CONFERENCE PROCEEDINGS/FULL PAPERS
ISBN: 978-625-97566-5-3/May 2025

"39th RSEP International Conference on Economics, Finance and Business, 18-19 April 2025, HCC. ST. MORITZ HOTEL, Barcelona, Spain"

Circular economy and industry 4.0 integration in SME sector: An open and responsible research and innovation perspective for stakeholder's collaboration to enhance social, economic and environmental performance

Kriselda Sulcaj Gura
Department of Economy and Business, Beder University, Tirana, Albania
kriseldasulcaj@gmail.com

Servet Gura
Department of Marketing, University of Tirana, Tirana, Albania
servetgurra@gmail.com

Fatma Guri
Department of Economy and Rural Development Policies/Agricultural University of Tirana
fatmirguri@ubt.edu.al

DOI: https://doi.org/10.19275/RSEPCONFERENCES348

Abstract

Developing economies are characterized by fragmented incentives towards any systemic or structural change. In those contexts, different actors show preliminary attempts toward systemic shifts like Circular Economy, SMEs among others. Recognizing the fact that those firms may not possess adequate resources and proper infrastructure to develop those practices alone open innovation approach is advocated. Open innovation involves different functional process which rely on the collaboration of stakeholders, for this reason this study aims to analyze how different forms of collaboration can contribute in proper implementation of CE and industry 4.0 in SME sector through open and responsible research and innovation processes. Focusing on process of the shift of SME sector towards CE, this research aims to evaluate how those firms "internalize-externalize the innovation" and know-how, and; expand their market to turn this innovation into higher profits considering the sensitivity towards the environmental, social and economic issues. Considering the Albanian cases this study comprehensively tackle how multi-faceted collaboration can deeply amplify innovative ideas and decomposes/simply the complex challenges of sustainable development. The data collected through licert scale questionnaire are analyses and synthetized using SPSS v24 for the description and Amos v24 for CFA and SEM (Semi-structural Equation Modeling) analysis. Interestingly the main result is that technological innovation capacity has higher impact on the CE implementation capacity than the CE innovation capability itself and as assumed open and responsible research and innovation has significant impact in CE implementation. Finally, a good implementation of CE results in increased performance of environmental, social and economic performance of SME sector in Albania. The novelty of the study consist on the measurement of the effect Open and Responsible Research and Innovation has CE implementation and the study recommends further analysis regarding value creation for self and value creation for others.

Keywords: CE, Industry 4.0, open and responsible innovation, sustainable development
Jel codes: L10

1. Introduction

Circular Economy (CE) and Industry 4.0 (I4.0) appeared in the age of massive consumption and production as a joint perspective resulting in a synergistic effect for the sustainability of production economics and efficient operations management (de Sousa Jabbour, 2022). The main assumption after the CE emerged is that, it can be enabled through the adoption of I4.0 to improve the sustainability. This tight connection is analyzed from the conceptual perspective (Rosa et al., 2020) or exploratory perspective (Rajput and Singh, 2019; Nascimento et al., 2019). Notably, today's transition that manufacturing process has undergone through the synergy of CE and I4.0 has improved not only the economic pillar but also the environmental sustainability (Hancevic, 2016). As a result, green innovation has been the main element which has improved the SMEs performance in reduction of ecological footprint (Li and We, 2019). Bossle et al. (2016) highlights the challenges in adopting the green innovation to integrate it on their business. As a solution to this Yang and Roh (2019) propose the open innovation, which link them up with their competitors and use their assets to promote open innovation that is internal or externally sourced and also participates in setting up innovation hubs with other firms to improve the manufacturing process. This process policy enhances SMEs competitiveness and make the SME sector the main driver of the economic growth (Ouyang et al, 2020). Environmental and manufacturing needs the efficiency of smart industrial solutions and open innovation to ameliorate environmental performance and such connections often merge resources allowing companies to reach their long-term goal and develop standardization (Ogiemwonyi et al, 2023). The paper aims to explore the moderating effect open innovation has on the reduction of the environmental foot print, improvement of the manufacturing process resulting in economic and social performance enhancement and enhancement of the SME sector on the overall. The main assumption of the study is that a good planning and innovation capacity will results in good implementation of CE and it will improve the three sustainability pillars; economic, environmental and social performance of the SME sector. To do so, the study conducts a Semi-structural Equation Modeling (SEM), analyzing the data collected during September-October 2024, from the Albanian SME sector through a likert scale questionnaire. Interestingly the main result is that technological innovation capacity has higher impact on the CE implementation capacity than the CE innovation capability itself and as assumed open and responsible research and innovation has significant impact in CE implementation. Finally, a good implementation of CE results in increased performance of environmental, social and economic performance of SME sector in Albania. The study recommends further analysis regarding value creation for self and value creation for others. The structure of the study is as follow: Section I is an introduction to the topic, research gap and the analysis done to solve the issue; Section II is an overview of the relevant literature which helps in the hypothesis raising; Section III is about the methodology, the method, the model, sampling and measures; in Section VI are given the results and findings from the CFA analysis; section V gives the results from the SEM model and does some discussions of the results, and; in the final part are arrived some conclusions and possible recommendations.

2. Literature Review

2.1. Overview of SME Sector and Circular Economy Transition

SME sector make up 99.8% of the Albania economy and provide 81.6% of the employment opportunity (INSTAT, 2023; OECD, 2022). Influenced by many contextual factors like, demographic change, structural dynamics and resource diminishment exposed this sector to different challenges stepping them to progress and grow. "Innovate or die" rule fits perfectly to the sector, considering also the large share of it makes it good option for the shift towards the CE associated with the proper innovation in technology, process and products. In this way, the sector may address the environmental problem and contribute on SDGs. Based on the World Bank (2023) data, Albanian economy has had a significant progress during the long-lasting transition from 1992 to 2023, surpassing from a low-income to a middle-income economy, currently having GDP/capita 6802 USD. The current GDP has been resulted from the following contributors to the economic activity of the state; the greatest contributor being agriculture, forestry and fishing, followed by retail trade, transport, accommodation and food service explained by heavy reliance on the tourism sector.

