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Research article

Linking the adoption of service-based business models to circular economy performance: the moderating role of supply chain practices

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A R T I C L E I N F O

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A B S T R A C T

Service-based business models (either product-, use-, or result-oriented) have gained attention as a way for manufacturing firms to transition toward a circular economy and foster the implementation of closing-the-loop strategies such as reuse, remanufacturing, and recycling. However, the relationship between the adoption of service-based business models and the achievement of greater circular economy performance remains complex and not fully understood. Adopting the Supply Chain Practice View and paradox theory as theoretical lenses, this paper addresses a literature gap by examining how supply chain practices shape the effectiveness of service-based business models in enhancing circular economy performance. Drawing on survey data from 380 Indian manufacturing firms and employing covariance-based Structural Equation Modeling, the study finds a direct effect of both the adoption of service-based business models and the implementation of supply chain practices on circular economy performance. It further shows that supply chain practices positively moderate the relationship between service-based business models and circular economy performance, strengthening their effectiveness in generating positive circularity outcomes. The study extends the Supply Chain Practice View by clarifying how transferable and imitable supply chain practices such as supply chain tracking, green partner selection, and co-design enable an effective implementation of service-based business models for circularity. Drawing on paradox theory, it also suggests that such practices help firms manage tensions triggered by service-based business models, sustaining a dynamic equilibrium that reinforces circularity performance. From a managerial and policy perspective, these results highlight a valuable opportunity for firms in developing economies to simultaneously support business growth and reduce environmental burdens through the joint implementation of service-based business models and supply chain practices.

1. Introduction

Pushed by societal challenges, several companies seek to simultaneously enhance economic prosperity, environmental quality and social justice (Dyllick and Hockerts, 2002; Elkington and Rowlands, 1999). The Circular Economy (CE) represents a promising paradigm shift for achieving environmental sustainability without compromising competitiveness, given its potential to decouple economic growth from resource consumption and waste generation by slowing, narrowing and closing resource loops (Bocken et al., 2016; Ellen MacArthur Foundation, 2019; Geissdoerfer et al., 2018). In this context, manufacturing firms aiming at closing resource loops must increase the share of products that are reused, remanufactured, or recycled at the end of their life (Geissdoerfer et al., 2020).

Service-based business models promise to facilitate the implementation of circular strategies. These models range from relatively simple approaches – where lifecycle services are added to existing products – to new forms of value creation that replace product sales with the delivery of product-as-a-service offerings (Tukker and Tischner, 2006). These models are often associated with revenue schemes based on pay-per-use, result-oriented, or performance-based contracts, where product ownership is retained by companies, thus facilitating efficient end-of-life product collection and recovery (Bressanelli et al., 2024; Tukker, 2015; Yang and Evans, 2019). For instance, Xerox's transition from selling printers to a pay-per-page service-based business model enables reuse, remanufacturing, and recycling (Linder and Williander,

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2017). Thus, service-based business models have a significant potential to reduce the lifecycle environmental footprint of goods by supporting the CE objective of 'closing-the-loop'. However, their contribution to CE outcomes remains largely theoretical, and some previous studies pointed out that this potential may not be achieved in practice (Kjaer et al., 2019; Kühl et al., 2020; Stabler et al., 2024). Challenges to be faced concern the emergence of adverse mechanisms such as burden shifting, rebound effects, pricing-induced behavioral responses, and tensions among conflicting business and environmental objectives that may outweigh the expected environmental benefits of service-based business models (Kjaer et al., 2019; Saccani et al., 2024). Therefore, the interplay between service-based business models and improved circularity performance requires more comprehensive investigation, especially at the empirical level, since the number of studies is limited and circularity outcomes are often assessed using generic environmental sustainability metrics rather than indicators that specifically capture closing-the-loop performance.

Moreover, implementing service-based business models often relies on supply chain partners for closing the loop (Parida and Wincent, 2019). The literature has proposed that, as with other performance outcomes, superior environmental performance may not necessarily stem from valuable, rare, and inimitable resources. Rather, it can derive from the effective application of publicly known, imitable, and transferable intra- and inter-organizational practices, as posited by the Practice-Based View and by its extension to the supply chain (Bromiley and Rau, 2016b; Carter et al., 2017). Some empirical studies have related the adoption of supply chain practices to an improvement in circularity performance (Rehman Khan and Yu, 2021; Sahoo et al., 2026; Zhu et al., 2011). These practices may support the execution of reverse logistics or broader system-wide transformations aimed at maintaining control over products during and after use, thereby enabling reuse, remanufacturing, and material recovery (Geissdoerfer et al., 2018). To this end, digital technologies such as RFID and IoT, which provide real-time tracking and information, might support end-of-life decisions (e.g., between reuse, remanufacturing, or recycling) based on product and part history (Chauhan et al., 2022; Das et al., 2025). Additionally, engaging supply chain partners during early product development stages facilitates effective CE implementation, e.g., through product design for reuse (Bocken et al., 2016). Other empirical studies have also shown that supply chain practices such as digital tracking and product co-design for end-of-life recovery facilitate the adoption of service-based business models (Freije et al., 2022; Ruiz-Alba et al., 2024), and are thus expected to influence both their effective implementation and the achievement of circularity outcomes (Ding et al., 2023; Ruiz-Alba et al., 2024). However, the specific influence of supply chain practices on the relationship between the implementation of service-based business models and the achievement of circularity outcomes in the closing-the-loop domain remains underexplored.

Finally, decoupling resource consumption from economic growth is vital for large, fast-developing economies such as India. Service-based business models provide a unique opportunity to adopt new value creation logics that achieve business growth while closing resource loops (Bocken et al., 2014), leapfrogging traditional linear economic growth trajectories that have intensified environmental pressures (Lee, 2019; Perez and Soete, 1988). In such countries, the systematic adoption of service-based business models remains underdeveloped due to resource constraints, which limit investments in the infrastructure required for service transition, including the reverse logistics systems that are essential for product and material recovery. Moreover, Indian firms often rely on fragmented, informal networks, hindering inter-organizational collaboration and trust necessary to shift from product ownership to service provision. However, limited research has focused on understanding the extent to which the adoption of service-based business models, together with the implementation of publicly known and transferable supply chain practices, could lead to circular outcomes in growing economies (Mishra et al., 2019). Yet, such evidence could provide a compelling basis to support managerial endeavors and inform policymaking efforts.

Motivated by the three gaps pointed out above, this paper aims to shed light on the interplay among service-based business models, supply chain practices, and CE performance in the closing-the-loop domain, especially in the context of growing economies. In particular, it proposes and empirically tests the hypothesis that potentially imitable and transferable supply chain practices moderate the relationship between the adoption of service-based business models and the achievement of circularity performance. Thus, this paper investigates the following research questions:

RQ1. *To what extent do service-based business models and supply chain practices contribute to improving Circular Economy performance in the closing-the-loop domain?*

RQ2. *To what extent do supply chain practices affect the relationship between the adoption of service-based business models and the achievement of Circular Economy performance?*

To address the RQs, the paper applies covariance-based Structural Equation Modeling to survey data collected from 380 Indian manufacturing firms. Moreover, this study adopts a dual theoretical perspective. First, it uses the Supply Chain Practice View (Carter et al., 2017), an extension of the Practice-Based View (Bromiley and Rau, 2014), to understand the extent to which some firms are more successful than others in translating service-based business models initiatives into superior circularity performance, focusing on how supply chain practices are implemented and leveraged by manufacturing companies. Second, paradox theory is adopted to frame and interpret the results of this study (Smith and Lewis, 2011). In particular, we discuss how service-based business models act as a response to performing tensions related to the achievement of circularity outcomes (De Angelis, 2021), and how supply chain practices can address the organizational and learning tensions generated by the introduction of service-based business models (Smith and Lewis, 2011; Kohtamäki et al., 2024). This sustains the positive effect of service-based business models on circularity performance, leading to a dynamic equilibrium (Smith and Lewis, 2011).

The study contributes to theoretical knowledge accumulation in different ways. First, no research to date has addressed the foundational link among the three investigated constructs simultaneously (service-based business models, supply chain practices, and circularity performance), at both the conceptual and empirical level. Our study empirically confirms the effectiveness of service-based business models in improving CE performance in the closing-the-loop domain and elucidates the moderating role of supply chain practices in strengthening this relationship. Second, it incrementally contributes to the Supply Chain Practice View by interpreting the mechanisms through which supply chain practices such as tracking, partner selection and co-design trigger the successful implementation of service-based business models and improvements in circularity outcomes. This interpretation is consistent with the capability-development role attributed to practice adoption (Parmigiani and Howard-Grenville, 2011): by fostering organizational learning and facilitating transferability across firms, supply chain practices can support the effective adoption of business innovations – such as circularity-oriented initiatives and service-based business models – and strengthen their contribution to environmental performance (Lafuente and Vaillant, 2023; Sun and Oliva, 2026). Third, it contributes to the underexplored literature on CE and service-based business models in emerging economies, providing new empirical insights from 380 Indian manufacturing firms and highlighting how these models, coupled with supply chain practices, can accelerate a circular transition in such contexts. Fourth, examined with the paradox theory lens, this study supports the role of both service-based business models and supply chain practices in dynamically overcoming organizing, performing and learning tensions related to the achievement of successful closing-the-loop performance.

