Circular Business Model in Pulp and Paper Industry

Subjects: Engineering, Geological

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Innovation in the circular economy (CE) and the deployment of effective circular business models (CBM) have attracted significant attention in times of growing natural resource scarcity.

circular business models (CBMs) resource recovery waste valorisation strategic management pulp and paper industry (PPI)

1. Introduction

It is widely recognised that the circular economy (CE) is gaining ground through a pyramidal increase [1][2][3]. Not only is academia contributing to this widespread diffusion but policymakers and public bodies (such as the European Commission) are also boosting measures, grants and research agendas to pave the way to achieve the so-desired transition to a complete CE. This paradigmatic shift certainly affects several industrial sectors, envisioning that a CE will reduce pressure on natural resources [4].

Both public and private efforts devoted to promoting CE across countries and sectors have been driven to improve resource efficiency, minimise external material supply dependence, and reduce waste in many sectors [5]. Resource recovery models offer the industry new challenging business opportunities such as obtaining new secondary raw materials (SRM) from end-of-life products and sub-products that, through (pre-)processing, can be used as an input for industrial production, for example, the industrial and household landfilled wastes. Within resource recovery, reusing ‘waste’ as a new secondary raw material is gaining attraction as it allows shifting economic benefits into social and environmental benefits by preserving the technical value gained from products [6].

Undeniably, pulp and paper (P&P) producers have been at the forefront of the transition towards a circular economy in Europe, and significant strides have been made to valorise the waste produced by this industry [7]. Currently, environmental aspects are becoming major issues that need intervention in this sector due to the large amount of solid waste generated by P&P mills. Around 400 million tons of paper and paperboard are produced globally, and estimates suggest that global paper consumption in 2025 will amount to 500 million tons [8][9]. In addition, according to the Confederation of European Paper Industries (CEPI), Europe is the world’s second-largest producer of pulp and paper, with 35.2 Mt/y of pulp production and 52.6 Mt/y of paper recycling [10],

producing nearly 88 Mt ton of paper articles (2022), which represents almost about a quarter of the world's production (The Confederation of European Paper Industries, 2021). In Europe, 11 Mt of solid waste, including 7.7 Mt of waste from recycled fibre processing, was generated during the production of 99.3 Mt of paper [11][12]. This means a generation rate of approximately 11% of solid waste vs. paper product, landfilling being their major option, except in some valorisation cases, such as the use of deinking sludge from recycling paper mills for energy obtention and the generation of inorganic materials. Inorganic solid wastes (e.g., green liquor dregs (GLD), slaker grits (SG), lime mud (LM) and boiler fly ash (BFA)) require an environmentally friendly solution [13] as long as they are produced in high quantities and landfilling is still the main disposal method; hence, techniques to valorise these wastes are seemingly important [7]. In fact, around 70–75% of solid waste from paper mills has been disposed of in a landfill. Paper solid wastes vary greatly in type and amount, according to the process type [14][15]. In Europe alone, pulp production generates the following solid wastes: boiler ash (32% of the total solid waste, 2.08 Mt/y—estimation), fibre sludge (16%, 0.93 Mt/y), slaker grits (6%, 0.35 Mt/y), lime mud (29%, 1.68 Mt/y), and GLDs (13%, 0.75 Mt/y). The paper recycling process, on the other hand, produces the following solid wastes: wastepaper ash (32%, 1.24 Mt/y), clarification sludge (5%, 0.19 Mt/y), deinking paper sludge (47%, 1.82 Mt/y), and paper rejects (16%, 0.62 Mt/y).

As one of the key contributors to the European economy, global trends are moving the P&P industry (PPI) into a new landscape, for example, giving way to more collaborative structures with players in and outside the industry [16]. Since Europe is today facing the challenge of resource scarcity and efficiency, PPI waste can become a valuable secondary raw material (SRM) for other resource-intensive industries such as construction, which accounts for 50% of the world's energy use and 40% of raw material consumption if managed sustainably (COP26, 2021). In such a context, CE represents a promising strategy for reducing PPI's negative environmental impacts while discovering new competitive advantages through novel business models [17]. New widespread markets are needed to extend the valorisation operations, reduce landfilling rates and increase the competitiveness of the PPIs to create new added-value markets for their inorganic waste. New opportunities via strategic sector partnerships and low-carbon and sustainability-driven innovations can help PPI to move forward to new market opportunities through circular strategies [18][19], and building business models based on integrated value chains that meet changing societal needs is becoming essential [19].

