Journal on

Circular Economy

RN: 1371567

Policy, Research, Ideas & Innovation

Volume: 03 ; Issue 02 | July-Sep'24 | www.ic-ce.com | Price: 200

INTERNATIONAL COUNCIL FOR CIRCULAR ECONOMY

Leading the CHANGE!

IN FOCUS
CASE STUDY AND INTERVIEW

ICCE
International Council For Circular Economy

Table of Contents

CONTENTS

Journal on
Circular Economy
Policy, Research, Ideas & Innovation
Volume: 03 | Issue 02

ACKNOWLEDGEMENTS

Publisher: *Shalini Bhalla on behalf of International Council for Circular Economy*
Printer: *Shalini Bhalla*
Printed at: *A-9, Okhla Industrial Area,Phase 1, Delhi*
Published at: *D-8/5, Vasant Vihar, New Delhi, Delhi-110057, India*

CONTACT

307, 3rd Floor,
Avanta Business Centre
Ambadeep Building
KG Marg, New Delhi- 110001
India
(+91) 76786 73079

www.ic-ce.com
info@ic-ce.com
icce.journal@gmail.com

EDITOR'S NOTE

A Note on Our Journey Forward

Dear Readers,

As we present the fourth edition of our Circular Economy Journal, we are both humbled and inspired by the overwhelming response and readership we've received. In just a short span, the journal has not only captured the attention of academia and policymakers but also sparked significant interest from industry leaders eager to share their insights. We are already hearing from companies and innovators who want to incorporate their views, which is a testament to the growing demand for knowledge and action in the field of circular economy.

This edition marks a turning point for us, as you will see a noticeable rise in articles and case studies from the industry, showcasing innovation, technology, and sustainable solutions. The MSME sector, in particular, is at the forefront of this transition. As they grapple with the challenges of circularity, we at ICCE are committed to building their capacity and equipping them to mitigate the risks they face. Together, we are forging a future where sustainability and profitability go hand in hand.

In this issue, we delve into key sectors such as electronics, textiles, and materials, offering a fresh perspective on how these industries can embrace circularity. Our goal is to promote systems thinking, where every decision contributes to a more sustainable and resource-efficient world.

I encourage you, our valued readers, to keep the ideas flowing. Your feedback, insights, and contributions will only strengthen our ability to deliver richer, more impactful content in future editions. We are excited about what lies ahead and look forward to your continued engagement.

Shalini Bhalla
Editor
Journal on Circular Economy

READERS SAY

"In a circular economy mindset we care how we do our products and what we do with them. Journal on Circular Economy is an important forum for circular ideas to spread."

Ester Lovsin-Barle,
Head of Product Stewardship & Health,
Takeda Pharmaceutical Company

"Journal on Circular Economy is a unique Indian knowledge product at intersection of climate, sustainability and institutional innovation. A unique scholarship platform to find breakthrough ideas in an accessible format. Accomplished contributors further make the Journal a compelling reference to targeted circularity issues

Pooran Chandra Pandey
International Visiting Fellow

"Well-compiled journal on circularity, most relevant in current times

Kishore Sampat,
Former President – AIPMA

International Council For Circular Economy

I AM CIRCULAR. I AM CIRCULAR. I AM CIRCULAR. I AM CIRCULAR.

Products & Services

Showcase the best circular economy innovations across various sectors. The initiative seeks to spotlight products and services that embody sustainability, resource efficiency, and environmental harmony

Design to Last

Work with Nature

Using Existing Resources

.Who Can Apply?

Industry Leaders

Designers

Creative Entrepreneurs

Start-ups

Last Date: November 15, 2024

https://ic-ce.com/i-am-ciruclar_-form/

A unique opportunity to gain national and international recognition for your work and contribute to the growing movement towards a sustainable future.

Dr Sandip Chatterjee

Senior Advisor, Sustainable Electronics Recycling International (SERI)
Ex. Group Coordinator, Ministry of Electronics and Information Technology (MeitY)

ACHIEVING CIRCULAR ECONOMY AND SUSTAINABILITY THROUGH GLOBAL BEST PRACTICES IN ELECTRONICS SECTOR

ELECTRONICS

ACHIEVING CIRCULAR ECONOMY AND SUSTAINABILITY THROUGH GLOBAL BEST PRACTICES IN ELECTRONICS SECTOR

Dr Sandip Chatterjee
Senior Advisor, SERI
Ex. Group Coordinator, MeitY

INTRODUCTION

Global resource consumption will outpace Earth's replenishment capacity by 2050, with materials like biomass, fossil fuels, metals, and minerals set to double by 2060. This surge in consumption is also projected to increase waste generation by 70% by 2050, contributing significantly to pollution and 40% of global greenhouse gas emissions. For instance, producing one tonne of laptops can emit up to 10 tonnes of CO2, emphasizing the importance of resource-efficient production and recycled inputs[1].

The United Nations introduced Sustainable Development Goals (SDGs) in 2015 to address these challenges. India has also committed to achieve SDGs like Responsible Consumption and Production, Sustainable Cities and Communities, and Industry, Innovation and Infrastructure align with the principles of the circular economy (CE). Many electronics manufacturers are already aligning their strategies with specific SDGs.

Transitioning to a CE can reduce reliance on virgin materials and boost resource productivity. As India strives for self-reliance (Atmanirbhar Bharat), the sustainable growth models are imperative to benefit citizen, the environment, and the economy. This requires increased investment in skills, sectors, products, business models, digitalization, and technologies that promote long-term prosperity and environmental health.

ELECTRONICS

This realization in the electronics sector necessitates in creating a system where electronic products are designed, used, and recycled in a way that minimizes waste and maximizes resource efficiency. The CE principle in e-waste management also demands green design, sustainable manufacturing, circular business models in order to reduce e-waste generation, resource recovery, and digital tools for transparency and stakeholder engagement. These innovative approaches can help shift towards a more sustainable and resource-efficient future.[1]

India faces a significant e-waste challenge, generating 4.17 million tonnes in 2022 ranking third globally. However, the collection and recycling of e-waste in India remain insufficient. A circular economy approach demands extended life of products till their usability, thereafter, responsible recycling using global best practices to recover precious materials, once further use is impossible. India should also adopt one of the global best practices, like R2 Standards in refurbishing and recycling ecosystem. R2 standard offers a key solution for environmentally friendly electronics recycling. This article makes an attempt to examine the core features and benefits of this standard safety system, steps for obtaining R2 certification and reasons to align with certified electronics recyclers. As the problem of electronic waste grows, the R2 certification will be imperative to measures the outcome of the achieving CE principles in EEE sector[2].

ELECTRONICS

1.SUSTAINABILITY IN ELECTRONICS

The CE principle requires following four broad measures to ensure the sustainability in electronics:

Design for Longevity: Products should be designed to last longer, with modular components that can easily be repaired or upgraded. This reduces the need for frequent replacements.

Material Efficiency: Use materials that are less harmful to the environment and can be easily recycled or reused. This includes minimizing the use of rare or hazardous materials.

Energy Efficiency: Improve the energy efficiency of devices during their use and consider the energy consumption of the entire product lifecycle, including manufacturing, transportation, and disposal.

