Strategic Operations Management for Sustainable Supply Chains: Examining the Impact of Circular Economy Practices, Green Procurement, and Supply Chain Resilience

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Abstract - *The concepts of circular economy transformation, green procurement, and chain resilience are normally analyzed and researched in isolation, using the terminology and language of their respective claims regarding what makes for sustainable operational results. This conceptual synthesis suggests the separation is only theoretical, highlighting the difficulty with which it can be achieved. When read together they indicate that an underexplored dependency is to use resilience as the process by which a circular economy and green procurement initiatives' environmental and economic benefits translate into sustainable performance at the operational level; and 2) that Industry 4.0 and digital are not only an enabler of circularity, but also a boundary condition that, if not met, then circular economy and green procurement projects in any form are likely to not achieve resilience at all. The article develops a theoretical coherence based on 30 sources related to 4 key concepts SCM, green procurement strategy, supply chain resilience, and closed-loop SC design to formulate a few explicit propositions that explicitly specify the direct links between circularity, green procurement and supply chain resilience, as well as the infrastructure mediated connections, and the conditions under which digitalization translates supply chain resilience to operations performance. The analysis also brings to the fore several tensions current in the literature that need to be addressed when using the framework in an empirical study: The engineering and evolutionary perspective on resilience are confused, measurement inconsistencies in the literature hamper comparability of reported performance impacts, and the centralized literature of designing a closed-loop supply chain is instrumental for optimizing instead of coordinating fragmented reverse flows, which adds new cost implications to the practical introduction of reverse flows. The article wraps up with five managerial implications related to the four propositions and several longitudinal, multi-group, and configurational research designs that can assess the most important propositions of the framework.*

Keywords - *Circular Supply Chain Management; Closed-Loop Supply Chain; Green Procurement Strategy; Supply Chain Resilience; Sustainable Operations Management.*

I. INTRODUCTION

With the increased threat of some of the world's most critical resources becoming scarce, more and more stakeholders becoming activists, and repeated shocks due to pandemics, geopolitical conflict or logistics restrictions, it is impossible to contain environmental performance merely as a function of corporate social responsibility when it becomes a core requirement of an organization's operations to align cost, quality and disruption risk with commitments to environmental performance (Atasu et al., 2020; Van Wassenhove, 2019). A response in turn has been three literatures that have grown more or less independently of each other: a circular economy literature which focuses on rethinking material flow as re-use, re-manufacturing and recycle (Farooque et al., 2019; Lengyel et al., 2021); a green procurement literature that engages with the integration of environmental considerations in the activities of the supply chain immediately preceding the actual value chain of the product (Vocks et al., 2025; Ghosh, 2019); and a supply chain resilience literature that focuses on the ability to anticipate and absorb disruption, and to recover from it (Ponomarov & Holcomb, 2009; Tukamuhabwa et al., 2015). These literatures are well-matured, and each has its typologies, its performance demands, and more and more its own "on its own" criticisms. Still, they are seldom read with each other, and when they are, they usually only connect apparently not necessarily by making sense, and even then, the sense is seldom made explicit.

This gap is not just a spatial or even a national or cultural one; it actually leaves one with a theoretical mystery. While circular economy adoption and green procurement both alone contribute to the performance of an organization in terms of environmental performance and, as found in some studies, financial performance (Ghosh, 2019; Behl et al., 2023) and Resilience is also directly connected with a firm's performance (Jain et al., 2017; Zhao et al., 2023), the research literature provides no principled exploration of (a) whether the three capabilities are substitutes, are complements or are sequentially dependent capabilities; (b) whether a firm can contribute to sustainable OP (OE) by adopting one of these capabilities independently or whether it needs to take other action to make the capabilities matter at all; (c) whether a firm can pursue green procurement independently of CP and operational performance and still contribute to the sustainable OP (OE); or (d) whether Resilience can be independently adopted by a firm, and still matter to CP and its sustainable OP (OE). As for the literature, there is very little research explaining the failure of many circular economy and green procurement initiatives that result in no measurable performance despite having a theoretical basis for success (as is the case with many of these products; Lengyel et al., 2021; Wong et al., 2016), until resilience and digital

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infrastructure are introduced as trigger factors for success or failure.

To solve this puzzle, the following three research questions (RQ) will be raised: With this puzzle in mind, three research questions (RQ) are raised: How do practices and green procurement strategies of the concept of circular economy impact the resilience of the supply chain directly and via infrastructure (RQ1)? Second, when is digitalization a "boundary condition" instead of just an “additive enabler” for the transition of circularity, green sourcing, and resilience to sustainable operations performance (RQ2)? Third, what are some issues that are still unsettled in the literature in terms of theory and measurements that need to be remedied before testing these relationships in the field (RQ3)? The idea is not to provide an answer to these questions based on new data but to develop a theory that can be easily tested with data which is further explained below.

It's crucial to make an explicit expression of the kind of contribution this article makes. Not a systematic literature review in the sense of PRISMA, and there is no original empirical data reported. It is a conceptual synthesis rather than an ‘exhaustive and descriptive’ integrative review, and it follows a theory-development process that starts with a collection of previously known yet unconnected literature and ends with an explanatory structure of theory statements to be tested. The article builds upon the article of Hazen et al. (2021) about the conceptual framework and the research field of circular supply chain management (SCM) by explicitly introducing resilience and digitization as linking mechanisms of the SCM concept instead of topics that follow each other as parts of an independent research field. Unlike a systematic search protocol, a purposive selection was used to identify the 30 sources included, which are relevant to the four constructs considered: circular economy/CSCM, green procurement strategy, supply chain resilience, and closed-loop supply chain design in theory, and did not follow a comprehensive systematic process. Therefore, the framework presented should not be interpreted as a validated causal model, but as a set of propositions that can be empirically tested.

