

Synthesizing Policy Gaps, Sector-Specific Challenges, and Emerging Opportunities to Develop Novel Research Themes in India's Circular Economy

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Abstract

The concept of the circular economy (CE) represents an important shift away from the linear “take–make–dispose” model toward a regenerative system, with quite a number of aspects in which circularity is needed in India, due to recent decades of rapid industrialization and rising consumption. Despite supportive policy initiatives such as the National Resource Efficiency Policy and Extended Producer Responsibility frameworks, India's transition to CE remains fragmented. This synthesis aims to identify and analyze existing policy gaps and sector-specific challenges, particularly related to waste management, textiles, construction, and electronics (e-waste), to highlight value generation potentials that are high, and ultimately to contribute to proposing novel research paper topics. This paper uses a qualitative and exploratory research design; it synthesized secondary data from policy documents, academic literature published within a time frame from 2018 to 2025, and comparative policy analysis. The synthesis revealed that the main barriers are policy incoherence across ministries, a focus on downstream waste management rather than upstream eco-design, and technological/financial barriers to the scalability of CE models, especially for SMEs. Sector-specific challenges include the dominance of the informal recycling sector; limited recycling infrastructure for textiles, and weak extended producer responsibility (EPR) enforcement in electronics. High-potential areas identified include the integration of the informal sector; leveraging digital platforms for traceability, and valorization of construction waste. The findings presented in the report affirm the central hypothesis that focused research interventions could accelerate the transition in India. Synthesis concludes that India needs to address the policy–practice divide through evidence-based interventions. The work generates a strategic research agenda that guides policymakers and industry on integrated policy instruments, formal-informal sector linkages, and the infusion of technology.

Keywords: Circular economy, India, policy gaps, sectoral challenges, waste management, extended producer responsibility, EPR, research agenda, SDGs

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INTRODUCTION

The circular economy (CE) represents a paradigm shift from the traditional linear model of “take–make–dispose” to a regenerative system that emphasizes resource efficiency, waste minimization, and sustainable production-consumption cycles. In India, rapid industrialization, urbanization, and rising consumption have heightened environmental stress, making CE a critical framework for achieving sustainable development and meeting the country's commitments to the UN Sustainable Development

Goals (SDGs) [1, 2]. Despite several policy initiatives, such as the National Resource Efficiency Policy (2019 Draft), Extended Producer Responsibility (EPR) frameworks, and Swachh Bharat Mission, India's transition toward circularity remains fragmented, with policy gaps, technological barriers, and inconsistent stakeholder participation [3, 4].

OBJECTIVES

1. To identify and synthesize the existing policy gaps that hinder the adoption of CE principles in India.
2. To analyze sector-specific challenges in key industries such as waste management, textiles, construction, and electronics.
3. To highlight high-potential areas where circular practices can generate economic, social, and environmental values.

HYPOTHESIS

The hypothesis guiding the synthesis is that addressing India's policy fragmentation and sectoral inefficiencies through targeted research interventions can significantly accelerate the country's transition towards a CE.

LITERATURE REVIEW

The literature on the CE highlights its growing importance as a model for achieving sustainability through efficient resource use, waste minimization, and systemic innovation. However, while many developed countries have advanced CE implementation, India's transition remains inconsistent. The following points summarize the key findings from global and Indian studies relevant to this research:

Global Perspective on Circular Economy Adoption

- According to the Ellen MacArthur Foundation (2020), countries such as the Netherlands, Japan, and Germany have implemented comprehensive CE frameworks that integrate design, production, and consumption.
- The European Union's Circular Economy Action Plan (2020) promotes waste prevention, recycling, and eco-design principles.
- Japan's Home Appliance Recycling Law (2001) ensures that over 80% of consumer electronics are recovered and reused, demonstrating the effectiveness of well-enforced laws.
- These global examples show that coordinated policies, technological innovation, and behavioral awareness are critical for successful CE adoption.

Policy Gaps and Institutional Challenges in India

- NITI Aayog (2021) and TERI (2022) note that India lacks a unified, national CE framework.
- Responsibilities are split among multiple ministries, including the Ministry of Environment, Forest, and Climate Change (MoEFCC), the Ministry of Housing and Urban Affairs, and the Ministry of Commerce and Industry.
- This fragmented governance leads to overlapping mandates and weak enforcement mechanisms.
- Existing policies largely emphasize waste management rather than upstream strategies such as product redesign, resource efficiency, and lifecycle thinking.