Sustainable Supply Chain: Business process should stress with better coordination with the suppliers who adhere to sustainable practices and ensure that raw materials are sourced responsibly.

2.INDIAN SCENARIO

India regulates e-waste through the E-Waste (Management) Rules, 2022, since 1st April 2023. These rules cover 106 products and their components, recognizing stakeholders like manufacturers, producers, refurbishers, and recyclers. A recycling target-based Extended Producer Responsibility (EPR) system has been introduced, showing promise in formalizing waste collection and boosting e-waste recycling.

Initially, extraction of four metals (steel/iron, aluminium, copper, gold) have been considered for assessing the merits of EPR implementation, wherein EPR credits should be purchased by the producers from the authorised refurbishes and recyclers, who will generate those credits by proper refurbishing or recycling the products handed over by the producers. Environmental compensation is also been enforced on the stakeholders for violating the rules[3].

India has already generated 4.17Million MT per annum of e-waste in 2022, as per international report2. The secondary raw material available in the said volume of e-waste composes of 2.09 million MT of ferrous metals (~50%), 0.87 million MT of plastics (~21%), 0.67 million MT of other hazardous materials (~16%) and 0.54 million MT of non-ferrous metals (~13%), shown in Fig. 1. This could be used for economic development of the country.

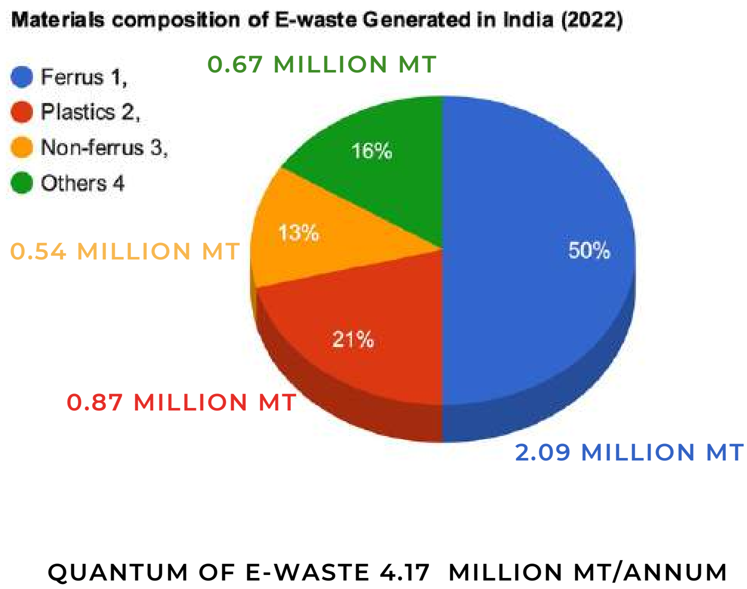


Fig 1: Materials potential in generated e-waste in India

ELECTRONICS

Under the present E-Waste (Management) Rules, 2022, Government of India has prioritised to track four important metals (steel/iron, aluminium, copper, gold) as secondary raw materials recovery through EPR implementation. After one year of EPR compliance, CPCB portal has been showing accumulation of the metals, as uploaded by the recyclers, which is very encouraging for the economy. However, we need to validate these claims through third party audits. India should learn the global best practices on entire ecosystem of recycling sector. This would be imperative for protecting health of the operators and the environment apart from a substantial business opportunity and employment generation.

Another important sector, India should can concerted efforts to upgrade its vast pool of informal operators, who are engaged in waste management process. Though regulatory measures could deterrent informal sector for waste collection or its processing in crude methods. Skill upgradation, handholding with affordable processing technologies, and tools would definitely improve their working condition, safety and health and economic condition in the long run. Upgraded informal units would then prefer to be formal entity for better earning possibility. This sector would continue to dominate in the country. Better skill set and appropriate technological will help them to protect environment as well as assist in saving significant amount of secondary raw materials with better yield. These upgraded units, however, need to be audited through third party for continuous improvement in recycling practices and ensuring health and safety measures.

3.GLOBAL BEST PRACTICES

The electronics sustainability can be learned through following global best practices:

Extended Producer Responsibility (EPR): This is a well-recognised policy which ensures manufacturers to take responsibility for the entire lifecycle of their products, including collection and recycling.

Product Take-Back Programs: Industries or local government may organise programs where consumers can return end-of-life products for proper recycling or refurbishment.

Standardization and Collaboration: The authority should encourage business houses to engage in industry-wide collaborations to standardize recycling processes and share best practices. R2 is one of the global recognised standards ensures refurbishing used equipment for longer use, advanced electronics recycling processes to maximize valuable recovery as well as reusable components from obsolete consumer electronics. Organizations like the Global E-Sustainability Initiative (GeSI) and the Electronics TakeBack Coalition are other examples of such collaborative efforts.

Regulations and Certifications: The authority should encourage industries to adhere to international regulations and certifications related to e-waste, such as RoHS (Restriction of Hazardous Substances) and WEEE (Waste Electrical and Electronic Equipment) directives and also national regulations on the subject matter.

Innovation in Recycling Technology: Government and industries should invest in and adopt new recycling technologies that improve the efficiency and effectiveness of material recovery from end-of-life electronics.

4.R2 STANDARDS

Exponential rise in electronics consumption, lack of design innovation and low recycling rates contribute to the rapid growth of e-waste

ELECTRONICS

Annually, 62 million tons of e-waste had been already generated globally in 2022. End of life electronics often contain harmful materials like lead, mercury, cadmium or brominated flame retardants, pose a significant health and environmental risks. Moreover, some e-waste components are economically significant due to containing of precious and rare earth metals. The estimated value of precious metals contained in them exceeds 91 billion dollars[2]. Therefore, managing e-waste is not only crucial for protecting human health and environment but also presents a substantial business and employment opportunities.

A study group published the R2 (Responsible Recycling) guidelines in 2008 to control and standardize the electronics recycling process. Their implementation is overseen by the organization Sustainable Electronics Recycling International (SERI). R2 is recognized and approved by Environmental Protection Agency (EPA), USA[4]

4.1 About R2 Standards

The R2 certification has been evolved through industry interactions and industry feedback and adapt to the changing landscape of global electronics use. The R2 certification is, therefore, dynamic. It has undergone three major revisions:

R2v1: the initial version, was established in 2008.
R2v2: The second iteration, was introduced in 2013.
R2v3: The latest and currently active version, was implemented in 2020.

A transition phase is offered with the launch of every new version. During this period, organizations with expiring certifications can opt to renew under either the old or new standard. However, after a set timeframe, all renewals must comply with the latest standard.

R2v3 is particularly distinguished by its modular framework, which includes a set of mandatory core standards alongside a range of "Speciality Process Requirements." In contrast to its predecessor, R2v3 places greater focus on safeguarding consumer information by enhancing data security measures. It also intensifies the criteria for securing materials handled by downstream vendors and provides clearer guidelines and expectations.