This is followed by 5 additional sections which further develop this argument. Section 2 lays out the theoretical underpinnings of sustainable operations management, circular economy, and green procurement; it does not seek to solve the problems of definitional and measurement inconsistencies, but instead makes them throughout the rest of the book. Section 3 considers closed-loop supply chain design as the operational "vehicle" or infrastructure that makes possible the application of the circular economy concepts, exploring in critical terms the deterministic assumptions given in many such studies. Section 4 then utilizes the tensions that were identified in Sections 2 and 3 as a springboard to develop the article's main theoretical contribution, an integrative framework (in four explicit propositions): Resilience should be viewed as a mediating mechanism for digitalization instead of just a simple moderator, and digitalization should instead be considered as a boundary condition. In Section 5, the implications of the framework are discussed; an explicit confrontation is made with the literature, and the propositions are turned into management advice. The article concludes with Section 6, which "clearly spells out" the limitations of the article and offers some specific empirical designs that could test the propositions outlined in Section 4 of the article.

II. Theoretical Foundations: Circular Economy, Green Procurement, And Sustainable Operations Management

With the puzzle outlined above as a foundation, this establishes a language of theory for the next sections to operationalise the relationships between circularity, green sourcing, and resilience, and calls out (rather than ignoring) the definitional ambiguity found in the puzzle that will frame various future sections of the book.

Unlike the classical theory of operations management, whose only focus is the cost, quality, and delivery of the services, environmental and social performance are included in the scope of sustainable operations management (SEM) as an additional focus (Gunasekaran & Irani, 2014). To integrate sustainability aspects into operations strategy, prior to this, Bettley and Burnley (2008) suggest that there have to be more than just efforts to minimize waste as the aim of compliance; operations have to take a different approach which involves innovative ways of designing the supply chain, process and product architectures. While these two are important starting words, more relevant to the nature of this field's more significant recent statements are those that link sustainability performance to certain enabling attributes as opposed to the general concept of "managerial orientation. The two statements provided above are useful starting points, but more significant are statements in the field of linking sustainability performance to certain enabling capabilities rather than simply general 'managerial orientation '.

The view of sustainable operations management by Atasu et al. (2020) puts sustainable operations management in the perspective of balancing environmental performance with traditional operational performance in industrial processes (including manufacturing) and service delivery, and by Van Wassenhove (2019) goes further by suggesting that sustainable innovation is not just about infusing sustainability into existing business models, but a reconsideration of product life cycles, network design, and value recovery. In this reframing, Raut et al. (2019) find that competences related to big data analytics reinforce operational sustainability practices and that the combined effect of Industry 4.0 and the three circular economy enablers (the reconceptualized 3Rs of the three R's) does not simply multiply the advantages, as is illustrated in the case of higher interoperability and more tangible business performance benefits. Sustainable operations management is much more than just a fourth independent construct, with the other three being CE practice, green procurement, and resilience building; it is assumed to surround them as the larger context in which they exist.

Circular supply chains have been a specific research area primarily focusing on the design of the operational and strategic mechanisms in which tenets of CE can be put into practice in a supply chain. The widely cited paper by Farooque et al. (2019) which is a structured literature review has given a classification definition for circular supply chain management as follows: A circular supply chain includes circular economy thinking in the process of supply chain management, which can be divided into 4 categories: (1) Eco-design, (2) Resource recovery, (3) Closed-loop logistics, and (4) Stakeholder collaboration. De Angelis et al. (2018) explain the evolution from a more traditional concept of closed-loop SCM towards a more circular perspective of the supply chain, pointing to the need to consider the additional concepts of reverse flows, secondary markets, and extended producer responsibility for achieving circularity. It can be seen that the extent of circularity reached is highly dependent on the industry; from incremental recycling to full closed loop redesign (similarities based on the research done by Zhang et al., 2021), but also that it is partially dependent on the time level as well because it can change both at the strategic and tactical, and also at the operational level (change in time level as presented by Hazen et al., 2021). From a technology point of view, Chen et al. (2022) argue that the growing use of digital technologies, such as blockchain, the Internet of Things (IoT), as well as advanced analytics, is helping to fulfil the traceability, transparency and coordination that is needed in a circular supply chain.

In the present context, however, it's a rather more typological than causal body and therefore is one that is much less relevant to the argument outlined in this article. While Farooque et al. (2019) report that circular practice in products, processes, organisations, and policy are four specific types of applications, the taxonomy does not detail how each type of practice should compare/connect to an observed outcome of a circular configuration, and neither unifying taxonomy specifies how a circular configuration is realized as a performance outcome. Additionally, Lengyel et al. (2021) note that there is still a lack of a consistent operational definition in circular practice as applied in studies, which could stand to be further elaborated. In this article, this instability is not considered a gap to fill when designing an integrative model, but rather a design constraint that the integrative model developed in Section 4 needs to take into account: constructs that can be measured but are not included in one study or another, yet are essential for any integrative model based on this body of work.

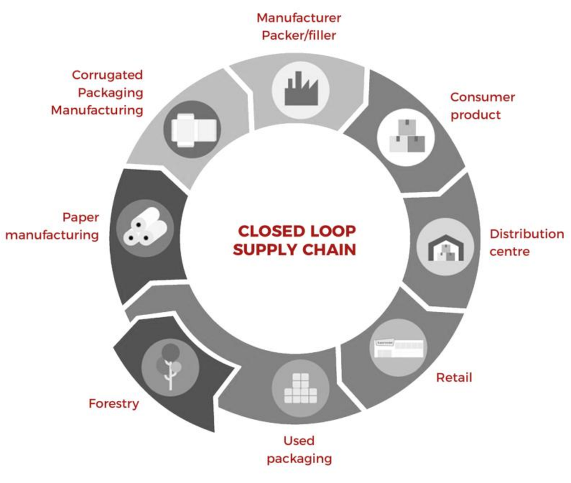

Fig. 1. Linear, closed-loop, and circular supply chain configurations.