2. Circular Business Model Literature within Resource Recovery Strategies

Despite the importance of the CBM concept, there is already a considerable lack of clarity and real understanding of its theoretical conceptualisation and position in economic literature [3]. More examples for comparison between value proposition, value capture, value delivery and value creation would clarify real practices of CBM [2]. Building upon the theoretical research study regarding circular economy and circular business models, this work revisits several relevant concepts from the literature to refine that initial development [20] to move forward with the implementation of CBM. The wide range of literature focused on circular economy and its archetypes did not allow us to identify the main drivers for implementing the circular economy within organisations. In that sense, and taking

into account that business model innovation enables a systemic transformation in the fundamental principles of businesses and aligns the incentives of various stakeholder groups [21][22], circular business model innovation was explored by this research as one relevant driver for implementing the circular economy within organisations. The intention of the review presented here is to explore key sources that span from the concept of circular business model innovation (CBMI) to literature about business cases for sustainability. This allowed authors to identify those research gaps that should be covered to create and operationalise CBMs. **Table 1** summaries the main findings obtained from the literature review.

Table 1. Literature review findings on circular business models.

Approach/Topic		Author	Main Contributions to This Research
CBI—Circular business innovation—concept	Defining BMI	[23]	It refers to changing "the way of doing business"; it is not only about products and services but encompasses a wider scope.
		[24]	It involves "shifting the focus away from developing individual technologies towards creating new systems".
		[25]	Four archetypical closed-loop value chains for BMI were identified. The archetype closest to this study's cases is the "post-business loop" in which material is exchanged between different companies.
	CBMI definition	[26]	Talks about CBM and that implementing circular strategies often requires more holistic and radical changes beyond the boundary of a company.
	CBMI related to the system	[27]	CBMI is networked and entails collaboration, communication and coordination within complex networks of interdependent but independent actors/stakeholders. The main challenge is then to find a "win–win–win" situation in which the self-interest of the different actors is respected.
	CBMI reference framework	[28]	"Triple fit challenge" to facilitate the transition from a linear to a CBM: (1) value proposition fits the customer segments; (2) the cost structure fits the revenue streams; and (3) how the changes a

Approach/Topic		Author	Main Contributions to This Research
			company implements, and adoption factors (internal and external) can hamper the process.
	System	[29]	A system thinking approach is recommended to optimise the whole circular business model: seven and nine blocks of BM Canvas can be affected by the circular character of the model.
Business case for sustainability	Critical elements	[30]	Special attention should be paid to proactive strategic management—to address many business case drivers strongly and continuously, which results in the regular creation of business cases for sustainability; attractiveness as an employer (indirect influence); innovative capabilities (indirect influence).
		[31]	An SBM draws on Economic, Environmental and Social Aspects and considers the needs of all stakeholders rather than giving priority to shareholders' expectations.
		[32]	Sustainable Public Procurement: specifications that are co-developed and decided between the government agency and the potential suppliers.
		[33]	Key Success Factors—Implementation: Governmental structures providing long-term and consistent support frameworks, enabling circular economy activities; legal and regulatory support (e.g., product and material eco-design); availability of investment capital (e.g., for new infrastructure).

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ead, there is a need for a systemic approach centred not only on one company but also on a consortium that collaborates (ecosystem) [23][24] and guarantees the interactions among all stakeholders involved in innovating the CBM. Hence, the organisational and the system strategic levels need to be defined in advance in which all stakeholders involved in the CBM must be represented: the firm, the partner network, the environment, the decision maker, and the customer [20][34]. Such an ecosystem perspective entails guaranteeing trusted collaboration, solid communication and coordination within complex networks of interdependent but independent actors/stakeholders [21]. Aligning the value proposition to customers' needs to the cost and revenue streams, as a second challenge, implies reinforcing several adoption factors that can hamper the implementation of innovative CBM [28]. Those adoption factors range from technological to non-technological elements of the CBM such as governmental structures providing long-term and consistent support frameworks, enabling circular economy activities; legal and regulatory support (e.g., product

and material eco-design); availability of investment capital (e.g., for new infrastructure) [33]; socio-cultural specifications and physical and social proximity between the stakeholders [32]; proactive strategic management, which results in the regular creation of business cases for sustainability; attractiveness as an employer (indirect influence); and innovative capabilities that have an indirect influence [30].

