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On the synergetic relationship between Circular Economy and Resilience: findings from a systematic literature review

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Abstract: Nowadays, industrial firms are increasingly required to develop resilient supply chains to better face turbulent environments by adapting to unforeseen and frequent disruptions. In this regard, researchers strongly agree that fostering innovation toward circular business models can influence resilience capability development. Findings, however, are still fragmented and sparse. To this aim, a systematic literature review of previous studies is conducted. The results of content analyses are presented, and their implications discussed.

Keywords: Circular Economy, resilience, circular business model, risk

1. INTRODUCTION

The circular economy (CE) is trending among scholars as a new paradigm breaking with the traditional linear economy characterized by a "take-make-disposal" logic, so reducing the use of scarce natural resources and the level of greenhouse gas emitted to the atmosphere (Centobelli et al., 2020). The CE has been defined as “an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling, and recovering materials in production/distribution and consumption processes”. Industrial stakeholders and organizations are thus called to implement the so-called CE strategies. A popular way is the implementation of Circular Business Models (CBMs), able to moderate and/or close resource cycles (Bocken et al., 2016). Further, compared to traditional BM implementation, the transition to CBMs turn out to build long-term supply chain (SC) resilience. In supply chain literature, resilience is defined in different ways entailing a static perspective i.e., as the ability to absorb disturbance and bounce back to the original equilibrium state, maintaining its core functions when shocked (Bhamra et al., 2011), and a dynamic one, instead of focusing on the ability to evolve over time, moving towards the original but even new, more favorable equilibrium states (Carvalho et al., 2012). Consistently to the dynamic perspective supply chain, the construct of supply chain viability has been introduced (Ivanov and Dolgui, 2020), as referring to the long-term adaptive capability toward disruptions ensuring the supply chain structure redesign and economic performance replanning. The need for developing resilient supply chains comes from the increasing complexity and turbulence of business environments firms today face with. Despite a long tradition of studies investigating the drivers for increased supply chain resilience (Massari and Giannoccaro, 2021), studies mentioning Circular Economy as driving factor for resilience capability development in industrial firms and their supply chains are few and recent (Kennedy and Linnenluecke, 2022). Instead, findings concerning the adoption of CBMs for the design of resilient supply chains are present, however, still fragmented, and sparse. For example, regenerative BMs rule how resources can circulate back to the original SC or the external ecosystem by lowering the firm's dependence on external suppliers, thus increasing firm resilience to supply shortages (Geissdoerfer et al., 2018). Resource-efficient BMs own intermediate leakages and waste, resulting in lean systems with fewer redundancies, which turn out to be less resilient to shocks (Whalen, 2019). Given the importance of the topic, the synergic relationship between CE and SC resilience driving factors has to be developed. To fill this gap, a Systematic Literature Review (SLR) of previous studies on CBMs is conducted in order to answer the following research questions:

1. What are the most important resilience dimensions in the context of Circular Economy?
2. What are the most relevant resilience improvements in the context of Circular Economy?

Answering this will lead to understand and clarify the state of the art concerning the synergetic relationship between CE and SC resilience.

The paper is organized as follows. Section 2 provides a brief description of the research methodology. Then the results of content analyses are given in Section 4. In the end, the main conclusions are drawn.

2. RELATED STUDIES

In literature, few and recent studies have investigated whether and how Circular Economy influences the resilience capability of industrial firms and their supply chains (Kennedy and Linnenluecke, 2022). On the supply chain- level, (Bag et al., 2021) supported the hypothesis for the positive moderating

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effect that flexible control has on the relations between dynamic remanufacturing capability and resilience. (Baars et al., 2021) concluded that circular economy strategies e.g., reuse and recycling, enhance supply diversity which in turn is beneficial for supply chain resilience. A similar effect derives from waste resource recovering (Fisher et al., 2020), and resource exchanges in industrial symbiosis networks (Fraccascia et al., 2020). (Kennedy and Linnenluecke, 2022) proposed a research agenda by drawing on the few studies investigating the relationship between CE strategies for increasing resource efficiency by closing, slowing, and narrowing resource loops and industry-level resilience. Review studies are, to the best of our knowledge, absent.

