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# From Linear to Circular: A Comprehensive SWOT Analysis of India's Circular Economy Potential

**Dr. Anil Kumar**[1]

[1]*Assistant Profesor (Economics), Government Degree College, Captainganj, Basti, U.P. Affiliated to: Siddharth University, Kapilvastu, Siddarth Ngar, U.P.*

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**Abstract**

*The conventional linear "take-make-dispose" approach has exacerbated the problems of environmental degradation and climate change by accelerating resource depletion, increasing greenhouse gas emissions, and producing a large amount of solid waste (Ellen MacArthur Foundation, 2013). An efficient substitute for the linear economy paradigm is the circular economy model. It fosters sustainable economic growth through effective resource-saving techniques like recycling, remanufacturing, industrial symbiosis etc. This SWOT analysis focuses on a comprehensive study of the Circular Economy in India and aims to provide policy recommendations for improving Circular Economy practices in India. It is backed by a systematic study of policy documents, data analysis, and literature as well as comparative assessments employing case studies from around the globe, based on information obtained from authentic sources. The findings of this research work suggest that while the circular economy paradigm has enormous potential to transform India due to technical improvements, foreign investments, and other factors, it is also threatened by various obstacles such as cultural barriers and market instabilities. However, focused efforts and targeted interventions would be needed to overcome these barriers.*

***Keyword: Circular Economy, India, SWOT Analysis, Waste Management, Extended Producer Responsibility, Industrial Symbiosis, Sustainable Development.***

**JEL Classification: Q54, O33, L26, Q56**

## INTRODUCTION

The Circular Economy (CE) provides a sustainable alternative to the linear economy model. It encourages resource efficiency, waste reduction, and the restoration of natural systems through practices such as recycling, remanufacturing, and industrial symbiosis. By decreasing reliance on virgin raw materials and encouraging resource recovery and creative product design, this paradigm shift towards CE not only lessens environmental effects but also generates economic benefits.

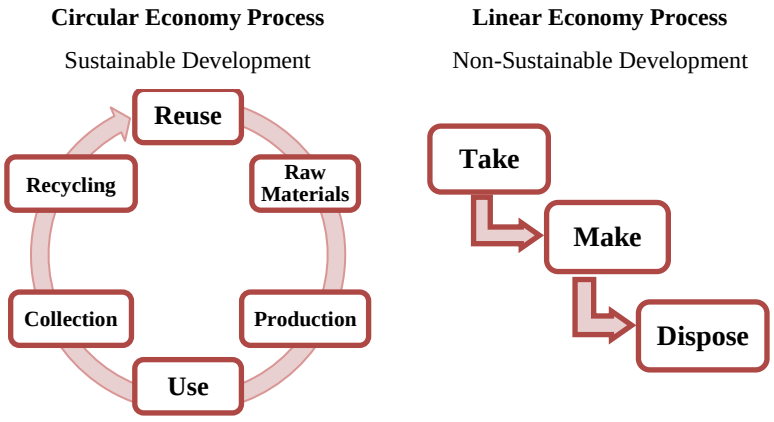


**Fig-1: Circular Economy vs. Linear Economy**.

**Source:** Prepared by the Researcher

India's rapid industrialization, large population, and specific socioeconomic conditions offer significant opportunities and challenges for CE implementation. The country's informal recycling sector along with the availability of a significant amount of secondary raw materials derived from construction debris and municipal solid waste [CPCB, 2022; NITI Ayog, 2022), provides a robust foundation for effective resource management. However, barriers such as lack of infrastructure, expensive advanced recycling technologies, and uneven rules continue to impede the intended development.

**Literature Review**

The Circular Economy (CE) paradigm, which promotes closed-loop systems through recycling, remanufacturing, and industrial symbiosis, has been extensively studied as a sustainable alternative to the traditional linear "take-make-dispose" model (Ellen MacArthur Foundation, 2013). Research by Kirchherr, Reike, and Hekkert (2017) and Geissdoerfer et al. (2017) underscores CE's potential to generate economic, environmental, and social benefits by reducing resource extraction, lowering waste disposal costs, and fostering innovation. The informal sector plays a critical role in CE implementation in India (World Bank, 2020). Moreover, India's substantial waste streams and significant volumes of plastic, e-waste, and construction and demolition waste offer enormous potential for resource recovery (ASSOCHAM, 2021; NITI Ayog, 2022; CPCB, 2022). According to many studies, the main barriers to CE include the high cost of modern recycling technology, a lack of infrastructure, and uneven regulatory enforcement (OECD, 2016; UNIDO, 2023). Furthermore, the application of technology enablers such as Blockchain, IoT, and AI applications in waste management is restricted by the lack of knowledge, skills, and competence (Murray et al., 2017; World Economic Forum, 2023). Due to shifting consumption patterns and cultural concerns, integrating modern CE technology with conventional waste management methods has proven difficult (Ghisellini, Cialani, & Ulgiati, 2016).

**Need for SWOT Analysis:** Given the complex circumstances covered in this literature study, a thorough SWOT analysis is required to assess India's CE ecosystem in depth. Targeting key initiatives and creating effective laws and regulations are crucial for bolstering India's dedication to environmental conservation and economic stability. This analysis will also contribute to the worldwide discussion about sustainable development.

**Research Objectives:**

The main goal of this research endeavour is to perform a thorough SWOT analysis of India's circular economy. The objectives of this research paper are as follows:

1) To determine and evaluate the strengths of India's circular economy (CE)

2) To critically examine the weaknesses of CE implementation in India.

3) To assess the potential threats and opportunities for expanding CE practices in India.

