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The Role of Circular Economy Dimensions in Strengthening Sustainable Supply Chain Management

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Abstract: This study aims to uncover the effect of circular economy practices on sustainable supply chain management and to identify which dimensions of the circular economy most significantly contribute to improving supply chain performance. The research was conducted between February and April 2025 in the Cigondewah area of Bandung City, West Java, known as a center for small and medium-sized textile industries. A quantitative approach was employed, utilizing surveys and documentation analysis. Data were collected from 120 textile business actors through structured questionnaires and interviews, supported by secondary data from industry reports and government sustainability policies. The findings demonstrate that the implementation of circular economy practices has a positive and significant influence on the performance of sustainable supply chains. Through dimensional analysis, the study reveals that Rethink, Refurbish, and Reuse strongly enhance cost efficiency; Reuse, Reduce, and Recycle improve agility; and Rethink, Repurpose, Reuse, and Recycle effectively support environmental sustainability. Social sustainability is primarily driven by Recycle, while Remanufacture and Recover require strategic improvement. Reliability is strengthened by Recycle, Repurpose, Reuse, and Rethink, but Recover remains a key challenge. In the dimension of responsiveness, Recycle performs well, while Remanufacture and Recover need targeted attention. These insights provide practical implications for prioritizing specific circular economy dimensions to advance supply chain sustainability in the textile sector.

Keywords: circular economy, supply chain management, sustainability.

INTRODUCTION

Building on this paradigm shift, the circular economy is increasingly recognized not only for its environmental benefits but also for its economic and social value creation across industrial systems. By reducing reliance on finite resources and improving material efficiency, circular strategies can enhance economic competitiveness while significantly lowering environmental impacts (Abad-Segura et al., 2020). Recycling remains a fundamental component of the circular model, helping to conserve resources and divert waste from landfills, even as its limitations highlight the need for broader systemic change (King, 2022). However, the transition to a circular economy is far from straightforward. Various barriers ranging from financial constraints and technological limitations to human resource capacity and consumer indifference continue to hinder practical implementation (Tan et al., 2022; Saha et al., 2021). Addressing these challenges requires a holistic and collaborative approach involving industry actors, supportive government policies, and increased public awareness (Saha et al., 2021). Moreover, integrating social dimensions such as employment quality and community well-being into CE initiatives is vital for ensuring inclusive and equitable outcomes (Padilla-Rivera et al., 2020). Industrial design also plays a pivotal role by promoting product durability and enabling processes such as reuse and remanufacturing, which support closed-loop systems and circular consumption behaviors (Dam et al., 2020). As companies rethink their business models to meet sustainability demands, innovation becomes essential to embed environmental and social considerations into core strategies (Koval et al., 2022). Although the transition involves significant structural and behavioral shifts, the circular economy offers a compelling framework for achieving sustainable development across industries and regions.

One sector that stands to benefit significantly from the application of circular economy principles is the supply chain, which encompasses the entire lifecycle of production and distribution processes. The integration of circular economy strategies into supply chain management is increasingly recognized as essential for enhancing sustainability, resilience, and operational efficiency in modern industrial networks. By adopting circular practices such as recycling, remanufacturing, reuse, and circular product design, supply chains can shift from traditional linear models toward more sustainable closed-loop systems that reduce waste, optimize resource use, and extend product lifecycles (Bhattacharya, 2021; Hazen et al., 2021). This transformation not only supports environmental and social objectives, but also delivers economic value by lowering operational costs and increasing resource efficiency. The integration of circular principles further enables innovation in product development and business models, especially when supported by emerging Industry 4.0 technologies like IoT and AI, which enhance real-time decision-making and adaptive capabilities (Kennedy-Schtyk, 2022). In addition, aligning performance measurement frameworks with the triple bottom line economic, environmental, and social goals helps guide planning, sourcing, and recovery activities in circular supply chains (Vegter et al., 2020). While this transition presents challenges, including technological investment and systemic restructuring (Zhang et al., 2021), strategic alignment and industrial collaboration offer significant opportunities for competitive advantage and long-term sustainability (Maranesi & Giovanni, 2020). As such, embedding circularity into supply chains is no longer optional it is becoming a strategic imperative for future-ready, sustainable enterprises.