3. METHOD

A systematic literature review (SLR) is performed following the well-established guidelines (Easterby-Smith et al., 2002; Grant and Booth, 2009; Massaro et al., 2016). SLR develops through the following methodological steps.

First, we collected a pool of academic contributions through a keyword search of publications indexed in Scopus. We chose Scopus as a database because it offers comprehensive scientific, technical, and social science material across all the relevant scientific literature, as well as a comprehensive suite of metrics (Mishra et al., 2017; Thelwall, 2018; Waltman, 2016).

We connected our key search terms – such as "circular economy", "green", "environmental", "bioeconomy", "eco", "sustainable", "open loop", "close* loop", and "reverse", with "supply chain", "supply network", "business* model*", "model* of business* – through the use of Boolean operators like AND/OR. This initial keyword search produced 693 results, which were then filtered through the application of exclusion/inclusion criteria. In particular, we included only articles written in English and excluded those published after July 2021. Based on this strategy, the 673 selected papers were further filtered to consider only articles published in peer-reviewed journals and conference proceedings, excluding book chapters, editorials, and notes, resulting in 645 articles. After, full-text assessment, the final sample of articles considered for the SLR involved 133 articles after this process.

4. RESULTS

4.1. What are the most important resilience dimensions in the context of Circular Economy?

Over the 133 collected articles, we found that inter-firm strategies e.g., collaboration, cooperation, competition, the adoption of Industry 4.0 technologies, necessary for the implementation of CE business models and strategies can play as enabling factors for supply chain resilience.

9 studies have explored the potential of collaborative relationships for increased coordination of closed-loop supply chains (Campos et al., 2020; Lüdeke-Freund et al., 2019; Paula et al., 2020) higher control by remanufacturing firms over the reverse supply chain stream (Dissanayake and Sinha, 2015); enhanced innovation-based synergies between supply chain firms in the fashion industry e.g., designers, fashion retailers and waste collectors, enhancing the inter-firm learning procedures necessary for the transition toward sustainable buildings (Brown and Bessant, 2003); exchange of information in closed-loop supply (Campos et al., 2020), and expertise in circular supply chains in the construction industry (suppliers, designers, demolishers, waste companies) (Hossain et al., 2020), and the creation of industrial symbiosis synergies for the local exchange of waste resources between selected companies in distant industrial sectors (e.g., fashion, construction, and paper) (Ghisellini and Ulgiati, 2020; Batista et al., 2019).

4 articles argue that a strong competitive advantage can be achieved through BM innovation for pursuing CE principles. In fact, the implementation of strategies for increasing material circularity e.g., maintenance, reconditioning, and recycling enable firms to access new markets (Mont et al., 2006), differentiate their products and brand (Shashi et al., 2021), and improve their financial performance due to investments in innovation (Lambrechts et al., 2021; Shashi et al., 2021). The results from (Mont et al., 2006) demonstrate that maintenance and reconditioning services created competitive advantages for manufacturers as these access to new markets and customer segments, thus receiving higher returns on profits and payback when operating on the second-hand market than on traditional ones. Furthermore, the potential of resource recycling processes drives firms to invest in new product design and product's innovation toward the development of innovative and more environment-friendly materials and products by increasing the use of recycled materials for driving internal production (Salnikova et al., 2021), thus favouring brand differentiation.

7 articles focused on the role of Industry 4.0 technologies. (Li and Leonas, 2019), (Bressanelli et al., 2020) have investigated the potential of digital technologies (IoT, BDA, Cloud Platforms, 3D printing) on the development of Product Service Systems integrated with take-back-logistic systems. Through sensors and tracking systems, firms can quickly monitor products and processes through real-time information (Bressanelli et al., 2020; Hofmann, 2019; Li and Leonas, 2019), which in turn can enhance return flows, end-of-use activities, renovation processes (Bressanelli et al., 2018), collection and reuse of waste and by-products, and the design of smart products (Li and Leonas, 2019). In (Shevchenko et al., 2021), the authors exploited interactive online cloud-based datasets to develop a new smart reverse system for e-waste to manage resource flow from the user to the recycling enterprise. Sensitiveness is strongly influenced by the adoption of Big-Data Analysis technology. In particular, big-data marketing technology can effectively predict and accurately locate consumer needs, thus slowing the production of low consumable products, save resources, reducing waste, thus improving the sustainability of closed-loop supply chains (Ma and Hu, 2020). Firms can thus obtain knowledge on customer behaviour, understand their habits better, and facilitate more efficient collaboration between the manufacturer, service provider, logistician, and customer (Hofmann, 2019). Improved information quality regarding product conditions, location, use intensity, and availability optimize the product's