**Methodology**

This study adopts a comprehensive mix-method research methodology that emphasises on careful analysis of government publications, industry studies, and peer-reviewed literature. The SWOT framework is used to systematically evaluate the circular economy's (CE) Strengths, weaknesses, opportunities, and threats in India. Authentic data has been sourced from organizations such as the Ellen MacArthur Foundation, OECD, UNIDO, CPCB, and various academic journals. A critical analysis of these sources serves as the foundation for the ensuing discussion and policy recommendations. A critical analysis of these sources serves as the foundation for the ensuing discussion and policy recommendations.

**SWOT Analysis of Circular Economy in India**

The Circular Economy (CE), is a revolutionary approach to sustainable development, which prioritizes resource efficiency, waste reduction, and regenerative practices. CE is crucial in India to manage the country's growing waste issues, resource shortage, and environmental deterioration. Even though India is making great progress in the direction of circularity, a thorough SWOT analysis is required to fully grasp its potential and related difficulties.

***Strengths of Circular Economy in India***

India has great underlying qualities for establishing a Circular Economy (CE) because of its distinct socioeconomic structure, traditional traditions, and governmental framework. A comprehensive analysis of these opportunities, supported by relevant data and examples is given below:

### 1) Vast Informal Sector Expertise

The informal sector plays a significant part in waste management in India. Waste pickers and recyclers from the informal sector have created highly effective methods and techniques for material recovery and segregation. Their expertise and practical experience guarantee waste management at low operating costs along with improved recovery rates.

a. More than 70% of recyclable materials, such as metals, plastics, and e-waste, are processed in India's unorganized sector (World Bank, 2020).
b. The informal sector collects over 15,000 tons of plastic waste every day (CPCB, 2022).
c. About 500,000 unorganized laborers are employed in e-waste management, which handles 90% of e-waste recycling (ASSOCHAM, 2021).
d. It guarantees minimal operating costs and high recovery rates, (40–60% higher than formal sector).
e. Efficiency and worker safety can be increased by integrating these workers into formal processes.

For instance, the SWaCH Cooperative in Pune reduces waste management expenses by 30% by integrating informal labour into the municipal trash management system.

### 2) Abundance of Secondary Raw Materials

Large amounts of garbage are produced in India, which offers an excellent opportunity to recover and reuse secondary raw materials. Along with a significant amount of construction and demolition (C&D) debris, significant amounts of plastic and e-waste are generated annually in India.

a. According to the CPCB (2022), 62 million tons of solid municipal waste are produced in India each year, and 60% of this waste is biodegradable.
b. Every year, 9.46 million tons of plastic trash and 1.5 million tons of e-waste are produced, which have high potential for recycling (ASSOCHAM, 2021).
c. The 530 million tons of garbage generated by construction and demolition (C&D) waste each year presents good opportunities for secondary raw materials (NITI Ayog, 2022).

For instance, Delhi's C&D waste recycling facilities effectively recover materials used in infrastructure projects, which lessens reliance on virgin materials and reduces production costs.

### 3) Government Policy Support

Circular Economy principles are becoming more and more prevalent in the Indian policy framework. Encouraging industries to embrace circular practices and innovate in recycling technologies has been made attainable by these progressive policies.

a. Extended Producer Responsibility (EPR), which requires manufacturers to manage the lifecycle of their products, is mandated under the Plastic Waste Management Rules of 2016.
b. Targets for collection and recycling are included in the E-Waste Management Rules (2016), and noncompliance carries penalties and sanctions.
c. The Waste to Wealth Mission and the National Resource Efficiency Policy (2019 draft) are key policies that encourage and reward sustainable CE practices across industries.

For instance, Coca-Cola India, has achieved 100% EPR compliance by recycling the equivalent of all PET bottles it produces (Coca-Cola India, 2023), demonstrating how policy support may lead to significant improvements in resource recovery.

### 4) Strong Startup and Entrepreneurial Ecosystem

Another significant strength in India's circular economy landscape is its thriving startup ecosystem. Innovative waste management, recycling, biodegradable products and sustainable packaging solutions are being developed by a large number of startups.

a. Significant investments are drawn to these business endeavours, engaged in encouraging innovation and promoting the use of CE principles in an extensive range of industries.
b. CE-focused startups in India have attracted over $300 million in investments (Inc42, 2023). Key players include:

    i. Banyan Nation: Uses advanced technologies to recycle over 1,200 tons of plastic waste annually into high-quality reusable plastic.
    ii. ReCircle: Manages waste segregation and recycling across urban centres.

An example of the disruptive potential of the startup ecosystem in promoting CE is Saahas Zero Waste, a Bengaluru-based startup, that offers integrated circular waste management solutions to urban homes and enterprises.

**5) Emerging Industrial Symbiosis**

Industrial symbiosis involves collaborative networks where the waste or by-products of one industry become valuable inputs for another. It facilitates resource optimisation, cost reduction, and significant waste diversion from landfills.

a. Industrial clusters like Ankleshwar (Gujarat) and Tirupur (Tamil Nadu) have implemented symbiosis systems where one industry's waste becomes another's resource. It demonstrates how industrial symbiosis can drive resource optimisation and significant cost reductions.
b. The Ankleshwar Industrial Cluster diverts over 50,000 tons of industrial by-products annually for reuse.
c. Tirupur, textile dyeing units reuse wastewater, saving 20 million litres of freshwater annually (UNIDO, 2022), illustrating how industrial symbiosis contributes to both environmental sustainability and cost efficiency.