The adoption of circular economy (CE) practices in small and medium-sized enterprises (SMEs) is essential for advancing sustainable supply chain management, which aims to simultaneously achieve environmental, social, and economic performance. Despite their potential, SMEs often face distinct challenges in adopting sustainability-oriented practices due to limited financial, technological, and human resources. However, recent empirical studies offer valuable insights into the specific dimensions of circularity that have the greatest impact on supply chain outcomes, enabling more targeted and effective implementation strategies. For instance, Dey et al. (2020) identify five key fields of action in CE take, make, distribute, use, and recover with the "make" and "use" phases being particularly influential on environmental and social performance, while all fields relate to economic outcomes. Le et al. (2022) emphasize the role of circular economy entrepreneurship (CEE) as a moderator that strengthens the relationship between CE practices and sustainable supply chain management. Similarly, Khan et al. (2023) highlight green technology adoption (GTA) as a key enabler of CE, noting that the adoption of such technologies improves sustainability performance and is influenced by both CEE and customer pressure. To address resource limitations, Correia et al. (2023) propose a governance-based framework, while Howard et al. (2022) advocate for adapting existing tools like value mapping and life cycle assessment for SMEs. A phased approach and regional collaboration are recommended for gradual CE integration (Howard et al., 2022), and Zhang et al. (2021) suggest a multi-dimensional framework incorporating reverse logistics and industrial symbiosis to support zero-waste goals. As Bhattacharya (2021) notes, the synergy between CE and Industry 4.0 can further enhance the sustainability of SME supply chains, provided there is systemic support from policymakers and industry stakeholders.

The textile industry, especially in developing economies, provides a compelling context for examining the intersection of circular economy and supply chain management. Textile production is known for its high resource intensity, including water, chemicals, and energy use, as well as significant waste generation and environmental pollution. In regions such as Cigondewah in Bandung, Indonesia, the textile industry comprises numerous SMEs engaged in manufacturing, processing, and trading textiles. These businesses operate within dense industrial clusters that offer opportunities for knowledge sharing and collaborative sustainability efforts. However, they also face systemic constraints related to infrastructure, regulation, and market access. In this context, understanding how circular economy principles can enhance supply chain performance is vital for driving local and regional sustainability.

This study was conducted in the Cigondewah area with the objective of uncovering the impact of circular economy practices on the performance of sustainable supply chain management and identifying which dimensions of circularity play the most critical roles. Using a quantitative approach, the study collected primary data through structured surveys and interviews with 120 textile business actors. The analysis focused on nine recognized dimensions of the circular economy, including Rethink, Refuse, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, and Recycle. These dimensions were evaluated against key performance areas of sustainable supply chain management such as cost efficiency, agility, reliability, responsiveness, environmental sustainability, and social sustainability.

While previous studies have explored the theoretical linkage between circular economy and supply chain sustainability, there remains a lack of detailed empirical work that disaggregates the impact of each circular economy dimension. In addition, most prior research has concentrated on large multinational corporations, leaving a significant gap in understanding how SMEs implement and benefit from circularity. This research addresses that gap by providing evidence from a developing-country context, where supply chain challenges are compounded by infrastructural and institutional limitations.

Moreover, the study contributes to the body of knowledge by applying a structured assessment approach that evaluates both the importance and performance of circular economy dimensions in relation to supply chain outcomes. This allows for the identification of priority areas for intervention, revealing which circular practices are most effectively implemented and which require greater focus and investment. For example, while practices such as Recycle and Reuse may already be well integrated in many businesses, dimensions like Recover or Refuse may lag behind due to lack of awareness or technical feasibility. These insights can inform policymakers, business leaders, and sustainability practitioners in designing targeted programs that support more holistic and impactful adoption of circular economy strategies.

From a policy perspective, the findings of this study have implications for regional development, particularly in promoting green industrial zones and eco-industrial clusters. By demonstrating the tangible benefits of circular economy integration within supply chains, this research provides a framework for local governments and development agencies to support SMEs in their sustainability transitions. At the same time, it underscores the importance of education, capacity building, and financial support mechanisms to overcome adoption barriers.

In conclusion, this study responds to the urgent need for sustainable transformation in industrial practices by investigating how the circular economy can be operationalized within the context of supply chain management. By focusing on the real-world experiences of textile SMEs in Cigondewah, the research offers actionable insights that bridge the gap between concept and practice. It emphasizes that circularity is not merely a theoretical ideal, but a strategic necessity for building resilient, sustainable, and competitive supply chains especially in sectors and regions where resource constraints and environmental impacts are most pronounced. The evidence generated through this study is intended to support ongoing efforts to mainstream sustainability within supply chains and to provide a basis for further academic exploration and practical innovation.