As the above literature depicts, we see a transition between a linear supply chain and a circular one, as shown in Figure 1. For decades, products & packaging have followed a linear 'take-make-dispose' chain, which sees products and packaging end up in the landfill or natural environment, as indicated in Panel (a). In a closed-loop supply chain be is the return of the used products are returned to the original producer, and the number of recovered products is limited to the scope of the original supply chain. Panel (c) illustrates a circular economy model, which includes reuse, repair, refurbishment, remanufacturing, and recycling, where multiple forks/circuits from different parts of the supply chain converge to the natural and industrial surroundings, as stated by Farooque et al. (2019), for the vision of resource regeneration in a zero-waste circular economy. For this discussion, these different forms of supply chain types can be conceptualized on two parallel continuum scales, based on the sustainability paradigms pursued and the degree of organizational changes needed, as presented in Figure 2.

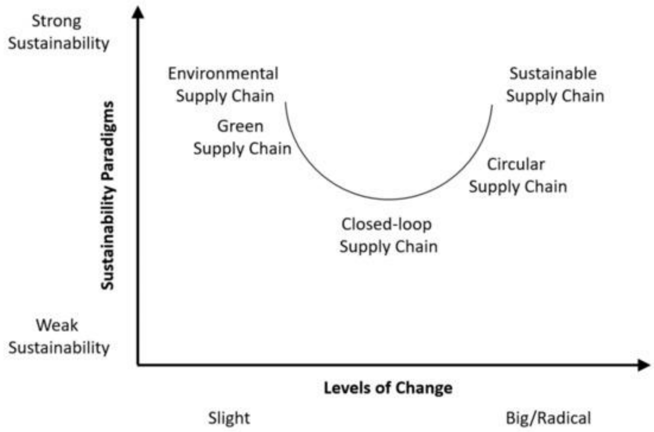

Fig. 2. Supply chain management types positioned by sustainability paradigm and level of change.

As depicted in Figure 2, the expectation/aspiration towards sustainability is moderate for both environmental and green supply chain management, while the transition with closed-loop supply chain management is placed between the two, through moderate sustainability orientation and moderate transition. At both extremes of both axes, Circular & Sustainable Supply Chain Management (SCCM) represents the best sustainability position, as well as the maximum level of organizational and structural change.

Green procurement strategy refers to criteria or measures that are adopted to reduce the environmental impact associated with various activities of the inbound supply chain used in procurement decisions (Routroy & Pradhan, 2012). Based on this research, Ghosh (2019) concludes that the drivers of green procurement implementation are organizational, regulatory, and market, and that companies that have an established green procurement strategy obtain measurable benefits from a green procurement strategy, including resource efficiency gains, cost savings, and reputational capital. Despite limited tools and resources to build green procurement, the authors in the construction sector indicate that the leading enablers are top management commitment, availability of information about green products, and buyer-supplier collaboration. Vocks et al. (2025) provide a summary of the mechanisms of action of green procurement strategies and conclude that, as well as external factors such as environmental legislation, complementary organizational capability is also an internal factor that impacts the successful implementation of environmental legislation into green procurement. Niu et al. (2024) further investigate this Continue at the global level, by taking into account the interplay among green procurement decisions, delivery disruption risk and global brands' allocation between local and global sourcing; Chotia et al. (2026) document sizeable improvements in performance in the decision to implement a green procurement policy, when integrated with investments in the adoption of information sharing along the supply chain.

However, there are a couple issues to note here: These performance claims need to be taken with a grain of salt, though: Ghosh's (2019) and Chotia et al.'s (2026) conclusions about how firms perform are primarily based on cross-section survey designs which do not eliminate reverse causality; it is just as likely that firms with extra resources after they become more profitable will invest in green procurement, as it is that green procurement leads to the performance benefiting. The results of the studies that focused on the introduction of green building resonate with the findings from the construction sector (Wong et al., 2016), which indicate that the enabler factors that successful implementation of a green building can lead to are not evenly distributed across firm size, implying a great level of uncertainty and heterogeneity that a simple description of such factors usually averages over.

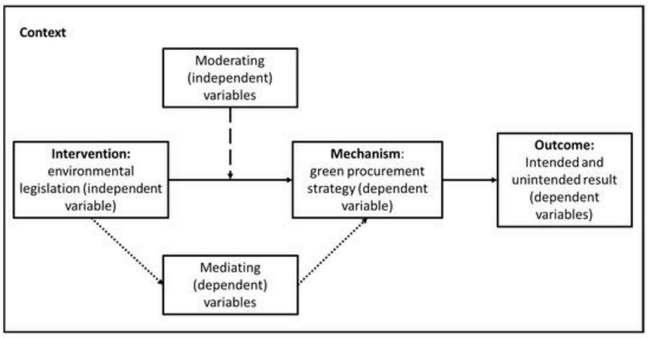

Fig. 3. Context-intervention-mechanism-outcome logic for green procurement.

Vocks et al. (2025) propose a relationship between regulation, which makes it easier to implement green procurement, and the outcome of green procurement, which is formalized as illustrated in Figure 3. In this model, green procurement strategy is an intervention that starts the process of environmental legislation that leads to intended and unintended outcomes, with the institutional and market context as a moderator between the implementation of the model and the challenges and/or opportunities that derive from this implementation, and organizational capacity and supplier readiness as a moderator between the implementation and intended and/or unintended outcomes. This finding is also in line with previous studies in the construction sector (Wong et al., 2016), suggesting that the effect of green procurement can be moderated by more than just the legislation, and that it can influence the outcomes of green procurement tremendously, varying from one similarly regulated firm to another. To provide the reference vocabulary for the discussion in the next section, Table I represents the major constructs, conceptual definitions of these constructs, and the sources used to define them.