4.2 Need of R2 Certification

The challenges in environmental and health requirement increasingly necessitate improved electronics recycling, reuse and lifecycle management. By 2030, it is estimated that e-waste generation globally will reach an alarming 75 million metric tons annually2. Many industries are keen to address this problem with their contributions. Endorsing R2 certification will be the measure of dedication for the businesses to the most advanced methods in electronics recycling. R2-certified refurbished used equipment recyclers strive to maximize the recovery of valuable and reusable components from obsolete consumer electronics, thereby, reducing waste effectively.

Moreover, adopting the R2 certification is not only environmentally beneficial but also makes commercial sense.

With growing awareness about product lifecycle, numerous organizations now prefer to collaborate with recyclers who adhere to the highest management standards.

ELECTRONICS

For electronics manufacturers, recyclers or resellers of used electronic devices, obtaining this certification is a way to assure potential partners and customers that they handle end-of-life electronics responsibly, recycling or reusing them following the industry's best practices.

Considering the importance of the certification, the R2 certification is getting popular among the businesses around the world. Presently, 1105 facilities in 41 countries have endorsed the R2 standards. This is also a fastest growing environmental certificate among e-waste refurbishers and recyclers in Asia and 50+ units in India have already adopted R2v3 certificate.[4]

4.3 R2 Certification process

Sustainable Electronics Recycling International (SERI) owns the R2 standards. The R2-certification process for electronics recyclers may take from eight to twelve months. The companies may engage specialized R2 consultant for guidance in obtaining this certification. Otherwise, they may also achieve this on their own. SERI outlines following five-stages roadmap for obtaining R2 certification:

- Educational phase to gain a comprehensive understanding of the R2 standard.
- Implementation phase, where a business documents and modifies its facility processes to align with the standard.
- Collection of records and evidence demonstrating the business's adherence to R2 requirements.
- Conducting an internal audit process to verify that the facility is in compliance with the standard.
- Undergoing a certification audit conducted by a certification body approved by SERI.

4.4 R2v3 standards requirements

R2 adapts to variety of business models & specialties including core and process requirements. The R2v3 certification encompasses a set of core requirements applicable to all businesses seeking certification, in addition to "process requirements" that outline additional standards for companies involved in specific activities. This approach allows for a more streamlined R2 certification for small businesses engaged in limited activities, while full R2 certification is necessary for those companies comprehensively involved in all facets of electronics reuse and recycling.

The CORE requirements, applied to all R2 facilities, have following 10 mandatory steps:

Scope
- Hierarchy of Responsible Management Strategies
- EH&S Management System
- Legal and Other Requirements
- Tracking Throughput
- Sorting, Categorization and Processing
- Data Security
- Focus Materials
- Facility Requirements
- Transport

The PROCESS requirements are the additional requirements, applied only for facilities that perform specific processes. Based on their business domain, following additional processes are included for the auditing:

- *Appendix A - Downstream Recycling Chain (Facilities outsourcing part of their recycling process must use Appendix A to ensure their partners adhere to certain standards)*

ELECTRONICS

- *Appendix B - Data Sanitization (R2v3 sets out requirements for erasing user data from devices, achievable either through physical destruction or logic sanitization, as detailed in Appendix B)*
- *Appendix C - Test & Repair (Businesses that test and, if needed, repair used devices or prepare them for reuse must adhere to Appendix C standards, which cover device testing and data cleansing procedures)*
- *Appendix D - Specialty Electronics Reuse*
- *Appendix E - Materials Recovery*
- *Appendix F - Brokering*
- *Appendix G - PV Modules (added in 2024)*

4.5 Advantage of Business Houses Aligning with Certified Recycler

Opting for an R2-Certified refurbisher ensures an enhanced health and safety management system, quality, and a reduced environmental footprint. It provides thorough data sanitization from devices, adherence to rigorous testing protocols, and participation in an environmentally conscious supply chain.

Following are the benefits for the manufacturers and producers:

- Guaranteed data sanitisation for all recycled products to ensure that data security is prioritized by the company or organization
- Full tracking throughout the recycling process
- End-to-end legal compliance, which simplifies compliance with national & international law
- A clear commitment to corporate social responsibility
- Added confidence for their consumers and investors
- Reduces negative environmental & health impacts
- Promotes safer & more sustainable electronic device reuse & recovery
- *Makes electronics manufacturers more conscientious about products' end-of-life.*

Following are the benefits for the refurbishers and recyclers:

- *Demonstrates compliance with domestic and international laws*
- *Encourages public confidence through certified third-party review*
- *Improved competitiveness with the help of R2 Recycling Certification*
- *Increasing access to quality reusable and refurbished equipment to those who need it*
- *Minimizes energy use & other environmental impacts associated with mining and processing of virgin materials, conserving limited natural resources*
- *Encourages safe and effective recovery and reuse of electronic equipment*
- *Guards downstream control of the recycling chain*
- *Reduces environmental and public health risks*
- *Minimizes liability and encourages reduced insurance costs for recyclers*
- *Assists original equipment manufacturers (OEMs) with due diligence for their end-of-life electronics*
- *Ensures accountability and adherence to the highest industry standards for data security, health/safety of workers and sustainability of environmental protection.*

Collaborating with R2-certified electronics recyclers offers assurance that all potential and environmental health and safety risks are effectively managed. This approach safeguards against unexpected fines or negative media attention that could result from improper handling or disposal of your assets.

ELECTRONICS

5. MARKET OPPORTUNITY

A circularity in electronics industry transcends mere waste management, it embodies resilience, resources efficiency, and economic property.

ICEA predicts in 2023 that circular electronics business models have the potential to create a $7 billion market in India by 2035. These models include circular design, product-as-a-service, repair, resell, refurbishment, and recycling. The current projected market size for these models stands at $13 billion by 2035, but the total addressable market could be as high as $20 billion with the right public and private sector actions. About 35% of this revenue potential may remain untapped, leading to wasted embedded value and capacity5.

In the electronics sector, three business models, repair, resell, and recycling, are already being implemented at scale. Informal and formal sectors together managed the recycling of around 119 million devices in FY21, while 55 million devices were repaired, and 50 million devices were resold as-is. However, refurbishment, product-as-a-service (PaaS), and circular design are still in their early stages, presenting untapped opportunities. Only about 3 million devices were refurbished in FY215.

The repairing sector is dominated by informal operators, with 60% of repair demand coming from the after-sales market. Refurbishing is a growing market, primarily driven by tier II and tier III cities, offering notable profit margins. In recycling, 90% of WEEE (Waste Electrical and Electronic Equipment) collection is handled by the informal sector. Scaling up the formal sector's recycling efforts is a challenge due to suboptimal cost structures and inadequate technologies for difficult-to-recycle fractions[5].

The recycling market potential in India is expected to reach nearly USD 13 billion by 2035, assuming the current pace of economic activities.

With effective implementation of Extended Producer Responsibility (EPR) compliances under the E-waste Management Rules 2022 and transformation of electronics industry practices, the market could potentially reach USD 20 billion, tapping into the untapped $7 billion market potential by 2035.