Literature Review

The concept of the circular economy has gained increasing attention in both academic and industrial fields as a strategic response to the environmental and resource-related challenges of linear economic models. According to the Ellen MacArthur Foundation (2015), the circular economy is based on designing out waste, keeping products and materials in use, and regenerating natural systems. This model is closely tied to sustainability principles and aligns with the triple bottom line framework (Elkington, 1997), which emphasizes the balance between economic, environmental, and social performance. Within the supply chain context, the adoption of circular economy principles can lead to greater resource efficiency, reduction in environmental impact, and long-term value creation, all of which are essential components of sustainable supply chain management.

The integration of circular economy practices into supply chain management is supported by the Resource-Based View (RBV) theory (Barney, 1991), which posits that firms can achieve sustained competitive advantage by leveraging valuable, rare, inimitable, and non-substitutable (VRIN) resources. Circular economy practices such as reuse, remanufacturing, recycling, and redesign serve as strategic capabilities that enhance operational efficiency and reduce environmental and supply risks. For example, Genovese et al. (2017) found that circular strategies contribute to cost reduction and improved supply chain resilience. Furthermore, by closing material loops and reducing dependency on virgin resources, circular practices help firms achieve sustainability targets and respond to stakeholder demands for responsible business practices.

Empirical studies further support the positive relationship between circular economy adoption and sustainable supply chain performance. For instance, Batista et al. (2018) demonstrated that circular supply chains improve environmental outcomes without compromising economic efficiency. Similarly, Govindan and Hasanagic (2018) emphasized the role of circular economy in improving agility, responsiveness, and environmental sustainability within supply chain networks. These findings suggest that circular economy implementation is not only environmentally beneficial but also strategically aligned with supply chain performance goals. Thus, building on the theoretical foundations of sustainability and resource-based strategy, this study proposes that the adoption of circular economy practices significantly enhances sustainable supply chain management.

Hypothesis Development

The circular economy has emerged as a transformative approach that shifts traditional linear production models toward more sustainable, regenerative systems. By focusing on strategies such as reducing material use, reusing products, recycling resources, and extending product lifecycles, the circular economy aims to minimize waste and resource consumption while promoting environmental and economic resilience. These principles directly align with the goals of sustainable supply chain management, which seeks to optimize operational efficiency while maintaining environmental responsibility and social equity across the supply chain. Through circular practices, companies can reduce dependency on raw materials, lower operational costs, and increase supply chain transparency, thus reinforcing the foundation of sustainability within their supply networks.

Given this alignment, the adoption of circular economy practices is expected to have a significant impact on improving the performance of sustainable supply chains. Prior studies have indicated that circular strategies can enhance cost efficiency, reduce environmental impact, and improve supply chain responsiveness and adaptability in the face of disruption. As such, businesses that integrate circular principles are more likely to develop supply chains that are not only economically viable but also environmentally and socially sustainable. Based on this theoretical and empirical foundation, the following hypothesis is proposed:

H1: Circular economy practices positively influence sustainable supply chain management.

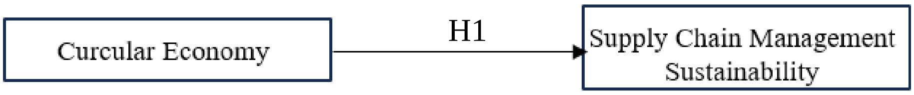

Figure 1. Research Framework

METHOD

Research Design

This study adopts a quantitative research approach to examine the influence of circular economy practices on sustainable supply chain management, specifically within small and medium-sized textile enterprises located in the Cigondewah area of Bandung, Indonesia. The research was conducted over a three-month period, from February to April 2025, to ensure comprehensive data collection from various actors involved in the textile supply chain. The Cigondewah area was strategically selected due to its concentration of textile SMEs and its relevance to circular economy and sustainability issues in manufacturing. The study employed a descriptive and explanatory research design. Descriptive analysis was used to observe the level of implementation of circular economy principles across nine dimensions: Rethink, Refuse, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, and Recycle. Explanatory analysis was conducted to determine the extent to which these circular economy dimensions affect supply chain performance across six key dimensions: cost efficiency, agility, reliability, responsiveness, environmental sustainability, and social sustainability.