**6) Global Commitment to Climate Goals**

Circular economy concepts are closely aligned with India's government aim to achieve net-zero emissions by 2070, along with interim targets such as producing 500 GW of renewable energy by 2030. Industry adoption of strategies that lower carbon footprints through resource recovery and energy efficiency is prompted by these climate goals.

a. India's commitment to attain net-zero emissions by 2070 (UNFCCC, 2021) sends a clear policy message to businesses to adopt circular practices and adhere to CE standards.
b. Achieving a 50% renewable energy mix and producing 500 GW of renewable energy by 2030 are interim targets (UNFCCC, 2021).
c. By reducing waste, recycling, and using less energy, CE practices lower carbon footprints.

For instance, in 2022, the Perform, Achieve, Trade (PAT) Scheme under National Mission for Enhanced Energy Efficiency, reduced CO2 emissions by more over 17 million tons (BEE, 2023). The effectiveness of the PAT Scheme in cutting emissions sets a standard for how CE practices—specifically in waste recycling and energy efficiency—can support more general climate goals.

**7) Abundant Renewable Energy Resources**

India has huge potential in the field of renewable energy. Powering cutting-edge recycling and waste management facilities with renewable energy is essential for guaranteeing that circular processes are low-carbon and resource-efficient. According to data from the Ministry of New and Renewable Energy (MNRE, 2023), India is quickly increasing its capacity for renewable energy, which has helped to reduce energy costs and carbon emissions.

a. Out of the 175 GW of renewable energy in India, 40 GW comes from wind and 114 GW from solar (MNRE, 2023).
b. An extra 10 GW of energy comes from biomass, which supports decentralized recycling facilities.

For instance, solar-powered recycling facilities in Gujarat and Rajasthan show how integrating renewable energy may support sustainable operations in industries like textiles, hence lowering dependency on fossil fuels.

**8) Traditional Practices Favouring Circularity**

The innate tendency towards circularity can be seen in India's long-standing cultural traditions of resource conservation, including the work of 'Kabadiwalas' (trash collectors), household composting, and ancient methods like 'Kantha' stitching. These methods greatly aid in waste reduction and resource recovery.

a. With recycling rates as high as 60% in urban areas, traditional systems like household composting and kabadiwalas (scrap collectors) handle a sizable percentage of urban waste (CSE, 2022).
b. Kantha stitching is one technique that reduces textile waste by reusing outdated materials.
c. Conventional waste collection systems in cities are capable of recycling up to 60% of their waste (CSE, 2022).
d. Large waste management has benefited greatly from these community-based efforts, which also offer a solid basis for official CE frameworks. These technologies promote community involvement in CE while lowering waste and conserving resources.

For instance, Varanasi's waste-to-compost programs reduce trash and aid local agriculture by turning about 1,000 tons of organic waste per year into nutrient-rich fertilizers.

**9) Global Partnerships**

Global collaborations speed up India's adoption of circular economy principles by facilitating information sharing, finance, and technology transfer. These collaborations are outstanding examples of teamwork that connects global knowledge with regional difficulties.

a. Programs like the EU-India Circular Economy Mission have made it easier to share expertise, build skills, and finance CE initiatives.
b. Circular supply chains for furniture and textiles have been introduced as a result of partnerships with global firms like IKEA and H&M, significantly reducing waste.
c. Indian CE projects have benefited greatly from financial and technical assistance from international partnerships, which have increased capacity and innovation.
d. India's transition to CE is accelerated by technology transfer and support for international partnerships, which increase access to cutting-edge recycling and resource optimization technologies.

For instance, IKEA India reduced material waste by 35% by introducing circular furniture designs that achieve zero-waste production. The circular furniture designs from IKEA India demonstrate how international collaborations can improve local industries' sustainability and resource efficiency.

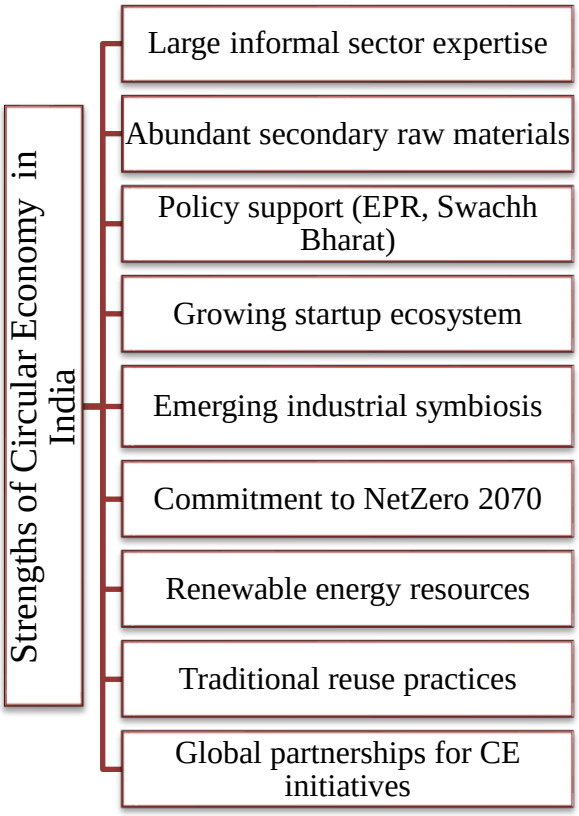


**Fig 2: Strengths of Circular Economy in India**

**Source:** Prepared by the Researcher

A thriving informal sector, numerous waste streams rich in secondary raw materials, strong government policy backing, an active start-up ecosystem, and a long history of resource conservation are just a few of India's strengths in the circular economy. These strengths, when coupled with international collaborations and a dedication to climate objectives, provide a strong basis for the shift to a sustainable circular economy. The possibility of expanding CE practices across the country will be further unlocked by addressing issues including the integration of informal

networks, investment requirements, and regulatory limitations.