The challenge of fostering a deeper comprehension of how to innovate within circular business models has led to the identification of several critical factors that, incorporated in any reference framework, will ensure success in their execution: top-management commitment from each of the firms participating in the system; creation of a well-defined partner network in favour of organisational innovation and market share growth; monitoring of the influence of value creation capacity over such a partner network; the performance of the circular business model should be measured through the selection of the appropriate KPIs that will be specific for each context; and the relationships between capabilities, processes, culture and strategy, on the one hand, and several mechanisms for their adaptation and integration in the global system, on the other.

3. Extant Frameworks for Developing CBMs

Despite the growing popularity and momentum of the circular economy (CE) concept, numerous scholars have consistently emphasised a shared research gap, namely, the need for further development of the knowledge and tools required to effectively implement it in practice [6][35][36][37]. Thus, the second literature evaluation focused on exploring existing frameworks for a CBM practical implementation that better fits with this research's objectives.

Within the growing body of CBM articles (see **Table 2**), there is a recognised need for tailored frameworks that facilitate the transition to a circular economy through circular business model design. These frameworks aim to deliver environmental and social value while also ensuring economic benefits [27][38][39]. This requires not only the creation of value for a network of stakeholders (including society and the environment) but also for the firm [31][40].

Table 2. Literature review findings on circular business model implementation.

Approach/Topic	Author	Main Contributions to This Research
Sustainable Circular Business Model	[27]	Extension of the classic BM canvas. Three strategic levels: business level, business ecosystem level (including macro factors and external stakeholders) and sustainability impact level, which enables the CBM sustainability and circularity.
Circular Business Model Canvas	[28]	An adapted version of all BM Canvas' dimensions takes into account the CE principles and two new constructs: take-back system and adoption factors.

Approach/Topic	Author	Main Contributions to This Research
	[40]	A value mapping tool assists firms in developing value propositions that are better aligned with sustainability.
Circular Value Chain Collaboration	[37]	A collaboration tool for managing circular buildings and related supply chain collaborations: a five-phase framework from vision development to reuse of materials.

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business model innovation [27] or the decision support tool for managing circular buildings and related supply chain collaborations [37]. These frameworks have envisioned relevant improvement areas to CBM design. In this regard, the value mapping tool developed by Bocken et al. (2013) aimed to support firms in gaining a deeper understanding of sustainable value creation within their business activities. It focuses on achieving a better balance in value creation for all stakeholders, including society, ensuring that conflicting demands are addressed and negative outcomes are minimised. Bocken et al. point out that such a balance effectively provides valuable support for organisations in their pursuit of sustainability, although its implementation requires some experts' facilitation to obtain the best results (sustainability innovation demands looking outside existing business practices). Therefore, they recommended the development of a complete toolset to assist organisations in developing complete solutions within the CBM context. Built upon Bocken et al.'s tool, Ferlito and Faraci (2022) develop a new structured framework combining elements and characteristics of various tools of both academic and practical matrices [41]. While the innovative framework of Antikainen and Valkokari (2016) introduces the role and relevance of systemic innovations, further longitudinal studies could enhance the understanding of the crucial stages involved in the processes of business model innovation through intentional design or re-configuration [27]. Although focused on the building sector, Leising et al. (2018) conceptualise the organisational aspects of circular value chain collaboration by connecting and integrating the fields of sustainable supply chain management and the CE [37]. The authors recommend further improvement of their conceptual framework, suggesting deepening the relationships between its four building blocks (vision, actor learning, network dynamics and business model innovation) since their proposal was mainly descriptive. Providing further elaboration on each building block can be reinforced by exploring patterns, mechanisms and levels of performance [37]. In addition to the room for improvement previously identified, Hofmann (2019) stated that in transitioning from linear to circular business infrastructures, firms need to establish new collaborative production and consumption networks that facilitate the implementation of circular value creation and offerings [42]. As a result, the business models of participating manufacturers, service providers, retailers, logisticians, and other stakeholders must align, interconnect, and harmonise with each other. The concise description provided by Hofmann (2019) enables a systematic analysis and assessment of the normative and operational aspects of the theoretical foundations of CBMs. It covers the desirability of CBM implementation (normative dimension), the definition of potential approaches and offerings (strategic dimension), and the practical and feasible solutions that can be implemented at present (operational dimension) [42] that constitute insightful aspects to be integrated within a more comprehensive framework.