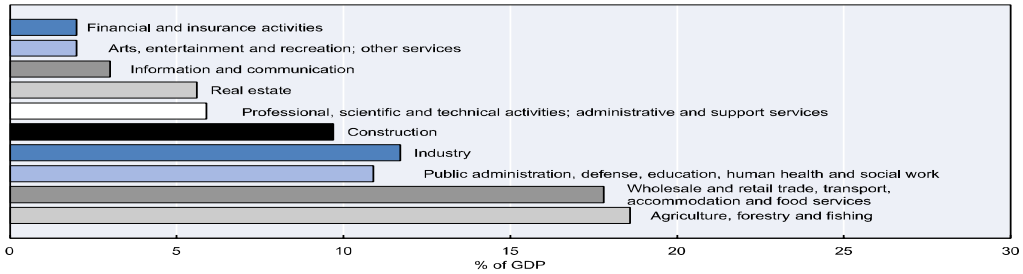

Figure 1. Value added by economic activity

Source: Eurostat (2023)

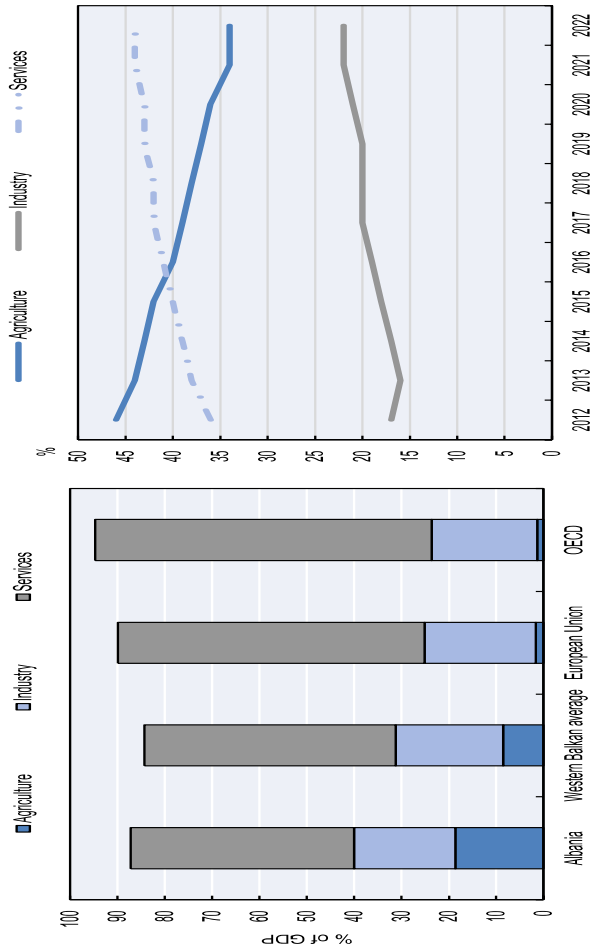

Figure 2: Employment by economic activity and value added by grouped activity

Source: World Bank (2022); OECD (2023)

Agriculture sector in Albania for years have contributed around 20% of GDP of the country, but compared to the region and other groups it has the highest values. Worth mentioning here is the fact that, despite the slight decline the sector has faced it is the sector with the highest employment at around 34%, even though most of the jobs are low skilled and low paid (Ministry of Agriculture and Rural Development, 2022). This sector remains less competitive due to the fact that is dominated by small-fragmented-unirrigated farms. Circular shift can enhance the productivity of the sector, ensure sustainable production and consumption, associated with technological improvements and efficient usage of resources. Such systemic change can initiate the sustainability of land-water-energy nexus in Albania contributing so in resource conservation and preservation of nature and biodiversity.

As obviously seen, despite the fact that agriculture has been the main contributor to the GDP, during the year's employability on this sector has been declining, giving rise to increase in other grouped activities, industry and

services. Despite the lack of proper work force, poor infrastructure, seasonality and segmented location of the sector, tourism represent, 17.4% of GDP and 20% of employment. As the overall economy this sector has been shaken by the other external shocks of the economy, and the main reason of the blooming is the comparative advantaged compared to the neighbor countries and due to this potential to increase even more in the future, it may serve as an opportunity to be sustainability designed considering the circular economy model.

The industry sector counts for 21.4% of the Albanian GDP and 22% of employment level, being so a very important contributor for the circular economy model, as the resource exploitation of this sector is very high and the disposal of the wastes is considerable also. Additionally, this sector has the highest potential for innovation as the main impending factors for its further development are the lack of know-how, lack of innovation and low technological development. According to Pieroni et al. (2021) this sector can lead in orienting linear economy to shift toward CE model emphasizing that "available approaches are still generic and provide limited help for contextualized solutions within sectorial challenges". Based on the above scholar's overview's this study rises the first hypothesis as follow:

H1: *CE Innovation Capacity positively effects CE Implementation Capacity*

2.2. Technological Innovation and Industry 4.0 integration

Industry 4.0 integration in Albanian SME sector is impeded by the financial constraints, and as it requires also the reorganizing and restructuring of the model. As the CE shift technological innovation also requires the collaborative participation of all actors, the government, international organizations, academia-industry partnership (Lica & Gashi, 2023).

SMEs sector in Albania is mainly familiar with the digitalization rather than the Industry 4.0 concept, and what is evident is that they have a perception better than the reality regarding their technological innovation and ICT integration (Angjeli et al., 2022). Most of the companies having the higher digitalization level are those that operate internationally or are affiliates of the multinational enterprises. Technological innovation enables the firms to integrate in the emerging markets (Betiol et al., 2017; Betiol et al., 2020) but the I4.0 is an advancement that needs the ecosystem to be functional. Albanian context of technological innovation is also a subject of cultural factors, the approach to risk, technology acceptance level (Lica & Gashi, 2023) and additionally human capacity, the skills and continuous learnings are determinant factors for the technological innovation and I4.0 integration, despite the consent that it helps in sustainability shelter of the country (Bitri et al., 2019; Lica & Gashi, 2023). As such the second hypothesis is:

H2: *Technological Innovation Capacity positively effects CE Implementation Capacity*

2.3. Open Innovation for Stakeholders Integration

Stakeholder's general perception is that civil society and non-governmental organizations (NGOs) have been the initial promoter and advocate of the environmental issues since the early 2004. Later on the focus of them shifted from simple raising awareness on different environmental issues, to directly conducting different projects and research even specifically on circular economy. International organizations also have started during to implement different projects, building the know-how, strengthen the capacities of central and local government and develop different strategic documents. Academia and research oriented entities also have been at the forefront on conducting research, analyzing the issues and proposing possible solutions. The private sector also has started sheltering the concept of CE with different raise awareness activities, round tables, knowledge sharing events. In this line, numerous companies have incorporated the concept in their business model supported this even by different technological improvements. It's obvious that, there are different separate attempts from the stakeholders to start the transition, but they lack the coordination and even more the integration. Freeman (1984) when explaining stakeholder theory perspective sets the firms as the main influential factor for all other stakeholders towards sustainable strategies. CE strategies are pushed from all the stakeholders: Siedschlag et al. (2022) points public policy stating that "green innovations at firm-level is limited and inconclusive"; Schmidt et al. (2021) highlights the role of SMEs as the mediator for all the stakeholders towards market orientations; Aguinis & Glavas (2012) reveals the reactive and proactive factors pushing firms to engages in sustainable strategies.