TABLE I. Summary of Core Constructs, Definitions, and Representative Sources

Construct	Core Definition	Representative Sources
Circular Economy / Circular Supply Chain Management	Integration of reuse, remanufacturing, recycling, and closed-loop material flows into supply chain design across the product life cycle.	Farooque et al. (2019); De Angelis et al. (2018); Zhang et al. (2021); Hazen et al. (2021)
Green Procurement Strategy	Deliberate incorporation of environmental criteria into supplier selection, purchasing specifications, and sourcing decisions.	Routroy & Pradhan (2012); Ghosh (2019); Wong et al. (2016); Vocks et al. (2025)
Supply Chain Resilience	Adaptive capability to anticipate, absorb, adapt to, and recover from disruption while sustaining operational continuity.	Ponomarov & Holcomb (2009); Tukamuhabwa et al. (2015); Wieland & Durach (2021)
Sustainable Operations Management	Strategic integration of environmental and social performance with conventional cost, quality, and delivery objectives.	Gunasekaran & Irani (2014); Atasu et al. (2020); Van Wassenhove (2019)
Closed-Loop Supply Chain (CLSC)	Integrated forward and reverse logistics system encompassing collection, inspection, remanufacturing, and redistribution.	Battini et al. (2017); Gaur et al. (2017); Choi et al. (2013)

III. Closed-Loop Supply Chain Design As Operational Infrastructure

Section 2 revealed that although the concept of a circular economy is well developed in theory, it is not easy to translate it to the practical level. Farooque et al. (2019) and Lengyel et al. (2021) highlight what circularity means, but not so much as they highlight how it is implemented in reality. This section tackles that gap and describes closed-loop supply chain (CLSC) design as the operation-based infrastructure where circular economy principles are being implemented in logistics and production decisions.

Battini et al. (2017) state that closed-loop supply chain research can be split into two related topics: the economic aspects of closed-loop systems and the modelling, managing, and controlling of both forward and backward flow processes involved in the collection and inspection process, reconfiguration process, and redistribution process. An integrated optimization model for closed-loop network configuration is presented by Gaur et al. (2017) that considers the initial and remanufactured products, and demonstrates the pro or con of the decisions in the network design on the economic viability of remanufacturing operations. In explored situations, closed-loop chains, as they are called, the specific decision-making power distribution between the manufacturer, retailer, and 3rd party recyclers is shown to be a factor that has a significant impact on profitability and the effectiveness of the reverse flows. Choi et al. (2013) investigate the issues of leadership, performance, and coordination in closed-loop chains and conclude that the distribution of decision-making power among manufacturer, retailer, and 3rd party recyclers matters. Recognizing the uncertainty of products returned with different volumes and quality, Zarandi et al. (2011) model the problem of designing the reverse logistics network using interactive fuzzy goal programming; furthermore, there is a current trend emphasising not only economical aspects, but also the environmental performance of reverse logistics, as reflected by the introduction of an energy value objective and a time value objective in the modeling tradition of Kadambala et al. (2017). The importance of variables most relevant to the area of effective environmental management in a closed-loop supply chain is directly related to network design, which is why Bhatia et al. (2020) discuss the following variables as most significant: regulatory pressure, reverse logistics infrastructure and top management commitment (Section 2).

But this mode of modelling does not focus on description and is overwhelmingly normative in character. All of the above papers relax one key assumption, namely uncertainty of coordinating demand across the channel, which Choi et al. (2013) have found to be a first-order source of channel-leadership performance metric. All of the above studies depart from the same key assumption of known demands (or their distributions), exogenous return rates, and single-period cost functions. The collection as a whole is very rich in analytic content for optimising a closed-loop network when its parameters are known to them, but rather limited in its contributions to the literature on how companies identify and adjust their parameters in the face of the volatility in demand and returns that spurs the resilience literature in the first place. As Section 4 further develops the earlier observation, this is the place where it is appropriate to read the literature on the closed-loop supply chain design side-by-side with the literature on resilience to gain combined insights.

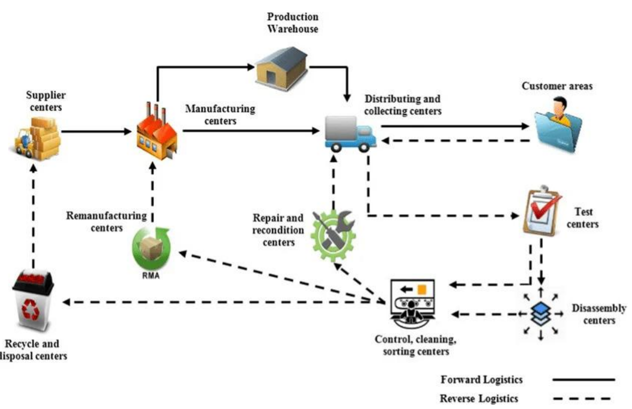

Fig. 4. Forward and reverse logistics flow structure of a closed-loop supply chain.

Figure 4 shows the forward and backward direction of the linkages between raw material extraction, production, and consumption and collection, inspection, re-use, and recycling, and also shows the recycled materials and components back to raw material sourcing and manufacturing. The recovered material and components are fed into the reverse flow indicated in the diagram; recovered material is recovered, sorted, and then sent to a counter-production to the previous stages of manufacturing and sourcing processes (Battini et al., 2017).

This leads to a dual sourcing and dual return chain and forces the operations manager to make coordinating decisions both locally and globally on the setting up of the network and on channel leadership in both directions simultaneously, not allowing reverse logistics to be seen as a background compliance issue. In contrast to ignoring the interaction between primary and secondary markets, product innovations – like the introduction of new plastic recycling technologies are found to have significant suboptimal implications (Gaur et al. 2017), and channel structures with distinct roles have been shown to generate significantly different profitability and reverse material recovery efficiencies (Choi et al. 2013) that have implications for the design of reverse product-market oriented contracts. Zarandi et al. (2011) present the adaptations fuzzy programming methods need to deal with the uncertainty in reverse logistics due to the return-volume and return-quality uncertainty, while Kadambala et al. (2017) illustrate how the addition of extra value efficiency objectives for material and energy changes the optimal network design when compared with designs that concern only material circularity. A summary of the focus of modeling and main contributions gained from these typical studies is presented in Table II.