***Weaknesses of Circular Economy in India***

Although India has made great strides in embracing a Circular Economy (CE), still several issues prevent its widespread adoption. Addressing these issues is essential to a successful shift to a resource-efficient and sustainable economy. An extensive examination of these shortcomings is provided below.

**1) Insufficient Recycling Infrastructure**

India's recycling infrastructure is insufficient to manage the enormous volumes of waste produced, which results in ineffective resource recovery. This restricts the recovery of resources and adds to contamination of the environment, especially in cities.

a. According to the Central Pollution Control Board [CPCB], 2022, 30% of trash in India is treated scientifically, with the remaining 70% being either disposed of in landfills or processed informally.
b. Only 11.9 million of the 62 million tons of municipal solid garbage produced in India each year are subjected to scientific treatment (Swachh Bharat Mission, 2022).
c. India is the third-largest producer of e-waste worldwide, yet recycling of e-waste is still disorganized, with less than 22% of e-waste being formally recycled (ASSOCHAM, 2021).
d. Only 9% of the 3.4 million metric tons of plastic garbage produced each year is recycled scientifically; the balance is disposed of in an unsafe or unofficial manner (Ministry of Environment, 2023).

**2) Fragmented Waste Collection Systems**

India has a very fragmented and insufficient waste collection system that depends on physical labor and unorganized operators. Significant losses and inefficient use of resources result from lack of coordination between the informal and formal garbage collection networks.

a. As much as 40% to 50% of garbage is not separated at the source since urban areas frequently rely on unorganized and informal waste collection systems (NITI Ayog, 2021).
b. It is difficult to establish smooth resource recovery cycles because of this fragmentation, particularly for mixed waste streams like municipal solid trash.
c. According to NITI Ayog (2021), inefficiencies in collection lead to resource loss because only 60% of municipal solid waste (MSW) gets collected, with significant disparities between urban and rural locations.
d. An average of 35% of rubbish in smaller towns fails to be collected up, which contributes to informal dumping and landfill overflow.

**3) High Cost of Technology Adoption**

High capital investment is necessary for advanced CE technologies such as waste-to-energy facilities, chemical recycling, and AI-driven garbage sorting. Advanced CE technologies are capital-intensive, which restricts their use, especially by SMEs.

a. Smaller firms cannot afford the ₹40–₹50 crores per megawatt cost of setting up a WTE plant (Ministry of New and Renewable Energy, 2022). This problem is made worse by SMEs' limited access to financial incentives or subsidies.
b. Due to a lack of funding, small and medium-sized businesses (SMEs), which make up 45% of India's manufacturing industry, find it difficult to implement these technologies (FICCI, 2022).
c. One waste-to-energy plant can cost more than ₹150 crores to install, which prevents smaller organizations or local governments from adopting it (CSE, 2021).

**4) Lack of Skilled Workforce**

Inadequate training programs and capacity-building initiatives hinder the adoption and operation of CE devices. Industries struggle to run sophisticated recycling systems and follow circular design principles in the absence of skilled workers.

a. According to the ILO (2021), 58% of Indian workers are not formally trained, which leaves them unprepared to operate sophisticated recycling and resource recovery equipment.
b. Waste management and CE principles vocational programs continue to be underfunded and neglected.

c. Sorting and processing are inefficient since just 25% of India's waste management personnel has formal training (ILO, 2022).

### 5) Low Consumer Awareness

The lack of public awareness about CE activities and their positive effects on the environment lowers the demand for environmentally friendly products and services. The environmental impact and significance of CE practices are not well understood by the majority of Indian customers.

a. Consumer interest is further decreased by misconceptions regarding the quality of reconditioned or recycled goods. The market for sustainable and circular products is diminished by this misunderstanding.
b. Consumer preferences continue to prioritize cost above sustainability, which is impeding the market for environmentally friendly products.
c. TERI conducted a survey in 2021 and found that 72% of Indian customers knew very little or nothing about concepts like "sustainable consumption" and "circular economy."

### 6) Weak Enforcement of Regulations

The enforcement of India's progressive policies, such as the Plastic Waste Management Rules (2016) and the E-Waste Management Rules (2016), continues to be inadequate.

The lack of fines and inadequate compliance monitoring have resulted in inconsistent on-ground implementation of these CE-friendly rules and regulations.

a. Only 22% of businesses adhere to Extended Producer Responsibility (EPR) standards, indicating that the E-Waste Management Rules (2016) and Plastic Waste Management Rules (2016) are not widely implemented (CPCB, 2021).
b. The effectiveness of these policies is weakened by inadequate government oversight and insufficient producer compliance and awareness.
c. Industries can evade Extended Producer Responsibility (EPR) regulations due to inadequate compliance monitoring and a dearth of penalties.
d. Weak enforcement measures were highlighted by the fact that less than 10% of e-waste manufacturers met their EPR targets in 2020 (CPCB, 2022).

### 7) Data Scarcity

There is a lack of current and trustworthy statistics on waste generation, recycling rates, and material movements. Policymaking and research are hampered by the absence of accurate, up-to-date, and thorough data on material flows, recycling rates, and trash generation.

a. India does not have a centralized database to monitor secondary material markets, recycling capabilities, or waste sources. This makes it challenging to evaluate and track the success of CE projects or develop data-driven policy.
b. The lack of baseline data on waste streams and resource flows has contributed to delays in the 2019 National Material Recycling Policy (MoEFCC, 2022).