Henry Chesbrough has coined the term Open Innovation which is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation". Open innovation paradigm can provide information flow to SME sector (Torkkeli, 2016). Open innovation allows actors to participate in knowledge networks and facilitate stakeholder's integration for the provision of "resources in multi-locational subsystems and the establishment of structural couplings among them in a global innovation system".

Systemic changes like CE require the parallel integration of all the actors to contribute on the collaborative process it goes through that's why open innovation could share the knowledge between all the external actors (Lappalainen et al., 2023; De Groote et al., 2023). In case of Albania, horizontal innovation as the basis of open innovation may be used as a solution for collaborative innovation of the stakeholders. Since till now know there has been implemented separate attempts from actors' open innovation may materialize the needed synergy to involve them in the same peace. This process requires also collective integration for the technological cluster integration and the open innovation paradigm can successfully commit the actors (Dosi et al., 2023). The outcome of this process is the integration of knowledge which implies collective organization to perform the interaction and collaboration. Miozzo et al. (2016) found that SMEs innovation, especially of those focused and services and industries, is tightly linked to different actors and by the provision of a collaborative innovation framework. Bacon et al. (2019) also conclude that collaborative integration of stakeholders is crucial for the successful open innovation process. Finally, stakeholder's collaborative integration plays essential role on a bias decision-making process and to build a common roadmap, for this reason we rise the next hypothesis:

H3: *Open and Responsible Research and Innovation positively effects CE Implementation Capacity*

2.4. Role of good CE implementation on three Sustainability Dimensions

Kiron at al. (2012) highlights that companies incorporating sustainability and shifting towards sustainable business models have increased economic performance. As cited by Epstein and Roy (2003) companies incorporating sustainability have to balance the three dimensions when they allocate the resources and quantify economic, social and environmental performance. In the same line Pinto (2020) reveals that different industrial sectors have improved economic performance when they have internalities green practices. While Katz-Gerro and Lopez Sintas (2019) argue that CE activities are interdepended and different dimensions are systematically engaged. But, evidences from the developing economies are somehow missing (Mangla et al., 2018; Dey et al., 2022) and as such the hypothesis raised are:

H4: *CE effective implementation positively affects SMEs economic performance*

H5: *CE effective implementation positively affects SMEs environmental performance*

H6: *CE effective implementation positively affects SMEs social performance*

3. Methodology

3.1. Concpetual Model

SMEs showed considerable recognition in the adoption of CE and I4.0 as a way to future development but such demanding directions sometimes appear complex to get in. But, this deep transformation implicate different pillars and SMEs face different challenges in embarking the shift. On the other side, SMEs based on their capacity and their business developmental phase place the change within their organization but in reality, they managed to deal with it to a limited extent. In such background, an exploratory analysis is appropriate to identify the possible gaps and opportunities to further develop the process. There is a considerable disruption in knowledge sharing in several sustainability initiatives and I4.0 innovation has shown limited collaboration between the stakeholders and especially limitation in open and responsible research and innovation. Considering such background, and based on the literature review the conceptual model of this work is as follow:

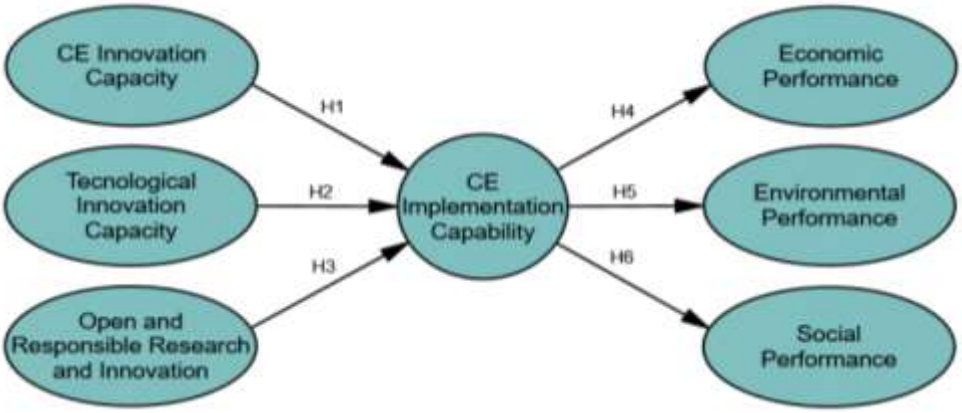

Figure 3: Conceptual Model

Source: Author's Construction

3.2. **Measurement, Survey and Sampling**

In order to collect the data from the Albanian SMEs a 5 licert scale questionnaire was formulated with seven constructs. Those constructs were identified based on the existing literature and were categorized in three main parts. The first part includes questions related to CE innovation capacity, technological innovation capacity and open and responsible research and innovation of those SMEs. The second part of the questionnaire is about the CE implementation capacity and the final part is about the effect it has on economic, social and environmental performance. Additional to the constructs the questionnaire includes some preliminary questions for the purpose of descriptive statistics like, the sector, age of the company, and the position of the responds in the company.

Table 1. Construct Measurement

Construct	Variable	Authors
Circular Economy Innovation Capability **CEINC**	CEINC 1 - We offer value propositions that are not dependent on material consumption, such as substituting digital services for tangible goods.	Blomsma et al. (2019)
	CEINC 2 - We provide replacement parts and/or repair services as stand-alone sales items to support goods throughout their lifespan.	
	CEINC 3 - Instead of selling the actual product, we offer the outcome or performance of a product as a service (performance based)	
	CEINC 4 - Rather than selling the actual goods, we offer the use or access to it as a service (usage-based business models).	
	CEINC 5 - We make our designs simple to disassemble.	
Technological Innovation Capability **TIC**	TIC 1 - In order to develop IT capabilities, we successfully integrate IT resources and assets.	Bürklin & Wynants (2020), Chen (2020)
	TIC 2 - We are proficient in adding new IT resources and assets to enhance or expand current IT capabilities.	
	TIC 3 - Our ability to innovate or develop new IT capabilities is effective.	
	TIC 4 - We are adept at directing our IT resources toward a shared goal and vision.	
	TIC 5 - Our IT capabilities can be efficiently coordinated or integrated.	
	TIC 6 - We successfully utilize our combined IT talents to capitalize on certain industry possibilities.	
Open and Responsible Research and Innovation ORRI	ORRI 1 - We collaborate with outside parties on all of our innovation projects, including universities, clients, rival businesses, research centers, consultants, suppliers, and the government.	Srisathan et al. (2023)
	ORRI 2 – or internal usage, we are purchasing licenses, intellectual property, or know-how (such as expertise in	