The remainder of the paper is structured as follows. Section 2 develops the hypotheses and introduces the proposed research model. Section 3 outlines the methods used to empirically examine the proposed relationships. Section 4 reports the results of the statistical analysis. Section 5 discusses the findings in relation to existing literature and elaborates on both theoretical and managerial implications. Finally, Section 6 draws concluding remarks.

2. Theoretical background and hypotheses development

2.1. Theoretical underpinnings

A dual theoretical perspective is adopted in this study, combining the Supply Chain Practice View with paradox theory.

The Supply Chain Practice View, emerged as an extension of the Practice-Based View, posits that firm performance is influenced by the adoption and use of practices that are publicly available, observable, and imitable (Bromiley and Rau, 2014; Carter et al., 2017). In contrast to the Resource-Based View, which emphasizes that resources should be valuable, rare, inimitable, and non-substitutable (Barney, 1991, 2001), practices are defined as sets of activities or routines that a variety of firms might execute that are neither rare nor difficult to imitate (Bromiley and Rau, 2016a,b). In particular, supply chain practices are operational mechanisms through which organizations coordinate supply chain activities and collaborate across the supply network to create, deliver, and capture sustainable value (Carter et al., 2017; Li et al., 2025). Within the Practice-Based View framework, performance is conceptualized as an observable outcome of practice adoption rather than as sustained competitive advantage (Bromiley and Rau, 2016a,b). Although the theory was originally proposed to explain heterogeneity in business outcomes across firms (Li et al., 2025), seminal papers point to its suitability also for sustainable operations and supply chain management research (Bromiley and Rau, 2016a,b; Carter et al., 2017). In particular, it has been applied to examine how managerial practices shape results in domains such as sustainable supply chain management and CE (Rehman Khan and Yu, 2021; Rodrigo et al., 2025; Schilling and Seuring, 2024). This suggests that the achievement of circularity outcomes may depend less on unique and inimitable firm-specific resources, and more on the adoption and effective implementation of well-known inter-organizational collaboration practices across the supply chain.

On the other hand, previous literature has adopted paradox theory (Smith and Lewis, 2011) to frame CE tensions (De Angelis, 2021; Tosi et al., 2024). According to Smith and Lewis (2011), paradoxes are defined as “contradictory yet interrelated elements that exist simultaneously and persist over time” (p. 382), and can be grouped under the categories of *learning* (related to innovation and knowledge), *organizing* (related to organizational and operational processes put in place), *belonging* (related to internal versus system-level value creation), and *performing* (related to conflicting demands and objectives) (Smith and Lewis, 2011). In particular, a primary CE *performing tension* arises between profitability and environmental performance (De Angelis, 2021; Tosi et al., 2024), as firms are profit-driven while CE strategies are not always connected with economic benefits (Gusmerotti et al., 2019). Managerial decisions taken to address performing tensions may, in turn, give rise to additional tensions (Smith and Lewis, 2011). For instance, tensions in the *organizing* domain may arise between centralization vs. decentralization, control vs. flexibility, and cooperation vs. competition (De Angelis, 2021). Since managerial decisions are also shaped by trade-offs between short- and long-term horizons, tensions such as exploitation versus exploration and innovation versus stability may arise at the *learning* level as well (De Angelis, 2021). Firms pursuing CE objectives are thus called to navigate these inter-related tensions not by resolving them permanently, but by managing them concurrently over time, achieving a dynamic equilibrium between competing demands (Smith and Lewis, 2011).

Taken together, these two theoretical perspectives offer a complementary understanding of how supply chain practices can support the effective implementation of service-based business models for circularity outcomes: the Supply Chain Practice View clarifies the operational mechanisms through which such practices operate, while paradox theory explains why their contribution is necessary to sustain the positive effect of service-based business models on CE performance over time.

2.2. The relationship between service-based business models and circular economy performance

Closing-the-loop CE strategies focus on efforts made by individual companies and supply chains to manage the end-of-life of products, components, and materials through closed-loop systems of reuse, remanufacturing, and recycling (Bressanelli et al., 2020). Manufacturing companies that aim to implement closing-the-loop strategies face performing tensions between conflicting business and circularity objectives (De Angelis, 2021; Hofmann, 2019; Tosi et al., 2024), as firms are profit-driven while these strategies are not always connected with economic profitability (Gusmerotti et al., 2019).

The adoption of service-based business models can be considered as a way to accommodate these performing tensions, according to a synthesis approach to the management of paradoxes (Smith and Lewis, 2011). This is in line with recent studies addressing the relationship between sustainability emphasis and company profitability (Kohtamäki et al., 2024), or addressing paradoxes in product design for circularity (Robertson et al., 2026). Service-based business models, in fact, shift manufacturers' focus from selling products to delivering services and product-service systems (Tukker, 2004, 2015). Simpler forms of product-oriented service-based business models, in which lifecycle services are offered for existing products, enhance product lifecycle management, control, and collection at the end-of-life (Tukker and Tischner, 2006), thus enabling the ‘interception’ and ‘transition’ of end-of-life products into resources, as discussed by Zeeuw van der Laan and Aurisicchio (2020). In most advanced forms of the servitization phenomenon, such as access- and result-oriented models, firms retain ownership of products, which naturally incentivizes them to introduce mechanisms for reuse, remanufacturing, and recycling (Geissdoerfer et al., 2018; Tukker, 2004). This minimizes their overall lifecycle cost and enables multiple product lifecycles (Bressanelli et al., 2018). For instance, Caterpillar, a global manufacturer of heavy equipment, has expanded its service offerings to include equipment leasing with a remanufacturing program for its components, thus reducing waste generation, the need for virgin materials, as well as their acquisition cost (Syncorn, 2023). Digital service innovation, as enabled through digital technologies for the collection and tracking of operational data (Opazo Basáez et al., 2024), further facilitates both the uptake of service-based business models and improvements in environmental performance (Jiang et al., 2025; Raddats et al., 2022). Moreover, service-based business models enabled by digital and cloud-based trading platforms encourage product sharing and multi-user access, which in turn favor take-back systems to manage surplus products and materials (Kühl et al., 2023; Yang and Evans, 2019).

In this context, empirical research supports the claim that service-based business models may enhance companies' CE performance. Kühl et al. (2022) empirically tested the links between different product-service system types and the implementation of CE in 114 UK manufacturing companies, finding that use-oriented service models support closing the loop – although they did not find the same support for result-oriented models. Johl et al. (2024) examined the effects of green servitization on 251 Malaysian and Japanese manufacturing firms, revealing that it promotes CE and the achievement of sustainable performance. Shah et al. (2025) investigated the role of platform-based servitization in 143 Chinese service firms, showing that it positively mediates the impact of institutional pressures on the implementation of

CE. In particular, a positive effect of service-based business models on CE can be crucial for fast-developing economies, as shown by Johl et al. (2024): through these models, companies may close resource loops (Bocken et al., 2014) and enable leapfrogging – i.e., the ability of latecomer economies to bypass intermediate stages of development by adopting advanced business models – thus avoiding the linear trajectories followed by more established economies (Lee, 2019; Perez and Soete, 1988).

However, the literature has also pointed out obstacles that may hinder the achievement of CE benefits through service-based business models. While some environmental benefits are "built-in" through advanced services (Abdelkafi et al., 2022), CE achievements are often reported only as potential outcomes supported by anecdotal exemplary cases (Ries et al., 2023; Saccani et al., 2024). In practice, service-based business models such as leasing and sharing may encourage faster replacement cycles, lead to less careful product use, and supplement rather than replace new purchases, ultimately challenging their circularity (Hofmann, 2019; Kjaer et al., 2019). Moreover, empirical research, even outside the servitization domain, does not adopt a common approach towards measuring CE performance. Most studies measure circular actions or processes (Johl et al., 2024), or broader environmental sustainability performance such as air emissions, wastewater, or environmental accidents (Farooque et al., 2019; Zhu et al., 2011). More specific operational measures related to closing the loop, such as the use of bills of materials for remanufacturing, the inclusion of recycled components from end-of-life products, or the monitoring of recycling rates for waste, are adopted only in a few cases (Bag et al., 2021a,b; Sahoo et al., 2026; Sahoo and Jakhar, 2024). Therefore, measuring circular performance in empirical settings is highly challenging (Alam et al., 2025), especially since system-wide (i.e., supply chain) and temporal (i.e., product lifecycle) dynamics are involved.