life-cycle analysis toward more efficient end-of-life activities (Hofmann, 2019). Big-data marketing also supports companies in promoting the importance of remanufacturing engineering to consumers, which will help more consumers return used products, increase their utilization rate, avoid the input of new materials, and avoid the environmental pollution caused by the landfill of used products (Ma and Hu, 2020). Flexible production planning is required for dealing with disassembly and remanufactured components (Li and Leonas, 2019). In this regard, the formulation of strategies for dematerialization (Li and Leonas, 2019), the use of additive manufacturing, digital manufacturing, and 3D printing for new material shaping processes play a crucial role (Emanuelsson et al., 2021).

4.2. What are the most relevant resilience improvements in the context of Circular Economy?

Within the core set of analyzed papers, only 17 (12.8%) of them have discussed the potential of CBMs and CE strategy implementation for supply chain resilience improvement. This has been mostly related to a reduced dependence on external supply sources (Borrello et al., 2020; Fogarassy and Finger, 2020; Geissdoerfer et al., 2018; Tura et al., 2019), reduced supply shortages through redundant supplier networks (Garcia-Muiña et al., 2018; Ünal et al., 2019), reliance on less resources (Aurisicchio et al., 2021; Baars et al., 2021; Predan, 2020), more autonomy and independence from international commodity markets (Hofmann, 2019), reduced resource price volatility (González-Sánchez et al., 2020; Kalverkamp et al., 2017; Okorie et al., 2021; Tura et al., 2019), reduced risks in logistic networks (Flodén and Williamsson, 2016), better management of material shortage risks through alternative and more sustainable sources (Rovanto and Bask, 2021), and shared business risks through collaborative relationships (Ray and Mondal, 2016). As demonstrated by (Goyal et al., 2015; Hofmann, 2019) CE strategies e.g., reduce, reuse, and recycle, and CBMs for regenerative manufacturing provide firms with new dynamic capabilities ensuring the reconfiguration toward resilient and waste free ecosystem (Emanuelsson et al., 2021).

5. CONCLUSIONS

What are the most important resilience dimensions in the context of Circular Economy? and What are the most relevant resilience improvements in the context of Circular Economy? In this study, we address these research questions to investigate the synergetic relationship between CE and resilience in the context of supply chain. To this purpose, we conducted a systematic literature review and presented the results of 133 full-text analyses.

As to the CE-driven resilience dimensions, we found that inter-firm collaboration and competition nurture the above synergetic relationship. The implementation of CE strategies and CBMs are positively influenced by the collaborative relationships within the same supply chain sector (*intra-sectorial* collaboration) and between two different ones (*inter-sectorial* collaboration). Collaborative relationships entail partnering firms being prone to share their own information, resources, capabilities, and best practices as considered complementary to others' for pursuing common goals and interests (Kim et al., 2013). This in turn enhances the adaptive capability, and hence the resilience, of the entire supply chain when facing with turbulent environments, by absorbing and reacting to disturbances to securing new effective configurations (Adobor and McMullen, 2018; Giannoccaro, 2015). Rethinking business models to pursue CE principles e.g., increasing material circularity, environment-friendly product design, increase inter-firm competition and enhances firm's market position and financial capability, which in turn positively affect the firm's recovery from disrupting events (Jüttner and Maklan 2011; Pereira et al., 2014; Fiksel et al., 2015). In facing with disrupted environments, competition push firms toward self-adaptation by continuously monitoring and revising internal practices to search for better configurations. In addition to the inter-firm relationships, our content analyses show that Digital Technologies enhance the transparency, flexibility, and agility of CE supply chain operations, so becoming more resilient to unpredictable disruptions (Ivanov and Dolgui, 2020). As to the CE-driven resilience improvement, we found that this are achieved mainly through the reduced dependence on external supply sources and better supply shortage risk management.