6. GLOBAL BEST PRATICES TO MITIGATE PRESENT CHALLENGES

Global best practices in auditing for Circular Economy in electronics sector can be elaborated as below:

- ***Lifecycle Assessment (LCA):*** *Conduct comprehensive lifecycle assessments to evaluate the environmental impact of products from production through disposal. This helps identify areas where circularity can be improved.*
- ***Compliance Audits:*** *Regularly audit compliance with environmental regulations, sustainability standards, and corporate policies. This includes verifying that products meet regulatory requirements and are being recycled properly.*
- ***Performance Metrics****: Develop and track metrics related to sustainability goals, such as the percentage of recycled materials used, the number of products returned for recycling, and reductions in carbon footprint.*
- ***Supply Chain Audits:*** *Ensure that all suppliers adhere to sustainable practices and that materials are sourced responsibly. This involves auditing supply chain practices for compliance with environmental standards.*
- ***Transparency and Reporting:*** *Provide transparent reporting on sustainability initiatives, progress towards circular economy goals, and any challenges encountered.*

ELECTRONICS

- These build trust with stakeholders and helps in continuous improvement. Implementation steps for the business houses for adopting CE principle in electronics secrtor:

- Develop a strategic plan that integrates circular economy principles into the business model. Set clear objectives, timelines, and responsibilities.
- Engage with stakeholders, including suppliers, customers, and regulatory bodies, to ensure alignment and collaboration.
- Provide training for employees and partners on circular economy practices, including design for recyclability and responsible waste management.
- Continuously monitor progress and evaluate the effectiveness of implemented strategies. Use insights gained to refine and improve practices.
- Stay updated with advancements in technology and best practices. Invest in research and development to enhance circularity in electronics.

Globally, lot of benchmarking has been established in entire ecosystem to track circularity in business process. Design change, component modularity, green material, refurbishment of products for longer life and secondary raw materials extraction with desired resource efficiency etc. are employed with perfection so as to reduce overall manufacturing cost and save environment.

In India, though CE has gained traction, a lot of challenges still persists. The informal sector is still predominant and manages a significant portion of the waste collection and recycling and thereto damages the environment beyond its repairability. This needs to be fixed through strict regulatory interventions and promotion of responsible recycling practices, ensuring global best practice in recycling process like R2 standards.

Moreover, the consumer awareness and easy access to formal recycling option will channelize materials to the formal units. Formal sector may achieve competitiveness by leveraging informal strength by offering suitable incentive. India should also establish a refinery of global standard for metal extraction, so that recyclers should have a viable option of downstream units. Strengthening demand of the secondary raw materials is another important driver for achieving the circular economy in electronics sector.

ELECTRONICS

7. CONCLUSIONS

A circular economy (CE) is an industrial system that contrasts with the linear take-make-dispose model. CE emphasizes restoration and regeneration, prioritizing superior design, waste reduction, and resource value retention. India aims to become prominent electronics manufacturing destination, requiring substantial raw materials. To meet this demand sustainably, the electronics industry must adopt CE practices.

CE presents opportunities in repairing, refurbishing, and recycling. Informal operators dominate the repair sector, with 60% of demand coming from after-sales markets. Only 18% is served by the formal sector, leaving 22% unaddressed. The refurbishing sector, though growing, is still small, with only about 6% of resold devices being refurbished.[5] Tier II and III cities are showing increased demand due to lower costs, offering significant profit margins (>20%).

India's recycling market could reach nearly USD 13 billion by 2035 at the current pace. Effective EPR implementation and industry transformation could push it to USD 20 billion, tapping into the untapped market of USD 7 billion by 2035. Approximately 90% of Waste Electrical and Electronic Equipment (WEEE) collection is managed by the informal sector, with around 206 million devices remaining as idle inventory.[5]

R2 standards could play a pivotal role in streamlining refurbishing and recycling market in India and realize the potential CE market, which is presently dragged to informal economy due to lack of regulations and compliances. The independent third-party audit with internationally established processes will ensure evidence-based processes, proper data sanitization, accurate mass balancing through downstream vendors. Adherence to R2 requirements will ensure record collection and evidence demonstration in business, internal audit process to verify the compliance of the facility. The data generated from such units can then be considered authentic. Mandating such standards in the country will ensure the seamless validation of the data on four metals generated in CPCB website as secondary raw materials repository for future economic growth.

References:

1.Circular Economy in EEE sector: Policy Paper https://www.meity.gov.in/writereaddata/files/Circular_Economy_EEE-MeitY-May2021-ver7.pdf
2.https://ewastemonitor.info/the-global-e-waste-monitor-2024/
3.https://cpcb.nic.in/uploads/Projects/E-Waste/e-waste_rules_2022.pdf
4.https://sustainableelectronics.org
5.Pathways to Circular Economy in Indian Electronics Sector INDIA CELLULAR & ELECTRONICS ASSOCIATION (ICEA), August 2023

About the Author

Dr Sandip Chatterjee
Senior Advisor, SERI
Ex. Group Coordinator, MeitY

Dr. Sandip Chatterjee, Senior Advisor, Sustainable Electronics Recycling International (SERI), USA & Adjunct Professor, IIT, Mandi and Former, Senior Director & Group Coordinator, Ministry of Electronics and Information Technology, Government of India, a leading global policymaker & experienced techno-administrator with 35 years' of experience in translating research outcomes into commercial viability and disruptive policy-making. As head of Materials, Photonics, demonstrated thorough leadership in bridging the gap between R&D outcomes and needs of emerging businesses and local industries. Formulated India's strategy for R&D in materials, photonics, IoT sensors, additive manufacturing, and its successful commercialization. Besides, also headed the Cyber Law and Data Governance Group and formulated DPDP Act amendment of Information Technology Act; IT Rules, 2021 etc.

PROF DHARAM BUDDHI
VICE CHANCELLOR
UTTARANCHAL UNIVERSITY

SIDDHARTH SWAMI
RESEARCH SCHOLAR AT
DOON UNIVERSITY

LEVERAGING TECHNOLOGY FOR ADOPTING CIRCULAR ECONOMY: ENHANCING EFFICIENCY AND SUSTAINABILITY

INDUSTRY APPROACH

LEVERAGING TECHNOLOGY FOR ADOPTING CIRCULAR ECONOMY: ENHANCING EFFICIENCY AND SUSTAINABILITY

Prof. Dharam Buddhi
Vice Chancellor
Uttaranchal University

Siddharthh Swami
Research Scholar at
Doon University

INTRODUCTION

Since industrial revolution global economies are following the “take-make-dispose” processes for production and consumption activities resulting in ecological degradation in form of soil erosion, deforestation and land degradation. New technologies, such as artificial intelligence (AI), Internet of Things (IoT), and blockchain, offer significant opportunities to reverse this trend by driving the adoption of circular economy practices. AI optimizes resource use through predictive maintenance in manufacturing, reducing waste and improving energy efficiency. Blockchain technology ensures transparent supply chains, better tracking of raw materials, and responsible sourcing, particularly for rare earth metals [1].