### 8) The Dominance of Linear Economy Models

The adoption of CE is resisted by companies and industries that are firmly rooted in linear production and consumption patterns because of long-standing customs and immediate financial gain. A lot of Indian companies still heavily rely on linear models of production and consumption because of economic considerations and long-standing customs.

Remanufacturing, product-as-a-service, and material recovery are examples of circular business models that are unable to be widely adopted due to resistance to change.

a. There is little investment in circular practices in industries like manufacturing and construction, which still mostly rely on virgin resources.
b. According to Garg (2020), the construction sector in India, which accounts for 25% of resource extraction, still favours linear procedures over circular alternatives.

With less than 1% of textiles recycled into new items, India's fast-fashion sector primarily uses linear models (Fashion for Good, 2023).

### 9) Environmental and Health Risks in the Informal Sector

Despite its efficiency, the informal sector works in hazardous unsafe conditions. Without adequate safety precautions, these workers in the unorganized sector are subjected to dangerous substances, such as poisonous e-waste, untreated chemicals dangerous substances like lead,

mercury, and cadmium, and toxic fumes, putting their health and the environment at risk.

a. According to a Chintan Environmental Research report from 2022, hazardous working circumstances cause respiratory or skin-related health problems for more than 90% of informal recyclers.
b. According to numerous studies, more than 70% of Indian e-waste recycling workers get respiratory problems as a result of being exposed to dangerous chemicals including lead and mercury (ASSOCHAM, 2021).

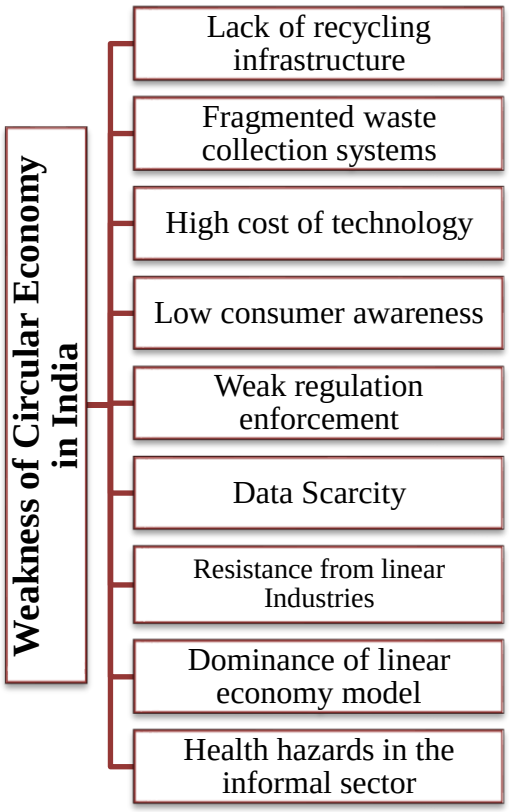


**Fig 3: Weakness of Circular Economy in India**

**Source:** Prepared by the Researcher

India's circular economy's weaknesses point to behavioural, technological, and structural flaws that impede its advancement. India must successfully move to a circular economy by addressing these issues through consumer education, policy enforcement, skill development, and infrastructural development. India can do this to capitalize on its advantages and lessen the negative effects of its shortcomings on long-term prosperity.

***Opportunities for Circular Economy in India***

India's transition to a Circular Economy (CE) offers tremendous opportunities, propelled by government initiatives, foreign investments, technical advancements, and heightened environmental consciousness. India can seize these chances to increase economic growth, minimise its environmental impact, and optimize resource efficiency.

**1) Integration of Smart City Initiatives**

The Smart Cities Mission introduced in 2015 emphasizes sustainable urban development and offers a framework for incorporating CE principles. It presents a unique opportunity to integrate CE concepts into urban planning, infrastructure construction, and waste management.

a. The Smart Cities Mission focuses on 100 cities and promotes resource-efficient architecture, intelligent waste management systems, and the integration of renewable energy sources as examples of sustainable urban practices (Ministry

of Housing and Urban Affairs, 2022). For instance, Pune implemented IoT-based garbage monitoring systems, which resulted in a 30% boost in waste collection efficiency.

b. Cities may cut their resource usage by 40% by implementing CE practices like water reuse and material recovery (NITI Ayog, 2021).
c. Municipal waste is converted into compost and bio-CNG in Indore, which is acknowledged as the cleanest city in India, demonstrating the application of CE principles (Ministry of Housing and Urban Affairs, 2022).

**2) Technological Advancements**

Emerging technologies like blockchain, the Internet of Things (IoT), and Artificial Intelligence (AI) offer prospects for traceability, real-time waste monitoring, and effective resource optimisation.

a. Blockchain can strengthen the traceability of resources, ensuring optimal recycling and reusability.
b. Blockchain boosts supply chain transparency, while IoT can monitor waste collection systems, cutting inefficiencies. AI helps with resource optimization and waste sorting.
c. In cities like Bengaluru, IoT-enabled trash cans have been tested, increasing waste segregation rates by 25% (CPCB, 2022).
d. Compared to human procedures, AI-driven technologies for e-waste disassembly increase material recovery efficiency by 30%–40% (ASSOCHAM, 2021).
e. To ensure quality and compliance, Indian businesses such as Banyan Nation employ AI-powered tools to track recovered plastic in supply chains (World Economic Forum, 2023).