References

1. Homrich, A.S.; Galvão, G.; Abadia, L.G.; Carvalho, M.M. The circular economy umbrella: Trends and gaps on integrating pathways. J. Clean. Prod. 2018, 175, 525–543.
2. Rosa, P.; Sassanelli, C.; Terzi, S. Towards Circular Business Models: A systematic literature review on classification frameworks and archetypes. J. Clean. Prod. 2019, 236, 117696.
3. Geissdoerfer, M.; Pieroni, M.P.; Pigosso, D.C.; Soufani, K. Circular business models: A review. J. Clean. Prod. 2020, 277, 123741.
4. A New Circular Economy Action Plan for a Cleaner and More Competitive Europe. 2020. Available online: https://eur-lex.europa.eu/legalcontent/EN/TXT (accessed on 3 July 2023).
5. Stegmann, P.; Londo, M.; Junginger, M. The circular bioeconomy: Its elements and role in European bioeconomy clusters. Resour. Conserv. Recycl. X 2020, 6, 100029.
6. Velenturf, A.P.; Jopson, J.S. Making the business case for resource recovery. Sci. Total Environ. 2019, 648, 1031–1041.
7. Mandeep; Gupta, G.K.; Shukla, P. Insights into the resources generation from pulp and paper industry wastes: Challenges, perspectives and innovations. Bioresour. Technol. 2020, 297, 122496.
8. Bajpai, P. Management of Pulp and Paper Mill Waste; Springer International Publishing: Cham, Switzerland, 2015.
9. dos Santos, V.R.; Cabrelon, M.D.; Trichês, E.d.S.; Quinteiro, E. Green liquor dregs and slaker grits residues characterization of a pulp and paper mill for future application on ceramic products. J. Clean. Prod. 2019, 240, 118220.
10. CEPI. European Pulp & Paper Industry. Key Statistics 2019. 2020. Available online: http://www.cepi.org/topics/statistics (accessed on 20 July 2022).
11. Monte, M.; Fuente, E.; Blanco, A.; Negro, C. Waste management from pulp and paper production in the European Union. Waste Manag. 2009, 29, 293–308.
12. Tofani, G.; de Nys, J.; Cornet, I.; Tavernier, S. Alternative Filler Recovery from Paper Waste Stream. Waste Biomass-Valorization 2021, 12, 503–514.
13. Quina, M.J.; Pinheiro, C.T. Inorganic Waste Generated in Kraft Pulp Mills: The Transition from Landfill to Industrial Applications. Appl. Sci. 2020, 10, 2317.
14. European Commission. Joint Research Centre. Institute for Prospective Technological Studies. Best Available Techniques (BAT) Reference Document for the Production of Pulp, Paper and

Board; Publications Office: Luxembourg, 2015; Available online: https://data.europa.eu/doi/10.2791/370629 (accessed on 1 November 2023).

