



The influence of sustainable supply chain management on circular economy capabilities in MSMEs in the fashion and cosmetics industries

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ABSTRACT

Background: The adoption of circular economy principles offers significant opportunities for micro, small, and medium enterprises (MSMEs) in Indonesia, particularly because of their close interaction with consumers who generate post-consumption waste. This study examines how sustainable supply chain management contributes to the development of circular economy capabilities among MSMEs operating in the fashion and cosmetics sectors. **Methods:** Data were collected from 72 MSMEs located in Java and Bali that had implemented at least one of the 3R practices (reduce, reuse, or recycle). The relationships among variables were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM). **Findings:** The analysis revealed that green supply chain management and sustainable supply chain design positively contribute to circular economy capabilities. In addition, supply chain relationship management affects circular economy capabilities indirectly through its influence on sustainable supply chain design. **Conclusion:** Sustainable supply chain practices play an important role in strengthening the ability of MSMEs to adopt circular economy principles. The results highlight the need for integrated supply chain strategies to support sustainable business transformation within the fashion and cosmetics industries. **Novelty/Originality of this article:** This study extends the circular economy literature by providing empirical evidence from Indonesian MSMEs and demonstrating both direct and indirect pathways through which sustainable supply chain management enhances circular economy capabilities.

KEYWORDS: circular economy; green supply chain management; MSMEs; supply chain relationship management; sustainable supply chain; sustainable supply chain design.

1. Introduction

Currently, 91.4% of the world's economy is still linear, which includes the process of extraction and production, consumption, collection, and ends at the landfill (Circular Economy, 2018; Ministry of National Development Planning et al., 2021). The energy required for production creates carbon emissions. More carbon emissions increase the impact on the global climate. The fashion industry is one of the world's largest sources of carbon emissions; in 2015, it was responsible for 1.715 million tons of carbon emissions. The fashion industry is also one of Indonesia's largest contributors to waste, with textile waste amounting to 2.3 million tons in 2020 and projected to increase by 70% by 2030 (Ministry of National Development Planning et al., 2021). In addition to textiles, plastic packaging waste is also a problem in Indonesia, with a total of 5.4 tons of waste in 2020,

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projected to increase by 40% by 2030 (Ministry of National Development Planning et al., 2021). The wholesale and retail trade sector generates this waste, where three-quarters of plastic consumption in Indonesia comes from single-use packaging (Ministry of National Development Planning et al., 2021). This issue can be addressed by replacing the linear economic model with a circular one.

The government has promoted and raised awareness of sustainability, including implementing the circular economy to achieve Indonesia's Nationally Determined Contribution (NDC), which aims to reduce greenhouse gas emissions by 29% by 2030 (Limanseto, 2021). The circular economy is an industrial system that is restorative or regenerative by design and is intended to encourage restoration and the use of renewable energy (World Economic Forum, n.d.), or it is a closed-loop economic system where the processes include manufacturing, consumption, collection, recycling, and processing (Ministry of National Development Planning, 2021). According to the Ellen MacArthur Foundation, the three main principles of the circular economy are designing out waste and pollution, keeping products and materials in use, and regenerating natural systems (Ellen MacArthur Foundation, n.d.). However, it is unfortunate that by 2020, only 8.6% of the world's economy had implemented the circular economy (Circular Economy, 2018).

The circular economy is very promising for MSMEs (Micro, Small, and Medium Enterprises) in Indonesia. MSMEs can play a better role in implementing the circular economy because they are closer to end-users who are likely to generate waste. Furthermore, the implementation of the circular economy can help MSMEs improve production efficiency, reduce significant waste, and potentially save raw materials by focusing on the 3R business model: reuse, recycle, and repurpose (Plant Chicago, 2020).

The circular economy concept is aligned with the concept of sustainable supply chain management. This alignment is evident in its activities, which include managing material, information, and capital flows as well as cooperation between companies along the supply chain while considering the three dimensions of sustainable development: economic, environmental, and social, which come from customer and stakeholder needs (Seuring & Müller, 2008). Sustainable supply chain management (SSCM) is a comprehensive integration of social, environmental, and economic goals or the triple bottom line of a company (Ahi & Searcy, 2013).

This study considers three dimensions of sustainable supply chain management. The first is green supply chain management (GSCM), which emphasizes environmental sustainability within supply chain activities. The second is supply chain relationship management (SCRM), which refers to efforts to reduce environmental impacts through effective relationships among supply chain actors across upstream and downstream processes (Pop et al., 2015). The third dimension is sustainable supply chain design (SSCD), which focuses on designing products, processes, and supply chain networks that support environmental sustainability through efficient resource utilization, waste reduction, and environmentally responsible production and distribution practices (Zeng et al., 2017).

Based on the research background and objectives, this study addresses several questions concerning the role of sustainable supply chain management in improving the circular economy capabilities of MSMEs in Indonesia. First, how does green supply chain management affect MSMEs' circular economy capabilities? Second, how does supply chain relationship management contribute to developing circular economy capabilities? Third, what is the relationship between supply chain relationship management and sustainable supply chain design? Finally, how does sustainable supply chain design influence MSMEs' circular economy capabilities? The findings of this study are expected to provide additional insights into the sustainable supply chain management factors that contribute to circular economy capabilities and serve as a useful reference for MSMEs seeking to adopt more sustainable supply chain practices. Furthermore, the study provides empirical evidence on the interconnected roles of green supply chain management, supply chain relationship management, and sustainable supply chain design in strengthening circular economy capabilities. These findings may also support policymakers and other stakeholders in

developing strategies that facilitate sustainable supply chain practices and circular economy adoption among MSMEs in Indonesia.