The depletion of essential resources like fresh water, rare earth metals, and fossil fuels poses both ecological and geopolitical challenges. Global water scarcity affects over 40% of the population, with regions like Sub-Saharan Africa and the Middle East particularly vulnerable. Rare earth metals are increasingly difficult to extract, with China controlling around 85% of the global supply. Renewable energy is proving to be a significant driver for transitioning to more sustainable systems, with renewable capacity reaching 3,372 GW globally by 2022. The United Nations has established the Sustainable Development Goals (SDGs) and the European Union's Circular Economy Action Plan, focusing on industries with high environmental impacts. The Global Environment Outlook report by the UN Environment Programme (UNEP) stresses that business-as-usual economic models are untenable and requires significant systemic changes to avoid irreversible damage to ecosystems. By leveraging technological advancements and aligning global policies, the transition from linear to circular economic models can mitigate environmental impacts, safeguard essential resources, and foster sustainable development.

The circular economy is a paradigm shift that addresses environmental, social, and economic challenges. It goes beyond traditional linear models by focusing on minimizing waste, designing out pollution, and regenerating natural systems. This approach offers a blueprint for a sustainable, equitable, and prosperous future. Adopting a circular economy could reduce global greenhouse gas emissions by 39%, demonstrating its potential impact on climate change.

INDUSTRY APPROACH

The circular economy decouples economic growth from resource consumption, as "urban mining" allows the recovery of valuable materials from discarded electronics and infrastructure [2]. This could stabilize markets, reduce dependence on finite resources, and boost economic resilience. The circular economy aligns with several Sustainable Development Goals (SDGs), such as SDG 12 (responsible consumption and production), SDG 6 (clean water and sanitation), and SDG 13 (climate action). By promoting resource efficiency and regeneration, circular practices can help achieve these targets by 2030. In the water sector, circular solutions like wastewater recycling and water-efficient irrigation systems can reduce pressure on 2.3 billion people living in water-stressed countries by up to 40%.

The European Union's Circular Economy Action Plan is an example of government-led initiatives integrating circular principles across industries, particularly textiles, plastics, and electronics [3]. By integrating reuse, recycling, and regeneration into policy frameworks, economies can shift from waste-heavy practices to resource-efficient and environmentally sound practices. The circular economy is projected to generate a $4.5 trillion economic opportunity by 2030, fostering innovation in sustainable materials, renewable energy, and resource management. In conclusion, the circular economy is not just an alternative system but a crucial shift towards long-term ecological balance, market volatility reduction, and resource security. Emerging technologies are driving the transition towards a circular economy, reshaping industries and promoting environmentally sustainable production systems.

These technologies can enhance circularity by enabling efficient reuse, recycling, and regeneration of materials, opening up new employment opportunities in sectors like recycling, sustainable product design, and resource management [4].

INDUSTRY APPROACH

Circular Economy Sustainable Model

Digital technologies, such as blockchain, AI, and the Internet of Things (IoT), are set to drive $9 trillion of economic value through the circular economy by 2030. Artificial intelligence (AI) is one of the most impactful technologies in this space, as it can optimize resource use, improve product lifecycle management, and improve recycling processes. Companies like Circularise use blockchain and AI to track raw materials from source to end product, ensuring traceability and accountability throughout supply chains. AI-driven sorting technologies can increase recycling efficiency by 25% in plastic waste, facilitating a more effective circular flow of materials. Additive manufacturing, also known as 3D printing, allows for on-demand, waste-minimizing production by using only the exact amount of material needed for each product.

This technology facilitates product design tailored for disassembly, supporting recycling and material reuse [5]. A 2021 study found that bio-based plastics, derived from renewable biomass sources, could reduce CO_2 emissions by up to 70% compared to traditional petroleum-based plastics. The intersection of technology and circularity extends beyond environmental benefits to socio-economic implications.

The International Labour Organization (ILO) predicts that the global transition to a circular economy could create 6 million jobs by 2030 in sectors such as recycling, remanufacturing, and sustainable design. Sustainable technologies can facilitate inclusive economic growth, particularly in developing regions where circular practices address resource scarcity and promote resilience.

Artificial intelligence (AI) and blockchain technology are poised to play a transformative role in the transition to more sustainable production models, essential for achieving the objectives of the circular economy [6]. AI has predictive capabilities and data-driven optimization that can optimize resource allocation, enhance product lifecycle management, and increase the efficiency of recycling and reuse processes. AI-powered robots and machine learning algorithms are increasingly being deployed to sort and classify waste materials with greater precision and speed, increasing the efficiency of material recovery by 20-30%.

Blockchain technology complements AI by providing transparency, traceability, and accountability throughout the supply chain. In the context of the circular economy, blockchain can be used to track the lifecycle of materials and products, ensuring they are sourced responsibly and recycled or reused at the end of their life. Circular, a blockchain company, has developed platforms to trace ethically sourced raw materials like cobalt and lithium from the mine to the final product, reducing the environmental and social impacts associated with these resources. Blockchain is also being used to facilitate the creation of decentralized marketplaces for recycled goods [7]. By recording transactions and product information on a decentralized ledger, blockchain enables companies and consumers to verify the quality and origin of recycled materials, promoting greater trust and higher rates of circular material use.

In practice, this could lead to increased demand for recycled materials, reducing the need for virgin resources. A report by IBM estimated that blockchain could reduce the global electronic waste problem by up to 30% by improving material recovery rates and promoting product reuse.

INDUSTRY APPROACH

Enhancing Efficiency and Sustainability through technological intervention.

AI and blockchain technologies are at the forefront of driving a circular economy transition by enabling smarter resource management, more efficient recycling, and greater transparency across supply chains. Their role in facilitating the circular economy is crucial, as they not only improve resource efficiency but also contribute to reducing environmental impacts and fostering more resilient production systems [8]. Artificial intelligence (AI) plays a crucial role in advancing circular economy principles by reshaping production processes and mitigating overproduction, a major driver of waste and environmental degradation. By leveraging AI's advanced analytical capabilities, industries can monitor and analyze consumption patterns in real-time, allowing for better alignment with actual demand. This adaptability minimizes the risk of producing excess goods that often end up as waste, moving production systems toward a more circular model. One of AI's most transformative applications lies in its ability to optimize production through machine learning algorithms and neural networks [9]. These technologies can predict future resource needs with greater accuracy by analysing historical data and real-time trends.

For example, AI-driven demand forecasting can improve inventory accuracy by up to 65%, reducing overproduction and associated waste by significant margins. AI systems can continuously monitor and adjust production parameters, creating a feedback loop that improves operational efficiency and resource utilization. This is particularly important for industries with high material and energy consumption, such as manufacturing and agriculture.

AI-driven systems, integrated with the Internet of Things (IoT), can monitor machinery, raw materials, and energy usage in real-time to reduce inefficiencies. Machine learning algorithms, particularly neural networks, are critical in facilitating circular production models by improving decision-making processes related to the use of secondary materials. Neural networks can identify patterns in vast datasets that would be impossible for humans to detect, allowing for optimized recycling and reuse processes [10].

AI's predictive capabilities can revolutionize supply chain management by improving resource allocation across the entire production cycle, particularly for industries reliant on finite or rare materials. By optimizing production parameters in real time, AI can lower energy consumption, contributing to climate goals such as those outlined in the Paris Agreement.