	technology, R&D-related services, online technical course platforms, etc.) from outside sources. ORRI 3 – We frequently sell other businesses in the market licenses, including patents, copyrights, trademarks, and know-how. ORRI 4 – We consistently make the sources or advances freely accessible to others. ORRI 5 – We participate in R&D joint ventures and/or alliances. ORRI 6 – We organize the information-sharing activities with our partners.	
CE Implementation Capability **CEIMC**	CEIMC 1 - Our materials are secondary, recycled, and/or renewable (e.g., biodegradable, non-toxic, or ocean plastics; industrial symbiosis). CEIMC 2 - By using less energy and resources, treating trash, and reworking, we operate a lean and clean production. CEIMC 3 - To maximize product usage, reduce energy consumption, and/or prolong product life, we optimize product use and operation. CEIMC 4 - We offer services to prolong the current lifecycles of parts and products (e.g., upgrade, repair, maintenance). CEIMC 5 - Reuse, refurbishment, and remanufacturing are some of the new use-cycles that we offer for goods and parts. CEIMC 6 - We offer actions (such as recycling, cascade, and energy recovery) that increase the lifespan of materials.	Fan et al. (2021), Ranta et al. (2020)
Economic Performance - EC	EC 1 - Over the past few years, our company's productivity has increased. EC 2 - Our company's turnover rate has increased in recent years. EC 3 - Our business has lowered its operating expenses in recent years. EC 4 - Our business is experiencing growth recently. EC 5 - In our company we have improved our turnover in recent years EC 6 - The past few years have seen an increase in our degree of client/customers satisfaction.	Adebanjo et al. (2016)
Environmental Performance **EP**	EP 1 - In our company we have reduced waste across our processes	Dey at al. (2020)

	EP 2 - In our company we have achieved resource efficiency across our processes	
	EP 3 - In our company we have improved compliance with environmental standards	
	EP 4 - In our company we have reduced CO2 emission	
Social Performance SP	SP 1 - Our company have improved work safety for all the workers engaged.	Abdul-Rashid et al. (2017)
	SP 2 - We have improved work environment.	
	SP 3 - In our company we have improved our relationship with the community and/or stakeholders in recent years	
	SP 4 - In our company we have improved living quality of surrounding community in recent years	
	SP 5 - In our company we have improved the inclusion of marginalized groups	

The survey was developed on google form and uploaded online, translated into Albanian and distributed via email. When distributed it was used snowballing sampling approach using the social networks and select the relevant representatives from the companies to take part on the survey. Those closed contact that were the referee to the others as suggested by Noy (2008).

SMEs included in sampling were mainly located in capital city of Tirana, as the most developed region of the country and representation for the latest development in the field. Additionally, it is the largest economic contributor, encompassing largest investments, and having strategic development. Representatives selected from the companies were employee from the top management to technicians and even lower positions in the hierarchy which are directly or indirectly linked to innovation process on the company. Data were collected during September-October, 2024 and the sample of the study (n=109) consist of 109 respondents, following Bollen and Doble (2011) rule of having ate least 100 respondents for SEM.

3.3. Method and Modeling

This study employs SEM model for the analysis and testing of hypothesis from H1-H6 based on the instructions suggested by Bollen (2014) and was done using AMOS statistical package based on Arbuckle (1995). This model is considered as very accurate in identifying the casual relationships between the contracts and the capability for the decomplexation of the interrelated independent variables in this case the latent one.

4. Results and Findings

4.1. Frequency Analysis

In here are given the frequencies showing how many times a value of a given variable occurs within a data set. Table 2 is a summary of data and with the aim of understanding their distribution.

Table 2. Frequency Data		**n**	**%**	**Valid %**
Industry	Construction	12	11.0	11.0
	Desing	5	4.6	4.6
	Service	37	33.9	33.9
	Telecommunication	20	18.3	18.3
	Manufacturing	25	22.9	22.9
	Agriculture and Food	10	9.2	9.2
	Total	***109***	***100.0***	***100.0***
Respondent's Position	CEO	8	7.3	7.3
	Entrepreneurs	6	5.5	5.5
	Managers	42	38.5	38.5
	High Executives	10	9.2	9.2
	Technicians or other top or middle positions	26	23.9	23.9
	Lower than the positions mentioned above (but involved in innovation processes or activities	17	15.6	15.6
	Total	***109***	***100.0***	***100.0***
No of years' operating	1-5 Years	13	11.9	11.9
	6-10 Years	24	22.0	22.0
	11-15 Years	20	18.3	18.3
	More than 15 Years	52	47.7	47.7
	Total	***109***	***100.0***	***100.0***
Number of employees	1-9 Employees	14	12.8	12.8
	10-49 Employees	24	22.0	22.0
	50-249 Employees	24	22.0	22.0
	250-500 Employees	5	4.6	4.6
	More than 500 Employees	42	38.5	38.5
	Total	***109***	***100.0***	***100.0***

Source: The author's Constructs

This table summarizes data from the group of respondents in several categories, including their industry, position in the company, years in operation, and number of employees. The majority of companies are in the service sector (33.9%), followed by manufacturing (22.9%) and telecommunications (18.3%). The highest number of respondents are managers (38.5%), followed by technicians or other middle and senior positions (23.9%). Almost half of the companies (47.7%) have been active for more than 15 years, indicating considerable experience in the market. About 38.5% of companies have more than 500 employees, while most of the others have between 10 and 249 employees.

4.2. Confirmatory factor analysis (CFA)

Table 3 presents the results of a confirmatory factor analysis (CFA) for several factors and indicators, including path values (Path), standardized coefficients (β0), unstandardized coefficients (β1), standard error (S.E.), critical value (C.R.), and p-values.