15. Bird, M. Waste Stream Reduction and Re-Use in the Pulp and Paper Sector; Center for Sustainable Economy: Lake Oswego, OR, USA, 2008.
16. Lingqvist, P.; Pulp, B.O. Paper, and Packaging in the Next Decade: Transformational Change. Available online: https://www.mckinsey.com/industries/paper-forest-products-and-packaging/our-insights/pulp-paper-and-packaging-in-the-next-decade-transformational-change (accessed on 30 March 2021).
17. Sakthivelmurugan, E.; Senthilkumar, G.; Karthick, K. Analysis of the impact of circular economy over linear economy in the paper processing industry. Mater. Today Proc. 2022, 66, 1446–1452.
18. Del Rio, D.D.F.; Sovacool, B.K.; Griffiths, S.; Bazilian, M.; Kim, J.; Foley, A.M.; Rooney, D. Decarbonizing the pulp and paper industry: A critical and systematic review of sociotechnical developments and policy options. Renew. Sustain. Energy Rev. 2022, 167, 112706.
19. Pätäri, S.; Tuppura, A.; Toppinen, A.; Korhonen, J. Global sustainability megaforces in shaping the future of the European pulp and paper industry towards a bioeconomy. For. Policy Econ. 2016, 66, 38–46.
20. Sopelana, A.; Auriault, C.; Bansal, A.; Fifer, K.; Paiva, H.; Maurice, C.; Westin, G.; Rios, J.; Oleaga, A.; Cañas, A. Innovative Circular Economy Models for the European Pulp and Paper Industry: A Reference Framework for a Resource Recovery Scenario. Sustainability 2021, 13, 10285.
21. Rashid, A.; Asif, F.M.A.; Krajnik, P.; Nicolescu, C.M. Resource Conservative Manufacturing: An essential change in business and technology paradigm for sustainable manufacturing. J. Clean. Prod. 2013, 57, 166–177.
22. Schulte, U.G. New business models for a radical change in resource efficiency. Environ. Innov. Soc. Transit. 2013, 9, 43–47.
23. Amit, R.; Zott, C. Creating Value Through Business Model Innovation. MIT Sloan Manag. Rev. 2012, 53, 41.
24. Johnson, M.W.; Suskewicz, J. How to Jump-Start the Clean-Tech Economy. Harv. Bus. Rev. 2009, 87, 52.
25. Wells, P.; Seitz, M. Business models and closed-loop supply chains: A typology. Supply Chain Manag. Int. J. 2005, 10, 249–251.
26. Nußholz, J.L.K. Circular Business Models: Defining a Concept and Framing an Emerging Research Field. Sustainability 2017, 9, 1810.

27. Antikainen, M.; Valkokari, K. A Framework for Sustainable Circular Business Model Innovation. Technol. Innov. Manag. Rev. 2016, 6, 5–12.
28. Lewandowski, M. Designing the Business Models for Circular Economy—Towards the Conceptual Framework. Sustainability 2016, 8, 43.
29. Poutiainen, P.S. Designing Out Waste: An Exploratory Study of Circular Business Models. Master's Thesis, Aalto University, Espoo, Finland, 2015.
30. Schaltegger, S.; Freund, F.L.; Hansen, E.G. Business cases for sustainability: The role of business model innovation for corporate sustainability. Int. J. Innov. Sustain. Dev. 2012, 6, 95–119.
31. Stubbs, W.; Cocklin, C. Conceptualizing a "Sustainability Business Model". Organ. Environ. 2008, 21, 103–127.
32. Witjes, S.; Lozano, R. Towards a more Circular Economy: Proposing a framework linking sustainable public procurement and sustainable business models. Resour. Conserv. Recycl. 2016, 112, 37–44.
33. Florin, N.; Madden, B.; Sharpe, S.; Benn, S.; Agarwal, R.; Perey, R.; Giurco, D. Shifting Business Models for a Circular Economy: Metals Management for Multi-Product-Use Cycles; University of Technology Sydney: Ultimo, Australia, 2015.
34. Lüdeke-Freund, F.; Dembek, K. Sustainable business model research and practice: Emerging field or passing fancy? J. Clean. Prod. 2017, 168, 1668–1678.
35. Kalmykova, Y.; Sadagopan, M.; Rosado, L. Circular economy—From review of theories and practices to development of implementation tools. Resour. Conserv. Recycl. 2018, 135, 190–201.
36. Leder, N.; Kumar, M.; Rodrigues, V.S. Influential factors for value creation within the Circular Economy: Framework for Waste Valorisation. Resour. Conserv. Recycl. 2020, 158, 104804.
37. Leising, E.; Quist, J.; Bocken, N. Circular Economy in the building sector: Three cases and a collaboration tool. J. Clean. Prod. 2018, 176, 976–989.
38. Bocken, N.M.P.; de Pauw, I.; Bakker, C.; van der Grinten, B. Product design and business model strategies for a circular economy. J. Ind. Prod. Eng. 2016, 33, 308–320.
39. Achterberg, E.; Hinfelaar, J.; Bocken, N. Master Circular Business with the Value Hill; Circle Economy: Utrecht, The Netherlands, 2016; p. 18.
40. Bocken, N.; Short, S.; Rana, P.; Evans, S. A Value Mapping Tool for Sustainable Business Modelling. Corp. Gov. 2013, 13, 482–497.
41. Ferlito, R.; Faraci, R. Business model innovation for sustainability: A new framework. Innov. Manag. Rev. 2022, 19, 222–236.

42. Hofmann, F. Circular business models: Business approach as driver or obstructer of sustainability transitions? J. Clean. Prod. 2019, 224, 361–374.