**3) Global Investments and Green Funds**

For CE projects, India is drawing in foreign funding and assistance. Financial support for CE-aligned projects is coming from the World Bank and the Green Climate Fund (GCF). CE projects in India are receiving more and more backing from international financing organizations. Such money promotes policy changes, technology breakthroughs, and infrastructural development.

a. For sustainable urban development in India, including CE-based initiatives, the Green Climate Fund (GCF) provided $43 million (UNFCCC, 2022).
b. The World Bank has committed $200 million to help India's circular economy and resource efficiency plan.
c. In 2022, $1.5 billion was invested in Indian green businesses by international venture capitalists and private equity firms, with an emphasis on waste management and recycling (Bloomberg NEF, 2023).
d. In an effort to decrease single-use plastics and encourage recycling, the World Bank sanctioned $105 million in funding for the West Bengal Plastic Waste Circular Economy Project (World Bank, 2023).

**4) Rising Consumer Demand for Sustainability**

The demand for environmentally friendly goods and services is being driven by rising consumer awareness of climate change and environmental deterioration.

a. According to a Deloitte poll conducted in 2022, 65% of Indian customers favor sustainable companies, generating demand for eco-friendly goods.
b. Approximately 79% of Indian customers are willing to pay more for sustainable products, according to a Capgemini Research Institute report from 2022, opening up new markets for CE-based companies.
c. India saw a 218% increase in demand for electric cars (EVs) in 2022, indicating a move toward sustainable consumption (NITI Ayog, 2023).
d. Companies like EcoKaari and Bare Necessities are prospering because they provide eco-friendly substitutes for conventional goods, such as repurposed bags and toiletries that produce no waste.

**5) Industrial Symbiosis Networks**

In order to improve resource efficiency, industrial symbiosis entails establishing networks where waste from one industry is used as input for another. Creating industrial symbiosis parks can help firms share resources, cut waste and boost productivity.

a. The Ankleshwar Industrial Park in Gujarat exhibits industrial symbiosis, using waste heat from one company to produce steam for nearby facilities, hence lowering total energy usage (CII, 2021).

b. In industries like steel and chemicals, industrial symbiosis could cut resource demand by 20% to 25%, according to NITI Ayog's Industrial Resource Efficiency Report (2021).
c. Industrial symbiosis parks, like the National Industrial Corridor Development Programme, can result in cost savings, waste reduction, and job creation.

**6) Agricultural Circularity**

Utilizing crop wastes for compost, bioenergy, or bio-based materials are examples of circular agricultural practices that can reduce waste, increase resource efficiency, and promote sustainability. The following are important observations: •

a. India produces 500 million tons of crop residue yearly, of which 92 million tons are burned, causing pollution (ICAR, 2022). Rural economies can be strengthened and pollution can be decreased by implementing CE practices in agriculture (ICAR, 2022).
b. In rural energy systems, projects like turning paddy straw into bio-CNG might replace 15% of fossil fuels.
c. Happy Seeder technology in Punjab and Haryana turns rice stubble into mulch, minimizing air pollution and enhancing soil health; composting agricultural leftovers might reduce the need for chemical fertilizers by 20% to 25%, improving soil health and lowering costs (Ministry of Agriculture, 2022).

**7) Waste-to-Energy Potential**

India's expanding waste streams present chances for Waste-to-Energy (WTE) plants to turn non-recyclable and organic waste into sustainable energy.

a. Municipal solid waste in India has a calorific value that can provide 3,000 MW of power a year (Ministry of New and Renewable Energy, 2022).
b. The Ghazipur plant in Delhi is one of the current WTE projects that produces 12 MW of power per day, however, this potential is still mainly unrealized.
c. According to the CPCB (2023), 50% of the 62 million tons of municipal solid waste produced in India each year is organic and appropriate for energy conversion.
d. Delhi's Okhla Waste-to-Energy Plant produces 16 MW of power every day while processing 2,000 tons of waste (Ministry of Power, 2022).

**8) Circularity in Construction**

Recycling construction and demolition (C&D) waste into new building materials encourages sustainable urban expansion and resource efficiency in the quickly expanding construction industry.

a. Less than 1% of the 170 million tons of construction and demolition trash produced in India each year is recycled (TERI, 2022). Reducing the demand for virgin materials can be achieved through increasing recycling.
b. C&D waste recycling can result in a 20%–30% reduction in raw material expenditures.
c. Recycled aggregates have been used in road construction in cities like Ahmedabad and Delhi, lowering reliance on natural resources. Over 2,000 tons of trash are recycled every day at Delhi's Burari C&D trash Processing Plant into bricks and pavement tiles.

**9) Policy Reforms for CE Incentives**

Businesses and consumers may be encouraged to participate by offering financial incentives for implementing CE practices, including as tax breaks, grants, and subsidies. Putting in place grants, tax breaks, and subsidies for the use of CE can promote the shift from linear to circular models. Incentives for waste management infrastructure and reduced GST rates on recycled goods can encourage more people to adopt CE practices.

a. To encourage businesses to embrace CE principles, the Production Linked Incentive (PLI) scheme for green energy technologies provided ₹19,500 crores (Ministry of Finance, 2023).
b. According to the Ministry of Commerce (2022), tax incentives for environmentally friendly products like solar panels and electric vehicles have boosted adoption rates by 35%.
c. Maharashtra's plastic buyback scheme has increased recycling rates by providing financial rewards for returned plastic bottles (State Pollution Control Board, 2022).