Population and Sampling

The population for this study comprises 120 textile business actors operating in the Cigondewah industrial cluster. These businesses range from micro-enterprises to medium-sized manufacturers and represent a diverse array of roles in the textile value chain, including production, distribution, and retail. Given the relatively small population size, the study adopted a census approach by surveying all 120 business actors, following the recommendation of Arikunto (2005) that when a population is fewer than 150, it is advisable to include the entire population for better representation and validity. However, the Slovin formula was also applied to validate the sample size, resulting in a minimum required sample of 92 respondents at a 5% margin of error. By engaging the full population, the study enhances statistical robustness and minimizes sampling bias.

Data Collection method

Two primary methods were used to collect data: structured surveys and semi-structured interviews. The survey instrument consisted of a Likert-scale questionnaire designed to measure the perceived level of circular economy practice implementation and the corresponding performance of supply chain dimensions. Each circular economy dimension was operationalized through 3–5 measurable indicators, adapted from existing literature on sustainable production and circular strategies. Supply chain performance indicators were aligned with the Supply Chain Operations Reference (SCOR) model, widely used in evaluating supply chain efficiency and effectiveness.

Data Analysis

The collected data were analyzed using SmartPLS 4 software. The SEM-PLS technique was chosen due to its suitability for models with multiple constructs and its ability to handle complex relationships with relatively small sample sizes. The analysis involved assessing the measurement model (outer model) for reliability and validity, followed by structural model (inner model) analysis to test the hypothesized relationships between circular economy dimensions and supply chain performance.

After evaluating the structural model, Importance-Performance Map Analysis (IPMA) was conducted to determine which circular economy dimensions are most influential in improving each aspect of supply chain performance. IPMA provided a visual mapping of each construct based on its importance (total effect) and performance (mean score), allowing researchers to identify strategic priorities. This methodological framework not only tested causal relationships but also generated practical recommendations by identifying which circular economy practices should be prioritized to enhance supply chain sustainability among textile SMEs.

RESULTS AND DISCUSSION

Profile of Respondents

This study involved 142 respondents representing various types of businesses in the Cigondewah area. The majority of respondents (45.21%) were engaged in both production and sales, indicating a dominance of business actors who not only manufacture but also directly market their own products. In terms of location, most businesses were situated in Cigondewah Kaler (56.85%), which serves as the central hub of commercial activity in the region. Regarding years of operation, a significant portion of businesses (63.01%) had been operating for less than five years, reflecting the prevalence of newly established enterprises still in their development phase. In terms of business scale, nearly all respondents (91.78%) were classified as micro-enterprises, with an annual turnover of no more than 300 million rupiahs. The employment profile further shows that 94.52% of these businesses employed only 1–20 workers, which aligns with the general characteristics of micro-enterprises in Indonesia. These findings underscore that the respondents largely consist of small-scale enterprises with limited production capacity but substantial growth potential. This context is crucial for understanding the capabilities and constraints faced by micro-business actors in Cigondewah, highlighting the need for targeted strategies focused on enhancing production capacity, marketing capabilities, and overall business management for micro-enterprise development in the region.

Table 1. Profile of Respondents

Characteristics	Category	f	%
Type of Business	Production & Sales	66	45.21%
	Sales	47	32.19%
	Distribution	24	16.44%
Business Location	Cigondewah Kaler	83	56.85%
	Cigondewah Hilir	32	21.92%
	Cigondewah Rahayu	18	12.33%
	Cigondewah Kidul	4	2.74%
Year of Operation	< 5 years	92	63.01%
	5 - 10 years	39	26.71%
	10 - 15 years	9	6.16%

	> 15 years	3	2.05%
Business Scale	Micro	130	91.78%
	Small	13	8.22%
Number of Employees	1 - 20 people	134	94.52%
	21 - 50 people	7	4.93%
	51 - 100 people	1	0.70%

SEM PLS Analysis

In this study, Structural Equation Modeling using Partial Least Squares (SEM-PLS) was employed to analyze the influence of circular economy practices on sustainable supply chain management. The analysis was carried out in two stages: evaluation of the measurement model (outer model) and evaluation of the structural model (inner model). The outer model assessment focused on testing the reliability and validity of the constructs, including indicator loadings, composite reliability, and average variance extracted. The inner model analysis examined the significance and strength of relationships between circular economy dimensions and supply chain performance indicators.