TABLE II. Comparative Overview of Closed-Loop Supply Chain (CLSC) Design Studies

Source	Modeling Focus	Principal Contribution
Battini et al. (2017)	Economics, modeling, management, and control of integrated CLSC flows	Establishes the foundational scope of CLSC research across economic and managerial dimensions
Gaur et al. (2017)	Integrated optimization of new and reconditioned product networks	Shows suboptimality when primary and secondary markets are not jointly configured
Choi et al. (2013)	Channel leadership and coordination	Demonstrates that leadership allocation affects profitability and recovery efficiency
Zarandi et al. (2011)	Interactive fuzzy goal programming under uncertainty	Addresses unpredictability in return volume and quality in CLSC design
Kadambala et al. (2017)	Energy and time value efficiency in network design	Extends CLSC objectives to the environmental performance of reverse logistics itself
Bhatia et al. (2020)	Organizational factors in environmental management	Identifies regulatory pressure and top management commitment as critical enablers

IV. An Integrative Conceptual Framework: Resilience As Mediator And Digitalization As Boundary Condition

This was followed by a discussion in the final section that highlighted that while closed-loop supply chain design research as an optimization problem is mature, the literature on resilience is dedicated to adaptation under uncertainty in the context of this design challenge. Taking this observation as a point of departure, this section also recognizes the tension between definition and measurement discussed in Section 2 and sets forth the article's core theoretical contribution: an integrative framework that, according to the arguments as noted below, differs from the models in the literature in four crucial ways that are presented as four propositional hypotheses.

The correlation of circularity and green sourcing with resilience has not ended the debate regarding the topic, as it is not devoid of the existing literature. Both Niu et al., 2024 and Zhao et al., 2023 provide connections that align with an association between them. This literature, however, views resilience as one of a handful of potential benefits of a circular and green initiative, not the deciding factor in whether other benefits will be realized. The first novelty introduced in this article is the differentiation of "resilience" from the other possible benefits of the circular economy, for example its impact on lowering costs or boosting reputation, by defining it instead as a "mediating capability. The first novelty of this article with respect to the current literature is the definition of "resilience" as a "mediating capability": the practices and strategies related to the circular economy are expected to affect the sustainable performance of operations primarily through their effect on the capability of being resilient, but only secondarily, either as a cost saving benefit, or as a reputational benefit.

Proposition 1 can be distilled into two distinguishable elements which relate to the supply chain resilience impacts of CE practices, namely a direct pathway and an infrastructure-mediated pathway: CE practices directly impact the resilience of the supply chain through reducing exposure to price volatility in virgin materials supplies and geopolitically concentrated supplies (Battini et al., 2017; Farooque et al., 2019); a second pathway occurs through the potential of integration within the reverse logistics capability developed for the CE design, which can become a general (purpose) adaptive capacity for a firm to respond to a disruption that is unrelated to the CE concept itself (Gaur et al., 2017). One proposition differs from the additive treatment that has been practiced in existing literature, none of which makes a distinction between the change-in-mechanism benefit (e.g., Zhang et al. (2021) list all the benefits of circular economy without distinguishing whether it is direct or mediated by infrastructure investment), and posits that investing in circular economy without investing in infrastructure will yield the direct pathway's resilience benefit, but not the larger, infrastructure-mediated benefit, which can be tested by comparing the resilience outcomes of firms that are matched but differ in their level of circular economy intensity and reverse logistics activity.

According to Proposition 2, green procurement strategy influences resilience mainly in two ways: firstly, by diversifying suppliers; and secondly, by screening risks for suppliers, that is, environmental risk screening (Niu et al., 2024). Proposition 2 further indicates that the resilience benefit of the decisions regarding green procurement depends largely on the ability of suppliers to share information along the supply chains, while the absence of such capacity significantly weakens the resilience impact of green procurement decisions (Chotia et al., 2026). Unlike Chotia et al. (2026) characterize information sharing as being one of many enablers of green procurement, part of the impact of green procurement's resilience effect in this proposition is that it requires information sharing as a prerequisite, meaning information sharing should thus be considered a moderating effect that is, a relationship in the broader green procurement literature that this framework predicts will be present.

The other, and more impactful, break-off this framework offers from the corresponding literature is about the part of digitalisation and Industry 4.0 technologies. Zhao et al. (2023) and Chen et al. (2022) both use digital capability as a linking function and link it back to the relationship between sustainability practices and digital outcomes. In this context, digital capability enabled the relationship between sustainability practices and outcomes to occur, but this relationship is assumed to exist, albeit weakly, without digital investment. Instead, this framework suggests that digital and Industry 4.0 capability becomes a threshold rather than a moderator; that is, that designing in characteristics of digital capabilities and information infrastructure, in addition to getting below a certain point, would not just make the critical relationship between circularity and resilience stronger, but actually reverse its sign.

Proposition 3 builds on and extends the arguments of both Chen et al. (2022) and Lengyel et al. (2021) whose independent findings about the cost of coordination and the variability in definitions address the same kind of threshold effect, powering up circular economy practices to enhance supply chain resilience, but not monotonically through digitalization, as it is pre-positioned before the adoption of a threshold level of digital traceability infrastructure. The claim that a moderation relationship exists as reported by Zhao et al. (2023) and Behl et al. (2023) separately is weaker and less falsifiable than Proposition 3 that predicts a specific moderation relationship: that the outcomes of resistance are no stronger, and likely weaker, for firms undertaking the circular economy execution or for those that have green procurement initiatives, who have low digital infrastructure, when compared with firms with neither green procurement initiatives nor the circular economy execution, but with low digital infrastructure.