Thus, more empirical research is needed to test the relationship between service-based business models and circularity performance, and the following hypothesis is proposed:

H1. ***The adoption of service-based business models has a positive effect on the achievement of closing-the-loop Circular Economy performance.***

2.3. The relationship between supply chain practices and circular economy performance

A single firm rarely controls all the lifecycle processes of the products it manufactures (Bressanelli et al., 2019; Burke et al., 2023; Calzolari et al., 2025). Thus, implementing closing-the-loop CE strategies requires companies to reconfigure their supply chains and collaborate with multiple actors (Lüdeke-Freund et al., 2019; Schöggl et al., 2024). In line with this, it has been empirically observed that inter-organizational collaboration has a positive effect on CE implementation (Schöggl et al., 2024; Zhu et al., 2011). Calzolari et al. (2025), examining 150 multinational enterprises, show that coercive and normative institutional pressures drive the adoption of CE primarily through supply chain integration, thanks to activities such as information exchange, collaborative activities, and strategic alignment with suppliers and customers. Similar findings arise from studies in developing economies such as India (Sahoo et al., 2026; Sahoo and Jakhar, 2024) and South Africa (Bag et al., 2021a,b).

These findings suggest that the achievement of circularity performance may depend less on unique and inimitable firm-specific resources, and more on the adoption and effective implementation of well-known inter-organizational collaboration practices across the supply chain. Three specific supply chain practices have emerged in the literature as particularly relevant for illustrating how these practices support circularity outcomes. First, supply chain tracking, as enabled by digital technologies such as Internet-of-Things and blockchain, allows monitoring products, components, and materials throughout their lifecycle (Chauhan et al., 2022; Ding et al., 2023). This enables firms to effectively manage their flow from their initial conception to end-of-life stages (Garcia-Torres et al., 2024; Li et al., 2024, 2025), facilitating product return and decision making about reuse, remanufacturing, or recovery (Das et al., 2025), thus leading to better circularity results (Bag et al., 2021). Second, green partner selection ensures alignment and compatibility with circular principles across the whole supply chain (Brömer et al., 2019; Feng and Gong, 2020). Evaluating and selecting partners based on environmental performance provides better support for reverse logistics and end-of-life activities such as material recycling, component remanufacturing, and product refurbishment (Li et al., 2025; Rehman Khan and Yu, 2021; Wang et al., 2026). Furthermore, by integrating environmental criteria into procurement decisions, firms increase their demand for secondary or recyclable materials which, in turn, creates an economic incentive to invest in effective end-of-life operations (Li et al., 2024). Third, collaboration with supply chain partners for co-design purposes facilitates the development of products that are easier to repair, disassemble, and reuse (Sudusinghe and Seuring, 2022), thereby facilitating the closing of resource loops (Brömer et al., 2019). Collaborative design efforts with suppliers allow them to standardize components and create modular interfaces, enhancing the interchangeability of parts and simplifying the repurposing or refurbishment of products (Li et al., 2024). Thus, the involvement of supply chain partners in design for circularity can lead to superior circularity performance compared to a purely internal approach (Sahoo et al., 2026). These circularity benefits are further reinforced by the sustainability learning processes and cross-boundary culture that the adoption of such practices tends to activate (Gong et al., 2018; Rodrigo et al., 2025), fostering mutual trust and long-term relationships among supply chain partners (Brömer et al., 2019; Garcia-Torres et al., 2024; Wang et al., 2026). At a conceptual level, practice adoption can lead to organizational learning (Levitt & March, 1988), achieve intra- and inter-organizational diffusion (e.g. spanning two or more partners across the supply chain), and thus ultimately lead to circular differential performance (Parmigiani and Howard-Grenville, 2011).

Taken together, the three supply chain practices discussed above are expected to exert a complementary effect and concurrently contribute to the achievement of superior CE performance. Building on this, the following hypothesis is proposed:

H2. ***Supply chain practices positively influence closing-the-loop Circular Economy performance.***

2.4. The moderating effect of supply chain practices on the relationship between service-based business models and circular economy performance

As previously discussed for the implementation of closing-the-loop CE strategies, the successful adoption of service-based business models also requires the involvement, alignment, and coordination of multiple supply chain actors (Lockett et al., 2011; Saccani et al., 2014). Previous empirical studies have found that the implementation of supply chain practices facilitates the adoption of service-based business models. Ruiz-Alba et al. (2024), analyzing 219 Spanish pharmacy stores, found that supply chain collaboration practices strengthen the effects of intermediate and advanced services on the development of servitization processes, capabilities, and firm performance. Likewise, Freije et al. (2022), using data from 104 manufacturing firms in the Basque Country, showed that highly servitized companies achieve stronger supply chain integration levels and, in turn, greater product innovation capability.

While the role of supply chain practices in both the adoption of service-based business models and the enhancement of CE performance has received conceptual and empirical support, a gap remains regarding the interplay between supply chain practices and service-based business models, and in particular concerning the specific influence the former might have on the latter for circularity outcomes. According to paradox theory (Smith and Lewis, 2011), it can be argued that organizational and learning tensions re-surface over time, as they are intrinsically rooted in the way service-based business models are operationally carried out and in the conflicting use of resources (Kohtamäki et al., 2024; Rabetino et al., 2024). New tensions might arise, for example, at the *organizing* level between customization (to deliver client-oriented circular solutions with maximum environmental benefit) and standardization (to enable scalability and economic efficiency), and at the *learning* level between exploring new circular solutions and exploiting existing service offerings (Kohtamäki et al., 2020; Sun and Oliva, 2026). This undermines the potential of service-based business models to address CE performing tensions as well. Through a paradox theory lens, previous studies identified inter-organizational practices (such as information-sharing, cross-boundary routines, and personnel exchanges) and partnerships as responses to tensions in servitization and outcome-based services (Kohtamäki et al., 2020; Korkeamäki et al., 2022). Adopting a paradox theory perspective, Tosi et al. (2024) empirically supported the idea that supply chain collaboration contributes to the accommodation of CE tensions as well.

Therefore, supply chain practices can be seen as a means to address CE and service-based business model tensions (Kohtamäki et al., 2020; Tosi et al., 2024). As suggested by Parmigiani and Howard-Grenville (2011), 'green' practices contribute to capability development and might lead to organizational ambidexterity (Andriopoulos and Lewis, 2009; Teece, 2007), which allows firms to simultaneously approach exploration and exploitation and find the right balance between efficiency and effectiveness (O'reilly Iii and Tushman, 2008). Ambidexterity can therefore provide an effective response to paradoxes (Smith and Lewis, 2011). Thus, resorting to external, complementary supply chain competences is crucial for amplifying the overall effect of business model innovation on performance (Lafuente and Vaillant, 2023; Sahoo et al., 2026), as in the cases of co-design and digital supply chain tracking practices (Garcia-Torres et al., 2024; Li et al., 2024; Vaillant et al., 2025). This can help firms navigate organizational and learning tensions connected to service-based business models, finding the right balance between efficiency and effectiveness, and sustaining improved CE results in the closing-the-loop domain.

Based on the abovementioned theoretical arguments, it is proposed that supply chain practices enhance the positive circularity effects that the adoption of service-based business models brings to companies, thus explaining CE performance heterogeneity across different companies even when similar servitization approaches are adopted. Therefore, the following hypothesis is formulated:

H3. ***The positive relation between the adoption of service-based business models and the achievement of Circular Economy performance is stronger at higher implementation levels of supply chain practices.***

Fig. 1 illustrates the resulting research framework, outlining the key variables and their interrelationships. Direct relationships are postulated between the adoption of service-based business models and the achievement of CE performance (H1), and between the implementation of supply chain practices and the achievement of CE performance (H2). Additionally, it is proposed that supply chain practices act as a moderator between the adoption of service-based business models and the achievement of CE performance (H3).