1.1 Theoretical review on circular economy

The concept of the circular economy applies a closed production model that aims to improve the efficiency of resource use, in this case, waste, to achieve a balance between the economy, environment, and society. The implementation of the circular economy concept is reflected in three main actions, namely the 3Rs: reduce, reuse, and recycle. The reduce principle aims to minimize the use of primary energy, raw materials, and waste by improving production and consumption efficiency. The reuse principle refers to any operational activities where the product or its components are not waste and can be used again for the same purpose. The recycle principle refers to any recovery activity where material waste can be reprocessed into products, materials, or other substances for different purposes (Ghisellini et al., 2016).

Sustainable supply chain, according to Seuring & Muller (2008), is the management of material, information, and capital flows and cooperation between companies along the supply chain while considering the three dimensions of sustainable development: economy, environment, and society, which come from customer and stakeholder needs. In general, the implementation of sustainable supply chain management (SSCM) can be divided into internal practices (waste reduction, designing production processes with minimal production, etc.) and external practices (supplier selection, warehouse management, and transportation modes) involving external parties (Alzubi & Akkerman, 2022). The three main components of a sustainable supply chain are. Meanwhile, according to Carter & Roger (2008), a sustainable supply chain is a strategic and transparent integration of organizational goals related to social, environmental, and economic issues in systemic coordination between key organizations to improve the long-term economic performance of each company and its supply chain.

1.1.1 Supply chain relationship management and design

This is the relationship formed between the company and its upstream and downstream partners (Zeng et al., 2017), with activities that include jointly planning, operating, and making business decisions that can significantly impact the achievement of sustainability goals (Tidy et al., 2016). In addition, previous studies have also shown that supply chain relationship management can determine the success of green production or sustainable manufacturing implementation in developed countries (Miocevic & Biljana, 2012; Sjoerdsma & Weele, 2015). This implementation requires a concept that can be implemented; in this context, sustainable supply chain design.

Sustainable supply chain design (SSCD) aims to model the best supply chain network configuration that enables a company to maximize long-term benefits in the three pillars of sustainability: economic, environmental, and social (Govindan et al., 2015), and it is a combination of effective suppliers, manufacturers, and distributors (Gimenez & Sierra, 2013). Three things to consider when designing a sustainable supply chain (Joshi, 2022). First, economic sustainability factors. Waste reduction can be key to saving costs, for example through recycling, transport route optimization, efficient packaging, or reducing energy consumption costs. Second is the environmental factor. To strengthen the environmental pillar, companies can implement indicators such as pollution prevention, resource management, waste management, and water management. Third is the social indicator. Sustainable behavior can benefit stakeholders such as workers and local communities. However, in reality, there is no comprehensive framework to help industries incorporate social factors into the sustainable supply chain design process (Ahmadi et al., 2016). This is because social factors as a pillar of sustainability are complex, as it is difficult to determine and measure social impacts in numerical terms (Popovic et al., 2018).

1.1.2 Green supply chain management

Green supply chain management, according to Srivasta, is the integration of environmental thinking into supply chain management, including product design, sourcing and selection of materials, manufacturing processes, delivery of the final product to consumers, and post-product lifecycle management (Ahi & Searcy, 2013). When sustainable supply chain management adopts the broad triple bottom line perspective, green supply chain management is typically more focused and places a strong emphasis on environmental issues (Ahi & Searcy, 2013).

1.2 Research hypotheses

This study adapted its research framework from previous studies. The relationship between green supply chain management and circular economy capabilities was adopted from the framework developed by Bag et al. (2022), while the relationships involving supply chain relationship management, sustainable supply chain design, and circular economy capabilities were based on Zeng et al. (2017). Green supply chain management emphasizes environmentally responsible practices throughout supply chain activities and can also improve economic performance (Costantini et al., 2015). The circular economy promotes efficient resource utilization while considering environmental sustainability (Liu et al., 2018). Previous research indicates that implementing GSCM supports the development of circular economy practices within organizations (Bag et al., 2022). Therefore, the following hypothesis is proposed: H1. Green supply chain management positively affects circular economy capabilities.

Supply chain relationship management is considered an important factor in supporting sustainable manufacturing practices and the implementation of 3R principles (reduce, reuse, and recycle) (Miocevic & Crnjak-Karanovic, 2012). Activities associated with SCRM include supplier selection, technological collaboration, and efforts to meet customer expectations through effective cooperation among supply chain partners. Based on these considerations, the following hypothesis is proposed: H2. Supply chain relationship management positively affects circular economy capabilities.

Effective supply chain management requires sustainable supplier selection and appropriate supply chain network design. These elements can facilitate the enhancement of circular economy capabilities within organizations (Xiong et al., 2015). Furthermore, strong relationships among supply chain actors provide a foundation for the development of sustainable supply chain design oriented toward environmental objectives. Previous studies have also shown that SCRM contributes to the successful implementation of sustainable manufacturing and supply chain design practices (Miocevic & Crnjak-Karanovic, 2012). Therefore, the following hypothesis is proposed: H3. Supply chain relationship management positively affects sustainable supply chain design.

Sustainable supply chain design supports the principles of reducing, reusing, and recycling resources, which are closely related to the circular economy concept. From a circular economy perspective, selecting environmentally responsible suppliers can strengthen circular economy capabilities (Murphy & Poist, 2003). In addition, sustainable supply chain networks, including green manufacturing, green logistics, and reverse logistics, contribute to the broader implementation of circular economy practices (Xiong et al., 2015). Accordingly, the following hypothesis is proposed: H4. Sustainable supply chain design positively affects circular economy capabilities.

