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INTEGRATING CIRCULAR ECONOMY PRINCIPLES IN ELECTRIC VEHICLE AND CONSTRUCTION SECTORS: A COMPREHENSIVE FRAMEWORK FOR SUSTAINABLE BUSINESS MODELS

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Abstract: The transition towards a circular economy represents a paradigm shift in contemporary business and industrial practices, aiming to replace traditional linear models of production and consumption with regenerative and restorative systems. This study critically examines the integration of circular economy principles within the electric vehicle (EV) battery value chain and the construction sector, emphasizing the development and implementation of circular business models (CBMs). By synthesizing insights from multidisciplinary literature, the research investigates theoretical underpinnings, operational enablers, and the barriers associated with circular transitions. The study employs a qualitative, theory-driven methodology, combining systematic literature review, stakeholder analysis, and conceptual mapping to construct an integrative framework for circular business model design. Findings highlight the significance of traceability mechanisms, multi-stakeholder collaboration, and value proposition alignment in fostering sustainable outcomes across both sectors. Additionally, the research identifies consumer behavior, institutional voids, and regulatory contexts as critical determinants influencing the adoption and scalability of CBMs. The discussion elaborates on the implications of circular transitions, including economic, environmental, and social dimensions, while acknowledging limitations related to data availability and generalizability. Finally, the study proposes directions for future research, emphasizing empirical validation of circular strategies, cross-sectoral knowledge transfer, and the development of competency frameworks for practitioners. The outcomes provide a comprehensive theoretical and practical guide for policymakers, industry leaders, and researchers seeking to operationalize circular economy principles in complex industrial ecosystems.

Keywords: Circular economy, electric vehicles, construction industry, sustainable business models, stakeholder collaboration, value proposition, circular transition.

Introduction

The concept of a circular economy (CE) has emerged as a critical response to the environmental, economic, and social limitations inherent in traditional linear production and consumption systems. Linear models, characterized by the extract-produce-consume-dispose trajectory, have increasingly been recognized as unsustainable due to their contribution to resource depletion, environmental degradation, and waste accumulation (Geissdoerfer et al., 2017). The CE paradigm, by contrast, emphasizes regenerative design, material recirculation, and service-oriented approaches to maximize value retention and minimize environmental impacts (Bocken et al., 2016; EMF, 2015). In this context, sectors with high material intensity and environmental footprint, such as electric vehicles (EVs) and construction, present both significant challenges and opportunities for circular transitions.

The EV sector, particularly the battery value chain, illustrates the critical role of traceability and multi-stakeholder coordination in enabling circular practices. Lithium-ion batteries, while central to sustainable mobility, pose complex end-of-life management issues due to their material composition, safety concerns, and recycling limitations (Agrawal et al., 2021). Effective circular strategies necessitate robust tracking mechanisms, reverse logistics, and collaboration across manufacturers, recyclers, regulators, and consumers to ensure the recovery of valuable materials and environmental compliance (Chirumalla et al., 2022).

Similarly, the construction sector, a globally resource-intensive industry, faces mounting pressure to integrate CE principles into design, material sourcing, and demolition practices (Kanther, 2025; Munaro & Tavares, 2023). Strategies such as modular design, material passports, and waste minimization practices are increasingly recognized as essential for achieving sustainable construction outcomes (Guerra & Leite, 2021; Cho et al., 2022).

Despite growing interest, a significant gap persists in the operationalization of circular business models (CBMs) within these sectors. Existing literature highlights theoretical frameworks and isolated case studies but often lacks integrative models that link stakeholder engagement, value creation, and consumer behavior with measurable sustainability outcomes (Urbinati et al., 2017; Centobelli et al., 2020). Moreover, the intersection of technological innovation, regulatory frameworks, and market dynamics complicates the design and implementation of CBMs, necessitating comprehensive, multi-dimensional research approaches (Jabbour et al., 2020; Han et al., 2022).

This study seeks to address these gaps by developing a holistic framework for CBMs in the EV and construction sectors. By synthesizing insights from empirical studies, conceptual analyses, and multi-stakeholder perspectives, the research aims to elucidate the mechanisms, enablers, and barriers for circular transitions, offering a robust foundation for both theoretical advancement and practical implementation.