3. Methodology

3.1. Sample and data collection

This study adopts a deductive approach to test the hypothesis, targeting manufacturing companies operating in India as the unit of analysis. To identify potential respondents, multiple databases of Indian manufacturers were consulted, including the Micro, Medium and Small Enterprises (MSME) registry maintained by the Government of India, the Confederation of Indian Industry (CII) directory, the Open Government Data (OGD) Platform India, and the Indian Industry Association database. These sources were used to identify manufacturing firms across different industrial sectors. Data was collected through an online survey administered between January and June 2024, addressing CE adoption in manufacturing firms and including the measurement model for this study. The survey targeted managerial-level respondents with knowledge of firm-level operational and strategic practices. Approximately 5000 managers were contacted through email and LinkedIn. Additional outreach was conducted through professional networks and ecosystem partners, including workshop organizers and industry associations. A total of 665 responses were collected. However, the dataset contained duplicate submissions, largely incomplete questionnaires, and responses with a high proportion of 'N/A' entries. After data cleaning, 380 useable responses were retained (response rate: 7.6%), forming the final dataset for analysis. "Don't know" responses were replaced with item-wise means. This decision was reached after conducting a sensitivity analysis, which confirmed that the substitution resulted in minimal distortion in the data.

Table 1 shows the characteristics of the respondents, including job title, firm's size, and industry type. This information was collected directly from the respondents through the survey instrument.

To account for potential extrinsic influences on the relationships among the study constructs, firm size and industry type were included as control variables. For coding industry type, the four most represented sectors were retained, while the remaining sectors were grouped into an overall "others" category. Dummy variables were used to distinguish between different industries in the analysis (Bag and Rahman, 2023).

Survey-based research is susceptible to common method bias (CMB), which occurs when the measurement process introduces systematic variance unrelated to the measured constructs, potentially compromising the validity of the findings (Flynn et al., 2018). CMB can arise from various sources, such as respondent perspective, social desirability, or consistent response patterns. Therefore, procedural remedies were implemented during the survey design and data collection stages to

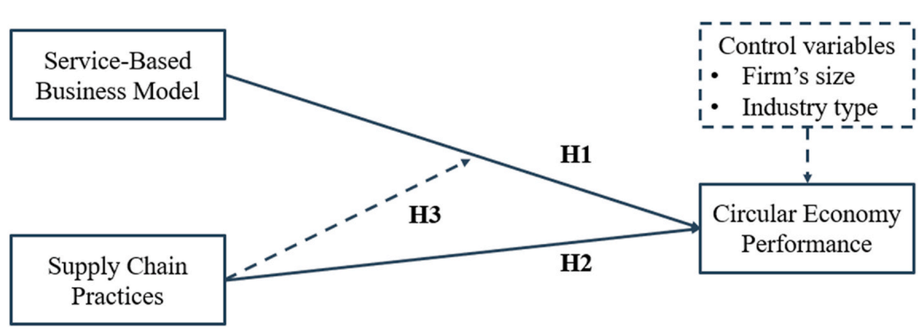

Fig. 1. – Research model.

Table 1
Respondent job profile and industrial sectors.

	Frequency	Percentage (%)
Job title		
CEO, Managing Director and Owner	76	20.0%
Management	72	18.9%
Quality department	61	16.1%
Technical department	48	12.6%
Purchasing/Supply Chain Management/Logistics	41	10.8%
Sales/Commercial/Marketing	35	9.2%
Administration, Finance and Control	25	6.6%
Other	22	5.8%
Industry		
Textile, clothing and leather	93	24.5%
Electrical and electronic equipment	86	22.6%
Metallurgy	73	19.2%
Oil, chemical and pharmaceutical	73	19.2%
Others	55	14.5%
Firm's size (Indian Industry coding system)		
Micro	13	3.4%
Small	196	51.6%
Medium	140	36.8%
Large	31	8.2%

mitigate the potential impact of CMB. The study targeted key respondents from senior management teams with substantial industry experience, ensuring that respondents had sufficient knowledge of organizational practices and performance. In addition, respondents were assured of anonymity and confidentiality, which helps reduce social desirability bias and encourages more accurate responses. Several statistical tests were then conducted to control for the potential effects of CMB. First, Harman's single-factor test (Podsakoff et al., 2003) was performed as an initial diagnostic tool. The results of the unrotated exploratory factor analysis indicate that the first factor accounts for 47.5% of the total variance (see Appendix I for full details), which is below the commonly used threshold of 50%. Second, the common latent factor (CLF) approach was applied using IBM SPSS AMOS, following the recommendations of Podsakoff et al. (2012). A latent method factor was connected to all measurement indicators of the core constructs, and the standardized factor loadings obtained from the model with the CLF were compared with those from the baseline model (without the CLF). The differences between the two sets of loadings – as shown in Appendix I – were minimal, with a maximum deviation of 0.054, which is well below the recommended threshold of 0.20. Furthermore, following recent recommendations for assessing potential method bias in Structural Equation Modeling, a full collinearity assessment was conducted (Hult et al., 2018; Podsakoff et al., 2012). The model was assessed through the examination of Variance Inflation Factor (VIF) values across all latent constructs. The highest VIF observed was 2.85, which falls well within the acceptable range and remains considerably below the commonly accepted threshold of 10. While primarily serving as a diagnostic for multicollinearity, the obtained VIF values provide reassurance regarding the absence of severe construct intercorrelation (Diamantopoulos and Siguaw, 2006). These results suggest a limited influence of common method variance on the measurement indicators. Nonetheless, we acknowledge that CMB concerns cannot be completely eliminated, as it is inherent to single-informant survey designs (Bag et al., 2020; Ghadge et al., 2022; Guide Jr and Ketokivi, 2015; Podsakoff et al., 2012), and this aspect should be considered when interpreting the findings.

Furthermore, to assess the presence of non-response bias, the wave method (Armstrong and Overton, 1977) was employed, involving a single follow-up email sent to initial non-respondents. Data from early respondents (first wave) and late respondents (those who replied after the follow-up) were compared using independent samples t-tests on key variables (as shown in Appendix I). The absence of significant differences between these groups indicates that non-response bias is unlikely to affect the study results.

3.2. Measurement model

The measurement model in the survey was designed to assess the level of adoption of service-based business models, the level of implementation of supply chain practices, and the achievement of CE performance by manufacturing companies. The questionnaire was developed using measures adapted from existing literature. To operationalize the factors of the conceptual model of Fig. 1, the study adopted the items and the scales proposed by Bressanelli and Saccani (2025), and supported by previous literature. Table 2 shows the list of items composing the questionnaire. In particular, despite the wide variety of CE performance measures found in previous studies (see section 2.2), in our survey instrument this construct was operationalized by focusing on firms' effectiveness in implementing 'closing-the-loop' strategies (Bocken et al., 2016). While the CE has become an umbrella concept encompassing a broad range of R-strategies (Blomsma and Brennan, 2017; Kirchherr et al., 2017), we deliberately focus on the results of closing-the-loop activities such as reuse, remanufacturing, and recycling, as they directly reflect the extent to which products, components, and materials are reintegrated into production and consumption cycles (Bressanelli et al., 2020). Specifically, we capture the extent to which firms achieve circularity outcomes related to product reuse, component remanufacturing, and material recycling. These items

Table 2
Constructs and survey items.

Construct	ID	Item	References used for item development
Service-Based Business Models (SBM)	SBM1	Does your company offer product-service systems solutions such as product leasing, renting, pay-per-use and, if so, to what extent these offerings are spread?	(Blackburn et al., 2025; Kühl et al., 2022; Ruiz-Alba et al., 2024; Souza et al., 2024; Tukker, 2004)
	SBM2	To what extent is it possible to share your products among different users (product sharing)?	
	SBM3	To what extent does your company use cloud-based trading platforms for scraps and waste?	
Supply Chain Practices (SCP)	SCP1	To what extent can your company track products, components, and materials along the supply chain (e.g., through sensors, IoT, RFID, blockchain technologies)?	(Alam et al., 2025; Garcia-Torres et al., 2024; Khan et al., 2023; Rehman Khan and Yu, 2021)
	SCP2	To what extent does your company select suppliers based on green criteria and on their environmental performances?	(Brömer et al., 2019; Li et al., 2024; Rehman Khan and Yu, 2021)
	SCP3	To what extent does your company collaborate with value chain partners to co-design products and processes?	(Garcia-Torres et al., 2024; Geissdoerfer et al., 2018; Li et al., 2024)
Circular Economy Performance (CEP)	CEP1	To what extent do initiatives for the reuse of your products exist and are widespread?	(Bag et al., 2021; Bocken et al., 2016; Kirchherr et al., 2017; Sahoo et al., 2026)
	CEP2	To what extent do initiatives for the remanufacturing of your components exist and are widespread?	
	CEP3	To what extent do initiatives for the recycling of your materials exist and are widespread?	

represent core mechanisms through which CE is realized at the end-of-life of products (Bressanelli et al., 2020). Accordingly, the selected items measure the extent to which reuse, remanufacturing, and recycling initiatives are implemented and widespread, providing a parsimonious yet robust proxy of CE performance (Bressanelli and Saccani, 2025). This measure inherently requires a lifetime and system-wide perspective, since closing-the-loop for several products and materials (except internal waste of a manufacturing process) occurs outside the company and potentially much later in time than production and distribution, and is therefore difficult to accurately assess. Given the firm-level nature of our data, CE closing-the-loop performance is assessed through respondents' perceptual evaluation of the extent to which circular strategies are effectively implemented within the surveyed firm and in its value chain. Thus, the perceived diffusion of reuse, remanufacturing, and recycling initiatives is used as a proxy for the effectiveness of CE adoption. Service-based business models were operationalized based on seminal literature such as Tukker (2004), and more specific literature discussing digital servitization and platforms (Blackburn et al., 2025; Ruiz-Alba et al., 2024). Supply chain practices were operationalized based on previous empirical and conceptual studies mentioned in section 2.3, and are treated in this study as a unified construct. However, to illustrate their expected functioning mechanisms, we identify three specific practices identified in the literature that jointly underpin this construct. A 5-point Likert-type scale was employed for measurement, as such scales are widely utilized in research for their reliability and simplicity.