Table 2. Outer Model Test Result

Construct	Indicator	Loading Factor	Cronbach's Alpha	Composite Reliability (rho_c)	AVE	HTMT
Supplay Chain Management	AGIL	0.944	0.974	0.979	0.884	0.575
	COST	0.915				
	ENV	0.953				
	RELI	0.951				
	RESP	0.949				
	SOCS	0.929				
Circular Economic	RECV	0.941	0.974	0.978	0.845	0.575
	RECY	0.941				
	RED	0.922				
	REF	0.899				
	REM	0.929				
	REP	0.896				
	RET	0.919				
	REU	0.908				

The results of the measurement model (outer model) evaluation indicate that all constructs and indicators in this study meet the criteria for reliability and validity. The loading factors for each indicator are above 0.70, with values ranging from 0.896 to 0.953, demonstrating strong indicator reliability. The Circular Economy construct achieved a Cronbach's Alpha of 0.974, composite reliability of 0.978, and an Average Variance Extracted (AVE) of 0.845, while the Supply Chain Management construct recorded a Cronbach's Alpha of 0.974, composite reliability of 0.979, and AVE of 0.884 far exceeding the minimum thresholds of 0.70 for reliability and 0.50 for convergent validity. Furthermore, the Heterotrait-Monotrait Ratio (HTMT) values were below 0.90, confirming discriminant validity between constructs. These results confirm that the measurement model is robust, and all indicators validly reflect their respective constructs, thus allowing for reliable interpretation in the structural model analysis.

Table 3. Goodness of fit model

Variable	R^2	Q^2	SRMR
Supply Chain Management	0.317	0.271	0.032

The results of the model goodness-of-fit test show that the Supply Chain Management construct has an R^2 value of 0.317, indicating that 31.7% of the variance in Supply Chain Management can be explained by the independent variables in the model. The Q^2 value of 0.271 demonstrates that the model has good predictive relevance, as Q^2 values greater than zero indicate predictive capability. In addition, the SRMR value of 0.032, which is well below the threshold of 0.08, indicates a very good model fit, reflecting a strong alignment between the empirical data and the proposed model.

Table 4. PLS Predict

	PLS loss	LM loss	Average loss difference	t value	p value
Supply Chain Management	0.360	0.379	-0.019	1.267	0.208
Overall	0.360	0.379	-0.019	1.267	0.208

The results of the model comparison show that the PLS loss value for the Supply Chain Management construct is 0.360, while the LM (Linear Model) loss is 0.379, resulting in an average loss difference of -0.019. The negative value indicates that the PLS model performs slightly better than the linear model in terms of predictive accuracy. However, the t-value of 1.267 and the p-value of 0.208 suggest that this difference is not statistically significant. Overall, while PLS shows a marginally lower prediction error, the improvement over the linear model is not significant at conventional confidence levels.

Table 5. Inner Model Test Result

	Original sample (O)	T statistics (|O/STDEV|)	P values
Circular Economy -> Supply Chain Management	0.563	10.280	0.000

The structural model analysis reveals that the path coefficient from Circular Economy to Supply Chain Management is 0.563, with a t-statistic of 10.280 and a p-value of 0.000. This indicates a strong, positive, and statistically significant relationship between circular economy practices and supply chain management performance. The high t-value and the p-value below 0.05 confirm that the influence is significant at the 95% confidence level. Thus, it can be concluded that greater adoption of circular economy principles leads to substantial improvements in sustainable supply chain management.