Furthermore, the framework establishes the pathway for resilience to turn into sustainable operations performance, after the resilience that is being realized in the pathways of Propositions 1 to 3, because relating circular economy and green procurement performance to firms' resilience products in Section 2 is not a strong pattern. According to Proposition 4, infrastructure-mediated circular economy practices and information-enabled green procurement practices lead to sustainable performance of their operations mainly via two pathways that are different from one another but have already been found separately in the existing literature low exposure to the disruptions of changes in costs affecting a firm's performance (Ponomarov & Holcomb, 2009; Jain et al., 2017), and high capacity to maintain a firm's environmental and social performance commitments in turbulent times (Wieland & Durach, 2021). The degree of importance of these two channels is a function of the resilience orientation of a company, either towards "re-stabilisation" to the previous normal operating state and/or towards "adaptation" to a new operating state (Wieland and Durach, 2021), which are not related to circular economy and green procurement outcomes.

There is some partial (and indirect) support for these propositions in existing empirical work, but such evidence hasn't been directed toward the testing of these specific propositions. Comparing the results with Proposition 3's boundary condition approach, Raut et al. (2019) confirm that big data analytics capability not only reinforces the connection between sustainability practices and business performance but also, in a context other than cross-sectional analysis, as is done in this project, it does not enable any causality beyond the mere establishment of the links. A similar relationship between the two in terms of operational sustainability was revealed by Behl et al. (2023) when looking at the relationship between Industry 4.0 and circular economy enablers. Proposition 3 is compatible with this result, but was not specifically designed to test for the threshold or sign-reversal pattern this prediction implies. Proposition 1 is indirectly supported by relevant work by Jain et al. (2017) and Proposition 4 by that of Gunasekaran et al. (2015), which, while demonstrating the correlation between both structural complexity management and outcomes of resilience and either visibility and structural complexity management, do not specifically link either resilience outcome to circular economy/Green procurement antecedents. Now, not surprisingly, it is the specification that contributes to the framework: It helps define, in compliance with the existing evidence but without being tested, a set of mechanisms and boundary conditions that are important for generating managerial implications, which are dealt with in Section 5, and can later be operationalized to form specific empirical designs, to which Section 6 is dedicated.

V. Discussion and Managerial Implications

The framework introduced in Section 4 has implications that go beyond restating the relationships that have been documented in Sections 2 and 3, and some of these implications would be best seen as tensions in the process of being resolved, rather than definite conclusions.

The first tension is about sequencing. If proposition 3 is correct, companies that begin to work with circular economy or green procurement are likely to be worse for this than they are better. Reverse flow coordination costs have an immediate impact, while the impact of a successful circular economy or green procurement program will only be apparent once they have reached a level of functional maturity. This observation is consistent with, but not actually tested through, Lengyel et al (2021), which note that circular economy outcomes differ between firms which have similar stated commitments, and Wong et al (2016), which found that while many small subcontractors have formed a fragmented supply chain were unable to achieve consistent green procurement compliance, there may be an unmeasured digital-readiness threshold operating below those reported by these studies. Managers can more easily understand that, as well as the amount of a particular investment, the order of investments is important. Instead, digital traceability and information-sharing infrastructure should be considered a prerequisite to scaling downstream the circular economy and green procurement agenda and not as a "bolt-on" investment once in place. This is a distinction from the more ubiquitous practitioner viewpoint, which would see digitalization framed as a 'bolt-on' to be installed once commitments to circular economy and green procurement have already been made.

The second tension is about the definition of resilience. (Wieland and Durach, 2021) observe that there are two conceptions of resilience: one engineering that aims to return to a previous stable situation and an evolutionary one that aims to reach new operational norms and configurations, and stress that responsible firms have to opt for one or the other and carefully consider their choice with intentionality. This choice is hardly just a strategic option; it could have direct design consequences for the architecture of closed-loop supply chains: an engineering resilience approach is better suited to the single-loop configuration panel (b), the aim of which is to quickly return to a known operating state, while an evolutionary resilience approach is better suited to the multi-loop configuration in panel (c), in which surplus resources are used across re-use, repair, re-manufacturing, and recycling pathways for the flexibility of adaptation. The use of the language of circular economy by firms without this choice being explicitly stated risks creating infrastructure that will support closed-loop activities, which some firms may not want to support because of the type of resiliency they are trying to achieve.

The third tension is related to the measurement. If the circular economy cannot be defined stably, as Lengyel et al. (2021) point out, then "performance" must be judged separately for each study, and businesses can likewise measure different material flows, all captured under the term "circular economy". This has a direct managerial corollary as well: managers should not be confident in comparing a firm with other published industry studies in terms of results of circular economy performance; instead, they should wait for new studies to be more precise and should rely on the results of other studies as an indicator.

These tensions manifest themselves in four managerial implications that are grouped around the propositions that were presented in Section 4. Proposition 1 describes two main paths to the resilience benefits of a circular economy that are mediated by investments in the supply chain, and at the very least the former is only halfway achievable unless the latter occurs. Second, green procurement programmes must be coupled explicitly with investment in information-sharing systems within the supply chain, since the model assumes that a series of green sourcing actions occurring without these information-sharing systems will yield feeble results from the resilience side of the argument, even if they are as strict as possible when applying environmental screening criteria to supplier selection. Third: Proposition 3, there is a need for the digital traceability infrastructure to be put in place first, or concurrently with, scaling of the circular economy and/or green procurement programs, instead of as an add-on at a later stage given the threshold logic above. Fourth, as a result of Proposition 4, firms need to choose engineering or evolutionary before they have completed the design of a network that will be closed: the two orientations are related to different structures and likely to different rewards that are earned for a sustainability investment.