Before administering the survey, a pilot study was conducted with four managers, to evaluate its clarity and validity. The feedback received was incorporated into the final instrument.

3.3. Reliability and validity

The statistical software Jamovi 2.6.23 and AMOS 23.0 were used to perform covariance-based Structural Equation Modeling, using the Maximum Likelihood estimation, to evaluate the measurement model and test the research hypotheses (Byrne, 2013; Jamovi, 2024). This statistical method was chosen because the research objective is theory testing and confirmation rather than theory development (Hair et al., 2019). Prior to testing the hypotheses using the structural model, the validity and reliability of the measures were confirmed, and the model's data fit was assessed.

As a preliminary step, the normality of the observed variables was assessed using the Shapiro–Wilk test. Results indicated a departure from normality for all variables (see details in Appendix I), which is a common occurrence with 5-point Likert-type scales (Hair et al., 2019). Nonetheless, Maximum Likelihood estimation is considered relatively robust to moderate deviations from normality, particularly with adequate sample sizes (Hair et al., 2019), and this was further corroborated by the bootstrapping results reported below. To assess the validity of the theoretical model, a confirmatory factor analysis was conducted. This statistical technique evaluates the extent to which the hypothesized factor structure aligns with the observed data (Byrne, 2013). This approach enables us to confirm the dimensionality of the constructs and assess the convergent validity of the measurement scales, ensuring that the constructs in the model are both theoretically sound and empirically robust. Prior studies have outlined several key indicators for assessing model fit (Hooper et al., 2008). The discrepancy divided by degrees of freedom (CMIN/Df) is 2.661, and this value is well below the threshold of 5 (Hu and Bentler, 1999). The value for Goodness of Fit Index (GFI) is 0.975, which is above the threshold of 0.95 (Hooper et al., 2008). In addition, the Root Mean Square Error of Approximation (RMSEA) is 0.066, which is below the threshold of 0.08 (Kline, 2015); the Comparative Fit Index (CFI) is 0.98, which is above the threshold of 0.95 (Mueller and Hancock, 2018); the Relative Fit Index (RFI) is 0.96, the Normed Fit Index (NFI) is 0.97, and the Tucker-Lewis index (TLI) is 0.97, which are all above the threshold of 0.9 established as indicative of good fit (Byrne, 2013). Therefore, it can be concluded that the model has a good fit. As a robustness check, bootstrapping with 10,000 subsamples was performed, yielding stable coefficients and p-values.

Furthermore, Table 3 reports the factor loadings, Cronbach's alpha and composite reliability (CR). Both Cronbach's alpha and CR values exceed the threshold of 0.7, supporting the reliability of the measures. In addition, the average variance extracted (AVE) values are all higher than 0.6, demonstrating satisfactory convergent validity.

Discriminant validity was assessed using the heterotrait–monotrait (HTMT) ratio criterion (Table 4). For certain construct pairs, HTMT values exceeded the recommended threshold of 0.90. However, following Henseler et al. (2015), we consider 0.85 and 0.90 as indicative rather than absolute cut-off points. The high HTMT values can be partly explained by the consistently high standardized factor loadings, ranging between 0.8 and 0.9, which are known to inflate HTMT estimates even among theoretically distinct constructs, as in our case (Fernando et al., 2023; Geissdoerfer et al., 2018; Sahoo and Jakhar, 2024). Despite these high HTMT values, the analysis proceeded with hypothesis testing. Nonetheless, we acknowledge that the empirical boundaries among SBM, SCP, and CEP are not sharply defined, and this aspect should be considered when interpreting the results of the hypothesis testing.

4. Results

We used AMOS to test the baseline model and the hypotheses. The baseline model demonstrated a good fit, with acceptable values: χ^2/df = 3.527, GFI = 0.975, RFI = 0.965, NFI = 0.98, TLI = 0.975, CFI = 0.987, and RMSEA = 0.08. These values fall within commonly accepted thresholds, indicating an adequate model fit. Results are visualized in Fig. 2.

First, the path coefficient from SBM to CEP is positive and statistically significant ($\beta = 0.425$, $p < 0.01$), supporting H1. This result indicates that the adoption of service-based business models is associated with higher CE performance, reflected in an increased share of products that are reused, remanufactured, or recycled. Overall, the finding provides empirical support for the positive role of service-based business models in enhancing firms' circularity outcomes, thereby confirming the hypothesized positive effect within the structural model.

Similarly, the relationship between SCP and CEP is positive and statistically significant ($\beta = 0.350$, $p < 0.01$), thereby supporting H2. This suggests that manufacturing firms implementing supply chain practices achieve higher levels of closing-the-loop circularity.

The moderating role of supply chain practices on the SBM–CEP relationship was then examined (Table 5). When supply chain practices are modeled as a latent construct, the interaction term is positive and statistically significant ($\beta = 0.154$, $p < 0.001$), providing support for H3. This indicates that stronger supply chain practices enhance the positive effect of the adoption of service-based business models on CE performance. In other words, firms with more developed supply chain practices are more capable of leveraging service-based business models for improving circularity outcomes. The inclusion of the interaction term increases the explained variance from $R^2 = 0.692$ to $R^2 = 0.711$ ($\Delta R^2 = 0.019$), suggesting a slight improvement in the model's

Table 3
Parameters model summary.

Factor	Item	Loadings	Cronbach's Alpha	CR	AVE
SBM	SBM1	0.824	0.87	0.87	0.69
	SBM2	0.831			
	SBM3	0.843			
SCP	SCP1	0.798	0.82	0.82	0.61
	SCP2	0.662			
	SCP3	0.874			
CEP	CEP1	0.874	0.85	0.86	0.67
	CEP2	0.865			
	CEP3	0.719			

Table 4
Discriminant validity (HTMT) of constructs.

Construct	SBM	SCP	CEP
SBM	1.000		
SCP	0.932	1.000	
CEP	0.896	0.929	1.000

explanatory power. However, the incremental contribution is modest. Fig. 3(a) illustrates this moderating effect, showing that the positive SBM-CEP relationship becomes stronger at higher levels of supply chain practices implementation.

Firm size and industry type were included as control variables. Results indicate that neither firm size ($p = 0.312$) nor industry type has a statistically significant effect on the dependent variable. Importantly, the SBM-CEP relationship remains positive and significant after accounting for these controls, thereby reducing the likelihood of confounding effects influencing the results (Li et al., 2025; Nielsen and Raswant, 2018).

To empirically show their individual effects, Models 2-4 specifically examine the moderating role of individual supply chain practices, and Fig. 3(b–d) illustrate these moderating effects. For supply chain tracking, the interaction term is positive and statistically significant ($\beta = 0.152$, $p < 0.001$). This suggests that firms successfully integrating digital tracking tools in their supply chain monitoring practices are better equipped to operationalize service-based business models for the achievement of circularity goals. Regarding green partner selection practices, the interaction term is again positive and significant ($\beta = 0.138$, $p < 0.001$). This implies that firms prioritizing environmental criteria in their partner selection practices are more successful in translating service-based business model implementation into improved circularity results. Lastly, for co-design practices, the results also show a positive and significant interaction term ($\beta = 0.129$, $p < 0.001$). This indicates that firms collaborating with partners to co-design products and processes are able to achieve higher circularity outcomes when implementing service-based business models. For all three sub-models, the explained variance slightly increases, although the incremental contributions are modest. Among the three moderating practices, supply chain tracking exhibits the highest interaction effect ($\beta = 0.152$), followed by green partner selection ($\beta = 0.138$) and supply chain co-design ($\beta = 0.129$).