Table 3. Research Constructs, Factor Loadings, S.E., C.R. and p value

Items	**Path**	**Factor**	**β^0**	**β^1**	**S.E.**	**C.R.**	**P**
TIC6	<---	TIC	0.856	1			
TIC5	<---	TIC	0.959	1.105	0.074	14.998	***
TIC4	<---	TIC	0.916	1.068	0.076	13.979	***
TIC3	<---	TIC	0.921	1.122	0.081	13.797	***
TIC2	<---	TIC	0.925	1.096	0.079	13.904	***
TIC1	<---	TIC	0.889	1.085	0.083	13.125	***
CEINC5	<---	CEINC	0.677	1			
CEINC4	<---	CEINC	0.89	1.321	0.192	6.885	***
CEINC2	<---	CEINC	0.821	1.338	0.183	7.291	***
ORRI6	<---	ORRI	0.915	1			
ORRI5	<---	ORRI	0.922	0.976	0.101	9.669	***
CEIMC6	<---	CEIMC	0.735	1			
CEIMC5	<---	CEIMC	0.772	1.067	0.167	6.371	***
CEIMC4	<---	CEIMC	0.855	1.152	0.234	4.933	***
EcP6	<---	EcP	0.874	1			
EcP5	<---	EcP	0.898	1.027	0.078	13.145	***
EcP4	<---	EcP	0.893	1.029	0.08	12.931	***
EcP2	<---	EcP	0.809	0.968	0.09	10.717	***
EnP4	<---	EnP	0.839	1			
EnP3	<---	EnP	0.891	0.986	0.09	11.005	***
EnP1	<---	EnP	0.858	1.052	0.098	10.749	***

SoP4	<---	SoP	0.88	1			
SoP3	<---	SoP	0.877	0.961	0.073	13.103	***
SoP2	<---	SoP	0.949	1.011	0.064	15.719	***
SoP1	<---	SoP	0.918	1.029	0.071	14.475	***

***β⁰** = Standardized regression coefficient, **β¹** = Unstandardized regression coefficient,*

***S.E.** = Standard Error, **C.R.** = Critical Ratio, ******* = p < 0.001.*

Source: The authors

Based on the literature their interpretation varies as follow: 1)Standardized Coefficients (β0): Most of the β0 values are above 0.7, indicating that the indicators have high loadings on their respective factors, suggesting that the indicators are good representatives of the factors; 2)Critical Values (C.R.) and P-values: The critical values (C.R.) are quite high and are statistically significant (***) for most of the indicators, meaning that the factor loadings are statistically significant; 3)Standard Error (S.E.): The standard errors are generally low, indicating a high stability in the model coefficients. These results indicate a good fit of the model, suggesting that the factor structures are supported by the data and that the indicators accurately express their intended factors.

4.3. Model Fit Measures for CFA

Table 4. Model Fit Measures

Measure	**Estimate**	**Threshold**	**Interpretation**	**Cutoff Criteria***			
				Measure	**Terrible**	**Acceptable**	**Excellent**
CMIN	357.257	--	--	--	--	--	--
DF	250.00	--	--	--	--	--	--
CMIN/DF	1.429	1 - 3	Excellent	CMIN/DF	> 5	> 3	> 1
CFI	0.957	>0.95	Excellent	CFI	<0.90	<0.95	>0.95
SRMR	0.051	<0.08	Excellent	SRMR	>0.10	>0.08	<0.08
RMSEA	0.063	<0.06	Acceptable	RMSEA	>0.08	>0.06	<0.06
PClose	0.080	>0.05	Excellent	PClose	<0.01	<0.05	>0.05

Source: The Authors. ***Hu and Bentler (1999).***

This "Goodness of Fit" table for confirmatory factor analysis shows the fit between the model and the data, based on several standard measures. Initially, CMIN/DF (Chi-square/degrees of freedom): The value of 1.429 falls within the range of "1 - 3," which is considered excellent and indicates a good fit of the model. Secondly, CFI (Comparative Fit Index): The value of 0.957 is above the threshold of 0.95, which suggests an excellent fit of the model, according to the literature. Thirdly, SRMR (Standardized Root Mean Square Residual): The SRMR value of 0.051 is below the threshold of 0.08, indicating an excellent fit of the model. Fourth, RMSEA (Root Mean Square Error of Approximation): The value of 0.063 falls into the "Acceptable," category, which indicates a reasonable fit, as it is close to the excellent threshold of <0.06. Finally, PClose: The PClose value of 0.080 (above 0.05) indicates an excellent fit, confirming that the RMSEA is not statistically significant. Overall, the results indicate that the model fits the data well, supporting the robustness of the factor structure.

4.4. Validity, Reliability, and Discriminant Analysis

After completing the Confirmatory Factor Analysis (CFA), it is essential to ensure convergent and discriminant validity, as well as the reliability of the model. The following table presents the results for the validity, reliability, and discriminant analysis for the TIC, CEINC, ORRI, CEIMC, EcP, EnP, and SoP factors with the following results. All factors have CR (Composite Reliability) values above the threshold of 0.7, suggesting good reliability for each construct. All AVE (Average Variance Extracted) values are above the threshold of 0.5, indicating that the factors explain a significant portion of the variance of their indicators and meet convergent validity. Discriminant Analysis (MSV - Maximum Shared Variance) values are lower than AVE for each construct, which suggests discriminant validity, meaning that the factors are distinguishable from each other.

Regarding the Correlations and Discriminant Validity (Heterotrait-Monotrait Ratio, H), values on the main diagonal (AVE) are higher than the correlations between the factors, confirming the discriminant validity between them. In summary, the results show that the factors have high reliability, satisfactory convergent and discriminant validity, supporting their stability and distinctness in the model.

Table 5. Model Validity and Reliability Measures

	CR	**AVE**	**MSV**	**(H)**	**TIC**	**CEINC**	**ORRI**	**CEIMC**	**EcP**	**EnP**	**SoP**
TIC	0.97	0.83	0.32	0.972	0.912						
CEINC	0.84	0.64	0.16	0.87	0.396***	0.801					
ORRI	0.92	0.84	0.33	0.915	0.319**	0.227†	0.919				
CEIMC	0.83	0.62	0.24	0.843	0.404**	0.290*	0.314*	0.789			
EcP	0.93	0.76	0.43	0.93	0.566***	0.332**	0.411***	0.425**	0.869		
EnP	0.9	0.75	0.33	0.9	0.312**	0.261*	0.577***	0.489***	0.437***	0.863	
SoP	0.95	0.82	0.43	0.955	0.414***	0.184†	0.395***	0.325**	0.657***	0.548***	0.91

Notes: CR = Composite Reliability; AVE = Average Variance Extracted: MSV = Maximum Shared squared variance; (H) = Maximal H Reliability MaxR(H); Significance of Correlations: ***= $p < 0.001$.

Source: The Authors

4.5. HTMT Analysis

HTMT (Heterotrait-Monotrait Ratio) analysis table measures the correlations between factors to assess discriminant validity. According to the HTMT method, a ratio lower than 0.85 (or in some cases 0.90) suggests that the factors are distinct from each other, fulfilling discriminant validity. All HTMT values are below the 0.85 threshold, which means that the factors are distinct and do not significantly overlap with each other. This confirms that the factors in the model are distinct and uniquely express different constructs, indicating satisfactory discriminant validity in the model.

Table 6. HTMT Results

	TIC	**CEINC**	**ORRI**	**CEIMC**	**EcP**	**EnP**	**SoP**
TIC							
CEINC	0.371						
ORRI	0.309	0.246					
CEIMC	0.422	0.249	0.3				
EcP	0.587	0.338	0.404	0.428			

EnP	0.315	0.214	0.579	0.442	0.436		
SoP	0.422	0.18	0.407	0.307	0.675	0.556	

Source: The Authors.