**10) Expansion of Green Jobs**

The implementation of CE practices is expected to generate employment in the recycling, resource management, and renewable energy sectors.

a. According to ILO predictions, India could create 14 million green jobs by 2030 as a result of CE adoption (ILO, 2021).
b. More than a million people might be employed in e-waste recycling alone with the proper formalization and training (Chintan Environmental Research, 2022).
c. A UNEP research from 2022 estimates that the transition to CE could lead to the development of 50 million green employment globally by 2030, with India most likely to gain from this given its sizeable workforce.
d. Workers are aimed at being prepared for jobs in renewable energy, waste management, and sustainable manufacturing through initiatives like the Skill Council for Green Jobs (SCGJ).

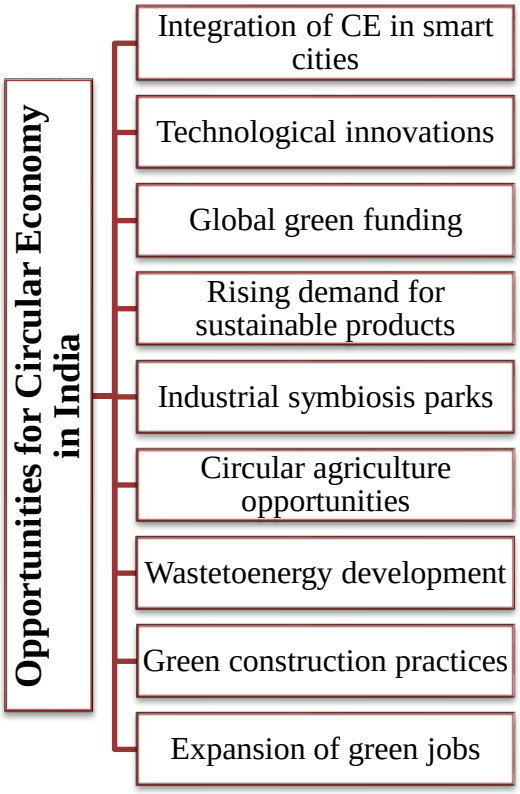


**Fig 4: Opportunities of Circular Economy in India**

**Source:** Prepared by the Researcher

India has a wide range of options for implementing a circular economy. India can attain sustainable growth and resource efficiency by utilizing global investments, government policies, public awareness, and technology advancements. These prospects can accelerate India's shift to a circular economy and bring it in accordance with international sustainability goals by resolving current deficiencies.

***Threats to the Circular Economy in India***

India's shift to a Circular Economy (CE) may be hampered by serious threats. To guarantee the success of CE programs, these issues—which range from financial limitations to environmental hazards—need immediate address. An in-depth examination of these risks, backed by reliable information and insights, is provided below.

**1) Economic Constraints**

The amount of funding available for CE projects may be constrained by competing demands for public investment on conventional infrastructure, such as housing, energy, and roads.

a. India devotes approximately 5–6% of its GDP to infrastructure development (Economic Survey, 2023), which leaves little room for investments in CE projects.

b. CE investments come with a greater initial cost. Investment in CE projects may be discouraged by the high capital needs for CE technologies, such as waste-to-energy facilities that cost roughly ₹15–20 crore per MW (Ministry of New and Renewable Energy, 2022).
c. SMEs, which account for 45% of India's industrial output and 29% of the country's GDP, frequently find it difficult to pay for the high capital expenses of circular technologies (ASSOCHAM, 2022).
d. Waste-to-energy initiatives in India often face delays due to insufficient funding, as seen in the closure of multiple plants in New Delhi (CSE, 2021).

**2) Global Supply Chain Dependencies**

Industries are more susceptible to supply chain interruptions and geopolitical unrest when they depend on imported supplies, machinery, and technology to apply CE standards.

a. India is susceptible to supply chain interruptions and geopolitical unrest since it imports 85% of its technologies for recycling electronic waste (CPCB, 2023).
b. Supply chain constraints caused CE-related projects to be delayed by an average of 6–12 months during the COVID-19 epidemic, highlighting these vulnerabilities (World Bank, 2021). These dependencies are made worse by geopolitical concerns, such as trade restrictions with China.
c. The pandemic-related delays in the importation of essential equipment caused major slowdowns in India's e-waste recycling industry.

**3) Resistance to Change**

Businesses that have made significant investments in linear models may oppose the adoption of CE practices because of the perceived risks, uncertainties, and initial expenses.

a. More than 75% of Indian manufacturing companies continue to use linear production models (FICCI, 2023). The adoption of CE techniques necessitates a substantial re-engineering of production processes, which is why resistance is especially strong in traditional industries like chemicals and textiles.
b. Traditional industries, like chemicals and textiles, must pay more to implement CE procedures, which include reworking manufacturing methods.
c. Lack of knowledge about the advantages of CE and behavioural inertia among company executives further impede adoption.
d. India's textile sector still uses unsustainable production techniques in spite of environmental concerns, citing financial constraints as an excuse (CII, 2022).

**4) Technological Obsolescence**

Rapid CE technology improvements have the possibility to make current systems and solutions outdated, necessitating regular updates and reinvestments.

a. With an average upgrade cycle of 5-7 years, technologies such as AI-driven trash sorting and enhanced chemical recycling develop swiftly (UNEP, 2022).
b. Due to a lack of funding, SMEs and startups—which make up a sizable portion of India's recycling ecosystem—find it difficult to keep up with these developments and cannot afford these frequent improvements.
c. The problem is made worse by the informal sector's antiquated technological foundation, which limits overall scalability and efficiency.
d. The technology gap is further widened by restricted access to research and development (R&D) for CE technologies.
e. The informal recycling industry in India is dependent on antiquated technology, which limits the effectiveness and expandability of CE programs (CPCB, 2022).