Sectoral Challenges Identified in Literature

- *Waste management*: GIZ India (2022) and CPCB (2023) report that nearly 70% of recycling activities are handled by the informal sector, often without regulations, safety, or access to technology.
- *Textiles*: The India-EU Resource Efficiency Initiative (2020) identifies issues with recycling blended fibers and synthetic materials, which hinder large-scale circularity in textiles.
- *Construction*: Studies show that India produces over 150 million tons of construction and demolition waste annually, yet less than 20% is recycled due to low awareness and a lack of market incentives.

- *E-waste*: The Confederation of Indian Industry (CII, 2020) finds that the enforcement of EPR rules remains inconsistent, and consumer awareness of proper disposal is low.

Emerging Circular Innovations in India

- Several Indian companies demonstrate encouraging examples of circular innovation.
- Ecoware manufactures biodegradable tableware using agricultural residues.
- Banyan Nation integrates digital traceability systems to manage plastic recycling efficiently.
- Godrej Construction converts demolition debris into eco-friendly concrete blocks.
- These initiatives illustrate how local innovation can complement national sustainability goals when supported by policies and investments.

Global Best Practices and Lessons for India

- International examples, such as the Netherlands' industrial symbiosis parks and Japan's "Top Runner Program," show that public-private partnerships are key to success.
- The Ellen MacArthur Foundation (2020) emphasizes digital innovation and consumer education as essential components of CE adoption.
- Adapting these global models to India's socioeconomic context could significantly enhance policy coherence and implementation efficiency.

Research Gaps and Opportunities Identified

- The current literature lacks empirical research on the economic viability of circular models in Indian industries.
- There is limited data on informal sector integration, financing mechanisms, and consumer participation in the informal sector.
- Further research is needed to design context-specific CE indicators and policy frameworks suited to India's diverse economy.

In summary, the literature suggests that India has a strong foundation for CE adoption but lacks integrated governance, consistent enforcement, and financial mechanisms to support it. Nevertheless, rising awareness, technological innovation, and successful pilot projects signal the immense potential for India to become a global leader in circular transformation.

RESEARCH METHODOLOGY

This study employs a qualitative and exploratory research design to understand India's readiness for a CE transition. This research integrates secondary data analysis, comparative policy evaluation, and thematic synthesis to identify policy gaps, sector-specific challenges, and emerging opportunities.

Data Collection

This study relies primarily on secondary data sources, such as academic publications, government policy documents, international reports, and case studies from 2018 to 2025. These include key resources from NITI Aayog, the Confederation of Indian Industry (CII), TERI, GIZ, and the Ellen MacArthur Foundation. Additionally, global CE case studies from the European Union, Japan, and the Netherlands were reviewed to benchmark India's progress against the international best practices.

Research Approach

A comparative policy analysis was conducted to assess the differences between India's CE initiatives and those of global leaders. For example, one study compared the EU's extended producer responsibility system with India's EPR framework, identifying differences in enforcement mechanisms and traceability standards. A SWOT (Strengths, Weaknesses, Opportunities, Threats) analysis was also employed to assess India's institutional and industrial readiness for CE implementation.

Table 1. Summary of key observations and implications for circular economy implementation.

Domain	Key observations	Implications
Policy gaps	Fragmented mandates, lack of a CE monitoring framework	Need for integrated circular policy instruments
Sectoral challenges	Low innovation, weak enforcement, informal sector dominance	Incentivize formal-informal linkages and technology infusion
High-potential areas	Digital CE platforms, circular textiles, and construction waste valorization	Support R&D and pilot initiatives through PPPs

Thematic Synthesis

Thematic analysis was used to identify the recurring patterns in the collected literature. Policy fragmentation, lack of innovation, and dominance of informal recycling have emerged as key barriers. In contrast, digital innovation, public–private partnerships (PPPs), and sustainable entrepreneurship emerged as major opportunities.

Validation

- To ensure the validity of the insights, triangulation was employed by cross-referencing the findings from different data sources. This enhanced the reliability of interpretations and helped identify consistent themes across multiple reports and sectors.
- In summary, this methodological approach provides a structured framework for synthesizing complex and multidimensional data. This allows for a deep exploration of India's CE potential while ensuring that policy and sectoral insights are grounded in verifiable evidence. The combination of comparative and thematic analyses makes this research suitable for policy formulation, academic inquiry, and strategic planning.