5. Discussion and implications

5.1. Discussion of the results

Concerning the first Research Question ("*To what extent do service-based business models and supply chain practices contribute to improving Circular Economy performance in the closing-the-loop domain*?"), our results confirm that a higher level of service-based business models' adoption and supply chain practices implementation by manufacturing firms leads to improved circularity outcomes. Service-based business models – either through end-of-life services in traditional product-oriented settings or retained product ownership in use- or result-oriented ones – create strong incentives to extend product lifecycles through reuse and refurbishment, or to recover residual value through recycling (Bocken et al., 2016; Tukker, 2015). This finding reinforces previous empirical evidence, such as Kühl et al. (2022), Johl et al. (2024), and Shah et al. (2025), who examined related topics such as product-service systems, green servitization, and platform servitization.

In addition, this evidence can be interpreted in light of the recent critical perspectives on servitization and CE. The assumed direct positive relationship between servitization models, circularity, and environmental sustainability has been questioned, pointing to rebound effects (Ackermann and Tunn, 2024; Kjaer et al., 2019), or arguing that product-service system adoption is mainly driven by commercial objectives, on both the manufacturer and customer sides, that may outweigh circular benefits (Saccani et al., 2024; Tukker, 2015). In this regard, our findings can be interpreted as consistent with the idea that service-based business models act as a synthesis response to CE

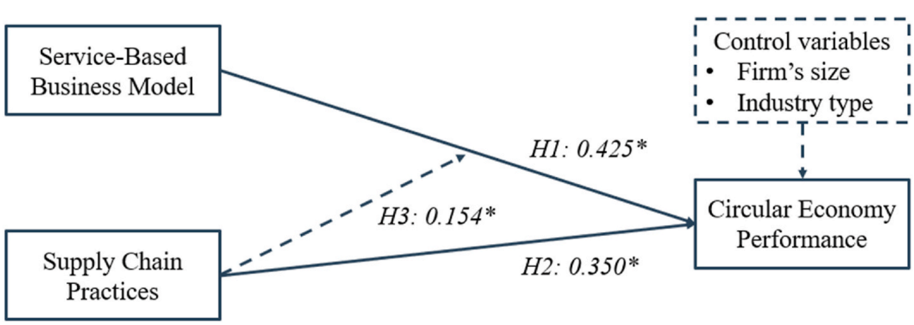

Fig. 2. Model results.

Table 5
Results of the moderation analysis.

Hypotheses	Interaction	Standard estimate	Std. Error	P values	R^2 (DV)	ΔR^2 (change)	Std. Error	Notes
Model 1 – Moderating effect of supply chain practices (latent variable)								
H1	SBM → CEP	0.425	0.049	p < 0.001	0.692			
H2	SCP→ CEP	0.350	0.044	p < 0.001	0.692			
H3	SCP*SBM → CEP	0.154	0.029	p < 0.001	0.711	0.019	0.029	Accepted
Model 2 – Moderating effect of supply chain tracking practices (individual item)								
	SBM → CEP	0.589	0.045	p < 0.001	0.655			
	SC1*SBM →CEP	0.152	0.025	p < 0.001	0.675	0.020	0.025	Accepted
Model 3 – Moderating effect of green partner selection (individual item)								
	SBM → CEP	0.638	0.038	p < 0.001	0.661			
	SC2*SBM → CEP	0.138	0.025	p < 0.001	0.678	0.017	0.025	Accepted
Model 4 – Moderating effect of co-design (individual item)								
	SBM → CEP	0.483	0.049	p < 0.001	0.681			
	SC3*SBM → CEP	0.129	0.029	p < 0.001	0.695	0.014	0.025	Accepted

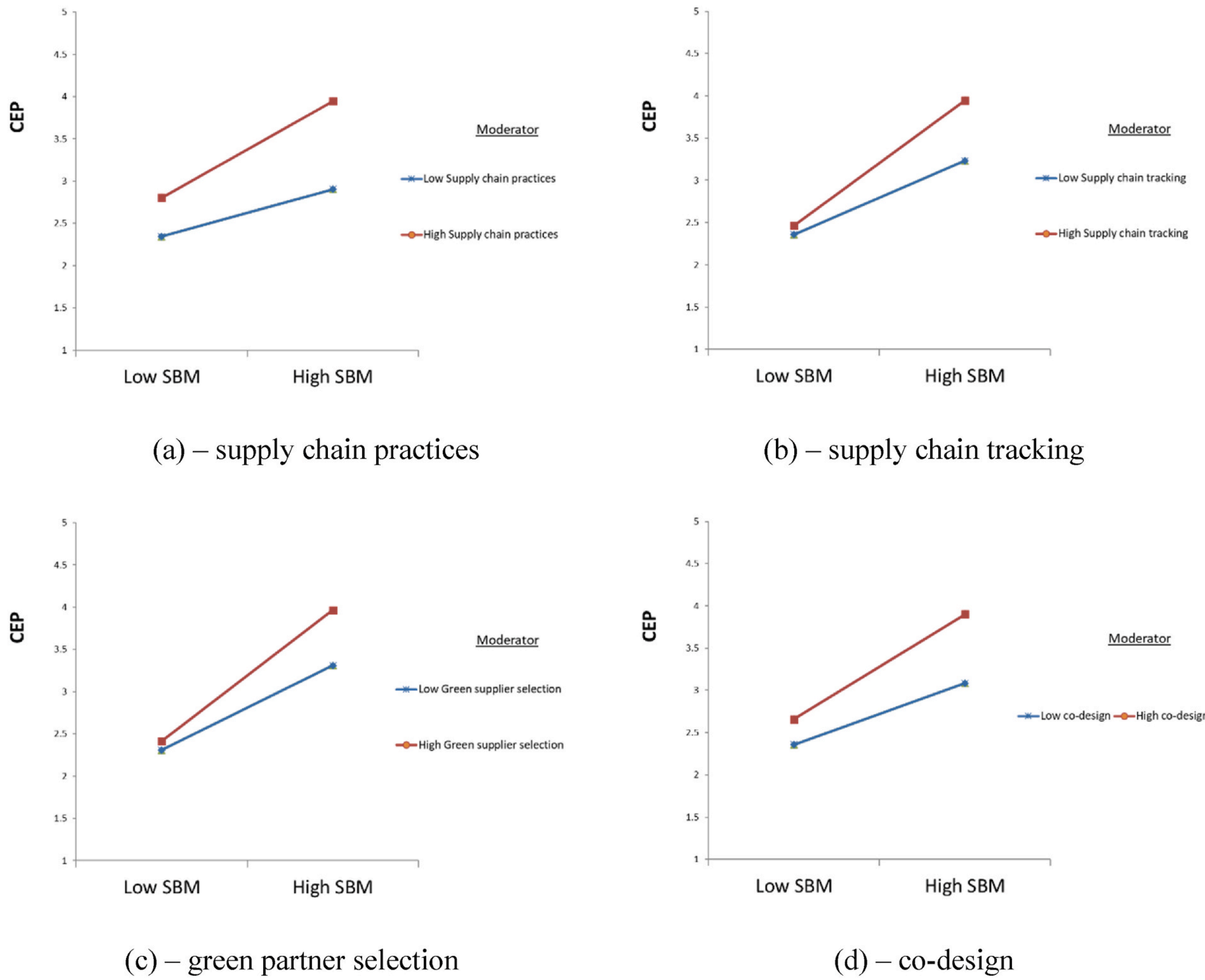

Fig. 3. The moderating effect of supply chain practices on the relation between SBM and CEP.

performing tensions through the integration of economic and environmental objectives (De Angelis, 2021; Kohtamäki et al., 2024; Smith and Lewis, 2011). These adverse mechanisms appear less prominent in the sample examined, possibly for two reasons. First, the sample companies mainly belong to B2B sectors. In these settings, the rebound effects due to slack resources or fashion are much more limited than in B2C contexts (Bączyk et al., 2024; Castro et al., 2022). Second, firms adopting service-based business models increasingly leverage digital technologies and platforms to enable, e.g., sharing systems and pay-per-use schemes. These are complemented by digital services, such as fleet management systems, allowing continuous monitoring of product usage. Although not directly measured in the empirical analysis, the literature acknowledges that digital services limit the risk of careless product usage by customers, thereby addressing a key obstacle to circularity outcomes (Tukker, 2015). More generally, the adoption of digital technologies supports the effective implementation of service-based business models, which can translate into superior CE performance (Wu and Pi, 2023). Thus, under appropriate conditions, the adoption of service-based business models emerges as an effective way for improving CE performance, without compromising economic profitability. This finding proves particularly significant in large and fast-developing economies such as India, where service-based business models offer the promise to leapfrog and decouple economic growth from resource consumption by enabling closing-the-loop strategies, mitigating the additional pressures on planetary boundaries connected to industrial growth (Steffen et al., 2015).