Blockchain technology, a decentralized and immutable ledger system, is revolutionizing the management of projects, people, and supply chains across industries by providing transparency and accountability. In the context of the circular economy, blockchain has significant implications for product traceability, contract validation, and compliance with sustainability standards. It ensures that every transaction or change in a product's life cycle is recorded and verified, making it a critical tool for advancing circular practices. Smart contracts, self-executing contracts with terms directly written into code, are one of the most significant applications of blockchain in business [11]. These contracts eliminate the need for intermediaries, reducing costs and potential disputes. In circular economy practices, smart contracts can ensure compliance with agreements related to resource use, recycling commitments, or product take-back schemes

INDUSTRY APPROACH

.Implementing smart contracts in supply chains could reduce administrative costs by 30% and increase the speed of contract execution by up to 50%.

Blockchain's most transformative potential lies in supply chain management, where it provides end-to-end traceability of products. By tracking a product's life cycle from raw material sourcing to final disposal, blockchain can authenticate the origins of materials, ensuring they are responsibly sourced and monitor the environmental impact throughout the product's use [12]. This is essential for validating sustainability claims and verifying that recycled materials are truly being reintroduced into production cycles. Blockchain also supports responsible sourcing by enabling companies to verify the ethical and environmental standards of their suppliers.

For industries reliant on critical raw materials, blockchain can track the origin of rare earth metals or conflict minerals, ensuring they are sourced in compliance with international standards. A 2020 report by the Ellen MacArthur Foundation highlighted that blockchain technology could enable circular material flows, with potential savings of $1 trillion globally by 2025 through enhanced recycling and reuse practices. Blockchain technology is being used in the disposal and recycling of e-waste in electronics, ensuring compliance with environmental regulations and promoting accountability.

The RecycleChain platform tracks electronic waste from collection points to recycling centres, promoting traceable, auditable records of e-waste handling. The International Telecommunication Union (ITU) reports that blockchain could increase the formal recycling rate by providing traceable, auditable records of e-waste handling [13].

Blockchain technology offers transformative potential for promoting transparency, traceability, and accountability in the circular economy. It ensures verifiable sustainability claims, responsibly sourced materials, and enforceable circular practices.

By providing a transparent and secure ledger, blockchain can facilitate more efficient and responsible production and consumption models, aligning with global sustainability goals and enabling the shift towards a circular economy. Artificial intelligence (AI) and blockchain technologies have the potential to significantly advance the circular economy by providing transparency, traceability, and efficiency.

AI's predictive capabilities can optimize resource management, reduce waste, and promote sustainable consumption models. For instance, AI algorithms can analyze vast amounts of data to predict waste generation patterns with high accuracy, allowing municipalities or companies to proactively manage waste streams and optimize collection routes [14]. This could improve recycling efficiency by up to 40%. Blockchain ledgers offer a transparent and verifiable way to track decisions and actions related to waste management, ensuring compliance with environmental regulations and preventing illegal dumping. Beyond waste management, AI and blockchain can support the development of collaborative consumption models. AI can match supply and demand in real-time, optimizing the availability and sharing of goods. In sectors like transportation or energy, AI can predict when resources are most needed and allocate them accordingly, minimizing waste and improving efficiency.

INDUSTRY APPROACH

The elimination of intermediaries through smart contracts on blockchain platforms further supports resource efficiency [15]. These contracts can automatically enforce agreements between parties, such as leasing products or services, without the need for third-party oversight. According to a 2021 report by PwC, such smart contracts could lower transaction costs by 25% while improving operational efficiency.

Conclusion

The synergy between AI and blockchain technologies offers transformative potential for advancing circular economy principles. AI's predictive insights enhance efficiency in resource management, while blockchain ensures transparency, security, and auditability. The integration of blockchain and artificial intelligence technologies can help policymakers develop and enforce regulations promoting circular practices, providing real-time data on resource flows and a transparent record of compliance. These technologies, particularly blockchain, have a transformative role in advancing the circular economy, emphasizing community and technology integration, ethical considerations, technological synergies, sustainable business models, and the burgeoning bioeconomy [16].

They offer economic and environmental benefits, enhance resource efficiency, optimize supply chains, and improve product lifecycle management. However, these opportunities also present challenges, such as integrating advanced production methods, ensuring supply chain transparency, overcoming skill gaps, avoiding data centralization, and adapting regulatory frameworks for equitable and sustainable growth.

Further research is needed to address these areas, particularly in developing employees' technological capabilities and adapting regulatory frameworks. As we approach a technological revolution, it is crucial to ensure that technological advances align with ethical, social, and environmental imperatives.

References

[1] Dumitrescu-Popa, I. S., Chita, E. I., Craciun, M. A., & Panait, M. (2024). Challenges of the Circular Economy: Inequality and Economic Behavior. In Proceedings of the International Conference on Business Excellence (Vol. 18, No. 1, pp. 798-810).
[2] Corvellec, H., Stowell, A. F., & Johansson, N. (2022). Critiques of the circular economy. Journal of industrial ecology, 26(2), 421-432.
[3] Velenturf, A. P., & Purnell, P. (2021). Principles for a sustainable circular economy. Sustainable production and consumption, 27, 1437-1457.
[4] Borrello, M., Pascucci, S., & Cembalo, L. (2020). Three propositions to unify circular economy research: A review. Sustainability, 12(10), 4069.
[5] Medaglia, R., Rukanova, B., & Zhang, Z. (2024). Digital government and the circular economy transition: An analytical framework and a research agenda. Government Information Quarterly, 41(1), 101904.
[6] Sánchez-García, E., Martínez-Falcó, J., Marco-Lajara, B., & Manresa-Marhuenda, E. (2024). Revolutionizing the circular economy through new technologies: A new era of sustainable progress. Environmental Technology & Innovation, 33, 103509.
[7] de Mattos Nascimento, D. L., de Oliveira-Dias, D., Moyano-Fuentes, J., Maqueira Marín, J. M., & Garza-Reyes, J. A. (2024). Interrelationships between circular economy and Industry 4.0: A research agenda for sustainable supply chains. Business Strategy and the Environment, 33(2), 575-596.
[8] Hahladakis, J. N., Iacovidou, E., & Gerassimidou, S. (2024). Plastic waste in a circular economy. In Environmental Materials and Waste (pp. 99-134). Elsevier.
[9] Kirchherr, J., Yang, N. H. N., Schulze-Spüntrup, F., Heerink, M. J., & Hartley, K. (2023). Conceptualizing the circular economy (revisited): an analysis of 221 definitions. Resources, Conservation and Recycling, 194, 107001.
[10] Dzhengiz, T., Miller, E. M., Ovaska, J. P., & Patala, S. (2023). Unpacking the circular economy: A problematizing review. International Journal of Management Reviews, 25(2), 270-296.
[11] de Oliveira, C. T., & Oliveira, G. G. A. (2023). What Circular economy indicators really measure? An overview of circular economy principles and sustainable development goals. Resources, Conservation and Recycling, 190, 106850.
[12] Kirchherr, J., Urbinati, A., & Hartley, K. (2023). Circular economy: A new research field?. Journal of Industrial Ecology, 27(5), 1239-1251.
[13] Chen, P. (2023). What lies about circular economy practices and performance? Fresh insights from China. Journal of Cleaner Production, 416, 137893.
[14] Valencia, M., Bocken, N., Loaiza, C., & De Jaeger, S. (2023). The social contribution of the circular economy. Journal of Cleaner Production, 408, 137082.
[15] Tambovceva, T. T., Melnyk, L. H., Dehtyarova, I. B., & Nikolaev, S. O. (2021). Circular economy: Tendencies and development perspectives.
[16] Morseletto, P. (2020). Targets for a circular economy. Resources, conservation and recycling, 153, 104553.