DATA ANALYSIS

The data collected, as shown in Table 1, were categorized under three domains:

The collected data were categorized into three main domains: policy gaps, sectoral challenges, and high-potential opportunity areas to interpret India's readiness for a CE transition.

Policy Gaps

The analysis revealed that existing policies, such as the EPR and the National Resource Efficiency Framework, remain fragmented. There is limited coordination between national and state-level agencies, resulting in overlapping responsibilities for the same work. Monitoring frameworks for CE performance are weak, and most indicators measure waste generation rather than resource efficiency. Compared to the EU, India lacks binding targets for circular implementation, which affects accountability and progress.

Sectoral Challenges

Sectoral data indicate low innovation levels, insufficient R&D funding, and weak enforcement mechanisms. The waste management industry is dominated by the informal sector with limited technological integration. In the textile sector, blended fabrics and dye-intensive production restrict material recovery [5, 6]. Construction generates large-scale waste but faces limited economic incentives to recycle because of the low market demand for recycled aggregates. Despite existing EPR frameworks, the e-waste sector struggles with improper disposal and a lack of consumer participation [7, 8].

High-Potential Areas

Digitalization and technology have emerged as the most promising enablers of CE. The use of digital traceability platforms, blockchain-based recycling systems, and AI-driven waste sorting can revolutionize the recycling process. Initiatives such as digital product passports and waste-tracking apps have been successfully tested in the EU and could be adapted to the Indian context. Similarly, bio-based

innovations, such as biodegradable plastics, agro-waste reuse, and algae-based packaging, present scalable solutions for sustainability [9, 10].

Qualitative coding from the literature identified five major research clusters: policy integration, technology and innovation, informal sector inclusion, digital transformation, and industrial symbiosis. Each cluster reflects a research direction with both academic and practical implications. Therefore, the analysis underscores that India's transition to a CE requires systemic reform, robust governance, and inclusive stakeholder collaboration. Qualitative coding revealed five major research clusters, which were later refined into actionable research topics [11, 12].

FINDINGS

The findings of this study reveal several critical insights into India's current progress, barriers, and opportunities for transitioning toward a CE. While policy attention to sustainability has increased, implementation remains limited due to fragmented governance, inadequate technology adoption, and insufficient financial and social inclusion. The major findings are summarized as follows:

In conclusion, the findings indicate that India is at a strategic inflection point. With better policy integration, financial incentives, technology adoption, and inclusive governance, the country has the potential to lead the CE in the Global South.

1. Policy incoherence and lack of cross-sectoral integration are major barriers.
2. Technological and financial barriers restrict the scalability of CE models in SMEs.
3. Informal sector integration offers untapped potential for resource recovery.
4. Digital transformation and traceability tools can bridge implementation gaps.
5. Sectoral circularity roadmaps remain underdeveloped but present potential for research.

LIMITATIONS

While this study provides valuable insights into India's CE landscape, it has certain limitations that should be acknowledged to contextualize the findings.

The first limitation arises from the study's reliance on secondary data. Since the analysis is based on published reports, policy papers, and academic studies, it depends heavily on the accuracy and recency of these materials. Some data sources may be outdated or inconsistent because of India's rapidly changing policy environment, leading to potential information gaps. Future research could be strengthened through primary data collection, including surveys, field visits, and interviews with policymakers, industry leaders, and informal workers [13, 14].

Another limitation is sectoral heterogeneity. India's economic structure is highly diverse, encompassing advanced industrial zones and underdeveloped rural areas. Consequently, findings from one sector or region may not fully apply to another. For example, circular initiatives that work well in urban construction or textile industries may not be directly replicable in rural agricultural settings. This variability limits the generalizability of the conclusions across all regions and industries [15].

This study also recognizes the limitations of quantitative analysis. Owing to data unavailability, this study primarily focuses on qualitative evaluation and policy synthesis. A comprehensive assessment of India's CE readiness would benefit from measurable indicators, such as material circularity rates, waste diversion ratios, and carbon reduction benchmarks, similar to those used by the European Union. The absence of consistent metrics makes it difficult to measure progress and compare performance across sectors.