5. Pathway Analysis and Structural Equation Modelling (SEM)

5.1. Model Fit measure and statistics

Initially the Chi-square value needs to be interpreted in comparison to the other values due to the fact that, it does not have clear cut threshold levels. When we relate it with the degree of freedom we see that its result is 1.475 which fall within the range of 1-3 indicating excellent result and showing that the model fits with the data. The value of CFI is greater than 0.95 which is acceptable but not the optimal one. SRMR is lower than the threshold of being lower than 0.08 having excellent results, indicating reasonable fit of the model, while RMSEA is within the threshold which means is acceptable but has a space for improvement. PClose value is lower than 0.05 which suggest that it is not statistically significant resulting in a rejection of null hypothesis.

Table 7: Model Fit Results for SEM

Model Fit Measures				**Cutoff Criteria***			
Measure	**Estimate**	**Threshold**	**Interpretation**	**Measure**	**Terrible**	**Acceptable**	**Excellent**
CMIN	385.049	--	--	--	--	--	--
DF	261.000	--	--	--	--	--	--
CMIN/DF	1.475	1 - 3	Excellent	CMIN/DF	> 5	> 3	> 1
CFI	0.950	>0.95	Acceptable	CFI	<0.90	<0.95	>0.95
SRMR	0.071	<0.08	Excellent	SRMR	>0.10	>0.08	<0.08
RMSEA	0.066	<0.06	Acceptable	RMSEA	>0.08	>0.06	<0.06
PClose	0.034	>0.05	Acceptable	PClose	<0.01	<0.05	>0.05

Source: The Authors Hu and Bentler (1999).

5.2. Model Path Analysis

In here are given the results of hypothesis testing, regarding the correlation between factors in the model of CFA. Overall, hypotheses H2, H3, H4, H5, and H6 are confirmed, indicating that TIC and ORRI affect CEIMC, and CEIMC affects EcP, EnP, and SoP. H1 is rejected, suggesting that CEINC does not have a significant impact on CEIMC. These results provide important insight into the relationships between factors of the model.

There are deep insights collected from the hypothesis testing. Initially we conclude that we don't have enough indicators to prove that CE innovation capability considerably effects the CE implementation capability, rejecting so the first hypothesis. The study confirms that open and responsible research and innovation significantly affect the CE implementation through the confirmation of hypothesis 2. As indicated from the beginning technological innovation capacity facilitates, improves and significantly affects the CE implementation capacity, confirming so the hypothesis 3. Finally, the study achieves great results regarding the three pillars of the sustainability; a good CE implementation capability significantly effects economic performance, environmental performance and social performance, confirming so hypothesis 4, 5 and 6.

Table 8. Pathway Coefficients, R-square, f-square, Effect Size and Hypothesis Results

H	Items	Path	Factor	β^0	β^1	S.E.	C.R.	P	R_I^2	R_E^2	F^2	Eff.Size	Decision
H1	CEIMC	<---	CEINC	0.087	0.053	0.062	0.847	0.397	0.546	0.540	0.013	None	Rejected
H3	CEIMC	<---	ORRI	0.416	0.171	0.058	2.959	0.003		0.433	0.249	Medium	Confirmed
H2	CEIMC	<---	TIC	0.445	0.219	0.071	3.085	0.002		0.398	0.326	Medium	Confirmed
H4	EcP	<---	CEIMC	0.81	1.577	0.409	3.855	***	0.656	0.000	1.907	Large	Confirmed
H5	EnP	<---	CEIMC	0.664	1.21	0.334	3.624	***	0.441	0.000	0.789	Large	Confirmed
H6	SoP	<---	CEIMC	0.749	1.356	0.362	3.744	***	0.562	0.000	1.283	Large	Confirmed

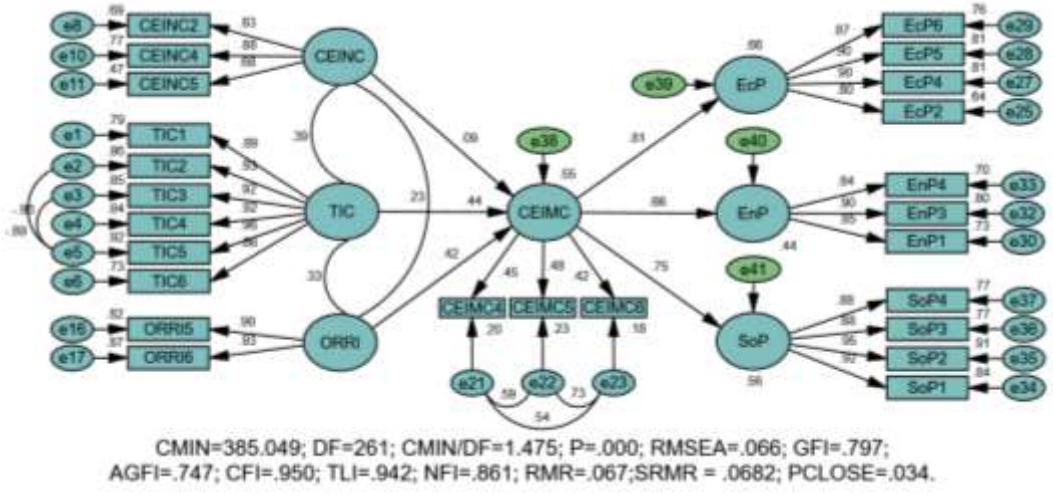

Figure 2. SEM Diagram

Source: The Authors

From the first construct (CEINC) results showed that companies still did not decouple from the physical use of the materials and digitalization is still on the process. Additionally, companies struggle to provide performance-based business models. Form the construct 2 (TIC) all the indicators remained on the final model, which appeared to be the factor that companies are advancing and deeply contribute on proper CE implementation. Regarded to construct 3 (ORRI) the study observed that the involvement with the external partners is still limited, acquiring and selling license is still weak and companies do not provide innovation resources for free.

When analyzing the construct 4 (CEIMC) which is directly related to the effectiveness of the CE implementation, its obviously seen that its still on transition: companies are not effective on the R (recycle, reuse, repair, renew, rework, etc.), the production is not lean and clean, and utilization of the energy is not efficient. Construct 5 (EcP) revealed that SMEs did not improve their productivity and did not reduce the operational costs; construct 6 (EnP) showed a limitation on resource efficiency and construct 7 (SoP) showed that marginalized groups are not included integrally.