Methodology

The research adopts a qualitative, theory-driven methodology designed to synthesize and extend the existing knowledge base on circular economy implementation. The approach combines systematic literature review, conceptual mapping, and multi-stakeholder analysis to construct an integrative framework for CBM development. The literature review encompasses peer-reviewed journal articles, conference proceedings, and authoritative reports published between 2001 and 2025, focusing on EV batteries, construction, and circular business model innovation. Key sources were selected based on their relevance to sustainability, stakeholder engagement, value proposition design, and operational enablers of circular practices (Agrawal et al., 2021; Chirumalla et al., 2022; Kanther, 2025).

Conceptual mapping was employed to identify recurring themes, interrelationships among stakeholders, and critical operational variables in circular transitions. This process involved categorizing literature into thematic clusters, including (i) circular economy principles and theoretical foundations, (ii) sector-specific implementation challenges and enablers, (iii) business model innovation strategies, and (iv) consumer behavior and adoption mechanisms. Each theme was further analyzed to identify causal relationships, barriers, and feedback loops influencing CBM effectiveness (Brown et al., 2018; Urbinati et al., 2021).

A multi-stakeholder analysis was conducted to contextualize theoretical insights within practical operational environments. Drawing on frameworks proposed by Chirumalla et al. (2022) and Jabbour et al. (2020), stakeholders were categorized into primary actors (producers, consumers, recyclers), secondary actors (regulators, NGOs, research institutions), and tertiary actors (logistics providers, service designers). This categorization enabled the identification of coordination mechanisms, value-sharing opportunities, and conflict points that influence circular transition efficacy.

Finally, the methodology incorporates a comparative synthesis across sectors to explore the transferability of CBM strategies between EVs and construction. This approach emphasizes cross-sectoral learning, highlighting both unique contextual constraints and universal principles applicable to circular transitions. The methodology does not rely on quantitative data or mathematical modeling, focusing instead on descriptive, theory-driven insights to capture the complexity and dynamism of circular business ecosystems.

Results

The analysis reveals multiple dimensions critical to successful circular business model implementation across both the EV and construction sectors.

Traceability and Material Management: Effective traceability mechanisms emerge as a fundamental enabler for circularity, particularly in the EV battery lifecycle. Battery components, including lithium, cobalt, and nickel, require accurate tracking to facilitate recycling, repurposing, and safe disposal (Agrawal et al., 2021). Digital solutions such as blockchain, IoT-enabled monitoring, and material passports are increasingly recognized as essential tools for enhancing transparency, reducing leakage, and aligning stakeholder incentives (Chirumalla et al., 2022). In the construction sector, material traceability is equally critical, enabling project managers to optimize material reuse, manage demolition waste, and adhere to regulatory requirements (Kanther, 2025; Munaro & Tavares, 2023).

Stakeholder Collaboration and Multi-Level Coordination: Cross-sectoral collaboration is identified as a determinant of CBM success. Studies demonstrate that sustainable outcomes are maximized when firms, consumers, and regulators engage in co-creation processes, share data, and align incentives (Brown et al., 2018; Han et al., 2022). The EV sector benefits from joint ventures and industry consortia that coordinate battery take-back schemes, whereas construction relies on integrated project delivery models and public-private partnerships to facilitate material circularity (Guerra & Leite, 2021; Górecki et al., 2019).

Consumer Behavior and Adoption: Consumer willingness to participate in circular practices, such as purchasing recycled products or engaging in take-back programs, is influenced by perceived value, environmental awareness, and social norms (Bigliardi et al., 2020; Islam et al., 2021). Behavioral theories, including the Theory of Planned Behavior and Value-Belief-Norm frameworks, provide explanatory power for predicting adoption patterns and designing interventions that enhance engagement (Asare, 2015; Hiratsuka et al., 2018).

Business Model Innovation: CBMs in both sectors are characterized by service-oriented approaches, product-as-a-service models, and shared use strategies. The lean startup and lean canvas methodologies support iterative development, testing, and validation of circular propositions, allowing firms to balance economic and environmental objectives (Maurya, 2012; Reis, 2011; Islam & Iyer-Raniga, 2023). Value mapping and value proposition design tools enable alignment of stakeholder needs with environmental objectives, fostering sustainable performance while maintaining market competitiveness (Bocken et al., 2015; Fernandes et al., 2020).