About the Authors

Prof Dharam Buddhi
Vice Chancellor
Uttaranchal University

Professor Dharam Buddhi is the Vice Chancellor of Uttaranchal University, Dehradun, and a prominent leader in academics, research, and innovation. An alumnus of IIT Delhi and former professor at Devi Ahilya University, Indore, he has contributed significantly to the fields of renewable energy, energy conservation, and green building. Recognized globally, he is ranked in the top 2% of energy researchers by Stanford University for three consecutive years (2021-2023). Dr. Buddhi has over 250 research publications, more than 150 patents, and has guided 20 Ph.D. scholars. His international experience spans numerous countries, and he has held prestigious roles, including as an international consultant for the Asian Development Bank. He received the Lifetime Achievement Award in 2023 for his contributions to academics and research.

Mr Siddharth Swami
Research Scholar in Renewable Energy
Doon University

Mr Siddharth Swami received his bachelor's degree from Uttarakhand Technical University in civil engineering and completed his masters in environmental engineering. He has also qualified UGC NET and GATE exam. He has published various SCI articles in Q1 journals and currently pursuing his Ph.D. in Renewable energy from Doon University. He has also published more than dozen patents in the field of sustainability, technology and innovation. He can be contacted at email:
siddharthswami3@gmail.com

UTTARANCHAL UNIVERSITY DEHRADUN | NAAC GRADE A+

पदं हि सर्वत्र गुणैर्निधीयते

100+ Multidisciplinary Programs | **490+** Recruiters | **₹1.50 CR.** Highest Package

Programs Offered

Engineering | Management | Law | Health Sciences | Nursing |Pharmacy | Agriculture
Hotel Management | Science | Computer Applications | Sustainability

USPs

- We are amongst the top 5% universities in India accredited with NAAC Grade A+.
- The First University in Uttarakhand with NAAC Grade A+ and UGC (12B).
- 100+ Multidisciplinary Programs.
- 2nd in India enlisted in the Top Innovative University (Global Band of 101-200) by World's Universities with Real Impact (WURI).
- 400+ Faculty members with rich & diverse experience.
- CII Industrial Innovation Awards 2022.
- Host Institution of MSME.
- Strong Alumni Base Network working with the top International brands across the globe.
- Engaging co-curricular & extracurricular activities.
- International Collaborations.

Vision

To be a world-class university through continuous innovations in education, research, creativity, and entrepreneurship with an aim to have a transformative impact on society.

Curriculum Innovation

- Comprehensive programs.
- Industry relevant courses.
- Experienced faculty members.
- Hands-on learning.
- Research and Innovation Support.
- State-of-the-Art facilities.
- International Collaborations.
- Skill Development.
- Strong Alumni Network.

Division of Research & Innovation

Uttaranchal University is on a mission of finding Excellence within 'U' through research, innovation and patents.

5000+	650+	120+	10+
Publications	IPR/Patents	Projects	Technology Transfer

Approvals & Accreditation

- Approval by UGC under Sections 2(f) & 12(B)
- National Assessment & Accreditation Council
- THE Impact Rankings
- Recognized by Pharmacy Council of India
- Indian Nursing Council
- Ministry of MSME
- AIU Membership Letter
- United Nations Academic Impact
- Confederation of Indian Industry
- Recognized by Bar Council of India
- World University Rankings with Real Impact
- Unnat Bharat Abhiyan

Piotr Barczak

CE Program Manager at Africa Circular Economy Network (ACEN)
Council Member at the European Environmental Bureau

THE BLACK SOLDIER FLY: NATURE'S RECYCLER AND PROTEIN POWERHOUSE

BIOECONOMY

THE BLACK SOLDIER FLY: NATURE'S RECYCLER AND PROTIEN POWERHOUSE

Piotr Barczak
CE Program Manager at ACEN
Council Member at the EEB

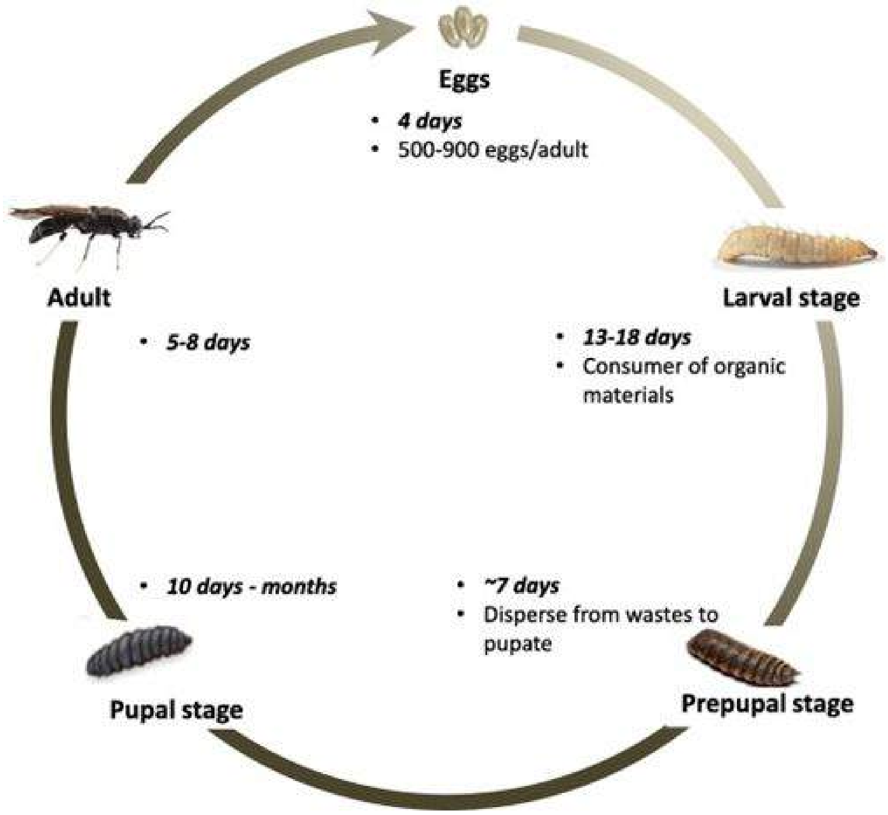
Introduction

The black soldier fly (Hermetia illucens) has recently gained global attention for its remarkable ability to contribute to sustainable practices, particularly in food production and waste management.. Originally found in warm, tropical climates, this insect has now adapted to environments worldwide, thriving in areas rich in organic waste. With an extraordinary life cycle that turns waste into valuable resources, the black soldier fly stands as a powerful symbol of environmental stewardship and circular economy innovation.