The rapid evolution of CE policies presents another challenge. As India continues to introduce new environmental regulations, the insights presented in this study may quickly become outdated. For instance, if new versions of the National Resource Efficiency Policy or EPR frameworks are enacted, they may alter existing assumptions and priorities.

Finally, although this study identifies several promising innovations and pilot programs, it does not assess their long-term scalability or financial viability. Therefore, future studies should include case-based and empirical analyses to evaluate the economic outcomes of circular practices in different industries.

Despite these limitations, this study provides a comprehensive foundation for understanding India's CE landscape. It highlights critical gaps and offers practical insights into policy and research development. These limitations open avenues for more data-driven and participatory research in the future.

Future Implications

These findings underscore the need for interdisciplinary CE research that combines policy analysis, technological innovation, and behavioral economics. Future research should focus on data-driven CE metrics, social inclusivity in circular systems, and urban-rural circular linkages to ensure a holistic transformation.

The implications of this study extend across policy, industry, research, and community engagement, offering a roadmap for accelerating India's circular transition.

From a policy perspective, these findings emphasize the need for a unified and enforceable CE framework. India should consider developing a National Circular Economy Mission that integrates cross-sectoral coordination, measurable targets, and transparent monitoring systems. Adopting a performance-based regulatory model similar to the EU's CE Action Plan can help to institutionalize accountability. Moreover, state-level policies must align with national objectives to ensure consistent implementation.

For the industrial sector, the implications point toward an innovation-driven transformation. Businesses must adopt circular business models, such as product-as-a-service, remanufacturing, and material sharing. For example, companies such as Tata Motors have introduced initiatives for remanufacturing spare parts, whereas Godrej Industries has implemented waste valorization strategies. Promoting industrial symbiosis within manufacturing clusters, where the waste of one company serves as an input for another, can enhance efficiency and reduce environmental footprints.

Technological advancements will also play a critical role. Incorporating digital tools such as blockchain for product traceability, AI for waste sorting, and Internet of Things (IoT) for smart resource management can drastically improve CE performance. Government-backed digital infrastructure can support the growth of such tools, especially among small and medium enterprises (SMEs).

The study's findings have implications for social inclusion and education. Integrating informal workers into formal CE systems through cooperative models and social enterprises ensures equitable growth. Training programs, awareness campaigns, and community-driven waste segregation initiatives can cultivate behavioral changes among citizens.

From an academic and research standpoint, future studies should focus on developing localized CE metrics, exploring urban-rural circular linkages, and measuring the economic outcomes of CE adoption. Collaborative research between universities, industries, and policymakers can help generate real-time data for decision-making.

Finally, at the global level, India's transition can serve as a model for other developing economies striving to balance growth and sustainability. By prioritizing circular innovation, India can strengthen its global competitiveness and contribute significantly to achieving the UN Sustainable Development Goals (SDGs), particularly SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action).

CONCLUSION

India's journey toward a CE represents both challenges and opportunities. Although policy initiatives such as the EPR framework, Swachh Bharat Mission, and National Resource Efficiency Policy have laid an initial foundation, a coherent and integrated approach remains necessary. The study concludes that bridging the policy–practice divide, leveraging digital innovation, and promoting inclusive participation are essential steps toward achieving systemic circularity.

A successful circular transition in India will depend on four critical enablers: governance, technological innovation, financial incentives, and social inclusion. Strengthening institutional coordination through a national CE policy can eliminate overlap and promote efficient resource use. Investing in research, green technologies, and skill development can enhance industrial readiness, whereas financial instruments such as tax credits, green bonds, and subsidies can stimulate private sector participation.

The inclusion of the informal sector is a pivotal factor in ensuring equitable growth. Formalizing and recognizing the contributions of informal recyclers will not only improve material recovery rates but also create safer and more dignified livelihoods for millions of workers. Furthermore, fostering behavioral change among consumers through awareness, education, and incentives will ensure the long-term cultural acceptance of circular principles.

Ultimately, the CE offers India a pathway to sustainable development without compromising economic progress. By embracing innovation, collaboration, and inclusivity, India can emerge as a global leader in circular transformation and set an example for other emerging economies. The synthesis presented in this study provides both academic and policy-based insights that can guide stakeholders toward building a resource-efficient, resilient, and sustainable future.

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