Regulatory and Institutional Contexts: Institutional voids, regulatory uncertainty, and sector-specific constraints pose significant barriers to circular implementation. In emerging economies, the absence of standardized recycling infrastructure and weak enforcement mechanisms limits the scalability of CBMs, highlighting the need for policy interventions and capacity-building programs (Jabbour et al., 2020; Urbinati et al., 2021). In contrast, well-defined regulatory frameworks in developed markets facilitate investment in circular technologies, incentivize resource efficiency, and support collaborative industry practices (Kanther, 2025; Cho et al., 2022).

Discussion

The findings underscore the multifaceted nature of circular economy implementation, emphasizing the interplay between technological, organizational, and behavioral factors. Traceability emerges not merely as a technical requirement but as a strategic enabler of trust, accountability, and stakeholder alignment (Agrawal et al., 2021). By embedding transparency into material flows, firms can reduce environmental risks, enhance recycling rates, and create market differentiation through sustainability credentials.

Stakeholder collaboration, while essential, presents inherent challenges. Conflicting objectives, competitive pressures, and uneven access to information can impede coordination, requiring governance structures, incentive alignment, and shared value creation mechanisms to overcome barriers (Brown et al., 2018; Chirumalla et al., 2022). The integrative framework proposed in this study highlights mechanisms such as multi-actor platforms, co-design workshops, and contractual arrangements to operationalize collaboration effectively.

Consumer behavior represents a critical leverage point for CBM success. While environmental awareness and social norms influence engagement, perceived convenience, cost, and product quality remain decisive factors (Bigliardi et al., 2020; Islam et al., 2021). Behavioral change strategies, informed by TPB and VBN theory, provide actionable insights for designing communication campaigns, incentive schemes, and product-service offerings that enhance participation and loyalty (Asare, 2015; Hiratsuka et al., 2018).

Business model innovation emerges as a core driver of circular transitions. Service-oriented models, product-as-a-service approaches, and shared platforms not only extend product lifecycles but also enable new revenue streams and sustainable value creation (Urbinati et al., 2017; Han et al., 2022). The iterative development of CBMs, guided by lean principles and value mapping tools, facilitates alignment between sustainability objectives and market realities, reducing implementation risk and enhancing adaptability (Maurya, 2012; Islam & Iyer-Raniga, 2023).

Nevertheless, limitations exist in both empirical and conceptual dimensions. Data availability, particularly regarding material flows, recycling rates, and consumer adoption in diverse geographies, constrains generalizability. Sectoral specificity further complicates transferability, as regulatory regimes, technological readiness, and market structures differ significantly between EVs and construction. Future research should focus on empirical validation, longitudinal studies, and cross-sectoral experimentation to strengthen theoretical models and practical guidelines.

The study also identifies competencies required for circular transitions, including design thinking, systems-level understanding, and collaborative problem-solving (Sumter et al., 2020). These competencies are essential for equipping practitioners to navigate complex industrial ecosystems, design effective CBMs, and implement circular strategies at scale. By emphasizing human capabilities alongside technological and organizational factors, the framework aligns with socio-technical perspectives on sustainability transitions (Brown et al., 2004).

Conclusion

This study provides a comprehensive framework for integrating circular economy principles in the EV battery and construction sectors, emphasizing the development of sustainable business models that balance environmental, economic, and social objectives. Traceability, stakeholder collaboration, consumer behavior, business model innovation, and regulatory contexts emerge as critical determinants of successful circular transitions. By synthesizing theoretical and empirical insights, the research offers actionable guidance for industry practitioners, policymakers, and scholars, highlighting mechanisms for operationalizing circular strategies, overcoming barriers, and creating lasting value. Future research should focus on empirical validation, cross-sectoral learning, and the development of competency frameworks to support practitioners in navigating the complexities of circular transitions. The outcomes underscore the transformative potential of circular economy principles, demonstrating that holistic, multi-dimensional approaches are essential for achieving sustainable, resilient industrial ecosystems.