The mention of "environmental legislation" is essential to this discussion in connection with being one of the most important outside forces of this system. While Vocks et al. (2025) find that legislation is an important driver for green procurement adoption, Proposition 2 takes the other word of the equation: with the lack of a 'information sharing infrastructure' (as they phrase it) the payoff of green procurement's resilience may not be spiritually felt without the information-sharing infrastructure that that proposition identifies as the weak link in green procurement in fragmented supply chains. Green material markets policy accordingly is best thought of as complementary, not supplanting, investments in company-level infrastructure for information.

It is only because of the conceptual and purposive-synthesis nature of the framework that these implications have to be provocative, however; finally, these are attacked directly in the concluding section, along with empirical designs that might be used to test each of the propositions.

VI. Conclusion, Limitations, And Future Research Directions

Based on three research questions, this article aims to examine the connection between the practice of the circular economy and green procurement strategy, and the relationship between the resilience of supply chains and the circular economy. To answer RQ1, Section 4 presented two differentiated paths (direct and infrastructure-mediated) through which circular economy practices relate to resilience, and another pathway related to green procurement, which is contingent on information sharing. The article addressed RQ2 and suggested a threshold effect could be expected, as well as a potential switch in sign for the relationship below this threshold, rather than a consistent reduction of the positive relationship. Based on RQ3, the authors in Sections 2 and 3 believed that three tensions cannot be ignored or solved in an empirical validation of the circular economy framework: definitional instability of the circular economy measurement; engineering and the evolutionary conception of resilience are conflated; and the optimization modeling of a closed-loop supply chain is undeniably normative.

The article's contribution is not only theoretical, but also based on theory; this is the focal point where an article can fall short. The propositions of the framework have not been tested with data; indeed, the framework is not a synthesis of a systematically reviewed population of studies, but a synthesis of 30 purposively selected studies, an appropriate approach for such a theory construction exercise and should not be derived as a finding. A second limitation arises from the measurement tension highlighted in Section 5, that the construct of the circular economy is operationalized in different ways and that the concepts of resilience are even more so, as discussed in the articles included in this review. Both of these mean that empirical testing of the propositions will first need to be constructed, which further slows the speed at which the framework can be taken from theories to evidence. A third limitation is the extension of the boundary conditions claim made in the framework's Proposition 3, which is currently a consistent extrapolation from various separate, individually reported results, but which has yet to be directly tested by any individual existing study.

These are not limiting suggestions for general further research, but more suggestive for empirical designs that seek to address these limitations. Such a threshold would need to be observed in a long enough timeframe to distinguish events of firms crossing over the proposed threshold from a simple linear effect of increasing intensity of digital traceability infrastructure investments, and that measured the outcomes of digital traceability infrastructure investments for resilience. The hypothesized threshold effect could not be captured by a cross-sectional design, that is, one that does not monitor outcomes across the length of the firms' digital traceability infrastructure investments. Testing the two Propositions in combination involves testing a multi-group SEM that contrasts firms matched on both circularity and green procurement intensity but varying in the reverse logistics capability of the firms (namely, infrastructure) and information sharing with the suppliers (namely, information sharing) for both direct pathways as well as infrastructure-mediated and information-mediated pathways. Testing the engineering versus evolutionary distinction of Proposition 4 is more appropriate with a configurational approach such as fuzzy-set qualitative comparative analysis, which allows the discovery of whether the two possible orientations of resilience (and the two possible closed-loop network configurations) are causally different, or simply equivalent elements on a single continuum.

Finally, implementing the measurement tension discussed in Section 5 will entail specific scale-development efforts to create accurate, comparable scales of CE and resilience measures across industry contexts in which this would have to be tested to advance the more ambitious designs of the above empirical projects. As supply chains in the world become more exposed, especially due to new threats from the environment and disruption, what relationships exist between circularity, green sourcing, and adaptive capability is expected to be a main topic not only for academics, but also for practitioners concerned with resiliency and not just economic measures. The present article will contribute to the specification of this relationship, while other literature often tacitly assumes this is self-evident.

References

[1] A. Atasu, C. J. Corbett, X. Huang, and L. B. Toktay, "Sustainable operations management through the perspective of manufacturing & service operations management," *Manufacturing & Service Operations Management*, vol. 22, issue 1, pp. 146–157, 2020.

[2] D. Battini, M. Bogataj, and A. Choudhary, "Closed loop supply chain (CLSC): Economics, modelling, management and control," *International Journal of Production Economics*, vol. 183, pp. 319–321, 2017.