2. Methods

This study employs a conclusive research design to examine the proposed hypotheses and the relationships among variables. The research is descriptive in nature, aiming to describe the characteristics of the studied phenomena, and adopts a cross-sectional approach in which data were collected at a single point in time. Data collection was

conducted through a survey of SMEs (Small and Medium-sized Enterprises) in Indonesia. Respondents were selected using purposive sampling, focusing on SMEs operating in the cosmetics and fashion sectors. The collected data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS software.

The study includes four variables adopted from previous research. Green supply chain management and supply chain relationship management serve as independent variables that influence circular economy capabilities. Sustainable supply chain design functions as a mediating variable in the relationship between supply chain relationship management and circular economy capabilities. All variables were measured using a five-point Likert scale. The operational definitions and measurements of the variables are presented in Table 1.

Table 1. Variable operationalization

Variable	Number of indicators	Source
Green Supply Chain Management (GSCM)	5	Bag et al. (2022)
Supply Chain Relationship Management (SCRM)	5	Zeng et al. (2017)
Sustainable Supply Chain Design (SSCD)	7	Zeng et al. (2017)
Circular Economic Capability (CEC)	6	Zeng et al. (2017)

2.1 Data analysis method

This study began with translating the list of questions into Indonesian. The researchers conducted a wording test to evaluate the questions and avoid ambiguity. The target respondents were seven MSMEs whose characteristics fit the main survey target. Respondents were given two answer options: correct if they understood the question in Indonesian, and others if they did not understand the question and suggested or recommended better wording. The researchers used respondents' feedback to adjust the questionnaire wording for distribution to the target respondents in the main study. This study used frequency distribution analysis to classify respondents based on their business profile, including business size according to the MSME classification in Indonesia, business location, and the industry sector.

2.2 Measurement model analysis and structural model analysis

This study used Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze relationships between indicator variables and latent constructs, as well as relationships among latent variables within the proposed research model (Hair et al., 2019). PLS-SEM has been widely used in social science studies, including supply chain management research, and is appropriate for studies with relatively small sample sizes (Hair et al., 2019). The measurement model was evaluated to ensure the constructs used in the study were adequate. Internal consistency reliability was assessed using Cronbach's alpha and composite reliability, with recommended values exceeding 0.70. Convergent validity was examined using the average variance extracted (AVE), with values of 0.50 or higher indicating adequate convergence. Discriminant validity was assessed using the heterotrait-monotrait ratio (HTMT), with values below 1.00 considered acceptable.

The structural model assessment included tests of collinearity, explanatory power, predictive relevance, and path relationships among variables. Collinearity was evaluated using the variance inflation factor (VIF), with values below 3 indicating no significant multicollinearity concerns. The coefficient of determination (R^2) assessed the proportion of variance explained by the exogenous variables, while Q^2 values greater than zero indicated predictive relevance. In addition, path coefficients were examined to determine the direction and magnitude of the relationships among constructs, where coefficients closer to +1 or -1 indicate stronger relationships and coefficients closer to zero indicate weaker relationships (Hair et al., 2019). We tested the statistical significance of the path relationships using a bootstrapping procedure with 5,000 resamples; hypotheses were

supported when the t-statistic exceeded 1.96 or the p-value was below 0.05 at the 5% significance level (Hair et al., 2019). All analyses were conducted using SmartPLS software.

3. Results and Discussion

3.1 Research result

The survey was targeted at MSMEs in the fashion and cosmetics industries operating on Java and Bali islands, with a total of 72 respondents. All respondents' answers were acceptable because the screening test filtered MSME profiles before the main questions (at least they had implemented one of the three 3R concepts).

Of the 72 MSMEs that participated, 62.5% were in the fashion industry and 37.5% in the cosmetics industry. The participants were classified as micro businesses (69.4%), small businesses (29.2%), and medium businesses (1.4%). The businesses' ages varied: 48.61% were 1-3 years old, 30.56% were 4-6 years old, and 20.83% were over 6 years old. The most common sustainability strategy implemented was reduce (91.7%), followed by recycle (52.8%) and reuse (56.9%).

Respondents represented MSMEs as owners (or equivalent to founders and CEOs) at 51.39%, representatives in director positions at 13.89%, managers at 19.44%, and those who did not mention their position at 15.28%. Most of the respondents worked at these MSMEs for 1-3 years (63.89%), while 25% worked for 4-6 years, and 11.11% had worked for more than 6 years. The respondents' latest education level was mostly Bachelor's degree (S1) at 73.6%. Master's degree holders (S2) made up 13.9%, diploma holders 6.9%, and high school/equivalent 5.6%.

Before evaluating the measurement and structural models, descriptive statistics were examined to provide an overview of respondents' perceptions regarding the variables investigated in this study. The descriptive analysis summarizes the central tendency and variability of each construct, allowing an initial assessment of the extent to which participating SMEs have implemented sustainable supply chain management practices and circular economy capabilities. Table 2 presents the results.