Similarly, our study finds that the adoption of publicly available and imitable supply chain practices facilitates an effective transition toward CE, in particular for closing-the-loop strategies, according to the Supply Chain Practice View (Carter et al., 2017). Our study provides specific empirical knowledge on the relationship between three supply chain practices (supply chain tracking, green partner selection, and co-design) and three among the '10Rs' imperatives of the CE, namely reuse, remanufacturing, and recycling, adding specificity to more general findings about the effects of supply chain collaboration on CE (Calzolari et al., 2025; Schöggl et al., 2024; Zhu et al., 2011). Thus, our findings support the relevance of spreading accessible and imitable practices to achieve sustainability goals (Brömer et al., 2019), in particular in emerging economies.

Concerning RQ2 ("*To what extent do supply chain practices affect the relationship between the adoption of service-based business models and the achievement of Circular Economy performance?*"), results indicate that supply chain practices positively moderate the relationship between service-based business models and CE performance. Thus, the positive effect of the adoption of service-based business models on circularity results is amplified when firms implement higher levels of supply chain practices. Previous empirical research has highlighted the importance of supply chain practices for both service business models adoption (Freije et al., 2022; Ruiz-Alba et al., 2024) and the enhancement of circularity outcomes (Calzolari et al., 2025; Schöggl et al., 2024; Zhu et al., 2011), but only in isolation. This study extends these separate streams by unveiling the moderating role of supply chain practices in the relationship between service-based business models and CE performance. While, for instance, Ruiz-Alba et al. (2024) showed that supply chain collaboration moderates the relationship between services provision and business performance, our study indicates that such practices also reinforce the achievement of circularity outcomes through various mechanisms. Supply chain tracking may enable real-time information sharing and resource synchronization across the multiple actors of a supply chain, reducing the complexity of implementing service-based business models (Garcia-Torres et al., 2024), and allowing the development of digital services based on data sharing among supply chain actors (Kowalkowski et al., 2024). It also supports optimized reverse logistics processes and end-of-life decision-making, thus improving reuse, refurbishment, and recycling outcomes (Alcayaga et al., 2019; Massari et al., 2023). Green partner selection may strengthen the alignment between service-based offerings and circularity objectives across the supply chain. Co-design with supply chain partners may foster product and process innovations that enable circularity and support the implementation of service-based business models, including product modular architectures, standardization, and ease of disassembly, which are all key for increasing reuse, remanufacturing, and recycling effectiveness (Burke et al., 2023). Co-design is also recognized for its potential to embed digital components in products for developing digital services (Paiola et al., 2021), improving the alignment between service-based offerings and circularity objectives. While all the above-mentioned mechanisms have been discussed in literature at a conceptual level, they have not been empirically addressed in combination. Our empirical results show that these supply chain practices have a complementary effect, leading – both individually and jointly – to superior CE performance through service-based business models' adoption.

These findings can also be interpreted in the light of paradox theory. Although the adoption of service-based business models can help firms overcome CE performing tensions, tensions are likely to resurface over time, as they are inherent in the implementation of service-based business models, especially at the organizing (e.g. customization vs standardization) and learning (e.g. exploration vs. exploitation) levels (Kohtamäki et al., 2020, 2024; Sun and Oliva, 2026). In turn, these resurfacing tensions can cause performing tensions to re-emerge as well, thereby undermining the achievement of circularity performance. In this context, supply chain practices play a critical role in sustaining a dynamic equilibrium through acceptance and iterative solutions, rather than forcing an either-or resolution between economic and environmental goals. For instance, supply chain tracking combined with co-design for circularity enables dynamically optimized end-of-life decisions — such as choosing among reuse, remanufacturing, and recycling options based on resource efficiency, circularity, and economic viability (Zeeuw van der Laan and Aurisicchio, 2020) — thus avoiding rebound effects and burden shifting (Kjaer et al., 2019). While prior research has already suggested that supply chain collaboration can help firms respond to CE tensions (De Angelis, 2021; Tosi et al., 2024), this role has so far been addressed only generically. This study, on the other hand, identifies specific and transferable supply chain practices that address CE tensions and examines their effect.

5.2. Theoretical implications

This study investigated the relationships among CE performance, service-based business models, and supply chain practices. It provides four contributions to knowledge accumulation. Three derive directly from our conceptual model and testing of hypotheses on empirical data, while the fourth is more speculative in nature, as it is based on the interpretation of our results in the light of the theoretical perspectives adopted in the study.

First, to the best of our knowledge, this is the first empirical study to illuminate the specific interplay among supply chain practices, service-based business model adoption, and CE performance achievement in the closing-the-loop domain. Our study empirically confirms the effectiveness of service-based business models in increasing circularity outcomes and elucidates the moderating role of supply chain practices in strengthening this relationship. By doing so, it contributes to recent discussions about sustainable and green servitization in supply chains, particularly regarding the role of servitization and product-service systems in fostering sustainability and circularity at the supply chain level (Bustinza et al., 2024; Rabetino et al., 2024).

Second, the study adds to the body of literature on CE and digital servitization in emerging economies, which has been historically underrepresented (Chiappetta Jabbour et al., 2020; Mishra et al., 2019; Paschou et al., 2020). Through data on 380 Indian manufacturing firms, this article provides evidence on how service-based business models and supply chain practices act as catalysts for circular transitions in emerging economies, potentially leapfrogging toward advanced circular models without replicating the long transitional phases observed in established industrial economies.

Third, by filling a gap in understanding the joint role of service-based business models and supply chain practices in enhancing circularity performance, the study provides an incremental contribution to the Practice-Based View and Supply Chain Practice View (Bromiley and Rau, 2014; Carter et al., 2017), particularly in relation to their links with organizational learning (Levitt & March, 1988). On the one hand, the mechanisms through which supply chain practices such as tracking, partner selection, and co-design trigger CE performance improvements point to the concepts of partnership building and sustainability learning (Gong et al., 2018; Rodrigo et al., 2025). This resonates with the capability perspective on practices, as practice adoption leads to organizational learning and transferability among firms (Parmigiani and Howard-Grenville, 2011). Moreover, the moderating effect of supply chain practices on service-based business models supports the idea that specific supply chain practices (such as the ones discussed in this paper) have a role in strengthening and amplifying the overall effect of business innovation (servitization-based, in our case) on performance (Lafuente and Vaillant, 2023) – in our case, on closing-the-loop circularity (Sahoo et al., 2026). This is again triggered by the role that supply chain practices play in developing capabilities, necessary for firms implementing diversification strategies through service-based business models (Sun and Oliva, 2026).

A fourth and more speculative theoretical contribution regards the application of the paradox theory (Smith and Lewis, 2011) to the service-based business models and CE bodies of knowledge, and its integration with the Supply Chain Practice View. Our empirical findings suggest that, through service-based business models, firms can address CE performing tensions to achieve improved circularity performance, in line with previous research (Kohtamäki et al., 2024; Robertson et al., 2026). However, the literature also recognizes the emergence of paradoxical tensions in firms' servitization efforts. These tensions may generate non-linear relationships between servitization initiatives and performance outcomes, both at the business level (Gebauer et al., 2005; Kohtamäki et al., 2020; Sun and Oliva, 2026) and at the environmental level (Kjaer et al., 2019; Saccani et al., 2024; Tukker, 2015; Kohtamäki et al., 2024), thereby potentially hindering the achievement of CE objectives. In line with the dynamic equilibrium model proposed by Smith and Lewis (2011) for addressing (inter-)organizational tensions in management, this study proposes that supply chain practices are a response to navigate and dynamically accommodate such tensions. In particular, our findings suggest that they are capable of addressing the organizing and learning tensions in service-based business models. The role of supply chain collaboration in addressing tensions has so far been examined in generic terms and in isolation (Kohtamäki et al., 2020; Tosi et al., 2024). In contrast, our study highlights the role of specific, publicly available, observable, and imitable supply chain practices in addressing such tensions, thereby enabling superior CE performance via service-based business models.