5.3. Discussion of Results

As seen from the diagram this model provides a framework on how effective CE implementation and innovation processes especially technology, can enhance the economic, social and environmental performance of the SMEs in developing countries. As Boons and Ludeke-Freund (2013) highlights that different innovation process have different effects on the sustainability dimensions. In line with Sehnem et al. (2022) address the need for maturation of CE and enforcement of transition capabilities like the technological capability and the open innovation, more than the Ce innovation itself. Additionally, we confirm that open and responsible innovation improve the CE implementation and moderating the performance of sustainability dimensions the same as Ovuakporie et al (2021). The study concludes that, open innovation and stakeholder collaboration deeply increase the innovation performance and its broader acceptability in the same way as Greco et al. (2016) supported by the argument of Li et al. (2018) "at least it will help to avoid poor innovation" and as Bengtsson et al. (2015) points out, companies have to be sustainable and cost effective even they are searching for knowledge.

6. Concusions

SMEs sector shift towards circular economy is directly translated to the shift of the economy itself and in this regard, stakeholders should facilitate the exchange of practices and learning from each-other. This may include both, inter-sectorial and cross-sectorial knowledge share. Supportive collaboration between SMEs, academia, policy makers, as well as regional and international collaboration on research and development and innovation is the key to proper shift of the sector. Only firms with change processes of integrating a wide range of CE-related activities, technological innovation, industrial symbiosis or/and collaborative solutions can achieve the most advanced levels of a CE. The level of adoption of the CE by SMEs can be measured using a set of indicators able to define the volume and stage of the CE-related activities performed by businesses that are considered relevant to the contexts in which they operate. Due to this, this sector in Albania should get out of the box and learn from other's experience to take the leading role for the sustainable and long-lasting solutions for our companies and widely for the economy as a whole.

Based on the results the study concludes that, more the then idea innovation the contexts are very important for the shift towards sustainability dimensions (as seen the technological innovation appeared more important than the CE innovation itself). Open innovation eppears to be the key to developing countries, as they face difficulties and challenges in complete adaptation of the institutional change. An interesting conclusion in here is that, the incorporation of open and sustainable innovation resulted in higher and better economic performances than before, in addition to the fulfilment of social and environmental dimensions. As such the study suggest a better collaboration between the stakeholders, and recommend the assessment of the value creation for self and for the others.

Authors contribution*: Introduction, Conceptualized and Written by K.G and S.G, reviewed by F.G.; Literature review, K.G., reviewed by F.G.; Methodology and data, S.G.; Research results and comments, K.G and F.G.; Conclusion, K.G., S.G., F.G.*

References

Abdul-Rashid, S. H., Sakundarini, N., Raja Ghazilla, R. A., & Thurasamy, R. (2017). The impact of sustainable manufacturing practices on sustainability performance: Empirical evidence from Malaysia. International Journal of Operations & Production Management, 37(2), 182-204.

Adebanjo, D., Teh, P. L., & Ahmed, P. K. (2016). The impact of external pressure and sustainable management practices on manufacturing performance and environmental outcomes. International Journal of Operations & Production Management, 36(9), 995-1013.

Aguinis, H., & Glavas, A. (2012). What we know and don't know about corporate social responsibility: A review and research agenda. *Journal of management*, *38*(4), 932-968.

Angjeli, G., Pano, N., & Lacka, S. (2022). Industry 4.0-reality and perception in the Albanian market. *group*.

Arbuckle, J. L. (1995). Amos™ 7.0 user's guide. Amos Development Corporation.

Bacon, E., Williams, M. D., & Davies, G. H. (2019). Recipes for success: Conditions for knowledge transfer across open innovation ecosystems. *International Journal of Information Management*, *49*, 377-387.

Bengtsson, L., Lakemond, N., Lazzarotti, V., Manzini, R., Pellegrini, L., & Tell, F. (2015). Open to a select few? Matching partners and knowledge content for open innovation performance. Creativity and innovation management, 24(1), 72-86.

Bettiol, M., Capestro, M., & Di Maria, E. (2017). Industry 4.0: The strategic role of marketing. *Proceedings of the XIV Convegno Annuale SIM, Bergamo, Italy*, 26-27.

Bettiol, M., Capestro, M., De Marchi, V., & Di Maria, E. (2020). Industry 4.0 investments and internationalization: does size matter?. *Piccola Impresa/Small Business*, (2).

Bitri, A., Marinova, G., & Hajrizi, E. (2019). Internet of Things to Help SDGs Implementation: A case of Albania and Kosovo, Opportunities and Challenges.

Blomsma, F., Pieroni, M., Kravchenko, M., Pigosso, D. C., Hildenbrand, J., Kristinsdottir, A. R., ... & McAloone, T. C. (2019). Developing a circular strategies framework for manufacturing companies to support circular economy-oriented innovation. Journal of cleaner production, 241, 118271.

Bollen, K. A. (2014). Structural equations with latent variables. John Wiley & Sons.

Bollen, K. A., & Noble, M. D. (2011). Structural equation models and the quantification of behavior. Proceedings of the National Academy of Sciences, 108(supplement_3), 15639-15646.

Boons, F., & Lüdeke-Freund, F. (2013). Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. Journal of Cleaner production, 45, 9-19.

Bossle, M. B., de Barcellos, M. D., Vieira, L. M., & Sauvée, L. (2016). The drivers for adoption of eco-innovation. *Journal of Cleaner production*, *113*, 861-872.

Bürklin, N., & Wynants, J. (2020). Opening new opportunities to close the loop: How technology influences the circular economy. Technology-Driven Sustainability: Innovation in the Fashion Supply Chain, 219-240.

Chauhan, C., Sharma, A., & Singh, A. (2021). A SAP-LAP linkages framework for integrating Industry 4.0 and circular economy. *Benchmarking: An International Journal*, *28*(5), 1638-1664.

Chen, C. W. (2020). Improving Circular Economy Business Models: Opportunities for Business and Innovation: A new framework for businesses to create a truly circular economy. Johnson Matthey Technology Review, 64(1), 48-58.

De Groote, J. K., Schell, S., Kammerlander, N., & Hack, A. (2023). The role of similarity and complementarity in the selection of potential partners for open innovation projects in family firms. Small Business Economics, 60(4), 1347-1367.

de Sousa Jabbour, A. B. L., Jabbour, C. J. C., Choi, T. M., & Latan, H. (2022). 'Better together': evidence on the joint adoption of circular economy and industry 4.0 technologies. International Journal of Production Economics, 252, 108581.

Dey, P. K., Malesios, C., De, D., Budhwar, P., Chowdhury, S., & Cheffi, W. (2022). Circular economy to enhance sustainability of small and medium sized enterprises. In Supply chain sustainability in small and medium sized enterprises (pp. 10-45). Routledge.