Table 2. Descriptive statistics

Variable	Indicator	Min	Max	SD	Indicator mean	Variable mean
Green supply chain management (GSCM)	GSC1	3	5	0.527	4.667	4.408
	GSC2	3	5	0.623	4.472	
	GSC3	3	5	0.700	4.306	
	GSC4	3	5	0.684	4.569	
	GSC5	1	5	0.971	4.028	
Supply chain relationship management (SCRM)	SCR1	2	5	0.855	4.069	3.833
	SCR2	1	5	0.844	4.153	
	SCR3	1	5	0.986	3.486	
	SCR4	1	5	0.965	3.986	
	SCR5	1	5	1.013	3.472	
Sustainable supply chain design (SSCD)	SCD1	1	5	0.864	4.444	3.980
	SCD2	2	5	0.666	4.528	
	SCD3	1	5	1.003	3.722	
	SCD4	1	5	0.870	3.722	
	SCD5	1	5	0.841	3.958	
	SCD6	1	5	1.054	4.167	
	SCD7	1	5	1.373	3.319	
Circular economic capability (CEC)	CEC1	2	5	0.862	4.250	3.820
	CEC2	1	5	1.048	4.111	
	CEC3	1	5	1.145	3.778	
	CEC4	1	5	1.146	3.861	
	CEC5	1	5	1.394	3.264	
	CEC6	1	5	1.204	3.653	

As presented in Table 2, Green Supply Chain Management (GSCM) recorded the highest overall mean (4.408), indicating that environmentally oriented practices have been relatively well adopted among the surveyed SMEs. Sustainable Supply Chain Design (3.980), Supply Chain Relationship Management (3.833), and Circular Economy Capability (3.820) showed moderately high mean values, suggesting that although SMEs have implemented sustainability initiatives, considerable room for improvement remains. The relatively larger standard deviations observed for several indicators also indicate variations in implementation across SMEs, reflecting differences in organizational capabilities and sustainability maturity.

This research excluded indicators with outer loading values below 0.6. Hair (2014) stated that indicators with outer loading values between 0.40 and 0.70 can be removed if the exclusion increases the composite reliability. The GSC1 indicator in the green supply chain management variable (0.511) and the SCD5 indicator in the sustainable supply chain variable (0.226) were excluded. The measurement and structural model analyses were then calculated from the model that removed the GSC1 and SCD5 indicators.

Before evaluating construct reliability and validity, we assessed indicator reliability through outer loading analysis. Indicators with insufficient loadings were removed to improve the measurement model quality, in accordance with the recommendations of Hair et al. (2019).

Table 3. Outer loading values (after adjustment)

Variable	Indicator	Outer loading value
Green supply chain management (GSCM)	GSC2	0.720
	GSC3	0.626
	GSC4	0.729
	GSC5	0.778
Supply chain relationship management (SCRM)	SCR1	0.876
	SCR2	0.840
	SCR3	0.739
	SCR4	0.750
	SCR5	0.705
Sustainable supply chain design (SSCD)	SCD1	0.806
	SCD2	0.719
	SCD3	0.829
	SCD4	0.772
	SCD6	0.891
	SCD7	0.779
Circular economy capability (CEC)	CEC1	0.747
	CEC2	0.829
	CEC3	0.786
	CEC4	0.742
	CEC5	0.764
	CEC6	0.785

The retained indicators exhibited satisfactory outer loading values ranging from 0.626 to 0.891, indicating acceptable indicator reliability. The exclusion of GSC1 and SCD5 improved the measurement quality without compromising the conceptual representation of the constructs.

3.1.1 Internal consistency reliability

This test evaluated the reliability of the variables included in the study. In general, higher reliability values indicate greater consistency of the measurement items used to represent a construct. Reliability was assessed using composite reliability and Cronbach's alpha. A Composite Reliability value above 0.70 indicates satisfactory reliability, while a Cronbach's alpha value above 0.70 is generally recommended (Hair et al., 2019).

Based on the results presented in Table 4, all variables included in this study meet the reliability criteria. Although the Cronbach's alpha value of the green supply chain management variable is slightly below the recommended threshold, the construct can still be considered reliable because its Composite Reliability value exceeds 0.70. According to Hair et al. (2019), Composite Reliability is regarded as a more appropriate measure of internal consistency in PLS-SEM, whereas Cronbach's alpha serves as a supporting indicator rather than a strict requirement.

Table 4. Internal consistency test

Variable	Composite reliability	Cronbach's alpha
Green supply chain (GSC)	0.802	0.669
Supply chain relationship management (SCRM)	0.853	0.800
Sustainable supply chain design (SSCD)	0.880	0.838
Circular economy capability (CEC)	0.863	0.809

3.1.2 Convergent validity

The convergent validity test assessed the extent to which the indicators represent their respective constructs. This test evaluates a construct's ability to explain the variance in its indicators and reflects the relationship between latent variables and their measurement items. Convergent validity was assessed using the Average Variance Extracted (AVE), with a minimum recommended value of 0.50, indicating that a construct explains at least 50% of the variance of its indicators (Hair et al., 2019).

The results show that the Green Supply Chain Management (GSCM) variable has an AVE value of 0.507, Supply Chain Relationship Management (SCRM) has an AVE value of 0.540, Sustainable Supply Chain Design (SSCD) has an AVE value of 0.552, and Circular Economy Capability (CEC) has an AVE value of 0.513. Since all AVE values exceed the recommended threshold of 0.50, the constructs demonstrate adequate convergent validity. These findings indicate that the indicators are sufficiently associated with their respective latent variables and are able to explain a substantial proportion of the variance within each construct.

3.1.4 Discriminant validity

The discriminant validity test measures how a construct empirically differs from other constructs in the structural model. Henseler et al. (2015) stated that an HTMT value above 0.90 indicates that discriminant validity does not exist. Table 5 shows that in this study, each variable is considered valid because its value is below 0.90.