[3] A. Behl, R. Singh, V. Pereira, and B. Laker, "Analysis of Industry 4.0 and circular economy enablers: A step towards resilient sustainable operations management," *Technological Forecasting and Social Change*, vol. 189, p. 122363, 2023.
[4] A. Bettley and S. Burnley, "Towards sustainable operations management integrating sustainability management into operations management strategies and practices," in *Handbook of Performability Engineering*, pp. 875–904, Springer, 2008.
[5] M. S. Bhatia, S. K. Jakhar, S. K. Mangla, and K. K. Gangwani, "Critical factors to environment management in a closed loop supply chain," *Journal of Cleaner Production*, vol. 255, p. 120239, 2020.
[6] L. Chen, F. Jia, M. D. Steward, and T. Schoenherr, "The role of technology in enabling circular supply chain management," *Industrial Marketing Management*, vol. 106, pp. A1–A6, 2022.
[7] T. M. Choi, Y. Li, and L. Xu, "Channel leadership, performance and coordination in closed loop supply chains," *International Journal of Production Economics*, vol. 146, issue 1, pp. 371–380, 2013.
[8] V. Chotia, M. Sharma, R. Alghafes, and S. T. Walsh, "Driving business performance through green procurement policy: The power of supply chain information sharing for robust supply chain," *Technovation*, vol. 149, p. 103358, 2026.
[9] R. De Angelis, M. Howard, and J. Miemczyk, "Supply chain management and the circular economy: Towards the circular supply chain," *Production Planning & Control*, vol. 29, issue 6, pp. 425–437, 2018.
[10] M. Farooque, A. Zhang, M. Thurer, T. Qu, and D. Huisingh, "Circular supply chain management: A definition and structured literature review," *Journal of Cleaner Production*, vol. 228, pp. 882–900, 2019.
[11] J. Gaur, M. Amini, and A. K. Rao, "Closed-loop supply chain configuration for new and reconditioned products: An integrated optimization model," *Omega*, vol. 66, pp. 212–223, 2017.
[12] M. Ghosh, "Determinants of green procurement implementation and its impact on firm performance," *Journal of Manufacturing Technology Management*, vol. 30, issue 2, pp. 462–482, 2019.
[13] A. Gunasekaran and Z. Irani, "Sustainable operations management: Design, modelling and analysis," *Journal of the Operational Research Society*, vol. 65, issue 6, pp. 801–805, 2014.
[14] A. Gunasekaran, N. Subramanian, and S. Rahman, "Supply chain resilience: Role of complexities and strategies," *International Journal of Production Research*, vol. 53, issue 22, pp. 6809–6819, 2015.
[15] B. T. Hazen, I. Russo, I. Confente, and D. Pellathy, "Supply chain management for circular economy: Conceptual framework and research agenda," *The International Journal of Logistics Management*, vol. 32, issue 2, pp. 510–537, 2021.
[16] V. Jain, S. Kumar, U. Soni, and C. Chandra, "Supply chain resilience: Model development and empirical analysis," *International Journal of Production Research*, vol. 55, issue 22, pp. 6779–6800, 2017.
[17] D. K. Kadambala, N. Subramanian, M. K. Tiwari, M. Abdulrahman, and C. Liu, "Closed loop supply chain networks: Designs for energy and time value efficiency," *International Journal of Production Economics*, vol. 183, pp. 382–393, 2017.
[18] P. Lengyel, A. Bai, Z. Gabnai, O. M. A. Mustafa, P. Balogh, E. Peter, and K. Nemeth, "Development of the concept of circular supply chain management: A systematic review," *Processes*, vol. 9, issue 10, p. 1740, 2021.
[19] B. Niu, F. Xie, and L. Chen, "Analysis of global brands' green procurement strategy: Co-opetitive local sourcing vs. overseas sourcing under delivery disruption," *Omega*, vol. 123, p. 102991, 2024.
[20] S. Y. Ponomarov and M. C. Holcomb, "Understanding the concept of supply chain resilience," *The International Journal of Logistics Management*, vol. 20, issue 1, pp. 124–143, 2009.
[21] R. D. Raut, S. K. Mangla, V. S. Narwane, B. B. Gardas, P. Priyadarshinee, and B. E. Narkhede, "Linking big data analytics and operational sustainability practices for sustainable business management," *Journal of Cleaner Production*, vol. 224, pp. 10–24, 2019.
[22] S. Routroy and S. K. Pradhan, "Framework for green procurement: A case study," *International Journal of Procurement Management*, vol. 5, issue 3, pp. 316–336, 2012.
[23] B. R. Tukamuhabwa, M. Stevenson, J. Busby, and M. Zorzini, "Supply chain resilience: Definition, review and theoretical foundations for further study," *International Journal of Production Research*, vol. 53, issue 18, pp. 5592–5623, 2015.
[24] L. N. Van Wassenhove, "Sustainable innovation: Pushing the boundaries of traditional operations management," *Production and Operations Management*, vol. 28, issue 12, pp. 2930–2945, 2019.
[25] L. Vocks, V. Verboeket, and B. Vos, "The effects of environmental legislation via green procurement strategies: A systematic literature review," *Logistics*, vol. 9, issue 3, p. 95, 2025.
[26] A. Wieland and C. F. Durach, "Two perspectives on supply chain resilience," *Journal of Business Logistics*, vol. 42, issue 3, pp. 315–322, 2021.
[27] J. K. W. Wong, J. K. San Chan, and M. J. Wadu, "Facilitating effective green procurement in construction projects: An empirical study of the enablers," *Journal of Cleaner Production*, vol. 135, pp. 859–871, 2016.
[28] M. H. F. Zarandi, A. H. Sisakht, and S. Davari, "Design of a closed-loop supply chain (CLSC) model using an interactive fuzzy goal programming," *The International Journal of Advanced Manufacturing Technology*, vol. 56, issue 5, pp. 809–821, 2011.
[29] A. Zhang, J. X. Wang, M. Farooque, Y. Wang, and T. M. Choi, "Multi-dimensional circular supply chain management: A comparative review of the state-of-the-art practices and research," *Transportation Research Part E: Logistics and Transportation Review*, vol. 155, p. 102509, 2021.
[30] N. Zhao, J. Hong, and K. H. Lau, "Impact of supply chain digitalization on supply chain resilience and performance: A multi-mediation model," *International Journal of Production Economics*, vol. 259, p. 108817, 2023.
[31] C. O. Yan, "Non-citizens' continuity of citizenship in the Baltic States," *The International Journal of Interdisciplinary Social and Community Studies*, vol. 20, issue 1, p. 1, 2024.
[32] C. O. Yan, "Negotiating citizenship and belonging in South Africa: Local naturalization histories as a gateway to global citizenship education," in *Local History Education for Shaping Global Citizenship*, pp. 239–260, IGI Global Scientific Publishing, 2026.
[33] C. O. Yan, "The global retreat from jus soli: Historical drivers and contemporary policy shifts," in *The Evolution and Future Trajectory of Birth Health Tourism*, pp. 333–366, IGI Global Scientific Publishing, 2026.
[34] C. O. Yan, "Nationality law as an instrument of exclusion in developing democracies: Systematic discrimination and minority marginalization," in *Digital Governance, Democracy, and Inclusion in Developing Countries*, IGI Global Scientific Publishing, 2026.