**5) Environmental Risks of Improper Handling**

There are serious threats to the environment and human health from improperly managed garbage, especially dangerous e-waste and biological waste.

a. About 90% of India's 3.2 million tons of e-waste are processed in the unregulated informal sector in hazardous conditions each year (Ministry of Environment, Forest and Climate Change, 2023).
b. Hazardous waste, including hazardous chemicals and heavy metals, frequently seeps into soil and water, impacting both human health and ecosystems.

c. The generation of biomedical waste grew to 710 tons per day due to the COVID-19 epidemic, exposing deficiencies in the infrastructure for waste processing and treatment (CPCB, 2021). During the COVID-19 pandemic, biomedical waste increased to 710 tons per day, revealing weaknesses in the system for waste treatment (CPCB, 2021).
d. Unsafe recycling methods have been linked to high groundwater contamination in cities like Moradabad, which are well-known for their informal e-waste recycling (CSE, 2022).

**6) Policy Gaps and Regulatory Inconsistencies**

The effectiveness of CE procedures is weakened by ambiguous policy frameworks, poor stakeholder collaboration, and inadequate enforcement.

a. Despite the existence of regulations such as the Plastic Waste Management Rules (2016) and the E-Waste Management Rules (2016), there is still inadequate level of enforcement of these, with 60% of industries failing to comply (FICCI, 2022).
b. Overlaps between state and federal regulations often lead to miscommunications and delay the implementation of CE projects.
c. The lack of explicit guidelines for Extended Producer Responsibility (EPR) leads to industry misunderstandings. The absence of clear guidelines for material recovery goals and incentives further impedes progress.
d. Only 30% of plastic garbage is being scientifically processed as a result of the ineffective application of EPR (CPCB, 2022).

**7) Market Uncertainties**

Large-scale investments in CE are deterred by the unpredictable nature of the markets for secondary raw materials and recycled products.

a. Industries only reach 50–60% of their potential in recycling and resource recovery due to market volatility (CSE, 2022).
b. The yearly 15%–30% price fluctuations for recycled resources, like metals and plastics, make it difficult for industries to plan for long-term production (World Economic Forum, 2022).
c. The low demand for recycled goods as a result of poor quality and ignorance makes the market even more unstable.
d. Variations in demand and growing input costs have caused uneven growth in India's paper recycling sector.

8) **Climate Change Impacts**

Growing climatic and environmental uncertainty affects the availability of resources and the successful implementation of CE programs.

a. The availability of renewable raw resources, such as biomass, is diminished by erratic monsoons and warming temperatures, which impacts sectors that rely on agricultural waste.
b. Climate-related natural disasters, such as floods and cyclones, affect CE operations by damaging recycling infrastructure and upsetting supply chains.
c. Cyclone Amphan (2020) caused ₹1 lakh crore in losses in Bangladesh and India, significantly affecting the infrastructure for resource recovery (World Bank, 2020).
d. Mumbai floods frequently cause waste management systems to malfunction, allowing untreated trash to reach water bodies (Ministry of Environment, 2022).

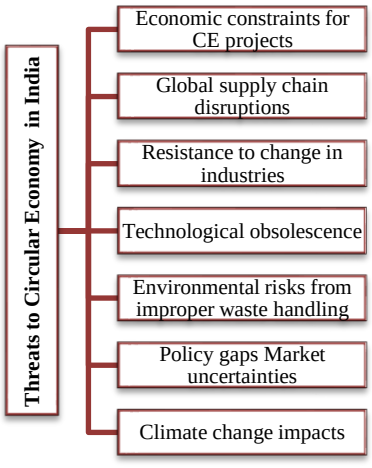


**Fig 5: Threats to Circular Economy in India**

**Source:** Prepared by the Researcher

The country's circular economy faces technological, legal, and economic obstacles that must be addressed if India is to overcome them. In order to reduce these dangers and

fully fulfill CE's potential in India, the government, business community, and civil society can cooperate.

**Conclusion**

SWOT analysis of the circular economy's (CE) in India, highlights how CE methods can be transformative in fostering environmental stewardship, economic resilience, and sustainable development. An abundance of secondary raw materials derived from different waste streams (CPCB, 2022; NITI Ayog, 2022), a strong informal recycling sector that processes over 70% of recyclable materials (World Bank, 2020), and supportive policy frameworks like the Plastic Waste Management Rules (2016) and the E-Waste Management Rules (2016) are just a few of India's strengths. These elements provide an excellent foundation that allows CE projects to progress. Additionally, the nation's capacity for innovation and efficient resource recovery is demonstrated by the rapid expansion of startups related to CE and the growing trend of industrial symbiosis (Inc42, 2023; UNIDO, 2023).

However, there are still many obstacles to overcome. Inconsistent rules, shortages of skilled workers, fragmented infrastructure, and high capital costs for sophisticated recycling systems prevent CE practices from being widely used. External challenges that worsen these internal shortcomings include cultural reluctance to change, market uncertainty, and the difficulties of integrating formal and informal waste management systems (OECD, 2016). Furthermore, despite the fact that new technologies (including artificial intelligence, the Internet of Things, and blockchain) offer encouraging prospects for streamlining resource flows, their use is still constrained by capacity and cost issues.

Strategic interventions are necessary to fully realize the Circular Economy's potential. Harmonizing regulatory frameworks, offering financial incentives and encouraging public-private collaborations, and funding capacity building to bridge skill and technology gaps should be the main goals of policy suggestions. In order to overcome present obstacles, it will be essential to promote enhanced creativity and substantial stakeholder participation, both locally and through international partnerships. Through these coordinated efforts, India will be able to move toward a waste-free and resource-efficient economy, establishing itself as a pioneer in the field of the global circular economy.

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