Table 5. HTMT Value

	GSCM	CEC	SCRM	SSCD
GSCM				
CEC	0.803			
SCRM	0.714	0.420		
SSCD	0.710	0.662	0.648	

3.2 Structural model analysis

The structural model analysis was conducted to examine the relationships among the latent variables in the proposed research model. Several evaluation criteria were used, including the coefficient of determination (R^2), predictive relevance (Q^2), and path coefficients to assess the significance and strength of the relationships between variables. Prior to evaluating the structural model, a collinearity assessment was performed to ensure that the estimated relationships were not affected by multicollinearity issues (Hair et al., 2019). Collinearity was assessed using the Variance Inflation Factor (VIF), with values below 3.0 indicating an acceptable level of collinearity. Table 6 presents the inner VIF values obtained from the relationships among the variables in the model. The results show that all

VIF values are below the recommended threshold, indicating that multicollinearity is not a concern and that the structural model estimates can be interpreted reliably.

Table 6. Inner VIF Values

	GSCM	CEC	SCRM	SSCD
GSCM		1.483		
CEC				
SCRM		1.641	1.000	
SSCD		1.740		

3.2.1 Coefficient of determination (R^2) test

The coefficient of determination (R^2) assesses the explanatory power of endogenous constructs within the research model. Higher R^2 values indicate that exogenous variables explain more variation in endogenous variables. According to Hair et al. (2019), R^2 values of 0.75, 0.50, and 0.25 can be interpreted as substantial, moderate, and weak, respectively. The results show that the Sustainable Supply Chain Design (SSCD) variable has an R^2 value of 0.470 and an adjusted R^2 value of 0.447. Meanwhile, the Circular Economy Capability (CEC) variable has an R^2 value of 0.349 and an adjusted R^2 value of 0.340. These findings indicate that the model explains a moderate proportion of the variance in both endogenous variables, suggesting acceptable predictive power within the proposed research framework.

3.2.2 Predictive relevance (Q^2) test

The predictive relevance (Q^2) assessment was conducted using the blindfolding procedure available in SmartPLS. A Q^2 value greater than zero indicates that the model has adequate predictive relevance for the endogenous constructs being evaluated. In this study, the Q^2 values were calculated using the cross-validated redundancy approach with the default omission distance (D) set at 7. As presented in Table 7, all endogenous variables exhibit Q^2 values above zero, indicating that the proposed model possesses predictive relevance. The Circular Economy Capability (CEC) variable obtained a Q^2 value of 0.211, while the Sustainable Supply Chain Design (SSCD) variable recorded a Q^2 value of 0.179. These results suggest that the model has satisfactory predictive capability for both endogenous constructs included in the study.

Table 7. Results of predictive relevance (Q^2)

	SSO	SSE	$Q^2 (=1-SSE/SSO)$
GSCM	288,000	288,000	
CEC	432,000	340,766	0.211
SCRM	360,000	360,000	
SSCD	432,000	354,626	0.179

3.2.3 Hypothesis testing using direct path and indirect path

Following the measurement model and structural model evaluations, the significance of the proposed relationships was assessed using the bootstrapping procedure in SmartPLS. The analysis was performed with 5,000 bootstrap subsamples, a one-tailed testing approach, and a significance level of 0.05. According to Hair et al. (2019), a relationship is considered statistically significant when the T-statistic is equal to or greater than 1.645 and the corresponding p-value is below 0.05, indicating a 95% confidence level. Table 8. Presents the results of the direct path coefficient analysis obtained from the bootstrapping procedure. These results were used to evaluate the significance and direction of the relationships among the variables included in the research model. Based on the bootstrapping results, hypotheses with T-statistics equal to or greater than 1.645 and p-value s below 0.05 were considered supported, whereas those that did not meet these

criteria were considered not supported. The detailed findings for each hypothesis, including the direction and strength of the relationships, are discussed in the following section. Overall, these bootstrapping results provide the empirical basis for testing the proposed hypotheses and for interpreting the structural relationships within the research model.

Table 8. Direct path values

	Original sample	Sample mean	Standard deviation	T-value	p-value
GSCM to CEC	0.443	0.417	0.157	2.822	0.002
SCRM to CEC	-0.113	-0.123	0.132	0.855	0.196
SCRM to SSCD	0.591	0.622	0.068	8.644	0.000
SSCD to CEC	0.414	0.461	0.180	2.304	0.011

Table 8 shows that Green Supply Chain Management (GSCM) has a significant positive effect on Circular Economy Capability (CEC). Similarly, Sustainable Supply Chain Design (SSCD) shows a significant positive influence on Circular Economy Capability (CEC). In addition, Supply Chain Relationship Management (SCRM) significantly and positively affects Sustainable Supply Chain Design (SSCD). However, the direct relationship between Supply Chain Relationship Management (SCRM) and Circular Economy Capability (CEC) was not significant. This is reflected in a T-statistic of 0.855, below the recommended threshold of 1.645, and a p-value of 0.196, which exceeds the 0.05 significance level. Therefore, the direct effect of SCRM on CEC is not supported. The indirect effect analysis reveals that Supply Chain Relationship Management (SCRM) influences Circular Economy Capability (CEC) through Sustainable Supply Chain Design (SSCD) as a mediating variable. The indirect relationship is statistically significant, with a T-statistic of 2.176 and a p-value of 0.015. These findings suggest that SCRM indirectly improves circular economy capability by strengthening sustainable supply chain design practices.