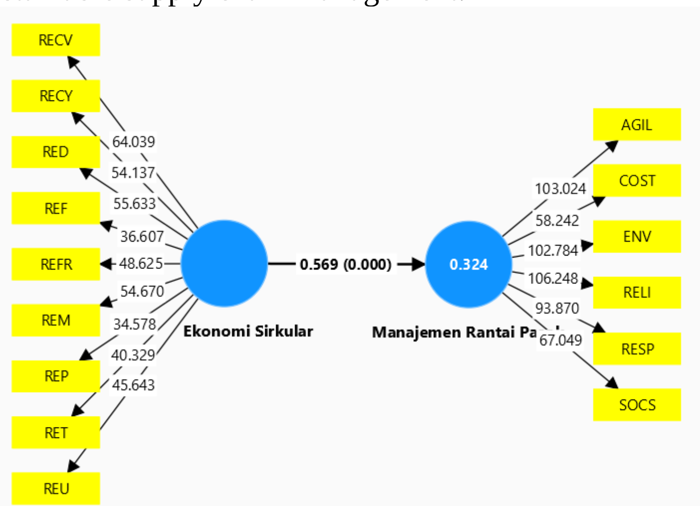

Figure 2. Bootstrapping Result of SEM PLS Model

IPMA Analysis

In this study, the analysis was extended with Importance-Performance Map Analysis (IPMA) to identify priority areas for improvement among the circular economy dimensions that contribute to enhancing supply chain management performance. IPMA not only evaluates the magnitude of influence (importance) between variables, as examined in the structural path analysis, but also assesses the performance level of each indicator or dimension that constitutes the variables. Through this approach, the research provides strategic insights into which circular economy dimensions have a significant impact yet exhibit low performance, thereby becoming priority areas for improvement by companies or organizations. The IPMA results serve as a foundation for designing more targeted interventions or policies to strengthen the integration of circular economy principles in sustainable supply chain management.

Table 6. IPMA Analysis Result Summary

Supply Chain Management Dimensions	High Priority (Quadrant IV)	Maintain Performance (Quadrant II)	Low Priority (Quadrant III)	Excessive Risk (Quadrant I)
Cost (Cost Efficiency)	RECV	RET, REFR, REU	RED, REM, REF	RECY, REP
Agility	RET, REF, RECV	REU, RED, RECY	REFR	REP, REM
Environmental Sustainability	RECV	RET, REP, REU, RECY	REF, REFR, REM	RED
Social Sustainability	REM, RECV	RECY	REF, REFR	RED, REP, RET, REU
Reliability	RECV	RECY, REP, REU, RET	REFR, REM	RED, REF
Responsiveness	REM, RECV	RECY	REF, REFR	RED, REP, RET, REU

Overall, it is evident that the dimensions of the circular economy play distinct strategic roles in enhancing the performance of each component within supply chain management. Each area such as Cost, Agility, Environmental Sustainability, Social Sustainability, Reliability, and Responsiveness requires different focus areas for improvement based on the positioning of circular economy practices in the IPMA analysis. Dimensions such as Reuse, Rethink, and Recycle generally emerge as key strengths that help sustain high performance, while Recover, Refurbish, and Remanufacture are identified as top priorities for improvement due to their high importance but relatively low performance. These findings underscore the necessity of reinforcing the implementation of circular economy practices in a targeted manner, tailored to the specific needs of each supply chain dimension. Such focused interventions are essential to promoting sustainability and enhancing the competitive advantage of enterprises. The following section presents a detailed analysis of the six dimensions of supply chain management.

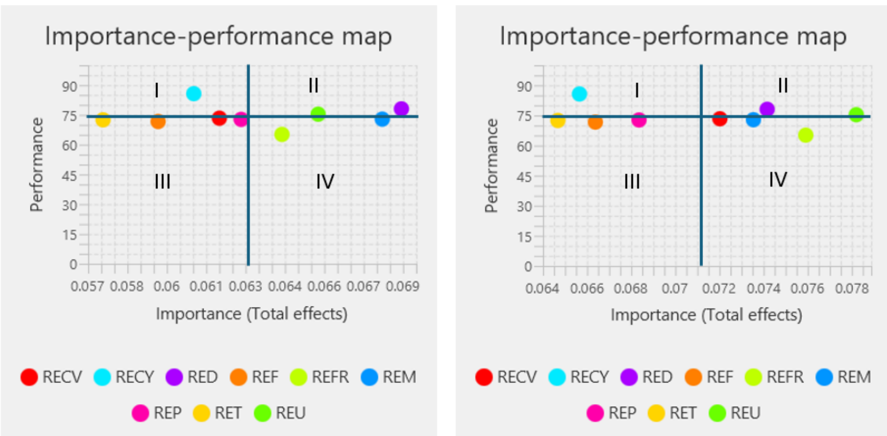

Figure 3. IPMA Analysis Result of Cost (left) and Agility (right)

Based on the results of the Importance-Performance Map Analysis (IPMA) for the Cost dimension (cost efficiency) in supply chain management, the Circular Economy dimensions exhibit a diverse distribution across the four quadrants. Rethink (RET), Refurbish (REFR), and Reuse (REU) are positioned in Quadrant II, indicating both high importance and high performance. These practices are already effectively contributing to cost efficiency and should be maintained. Recycle (RECY) and Repurpose (REP) fall into Quadrant I, characterized by high performance but low importance, suggesting that while their implementation is strong, their impact on cost efficiency remains limited. On the other hand, Reduce (RED), Remanufacture (REM), and Refuse (REF) are located in Quadrant III, reflecting low levels of both importance and performance, and thus require significant improvement. Meanwhile, Recover (RECV) is positioned in Quadrant IV, showing high importance but low performance, making it a top priority for enhancement to further optimize cost efficiency.