References

1. Agrawal, T. K., Angelis, J., Thakur, J. R., Wiktorsson, M., & Kalaiarasan, R. (2021). Enabling circularity of electric vehicle batteries-the need for appropriate traceability. 2021 IEEE International Conference on Technology Management, Operations and Decisions (ICTMOD), Marrakech, Morocco. https://doi.org/10.1109/ICTMOD52902.2021.9739531

2. Asare, M. (2015). Using the theory of planned behavior to determine the condom use behavior among college students. American Journal of Health Studies, 30(1), 43–50. https://doi.org/10.47779/ajhs.2015.168

3. Bigliardi, B., Campisi, D., Ferraro, G., Filippelli, S., Galati, F., & Petroni, A. (2020). The intention to purchase recycled products: Towards an integrative theoretical framework. Sustainability, 12, 9739. https://doi.org/10.3390/su12229739

4. Bocken, N. M. P., De Pauw, I., Bakker, C., & Van Der Grinten, B. (2016). Product design and business model strategies for a circular economy. Journal of Industrial and Production Engineering, 33, 308–320. https://doi.org/10.1080/21681015.2016.1172124

5. Bocken, N. M. P., Rana, P., & Short, S. W. (2015). Value mapping for sustainable business thinking. Journal of Industrial and Production Engineering, 32(1), 67–81. https://doi.org/10.1080/21681015.2014.1000399

6. Brown, H.S., Vergragt, P.J., Green, K., & Berchicci, L. (2004). Bounded socio-technical experiments (BSTEs): higher order learning for transitions towards sustainable mobility. In B. Elzen, F. Geels, & K. Green (Eds.), System innovation and the transition to sustainability (pp. 191–219). Edward Elgar, Cheltenham.

7. Brown, P., Bocken, N., & Balkenende, R. (2018). Towards Understanding Collaboration Within Circular Business Models. In L. Moratis, F. Melissen, & S. O. Idowu (Eds.), Sustainable Business Models Principles, Promise, and Practice (pp. 169-201). Springer, Cham. https://doi.org/10.1007/978-3-319-73503-0_9

8. Centobelli, P., Cerchione, R., Chiaroni, D., Vecchio, P. D., & 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. https://doi.org/10.1002/bse.2466

9. Kanther, S. D. (2025). Integrating circular business models in construction: A framework for design and planning to enhance sustainability. International Journal of Sustainability and Innovation in Engineering, 3, 26–33. https://doi.org/10.56830/IJSIE202502

10. Chirumalla, K., Reyes, L. G., & Toorajipour, R. (2022). Mapping a circular business opportunity in electric vehicle battery value chain: A multi-stakeholder framework to create a win–win–win situation. Journal of Business Research, 145, 569–582. https://doi.org/10.1016/j.jbusres.2022.02.070

11. Cho, N., El Asmar, M., & Aldaaja, M. (2022). An Analysis of the Impact of the Circular Economy Application on Construction and Demolition Waste in the United States of America. Sustainability, 14, 10034. https://doi.org/10.3390/su141810034

12. EMF (Ellen MacArthur Foundation). (2015). Towards the Circular Economy: Business rationale for an accelerated transition. Greener Management International, 20(3), 3.

13. Fernandes, S. d. C., Pigosso, D. C. A., McAloone, T. C., & Rozenfeld, H. (2020). Towards product-service system oriented to circular economy: A systematic review of value proposition design approaches. Journal of Cleaner Production, 257, 120507. https://doi.org/10.1016/j.jclepro.2020.120507

14. Geissdoerfer, M., Savaget, P., Bocken, N.M., & Hultink, E.J. (2017). The Circular Economy–A new sustainability paradigm? Journal of Cleaner Production, 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

15. Górecki, J., Núñez-Cacho, P., Corpas-Iglesias, F.A., & Molina, V. (2019). How to convince players in construction market? Strategies for effective implementation of circular economy in construction sector. Cogent Engineering, 6, 1690760. https://doi.org/10.1080/23311916.2019.1690760

16. Guerra, B.C., & Leite, F. (2021). Circular economy in the construction industry: An overview of United States stakeholders' awareness, major challenges, and enablers. Resources, Conservation and Recycling, 170, 105617. https://doi.org/10.1016/j.resconrec.2021.105617

17. Han, D., Konietzko, J., Dijk, M., & Bocken, N. (2022). How do companies launch circular service business models in different countries? Sustainable Production and Consumption, 31, 591–602.

https://doi.org/10.1016/j.spc.2022.03.011

18. Islam, M. T., & Iyer-Raniga, U. (2023). Circular Business Model Value Dimension Canvas: Tool Redesign for Innovation and Validation through an Australian Case Study. Sustainability, 15, 11553. https://doi.org/10.3390/su151511553

19. Islam, M.T., Islam, M. T., Huda, N., Baumber, A., Shumon, R., Zaman,