Table 9. Indirect path values

	Original sample	Sample mean	Standard deviation	t-value	p-value
GSCM to CEC					
SCRM to CEC	0.245	0.285	0.115	2.130	0.017
SCRM to SSCD					
SSCD to CEC					

Table 10 shows the results of hypothesis testing based on the direct path coefficient values, specifically the t-values of each correlation relationship examined in this study. These results provide evidence regarding the strength and significance of the proposed relationships among variables. The findings also serve as the basis for determining whether each hypothesis is supported or rejected.

Table 10. Research hypothesis summary

Hypothesis	Hypothesis statement	Reference research results	Research results
H1	Green supply chain management positively affects circular economy capabilities	Accepted	Accepted
H2	Supply chain relationship management positively affects circular economy capabilities	Accepted	Not accepted
H3	Supply chain relationship management positively affects sustainable supply chain design	Accepted	Accepted
H4	Sustainable supply chain design positively affects circular economy capabilities	Accepted	Accepted

Overall, the structural model results indicate that three of the four proposed hypotheses are supported. Green Supply Chain Management and Sustainable Supply Chain Design exert significant positive effects on Circular Economy Capability, whereas Supply

Chain Relationship Management contributes indirectly through Sustainable Supply Chain Design. These findings provide the empirical basis for a more comprehensive discussion regarding the theoretical implications and practical relevance of sustainable supply chain management in strengthening circular economy capabilities among Indonesian SMEs.

3.3 Discussion

3.3.1 Green supply chain management positively affects circular economy capabilities

The hypothesis proposing a positive effect of Green Supply Chain Management (GSCM) on Circular Economy Capability (CEC) is supported. This result is evidenced by a T-statistic of 2.822, which exceeds the minimum threshold of 1.645, and a p-value of 0.002, which is below the significance level of 0.05. The finding is consistent with the study conducted by Bag et al. (2022), which reported a positive relationship between green supply chain management practices and circular economy implementation among manufacturing SMEs in South Africa.

In the cosmetics sector, green supply chain management is reflected in operational decisions aimed at reducing environmental impacts. Several SMEs have introduced initiatives such as packaging return programs, the use of more environmentally friendly packaging materials, and efforts to reduce the use of shipping materials, including plastic-based protective packaging. Although not all SMEs have completely transitioned away from conventional plastic packaging, many have demonstrated a commitment to adopting more sustainable alternatives. Since the effectiveness of packaging return programs depends on customer participation, these businesses actively communicate environmental information and program details through their social media platforms.

In the fashion sector, SMEs implement green supply chain management by reducing production waste and maximizing the use of available resources. Some businesses utilize deadstock fabrics or unsold textile inventories as raw materials, while others repurpose fabric remnants generated during the production process into new products. In addition, several SMEs have adopted environmentally friendly packaging options, such as biodegradable cassava-based plastics and cardboard packaging. To strengthen environmental awareness, many fashion SMEs also use social media channels to share information regarding textile waste reduction and responsible packaging practices.

3.3.2 Supply chain relationship management positively affects circular economy capabilities

The hypothesis proposing a positive effect of Supply Chain Relationship Management (SCRM) on Circular Economy Capability (CEC) was not supported. The result shows a T-statistic of 0.855, which is below the required threshold of 1.645, and a p-value of 0.196, which exceeds the significance level of 0.05. Furthermore, the path coefficient value of -0.113 indicates a negative and statistically insignificant relationship between SCRM and CEC. These findings suggest that supply chain relationship management alone is not sufficient to directly improve circular economy capability among SMEs in the fashion and cosmetics industries.

However, the indirect effect analysis reveals a different pattern. Supply Chain Relationship Management (SCRM) significantly influences Circular Economy Capability (CEC) through Sustainable Supply Chain Design (SSCD) as a mediating variable. This indirect relationship is supported by a T-statistic of 2.130, which exceeds the minimum threshold of 1.645, and a p-value of 0.017, which is below 0.05. The results indicate that the contribution of supply chain relationships to circular economy capability becomes significant when sustainability principles are integrated into supply chain design.

This finding implies that relationships among suppliers, business partners, and other supply chain actors can strengthen the circular economy capability of SMEs when supported by sustainable supply chain design practices. Through the adoption of sustainability-oriented supply chain designs, SMEs are better positioned to implement circular economy

initiatives, including resource efficiency, waste reduction, and closed-loop production systems.

3.3.3 Supply chain relationship management positively affects sustainable supply chain design

The results indicate that Supply Chain Relationship Management (SCRM) has a significant positive effect on Sustainable Supply Chain Design (SSCD), as evidenced by a T-statistic of 8.644 and a p-value of 0.000. Although SCRM does not directly influence Circular Economy Capability (CEC), relationships among business owners, suppliers, distributors, and retailers remain important in supporting the implementation of sustainability-oriented business practices. Strong collaboration among supply chain actors can facilitate the development of sustainable supply chain designs that ultimately contribute to circular economy initiatives. In the cosmetics industry, sustainable supply chain design can be implemented throughout the production process. Most SMEs included in this study utilize natural raw materials to reduce the potential environmental impacts associated with chemical waste. Several businesses have also adopted return-based initiatives, encouraging consumers to return used packaging through courier services or through partnerships with offline retailers that provide collection points for packaging waste. These efforts support resource recovery and waste reduction within the supply chain.

In the fashion industry, production activities generally rely on traditional technologies, particularly among SMEs producing and marketing woven fabrics. To minimize waste generation, many businesses focus on controlling production volumes and preventing the accumulation of unsold inventory or deadstock. Such practices contribute to more efficient resource utilization and support sustainability objectives. However, SMEs still face limitations regarding logistics facilities and transportation arrangements. Since products are distributed through multiple sales channels and platforms, the location of logistics facilities often depends on the locations of partner retailers or distributors. Similarly, transportation decisions are constrained because most SMEs rely on third-party courier services to deliver products to customers. These conditions highlight the operational challenges faced by SMEs in implementing fully integrated sustainable supply chain systems.