Our results provide theoretical and managerial contributions. We develop the first systematic literature review addressing the synergetic relationship between CE and supply chain resilience. In particular, we reorganize previous studies concerning the design and implementation of CE strategies and CBMs around the dimensions for increasing supply chain resilience and improvements so obtained. From the managerial point of view, we explain to managers why CE supply chain design is, per-se, resilient and inform them on the importance of rethinking business models around the CE principles to reduce dependence on external supply sources and better manage supply shortage, so increasing the resilience of the entire supply chain.

This study presents some limitations. We conducted a full-text analysis to investigate the most relevant resilience dimensions and improvements in the context of Circular Economy. Instead, the analyses of bibliometric indices (publication year, journal, country) and networks (keyword co-occurrence, citation, co-citation) can provide important insights e.g., the existence and quality of research collaborations, the most and less investigated topics etc., which in turn help us to understand and organize the literature so far and, based on this, develop a thorough research agenda. We intend to address these limitations in future studies.

REFERENCES

Adobor, H., and McMullen, R. S. (2018). Supply chain resilience: a dynamic and multidimensional approach. The International Journal of Logistics Management.

Aurisicchio, M., Van Der Laan, A. Z., and Tennant, M. (2021). Material-service systems for sustainable resource management. Sustainable Production, Life Cycle Engineering and Management, (August), 89–101.

Baars, J., Domenech, T., Bleischwitz, R., Melin, H. E., and Heidrich, O. (2021). Circular economy strategies for electric vehicle batteries reduce reliance on raw materials. Nature Sustainability, 4(1), 71–79.

Bag, S., Dhamija, P., Gupta, S., and Sivarajah, U. (2021). Examining the role of procurement 4.0 towards remanufacturing operations and circular economy. Production Planning and Control, 32(16), 1368–1383.

Bocken, N. M. P., de Pauw, I., Bakker, C., and van der Grinten, B. (2016). Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering, 33(5), 308–320.

Borrello, M., Pascucci, S., Caracciolo, F., Lombardi, A., and Cembalo, L. (2020). Consumers are willing to participate in circular business models: A practice theory perspective to food provisioning. Journal of Cleaner Production, 259, 121013.

Bressanelli, G., Perona, M., and Saccani, N. (2018). Towards the circular supply chain: A literature review of challenges. Proceedings of the Summer School Francesco Turco, 2018-Septe, 171–178.

Bressanelli, Gianmarco, Saccani, N., Perona, M., and Baccanelli, I. (2020). Towards circular economy in the household appliance industry: An overview of cases. Resources, 9(11), 1–23.

Brown, S., and Bessant, J. (2003). The manufacturing strategy-capabilities links in mass customisation and agile manufacturing -- an exploratory study. International Journal of Operations and Production Management, 23(7), 707–730.

Campos, E. A. R. de, Paula, I. C. de, Caten, C. S. ten, Maçada, A. C. G., Marôco, J., and Ziegelmann, P. K. (2020). The effect of collaboration and IT competency on reverse logistics competency - Evidence from Brazilian supply chain executives. Environmental Impact Assessment Review, 84(July), 106433.

Centobelli, P., Cerchione, R., Chiaroni, D., Del Vecchio, P., and Urbinati, A. (2020). Designing business models in circular economy: A systematic literature review and research agenda. Business Strategy and the Environment, 29(4), 1734–1749.

Dissanayake, G., and Sinha, P. (2015). An examination of the product development process for fashion remanufacturing. Resources, Conservation and Recycling, 104, 94–102.

Easterby-Smith, M., Thorpe, R., and Lowe, A. (2002). Management and business research: an introduction. In Sage (Ed.), Sage.

Emanuelsson, E. A. C., Charles, A., and Shivaprasad, P. (2021). A regenerative business model with flexible, modular and scalable processes in a post-covid era: The case of the spinning mesh disc reactor (smdr). Sustainability (Switzerland), 13(12).