For the Agility dimension in supply chain management, the IPMA results reveal that Reuse (REU), Reduce (RED), and Recycle (RECY) are in Quadrant II, indicating high importance and high performance, and therefore are already making a strong contribution to supply chain agility and should be sustained. Repurpose (REP) and Remanufacture (REM) are situated in Quadrant I, demonstrating high performance but low importance, meaning that although their application is effective, their influence on agility is still limited. Refurbish (REFR) is found in Quadrant III, with both low importance and low performance, highlighting its weak contribution to agility and the need for further development. Rethink (RET), Refuse (REF), and Recover (RECV) fall into Quadrant IV, which indicates high importance but low performance, making them strategic priorities for improvement in order to strengthen overall supply chain agility.

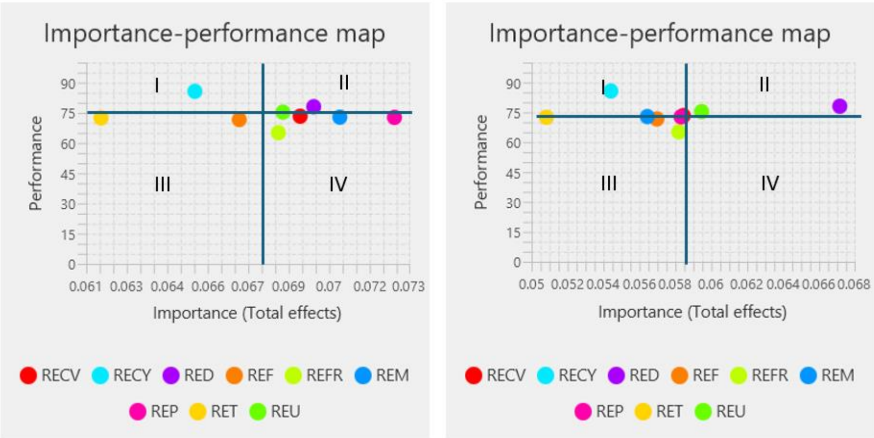

Figure 4. IPMA Analysis Result of Envs (left) and REF (right)

Based on the results of the Importance-Performance Map Analysis (IPMA) for the Environmental Sustainability (ENVS) variable in supply chain management, the distribution of Circular Economy dimensions shows that Rethink (RET), Repurpose (REP), Reuse (REU), and Recycle (RECY) are positioned in Quadrant II, reflecting high levels of both importance and performance. This indicates that these four dimensions have been effectively supporting environmental sustainability and should be maintained in their implementation. In Quadrant I, Reduce (RED) demonstrates high performance but low importance, suggesting that although its application is strong, its contribution to environmental sustainability remains limited. Furthermore, Refuse (REF), Refurbish (REFR), Remanufacture (REM), and Recover (RECV) are located in Quadrants III and IV. REF, REFR, and REM are found in Quadrant III, showing low importance and performance, thus requiring improvement. Meanwhile, RECV falls into

Quadrant IV, with high importance but low performance, making it a top priority for enhancement in order to strengthen environmental sustainability outcomes.

Regarding the Social Sustainability (SOCS) variable, the IPMA results indicate that only Recycle (RECY) is situated in Quadrant II, demonstrating both high importance and high performance. This confirms RECY as an effective dimension in supporting social sustainability and warrants its continued implementation. In Quadrant I are Reduce (RED), Repurpose (REP), Rethink (RET), and Reuse (REU), which show high performance but low importance, indicating that while these practices are well-executed, their impact on social sustainability is still limited. Refuse (REF) and Refurbish (REFR) are located in Quadrant III, where both importance and performance are low, suggesting a weak contribution to SOCS that needs to be addressed. Meanwhile, Remanufacture (REM) and Recover (RECV) are positioned in Quadrant IV, reflecting high importance but low performance. These two dimensions are therefore identified as top priorities for improvement to enhance social sustainability within supply chain management.