3.3.4 Sustainable supply chain design positively affects circular economy capabilities

The results indicate that Sustainable Supply Chain Design (SSCD) has a significant positive effect on Circular Economy Capability (CEC), as demonstrated by a T-statistic of 2.304 and a p-value of 0.011. This finding suggests that implementing sustainable supply chain design strengthens SMEs' ability to adopt circular economy practices. As an approach that integrates economic, environmental, and social considerations into supply chain activities, SSCD aligns closely with circular economy principles, particularly the concepts of reduce, reuse, and recycle (Ghisellini et al., 2016). Several indicators used to measure SSCD in this study reflect efforts to transform production outputs that would otherwise become waste into resources with continued economic value.

Among the three circular economy principles, reducing resource consumption appears to be the most widely adopted practice among the surveyed SMEs. The screening results support this, showing that 91.7% of respondents have implemented initiatives to minimize waste generation, pollution, or excessive resource use during production. In the cosmetics sector, these efforts include reducing dependence on chemical-based materials and increasing the use of natural ingredients. Meanwhile, SMEs in the fashion industry tend to control production volumes to avoid excess inventory and prevent unsold products from accumulating.

Reuse practices differ between the two industries. In the cosmetics sector, several SMEs have introduced programs to collect used packaging from consumers for recycling or to transfer materials to organizations that can process them more effectively. In contrast, fashion SMEs primarily focus on utilizing production residues generated during

manufacturing activities. Fabric scraps and leftover materials are often redesigned and transformed into new products, thereby extending the useful life of materials and reducing waste generation. These practices demonstrate how sustainable supply chain design can support the development of circular economy capabilities within SMEs.

3.3.5 The impact of green supply chain management on circular economy capabilities

The results support the hypothesis that Green Supply Chain Management (GSCM) positively influences Circular Economy Capability (CEC). This is supported by a T-statistic of 2.822, which exceeds the threshold of 1.645, and a p-value of 0.002, which is below the 0.05 significance level. These findings indicate that SMEs operating in the fashion and cosmetics sectors have begun integrating green supply chain practices into their operations, thereby supporting the implementation of circular economy principles, particularly the concepts of reduce, reuse, and recycle.

In the cosmetics industry, green supply chain management is reflected in a variety of operational and strategic decisions. Most SMEs in this study were founded on sustainability-oriented values and have adopted initiatives to reduce environmental impacts. One common practice is the gradual transition toward environmentally friendly packaging solutions. Although some businesses still rely partially on plastic packaging, many have introduced packaging return schemes, reduced the use of shipping materials such as bubble wrap, and explored alternative packaging options with lower environmental footprints. These initiatives are closely linked to investment recovery practices, in which used packaging is collected for recycling or transferred to organizations that can further process the materials. Because the success of such programs depends on consumer participation, SMEs use social media to raise awareness of plastic waste issues and encourage responsible consumption. Several businesses also provide incentives, such as reward points or small gifts, to motivate customers to return used packaging.

The fashion industry demonstrates a somewhat different approach to implementing green supply chain management. Many SMEs focus on minimizing textile waste by optimizing material utilization throughout the production process. Some businesses use deadstock fabrics or unsold inventories as raw materials, while others transform fabric remnants into new products. In terms of packaging, sustainability-oriented SMEs have adopted biodegradable cassava-based plastics or cardboard materials as alternatives to conventional packaging. Although plastic packaging is still used in certain cases, particularly for shipping purposes, business owners generally recognize its environmental implications and seek to reduce its usage whenever possible. Similar to cosmetics SMEs, fashion businesses also use social media platforms to share information related to textile waste management and environmentally responsible packaging practices, reflecting efforts to engage consumers in sustainability initiatives and strengthen collaboration throughout the value chain.

3.3.6 The influence of supply chain relationship management on circular economy capability

The findings indicate that Supply Chain Relationship Management (SCRM) does not have a direct effect on Circular Economy Capability (CEC). This result is supported by the hypothesis testing outcome, which shows a T-statistic of 0.855, below the required threshold of 1.645, and a p-value of 0.196, exceeding the significance level of 0.05. Nevertheless, the indirect effect analysis reveals that SCRM contributes to Circular Economy Capability through Sustainable Supply Chain Design (SSCD) as a mediating variable. This relationship is statistically significant, as indicated by a T-statistic of 2.130 and a p-value of 0.017. According to Tidy et al. (2016), effective supply chain relationships involve coordination, collaboration, information exchange, joint planning, and collective decision-making among supply chain actors. However, the results of this study suggest that such conditions are not fully realized among the surveyed SMEs. In practice, SMEs generally possess limited bargaining power to influence suppliers, distributors, or retailers in

adopting sustainability-oriented practices. Instead, their role is largely restricted to selecting and evaluating business partners that are already supportive of environmental and sustainability objectives. As a result, supply chain relationships alone are insufficient to directly enhance circular economy capability within SMEs operating in the fashion and cosmetics sectors.

The results further suggest that the contribution of supply chain relationships becomes meaningful when supported by a sustainable supply chain design. In the absence of sustainability-oriented business processes, interactions between SMEs and their suppliers or retailers are comparable to those found in conventional linear business models. Conversely, when sustainability principles are integrated into supply chain design, relationships with suppliers, distributors, and retailers can facilitate the adoption of circular economy practices. Under these conditions, collaboration within the supply chain can support the implementation of closed-loop systems, improve resource utilization, and strengthen the overall circular economy capability of SMEs.