Fiksel, J. (2015). From risk to resilience. In Resilient by design (pp. 19-34). Island Press, Washington, DC.Fisher, O.

Watson, N. J., Escrig, J. E., and Gomes, R. L. (2020). Intelligent resource use to deliver waste valorisation and process resilience in manufacturing environments moving towards sustainable process manufacturing. Johnson Matthey Technology Review, 64(1), 93–99.

Flodén, J., and Williamsson, J. (2016). Business models for sustainable biofuel transport: The potential for intermodal transport. Journal of Cleaner Production, 113, 426–437.

Fogarassy, C., and Finger, D. (2020). Theoretical and practical approaches of circular economy for business models and technological solutions. Resources, 9(6), 1–9.

Fraccascia, L., Yazan, D. M., Albino, V., and Zijm, H. (2020). The role of redundancy in industrial symbiotic business development: A theoretical framework explored by agent-based simulation. International Journal of Production Economics, 221(January 2018), 107471.

Garcia-Muiña, F. E., González-Sánchez, R., Ferrari, A. M., and Settembre-Blundo, D. (2018). The paradigms of Industry 4.0 and circular economy as enabling drivers for the competitiveness of businesses and territories: The case of an Italian ceramic tiles manufacturing company. Social Sciences, 7(12).

Geissdoerfer, M., Morioka, S. N., de Carvalho, M. M., and Evans, S. (2018). Business models and supply chains for the circular economy. Journal of Cleaner Production, 190, 712–721.

Ghisellini, P., and Ulgiati, S. (2020). Circular economy transition in Italy. Achievements, perspectives and constraints. Journal of Cleaner Production, 243, 118360.

Giannoccaro, I. (2015). Adaptive supply chains in industrial districts: A complexity science approach focused on learning. International Journal of Production Economics, 170, 576-589.

González-Sánchez, R., Settembre-Blundo, D., Ferrari, A. M., and García-Muiña, F. E. (2020). Main dimensions in the building of the circular supply chain: A literature review. Sustainability (Switzerland), 12(6), 1–25.

Goyal, N., Aggarwal, N., and Dutta, M. (2015). Advances in Intelligent Informatics. Advances in Intelligent Systems and Computing, 320(August), 493–501.

Grant, M. J., and Booth, A. (2009). A typology of reviews: an analysis of 14 review types and associated methodologies. Health Information and Libraries Journal, 26(2), 91–108.

Hofmann, F. (2019). Circular business models: Business approach as driver or obstructer of sustainability transitions? Journal of Cleaner Production, 224, 361–374.

Hossain, M. U., Ng, S. T., Antwi-Afari, P., and Amor, B. (2020). Circular economy and the construction industry: Existing trends, challenges and prospective framework for sustainable construction. Renewable and Sustainable Energy Reviews, 130(May), 109948.

Ivanov, D., and Dolgui, A. (2020). Viability of intertwined supply networks: extending the supply chain resilience angles towards survivability. A position paper motivated by COVID-19 outbreak. International Journal of Production Research, 58(10), 2904–2915.

Jüttner, U., and Maklan, S. (2011). Supply chain resilience in the global financial crisis: an empirical study. Supply chain management: An international journal.

Kalverkamp, M., Pehlken, A., and Wuest, T. (2017). Cascade Use and the Management of Product Lifecycles. Sustainability, 9(9), 1540.

Kennedy, S., and Linnenluecke, M. K. (2022). Circular economy and resilience: A research agenda. Business Strategy and the Environment, (July 2021), 1–12.

Kim, Y., Chen, Y. S., and Linderman, K. (2015). Supply network disruption and resilience: A network structural perspective. Journal of operations Management, 33, 43-59.

Lambrechts, W., Mitchell, A., Lemon, M., Mazhar, M. U., Ooms, W., and van Heerde, R. (2021). The transition of dutch social housing corporations to sustainable business models for new buildings and retrofits. Energies, 14(3), 1–24.

Li, J., and Leonas, K. K. (2019). Trends of sustainable development among luxury industry. In Environmental Footprints and Eco-Design of Products and Processes.