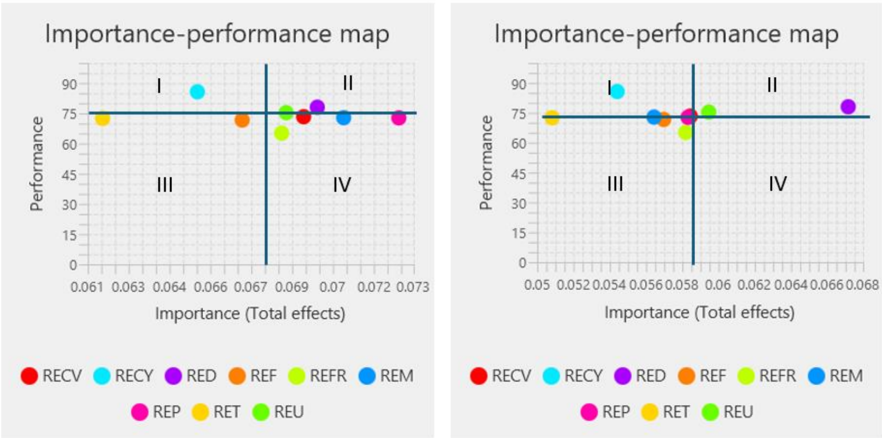

Figure 5. IPMA Analysis of RELI (left) and RESP (right)

Based on the results of the Importance-Performance Map Analysis (IPMA) for the Reliability (RELI) variable in supply chain management, several Circular Economy dimensions are positioned in Quadrant II, namely Recycle (RECY), Repurpose (REP), Reuse (REU), and Rethink (RET), indicating high levels of both importance and performance. These four dimensions have proven effective in enhancing supply chain reliability and should be sustained in their implementation. Reduce (RED) and Refuse (REF) are located in Quadrant I, reflecting high performance but low importance, which suggests that although these practices are well-executed, their impact on reliability remains limited. Meanwhile, Refurbish (REFR), Remanufacture (REM), and Recover (RECV) fall into Quadrants III and IV. REFR and REM are in Quadrant III, with both low importance and performance, indicating weak contributions to reliability. RECV is found in Quadrant IV, with high importance but low performance, making it a key priority for improvement in order to strengthen reliability in supply chain management.

Regarding the Responsiveness (RESP) variable, the IPMA results show that only Recycle (RECY) is placed in Quadrant II, demonstrating high importance and performance, thus confirming its effectiveness in enhancing supply chain responsiveness. In Quadrant I are Reduce (RED), Repurpose (REP), Rethink (RET), and Reuse (REU), which exhibit high performance but low importance, suggesting that while these dimensions are well-implemented, their influence on responsiveness is not yet optimal. Refuse (REF), Refurbish (REFR), Remanufacture (REM), and Recover (RECV) are located in Quadrants III and IV. REF and REFR are positioned in Quadrant III, reflecting low importance and low performance, and therefore require further attention. REM and RECV are found in Quadrant IV, showing high importance but low performance, and are identified as top priorities for improvement to enhance responsiveness in supply chain management.

CONCLUSION

The findings of this study conclude that circular economy practices have a positive and significant influence on supply chain management, meaning that the greater the adoption of circular economy practices, the better the resulting performance of sustainable supply chain management. Based on the Importance-Performance Map Analysis across six dimensions of supply chain management, certain circular economy practices emerge as key strengths in specific areas. Rethink, Refurbish, and Reuse play a major role in enhancing cost efficiency and should be maintained, while Recover requires focused improvement. In the agility dimension, Reuse, Reduce, and Recycle are the most impactful, whereas Rethink, Refuse, and Recover show lower performance and should be prioritized for development. For environmental sustainability, Rethink, Repurpose, Reuse, and Recycle are effectively implemented, while Recover remains an area in need of improvement. In terms of social sustainability, only Recycle demonstrates optimal performance, while Remanufacture and Recover require strategic strengthening. Regarding reliability, Recycle, Repurpose, Reuse, and Rethink serve as core contributors, with Recover once again identified as a critical dimension for enhancement. Finally, in the responsiveness dimension, Recycle performs well, while both Remanufacture and Recover must be improved immediately. These findings emphasize the importance of optimizing circular economy dimensions identified as priorities in order to strengthen all aspects of supply chain performance.

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