Dey, P. K., Malesios, C., De, D., Chowdhury, S., & Abdelaziz, F. B. (2020). The impact of lean management practices and sustainably-oriented innovation on sustainability performance of small and medium-sized enterprises: empirical evidence from the UK. British Journal of Management, 31(1), 141-161.

Dosi, G., Lamperti, F., Mazzucato, M., Napoletano, M., & Roventini, A. (2023). Mission-oriented policies and the "Entrepreneurial State" at work: An agent-based exploration. Journal of Economic Dynamics and Control, 151, 104650.

Epstein, M. J., & Roy, M. J. (2003). Making the business case for sustainability: Linking social and environmental actions to financial performance. Journal of Corporate Citizenship, (9), 79-96.

Fan, M., Qalati, S. A., Khan, M. A. S., Shah, S. M. M., Ramzan, M., & Khan, R. S. (2021). Effects of entrepreneurial orientation on social media adoption and SME performance: The moderating role of innovation capabilities. PloS one, 16(4), e0247320.

Freeman, R. E. (2010). Strategic management: A stakeholder approach. Cambridge university press.

Ghobakhloo, M. (2020). Industry 4.0, digitization, and opportunities for sustainability. Journal of cleaner production, 252, 119869.

Greco, M., Grimaldi, M., & Cricelli, L. (2016). An analysis of the open innovation effect on firm performance. European Management Journal, 34(5), 501-516.

Hancevic, P. I. (2016). Environmental regulation and productivity: The case of electricity generation under the CAAA-1990. Energy Economics, 60, 131-143.

Katz-Gerro, T., & López Sintas, J. (2019). Mapping circular economy activities in the European Union: Patterns of implementation and their correlates in small and medium-sized enterprises. Business Strategy and the Environment, 28(4), 485-496.

Kiron, D., Kruschwitz, N., Reeves, M., Haanaes, K., & Goh, E. (2012). The benefits of sustainability-driven innovation. Own the Future: 50 Ways to Win from the Boston Consulting Group, 119-123.

Lappalainen, L., Aleem, M., & Sandberg, B. (2023). How to manage open innovation projects? An integrative framework. Project Leadership and Society, 100095.

Li, D., Lin, J., Cui, W., & Qian, Y. (2018). The trade-off between knowledge exploration and exploitation in technological innovation. Journal of Knowledge Management, 22(4), 781-801.

Li, G., Wang, X., & Wu, J. (2019). How scientific researchers form green innovation behavior: an empirical analysis of China's enterprises. Technology in Society, 56, 134-146.

Liça, D., & Gashi, S. (2023) Industry 4.0 and Manufacturing Firm Performance in Albania: A Comprehensive.

Mangla, S. K., Luthra, S., Mishra, N., Singh, A., Rana, N. P., Dora, M., & Dwivedi, Y. (2018). Barriers to effective circular supply chain management in a developing country context. Production Planning & Control, 29(6), 551-569.

Miozzo, M., Desyllas, P., Lee, H. F., & Miles, I. (2016). Innovation collaboration and appropriability by knowledge-intensive business services firms. Research policy, 45(7), 1337-1351.

Nascimento, D. L. M., Alencastro, V., Quelhas, O. L. G., Caiado, R. G. G., Garza-Reyes, J. A., Rocha-Lona, L., & Tortorella, G. (2019). Exploring Industry 4.0 technologies to enable circular economy practices in a manufacturing context: A business model proposal. Journal of Manufacturing Technology Management, 30(3), 607-627.

Noy, C. (2008). Sampling knowledge: The hermeneutics of snowball sampling in qualitative research. International Journal of social research methodology, 11(4), 327-344.

Obradović, T., Vlačić, B., & Dabić, M. (2021). Open innovation in the manufacturing industry: A review and research agenda. Technovation, 102, 102221.

Ogiemwonyi, O., Alam, M. N., Hago, I. E., Azizan, N. A., Hashim, F., & Hossain, M. S. (2023). Green innovation behaviour: Impact of industry 4.0 and open innovation. Heliyon.

Ouyang, X., Li, Q., & Du, K. (2020). How does environmental regulation promote technological innovations in the industrial sector? Evidence from Chinese provincial panel data. Energy Policy, 139, 111310.

Ovuakporie, O. D., Pillai, K. G., Wang, C., & Wei, Y. (2021). Differential moderating effects of strategic and operational reconfiguration on the relationship between open innovation practices and innovation performance. Research Policy, 50(1), 104146.

Pieroni, M. P., McAloone, T. C., & Pigosso, D. C. (2021). Circular economy business model innovation: Sectorial patterns within manufacturing companies. Journal of cleaner production, 286, 124921.

Pinto, L. (2020). Green supply chain practices and company performance in Portuguese manufacturing sector. Business Strategy and the Environment, 29(5), 1832-1849.

Rajput, S., & Singh, S. P. (2019). Connecting circular economy and industry 4.0. International Journal of Information Management, 49, 98-113.

Ranta, V., Keränen, J., & Aarikka-Stenroos, L. (2020). How B2B suppliers articulate customer value propositions in the circular economy: Four innovation-driven value creation logics. Industrial Marketing Management, 87, 291-305.

Rosa, P., Sassanelli, C., Urbinati, A., Chiaroni, D., & Terzi, S. (2020). Assessing relations between Circular Economy and Industry 4.0: a systematic literature review. International Journal of Production Research, 58(6), 1662-1687.

Schmidt, C. V. H., Kindermann, B., Behlau, C. F., & Flatten, T. C. (2021). Understanding the effect of market orientation on circular economy practices: The mediating role of closed-loop orientation in German SMEs. Business strategy and the environment, 30(8), 4171-4187.

Sehnem, S., de Queiroz, A. A. F. S., Pereira, S. C. F., dos Santos Correia, G., & Kuzma, E. (2022). Circular economy and innovation: A look from the perspective of organizational capabilities. Business Strategy and the Environment, 31(1), 236-250.

Siedschlag, I., Meneto, S., & Tong Koecklin, M. (2022). Enabling green innovations for the circular economy: what factors matter?. Sustainability, 14(19), 12314.

Srisathan, W. A., Ketkaew, C., Phonthanukitithaworn, C., & Naruetharadhol, P. (2023). Driving policy support for open eco-innovation enterprises in Thailand: A probit regression model. Journal of Open Innovation: Technology, Market, and Complexity, 9(3), 100084.

Torkkeli, M. (2016). Open Innovation: A Multifaceted Perspective (in 2 Parts) (Vol. 1). World Scientific.

Yang, J. Y., & Roh, T. (2019). Open for green innovation: From the perspective of green process and green consumer innovation. Sustainability, 11(12), 3234.