5.3. Managerial and policy implications

The findings of this study have implications for managers seeking to improve their firms' circularity performance through service-based business models. Results indicate that the effectiveness of service-based business models' adoption in increasing circularity is enhanced when well-established, readily available, and imitable supply chain practices are implemented. Therefore, managers aiming to enhance a firm's circularity through service-based business models should recognize this potential and prioritize investments in the integration of supply chain practices—such as supply chain tracking, green partner selection, and co-design—rather than focusing primarily on the search for costly, scarce, and inimitable resources. In particular, the primary role of supply chain tracking in moderating the SBM-CEP relationship suggests that managers should invest in supply chain digital technologies (e.g., IoT, RFID, data analytics) to improve control through digital services and decision-making for reuse, remanufacturing, or recycling.

The results are also relevant for policymakers, particularly for developing economies such as India, where the transition toward the CE is still emerging and often constrained by structural and infrastructural limitations, uneven coordination practices, and fragmented, informal networks. First, our results show that the adoption of service-based business models is positively associated with higher circularity outcomes. From a policy perspective, this suggests the need to promote business models that shift value creation from product ownership to product use. Policymakers can support this transition by introducing targeted incentives for service-oriented offerings, such as fiscal benefits or public procurement schemes favoring service-based solutions. Second, the findings highlight that supply chain practices not only directly enhance circularity, but also substantially strengthen the circular effectiveness of service-based business models. Supply chain practices such as suppliers' monitoring and materials tracking are especially critical in developing countries, where supply chains are often fragmented and characterized by limited transparency. Therefore, policy interventions should focus on strengthening the implementation of these practices through investments in digital infrastructure to support product traceability or through the development of platform initiatives that foster collaboration among supply chain partners. The importance of enabling such transparency mechanisms, e.g., through digital product passports, is reinforced by our study, which suggests that an integrated policy approach to support both service-based business models and supply chain practices can be more beneficial than supporting isolated servitization or supply chain initiatives. By doing so, policymakers can contribute to improving circular outcomes not only at the firm level, but also at a system-wide scale.

5.4. Limitations and future research

This study has limitations that open avenues for future research. First, the data were collected exclusively from manufacturing firms operating in India, which limits the generalizability of the findings to other countries. Second, the study examines the supply chain practices construct focusing only on a limited set of individual practices. Future research could investigate a broader range of practices in different countries and industries. This research direction is further supported by the modest incremental explanatory contribution of the moderated model (i.e., with interaction terms) compared to the baseline model, suggesting that alternative practices may yield stronger effects. Third, this study focuses exclusively on the closing-the-loop dimension of CE (Bocken et al., 2016), measured through the three indicators of reuse, remanufacturing, and recycling. Future research could also consider the narrowing and the slowing dimensions of resource loops, offering a more holistic perspective on CE performance.

An additional issue concerns the measurement of CE performance. We observed a varied approach in the literature, which adopts general and qualitative sustainability measures (e.g., generic environmental sustainability improvement), potential effects of CE adoption (e.g., carbon emission reduction) or, less frequently, purely internal CE outcomes (e.g., wastewater reduction). We attempted to measure proxies of the success of the implementation of closing-the-loop strategies. Nonetheless, we acknowledge that our perceptual scale, based on the responses of a single respondent from a single company, is limited in capturing the system-side and lifecycle perspectives of these measures. Further efforts are needed to improve actual circularity measures, also in line with the Supply Chain Practice View perspective that calls for the operationalization of relational performance as a crucial element to test the outcomes of supply chain practice adoption (Carter et al., 2017).

Finally, it was not possible to test the role of some potential boundary conditions that can influence the interaction among the three constructs. Future research, in particular, could analyze whether the supply chain position of the firm plays a significant role, as well as the company's maturity in key domains such as environmental sustainability or digitalization.

6. Conclusion

Moving toward CE is urgent to reduce environmental pressures and resource depletion caused by the manufacturing sector. This study investigated the relationship between the adoption of service-based business models, the implementation of supply chain practices, and the achievement of CE performance in the closing-the-loop domain, with a particular focus on the moderating role of supply chain practices in the relationship between service-based business models and circularity outcomes. Drawing on survey data from 380 Indian manufacturing firms and employing covariance-based Structural Equation Modeling, the findings provide empirical evidence that both service-based business models and supply chain practices exert a positive direct effect on CE performance. In addition, results show that supply chain practices strengthen the relationship between service-based business models and circularity outcomes, enhancing the circular effectiveness of these models.

This study contributes to filling a gap in research on servitization and service-based business models, characterized by "*over-reliance on exploratory qualitative methods*" and "*limited theoretical development*" that "*hinder efforts to uncover its relationship with organizational performance*" (Sun and Oliva, 2026 p. 44), by empirically and theoretically linking service-based business models, supply chain practices, and circularity performance within a unified framework. It also incrementally extends the Supply Chain Practice View by showing how known, imitable, and transferable supply chain practices foster capability development and organizational learning, thereby enabling the effective implementation of service-based business models for circularity improvements. Drawing on paradox theory, the study finally proposes that supply chain practices can act as mechanisms that dynamically manage organizing and learning tensions in service-based business models, while shaping performing tensions in circularity outcomes.

From a managerial perspective, our findings suggest that the effectiveness of service-based business models in enhancing CE performance depends on the concurrent implementation of supply chain practices. Managers aiming to improve the circularity performance of their firm should therefore prioritize investments in supply chain practices such as tracking, green partner selection, and co-design, to fully leverage the circular potential of service-based business models. Policymakers in developing countries aiming to leverage leapfrogging opportunities are then encouraged to support this transition through incentives for service-based business models, as well as through foundational investments – such as in digital infrastructure or in digital product passport initiatives – to enable the implementation of supply chain practices, particularly those enhancing transparency, traceability, and collaboration.

Future research could extend this study by examining a broader range of supply chain practices across different countries and industries, as well as by exploring more complex relationships and boundary conditions, such as firms' supply chain position and digitalization maturity. A further interesting avenue for future research is the integration of the customer perspective into the analysis. In circular economy contexts, customers increasingly assume the role of suppliers — returning end-of-life products, components, or materials back into the supply chain. Extending our framework to incorporate customer integration and collaboration could therefore provide a more complete picture of circular supply chain dynamics. Lastly, further studies should also adopt more comprehensive and objective measures of CE performance, to capture system-level and lifecycle perspectives, and to expand the analysis beyond the closing-the-loop dimension of CE.

Disclosure statement

No potential conflict of interest was reported by the author(s)

CRediT authorship contribution statement

Suman Kumar Das: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Software, Writing – original draft, Writing – review & editing. **Gianmarco Bressanelli:** Conceptualization, Formal analysis, Methodology, Supervision, Validation, Visualization, Writing – review & editing. **Nicola Saccani:** Conceptualization, Formal analysis, Methodology, Resources, Supervision, Validation, Visualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix I

Table A1
Overview of the Shapiro-Wilk test of variables

	SBM1	SBM2	SBM3	SCP1	SCP2	SCP3	CEP1	CEP2	CEP3
N	380	380	380	380	380	380	380	380	380
Missing	0	0	0	0	0	0	0	0	0
Mean	2.40	2.62	2.59	2.61	2.67	2.99	2.45	2.54	2.97
Median	2.00	2.00	2.00	2.00	2.00	3.00	2.00	2.00	3.00
Standard deviation	1.19	1.20	1.30	1.35	1.39	1.47	1.34	1.30	1.18
Shapiro-Wilk p	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**	**<.001**

Table A2
Harman's Single factor test

Factor Loadings		
	Factor	
	1	Uniqueness
SBM1	0.820	0.327
SBM2	0.800	0.361
SBM3	0.822	0.324
SCP1	0.857	0.265
SCP2	0.788	0.380
SCP3	0.652	0.475
CEP1	0.835	0.304
CEP2	0.834	0.305
CEP3	0.697	0.414

Note. 'Principal axis factoring' extraction method was used in combination with a 'none' rotation.

Table A3
Common Latent Factor

Item	Loading without CLF	Loading with CLF	Difference
SBM1	0.843	**.827**	0.016
SBM2	0.824	**.802**	0.022
SBM3	0.831	**.816**	0.015
SCP1	0.874	**.863**	0.011
SCP2	0.798	**.781**	0.017
SCP3	0.662	**.652**	0.010
CEP1	0.860	**.859**	0.001
CEP2	0.865	**.811**	0.054
CEP3	0.719	**.670**	0.049

Table A4
Independent sample *t*-test

Independent samples t-test						
		Statistic	df	p		Effect Size
SCP	**Welch's t**	−6.16	298	<0.001	Cohen's d	−0.653
SBM	**Welch's t**	−6.01	278	<0.001	Cohen's d	−0.643
CEP	**Welch's t**	−6.94	298	<0.001	Cohen's d	−0.735

Note. H_a $\mu_0 \neq \mu_1$.

Data availability

Data will be made available on request.

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