customers for using less polluting transportation (CC3);
- Cooperation with customers for inverse logistics (CC4).

For measuring the cooperation with suppliers (CS), we have employed the following indicator variables:
- Cooperation with suppliers for developing environmentally friendly products (CS1);
- Cooperation with suppliers for using clean energy in production (CS2);
- Cooperation with suppliers for using less polluting transportation (CS3);
- Cooperation with suppliers for inverse logistics (CS4).

Environmental performance (EP)is also a latent variable, measured using the following items:
- Measuring the environmental performance (EP1);
- Developing adequate performance metrics (EP2);
- Integrating system of reporting economic and environmental performance. (EP3)

A 5 items Likert-type scale with answers from 1 = "strongly disagree" to 5 = "strongly agree" was used to measure Green purchase, Eco-design, Environmental innovation, Reverse logistics, Cooperation with Customers and Cooperation with suppliers. Also a 5 items Likert-type scale was employed for measuring environmental performance, with possible answers ranging from 1= "poor" to 5=" very strong".

As required by similar research in the field (Constăngioară, 2016), we first have conducted a review of existing literature to ensure the substantive and content validity of the scales. In obtaining our latent constructs we have used a reflexive approach and, consequently, assessed the indicator reliability, convergent reliability, internal consistency and discriminant validity of the constructs employed in the analysis.

In the second stage, to test our research hypothesis, we have conducted a structural equations analysis, using SmartPLS statistical software. Our choice for a PLS approach to structural equations modelling was based on its ability to handle small samples (Hair et al., 2012) which becomes relevant in our case. Additionally, SmartPLS provides a friendly interface and a comprehensive suite of tests for measuring the adequacy of the scale.

4. RESULTS

4.1 Measurement model assessment

As shown in Table 1, the exploratory model shows that all factor loadings are above the 0.5 threshold required for the indicator reliability condition (Hulland, 1999).

Table 1. Factor loadings

	Cooperation with customers (CC)	Cooperation with suppliers (CS)	Eco-design (ED)	Environmental Innovation (EI)	Environmental performance (EP)	Green Purchasing (GP)	Reverse Logistics (RL)
CC1	0.707***						
CC2	0.827***						
CC3	0.815***						
CC4	0.626***						
CS1		0.786***					
CS2		0.822***					
CS3		0.653***					
CS4		0.783***					
ED1			0.777***				
ED2			0.829***				
ED3			0.705***				
ED4			0.606***				
EI1				0.874***			
EI2				0.853***			
EI3				0.922***			
EI4				0.84***			
EP1					0.859***		
EP2					0.843***		
EP3					0.867***		
GP1						0.782***	
GP2						0.883***	
GP3						0.843***	
GP4						0.854***	
RL1							0.812***
RL2							0.877***
RL3							0.887***
RL4							0.425***

Note:*p<0.1, **p<0.05, ***p<0.01

Table 1 also shows that all the factor loadings are statistically significant.

Cronbach's alpha and rho_a are provided by SmartPLS statistical software. In our case, both are above the 0.7 threshold for all constructs (Table 2). Composite reliability (CR) is above the 0.7 threshold indicated by Gefen et al. (2000). All values of Average Variance Extracted (AVE) are greater than the threshold level of 0.5 suggested by Bagozzi & Yi, (1988), confirming convergent reliability.

Thus, as table 2 shows, analysis confirms construct reliability and validity. For assessing the discriminant validity, we are using both Heterotrait – Monotrait Ratio (HTMT) Matrix and the Fornell-Larcker criterion. If the HTMT value is below 0.90, discriminant validity is confirmed (Henseler et., 2014), which is true for all cases (Table 3).