3.3.7 The influence of supply chain relationship management on sustainable supply chain design

The results indicate that Supply Chain Relationship Management (SCRM) has a significant positive effect on Sustainable Supply Chain Design (SSCD), as demonstrated by a T-statistic of 8.644 and a p-value of 0.000. Although SCRM does not directly enhance Circular Economy Capability (CEC), effective relationships among business owners, suppliers, distributors, and retailers remain essential for supporting the implementation of sustainable business practices. Strong collaboration across the supply chain can facilitate the development of sustainability-oriented systems and operational processes. In this study, Sustainable Supply Chain Design (SSCD) is represented by several dimensions, including environmentally friendly production technologies and processes, sustainable product design, logistics facility location, transportation mode selection, retailer capability to market products, recycling activities, and the availability of recycling or waste-sorting facilities. The implementation of these elements generally requires support from external stakeholders. Consequently, achieving an effective sustainable supply chain design depends not only on internal business initiatives but also on cooperation with various actors throughout the supply chain.

One indicator related to retailers' ability to provide environmentally friendly products and packaging was excluded from the analysis. This decision was made because only a limited number of retailers and distributors currently operate with sustainability-oriented business models. Furthermore, restricting product distribution exclusively to environmentally focused retailers could reduce market access and limit consumer reach for SMEs in both industries. In practice, when products are distributed through specific retailers or sales channels, packaging requirements often need to comply with the standards established by those retailers. For SMEs in the cosmetics sector, the application of sustainable supply chain design can begin at the production stage. Businesses can incorporate sustainability considerations into raw material selection, manufacturing processes, packaging decisions, and waste management practices, thereby supporting broader circular economy objectives throughout the supply chain.

3.3.8 The influence of sustainable supply chain design on circular economy capabilities

The findings demonstrate that Sustainable Supply Chain Design (SSCD) has a significant positive effect on Circular Economy Capability (CEC), as indicated by a T-statistic of 2.304 and a p-value of 0.011. This result suggests that the adoption of sustainability-oriented supply chain designs contributes to strengthening the ability of SMEs to implement circular economy practices. As a framework that seeks to generate long-term value across environmental, social, and economic dimensions, SSCD is closely aligned with the core principles of the circular economy, namely reduce, reuse, and recycle (Ghisellini et al.,

2016). The indicators used to measure SSCD in this study reflect efforts to view production outputs not as end-of-life waste, but as resources that can be recovered, reused, or reintegrated into productive activities. The implementation of environmentally friendly technologies, sustainable product designs, and resource-efficient production processes supports the application of circular economy principles. These efforts can take the form of reducing raw material waste, reusing available resources such as deadstock materials in the fashion sector, or recycling packaging materials in the cosmetics industry. Through such practices, businesses can minimize environmental impacts while improving resource utilization throughout the supply chain.

Among the three circular economy principles, reducing resource consumption appears to be the most widely adopted strategy among the surveyed SMEs. This is supported by the screening results, which show that 91.7% of respondents have implemented measures aimed at reducing waste generation, pollution, or excessive resource use during production activities. The survey findings further indicate a strong commitment to lowering the consumption of raw materials and energy, with 48.6% of respondents strongly agreeing and 31.9% agreeing with statements related to resource reduction initiatives. In addition, efforts to improve energy efficiency are evident, as 45.8% of respondents strongly agreed and 30.6% agreed that their businesses actively seek to enhance the efficiency of production equipment. Industry-specific practices further illustrate the implementation of sustainable supply chain design. In the cosmetics sector, many SMEs attempt to reduce the use of chemical-based ingredients by incorporating natural raw materials into their products. Meanwhile, businesses in the fashion industry primarily focus on controlling production volumes to avoid overproduction and the accumulation of unsold inventory. These initiatives demonstrate how sustainable supply chain design can support the development of circular economy capabilities through more responsible resource management and production practices.

4. Conclusions

This study examined the effect of Sustainable Supply Chain Management (SSCM) on Circular Economy Capability (CEC) among SMEs in the fashion and cosmetics industries. The findings show that Green Supply Chain Management (GSCM) positively influences Circular Economy Capability, while Supply Chain Relationship Management (SCRM) affects Circular Economy Capability indirectly through Sustainable Supply Chain Design (SSCD). In addition, SCRM positively influences SSCD, and SSCD significantly enhances Circular Economy Capability. The results highlight the importance of sustainable supply chain practices in supporting circular economy implementation. Among the variables examined, GSCM was identified as the strongest driver of Circular Economy Capability. Environmental collaboration with consumers, eco-friendly product and packaging design, resource efficiency, and waste recovery initiatives contribute to strengthening circular economy practices. Although relationships with suppliers and retailers do not directly affect Circular Economy Capability, their value increases when integrated into a sustainability-oriented supply chain design.

Several limitations should be acknowledged. First, the adoption of circular economy practices among Indonesian SMEs remains relatively limited. Second, the study involved only 72 respondents, which was below the targeted sample size. Third, data were collected from a single respondent in each SME, potentially creating response bias. Finally, the study focused primarily on environmental dimensions and did not comprehensively address social sustainability aspects. Future research may expand the sample size and include other sectors such as food and beverage, electronics, and construction. Combining surveys with in-depth interviews may also improve data quality. In addition, future studies are encouraged to incorporate social, economic, and environmental dimensions simultaneously to provide a more comprehensive understanding of sustainability and circular economy implementation.

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Author Contribution

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