Luciano Batista, Michael Bourlakis, P. S., and Maull, and R. (2019). Business Models in the Circular Economy and the Enabling Role of Circular Supply Chains.

Lüdeke-Freund, F., Gold, S., and Bocken, N. M. P. (2019). A Review and Typology of Circular Economy Business Model Patterns. Journal of Industrial Ecology, 23(1), 36–61.

Ma, D., and Hu, J. (2020). Research on collaborative management strategies of closed-loop supply chain under the influence of big-data marketing and reference price effect. Sustainability (Switzerland), 12(4).

Massari, G. F., and Giannoccaro, I. (2021). Investigating the effect of horizontal coopetition on supply chain resilience in complex and turbulent environments. International Journal of Production Economics, 237(June 2020), 108150.

Massaro, M., Handley, K., Bagnoli, C., and Dumay, J. (2016). Knowledge management in small and medium enterprises: a structured literature review. Journal of Knowledge Management, 20(2), 258–291.

Mishra, D., Gunasekaran, A., Papadopoulos, T., and Hazen, B. (2017). Green supply chain performance measures: A review and bibliometric analysis. Sustainable Production and Consumption, 10, 85–99.

Mont, O., Dalhammar, C., and Jacobsson, N. (2006). A new business model for baby prams based on leasing and product remanufacturing. Journal of Cleaner Production, 14(17), 1509–1518.

Okorie, O., Charnley, F., Russell, J., Tiwari, A., and Moreno, M. (2021). Circular business models in high value manufacturing: Five industry cases to bridge theory and practice. Business Strategy and the Environment, 30(4), 1780–1802.

Paula, I. C. de, Campos, E. A. R. de, Pagani, R. N., Guarnieri, P., and Kaviani, M. A. (2020). Are collaboration and trust sources for innovation in the reverse logistics? Insights from a systematic literature review. Supply Chain Management, 25(2), 176–222.

Pereira, C. R., Christopher, M., and Da Silva, A. L. (2014). Achieving supply chain resilience: the role of procurement. Supply Chain Management: an international journal.

Predan, B. (2020). Circular design in design education: A case study on the use of paper in interior design. International Journal of Interdisciplinary Educational Studies, 15(2), 47–59.

Ray, A., and Mondal, S. (2016). Study of collaborative PRM business model for sustainability. Benchmarking: An International Journal.

Rovanto, I. K., and Bask, A. (2021). Systemic circular business model application at the company, supply chain and society levels—A view into circular economy native and adopter companies. Business Strategy and the Environment, 30(2), 1153–1173.

Salnikova, A., Kovalev, A., Iosifov, V., and Almastyan, N. (2021). Model of circular economy in environmental management. Case study. Journal of Environmental Management and Tourism, 12(1), 5–17.

Shashi, Centobelli, P., Cerchione, R., and Mittal, A. (2021). Managing sustainability in luxury industry to pursue circular economy strategies. Business Strategy and the Environment, 30(1), 432–462.

Shevchenko, T., Saidani, M., Danko, Y., Golysheva, I., Chovancová, J., and Vavrek, R. (2021). Towards a smart E-waste system utilizing supply chain participants and interactive online maps. Recycling, 6(1), 1–14.

Thelwall, M. (2018). Dimensions: A competitor to Scopus and the Web of Science? Journal of Informetrics, 12(2), 430–435.

Tura, N., Hanski, J., Ahola, T., Ståhle, M., Piiparinen, S., and Valkokari, P. (2019). Unlocking circular business: A

framework of barriers and drivers. Journal of Cleaner Production, 212, 90–98.

Ünal, E., Urbinati, A., and Chiaroni, D. (2019). Managerial practices for designing circular economy business models: The case of an Italian SME in the office supply industry. Managerial Practices for Designing Circ. 30(3), 561–589.

Waltman, L. (2016). A review of the literature on citation impact indicators. Journal of Informetrics, 10(2), 365–391.

Whalen, K. A. (2019). Three circular business models that extend product value and their contribution to resource efficiency. Journal of Cleaner Production, 226, 1128–1137.