Table 2. Construct reliability and validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Cooperation with customers	0.749	0.734	0.834	0.56
Cooperation with suppliers	0.76	0.77	0.848	0.583
Eco-design	0.728	0.764	0.822	0.539
Environmental Innovation	0.898	0.923	0.927	0.762
Environmental performance	0.819	0.824	0.892	0.734
Green Purchasing	0.863	0.885	0.906	0.708
Reverse Logistics	0.761	0.847	0.849	0.599

Table. 3. Discriminant validity – Heterotrait – Monotrait Ratio (HTMT) Matrix

	Cooperation with customers	Cooperation with suppliers	Eco Design	Environmental Innovation	Environmental performance	Green Purchasing	Reverse Logistics
Cooperation with customers							
Cooperation with suppliers	0.179						
Eco-design	0.394	0.199					
Environmental Innovation	0.108	0.093	0.167				
Environmental performance	0.353	0.37	0.489	0.154			
Green Purchasing	0.447	0.114	0.415	0.181	0.243		
Reverse Logistics	0.505	0.435	0.535	0.145	0.695	0.669	

In Table 4, on the principal diagonal we find the square root of the AVE of each construct.

Table 4. Discriminant validity – Fornell Larcker criterion

	Cooperation with customers	Cooperation with suppliers	Eco Design	Environmental Innovation	Environmental performance	Green Purchasing	Reverse Logistics
Cooperation with customers	0.748						
Cooperation with suppliers	0.133	0.764					
Eco-design	0.281	0.162	0.734				
Environmental Innovation	0.065	0.04	0.125	0.873			
Environmental performance	0.309	0.296	0.412	0.139	0.857		
Green Purchasing	0.358	0.074	0.309	0.16	0.211	0.841	
Reverse Logistics	0.388	0.343	0.408	0.078	0.575	0.433	0.774

As table 4 shows, the values on the principal diagonal are greater than the correlation between the respective latent construct and any other construct. Consequently, the Fornell-Larcker criterion also indicates discriminant validity.

4.1 Measurement model assessment

To investigate our research hypothesis, we have employed a structural equations' estimation. Results are presented in table 5.

Table 5. Results of the structural estimation

	Std Beta	T statistics	P values
Cooperation with customers -> Environmental performance	0.091 *	1.823	0.068
Cooperation with suppliers -> Environmental performance	0.097**	2.212	0.027
Eco-design -> Environmental performance	0.205***	3.898	0.000
Environmental Innovation -> Environmental performance	0.084*	1.81	0.070
Green Purchasing -> Environmental performance	0.105**	2.497	0.013
Reverse Logistics -> Environmental performance	0.461***	9.272	0.000

Note: *p<0.1, **p<0.05, ***p<0.01

As shown in Table 5, estimates corresponding to Cooperation with customers and Environmental innovation display a week statistical significance. All other coefficients are strongly significant.

5. CONCLUSIONS

As indicated in table 5, empirical results do support our research hypothesis that green logistics practices are positively contributing to environmental performances. Similar results have been reported in existing studies in the field (Constăngioară & Florian, 2022). Yet we must acknowledge that, according to our data, Cooperation with customers and Environmental Innovations are not recognized as contributors to environmental performance. This result is worrying, as it provides first evidence for failure of investing in environmental innovations in EU less developed regions.

Also results suggest that organizations in Bihor County are not investing enough in cooperation with customers for developing environmentally friendly products and finding less-polluting ways to distribute them. However, it is noteworthy that we have found evidence for the contribution made by the cooperations with suppliers in achieving the environmental goals set by the companies in Bihor County. Thus, cooperation with suppliers for developing environmentally friendly products, using cleaner energy sources, finding fewer polluting solutions for transportation and better ways for implementing reverse logistics have been found in present research to statistically contribute to environmental performance. Moreover, reverse logistics, waste disposal and recycling also contribute to environmental performance. Green purchasing and eco-labels also bring their contribution to increase environmental performance.

We underline that the progress towards environmental performance in logistics also provides evidence for the contribution of logistics in general and transportation in particular to improve the quality of the environment and thus to support the objectives set by the European Green Deal. However, as pointed out previously, further investment is needed in environmental innovation and involving customers in green projects. As noted in our previous research in the field (Constăngioară

& Florian, 2022), further investment in green innovation at supply chain level will contribute to increasing environmental performance and reduce greenhouse gas emissions attributable to logistics.

We intend to further analyze the logistics green practices and extend the structural analysis towards the network of relationships linking green logistics practices and environmental performance with organizational performance. A continuation of our study would allow us to better document the green practices at national level and to better inform policymakers on the relationship between green logistics and organizational performance.

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