Measuring 16–20 millimetres in length, the adult black soldier fly features a sleek, metallic black body that resembles a wasp. Despite its formidable appearance, the adult fly is entirely harmless—it doesn’t bite, sting, or spread disease. The true magic happens in the larval stage. These greyish-white, legless larvae, voraciously consume organic waste, including food scraps and manure. In doing so, they convert discarded material into nutrient-dense biomass, rich in proteins and fats. This larval biomass is processed into high-quality feed for livestock such as poultry, fish, pigs, and pets, creating a sustainable alternative to traditional animal feeds.

Beyond its role in producing animal feed, the black soldier fly also contributes to soil health. After the larvae have completed their feeding cycle, the remaining organic residue, known as frass, is an excellent source of natural fertiliser and soil conditioner. This by-product helps to close the loop in waste management systems by turning waste into renewable resources, reducing the need for chemical fertilisers and promoting healthier soils.

BIOECONOMY



The lifecycle of the black soldier fly is both rapid and efficient:

- Eggs are laid in batches near decaying organic material.
- The larvae feed voraciously on the waste for 2-4 weeks, rapidly growing in size.
- Once fully developed, the larvae enter the pupal stage, ultimately emerging as adults, whose primary function is reproduction.
- Adults live for only a few days, during which their sole focus is to reproduce and continue the cycle.

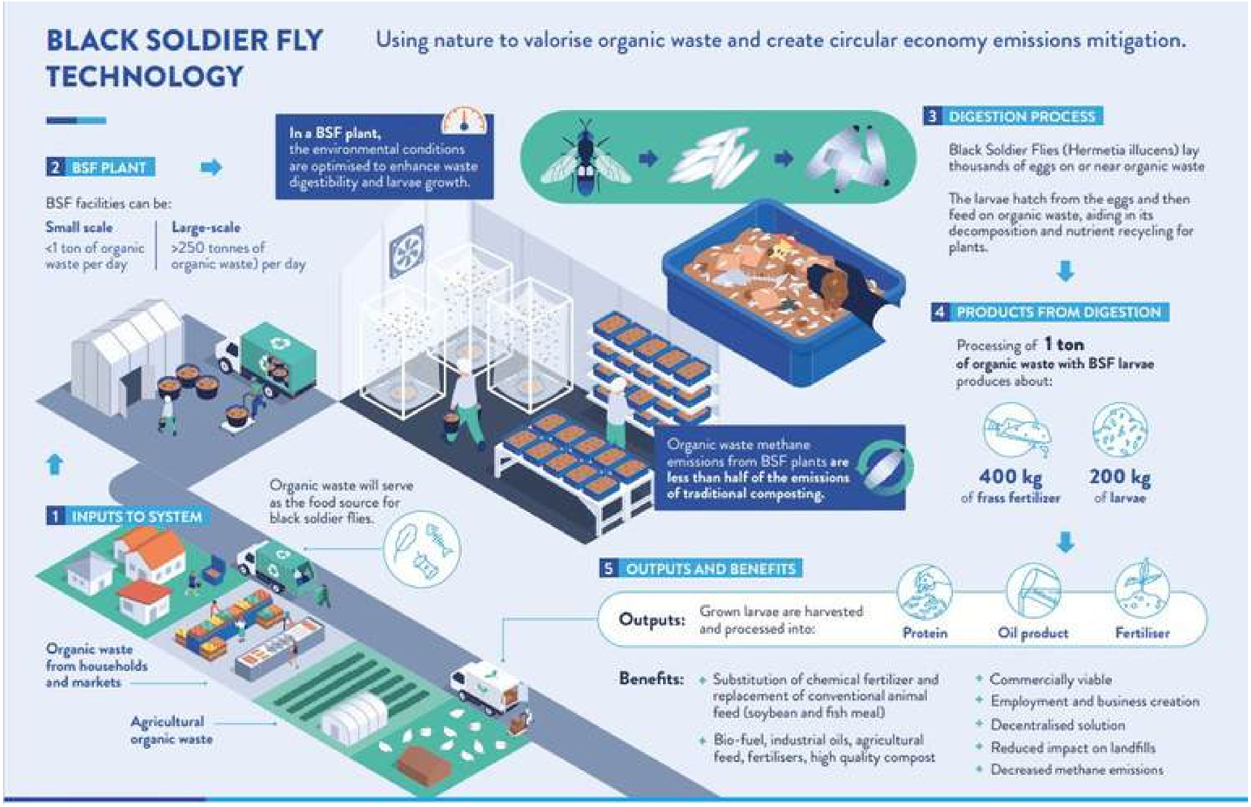
The black soldier fly (BSF) represents an attractive business model, thriving on continuous supply of feedstock (waste) and turning it into valuable products, with minimal investments. BSF-based businesses are rapidly expanding across Africa, tapping into a global market that is projected to reach a value of $3.96 billion by 2033.

Requirements for a Successful BSF Project

To establish and maintain a successful BSF project, several prerequisites must be met.

- Climate: BSF larvae flourish in warm, stable conditions, with optimal temperatures ranging from 24°C to 30°C.
- Humidity: Consistent humidity levels above 60% are essential for healthy larval development.
- Feedstock Supply: A reliable and homogeneous source of organic waste, such as food and kitchen scraps, is crucial for sustained larval feeding.
- Market Demand: A well-established market for larvae and their by-products, including animal feed and compost, is necessary for commercial success.

BIOECONOMY



Benefits of BSF

The black soldier fly has garnered attention for its wide-ranging practical applications, providing numerous benefits across various sectors:

1. Waste Management: BSF larvae are nature's most efficient recyclers, adeptly converting organic waste into usable biomass. Their ability to process food waste and other organic by-products offers an environmentally friendly solution to reduce landfill use, thereby mitigating waste disposal challenges.

2. Sustainable Protein Source: With the increasing demand for animal feed, black soldier fly larvae present a sustainable alternative. Rich in high-quality proteins and essential fats, they are ideally suited for feeding chickens, pigs, and fish within sustainable farming systems.
3. Economic Value: Interest in BSF farming is on the rise, as businesses leverage these insects for both waste management and cost-effective animal feed.
- The market for black soldier fly larvae is projected to experience significant growth, with estimates suggesting it could reach $3.4 billion by 2030, driven by a compound annual growth rate (CAGR) of 33.7%. (Meticulous Research, 2024).
- Similarly, the market for frass, the nutrient-rich by-product of larvae digestion, is expected to reach $317 million by 2029, growing at a CAGR of 24.3%. This underscores the economic potential not only for protein production but also for sustainable fertilisers that enhance soil health.

4. Climate Change Mitigation: Conventional organic waste treatment methods can emit methane and CO2, exacerbating climate change. However, case studies demonstrate that BSF technology can significantly reduce greenhouse gas (GHG) emissions from the waste sector. The frass produced boosts the soil's carbon sequestration capabilities. By replacing conventional feeds and synthetic fertilizers with BSF outputs, further GHG savings in agriculture can be realized, contributing to efforts against global warming. Thus, BSF technology supports low-carbon food production and plays a pivotal role in reducing GHG emissions from waste management practices.

Challenges and Considerations

Despite their numerous benefits, several challenges must be addressed to facilitate their widespread adoption. Regulatory hurdles in some regions impede the approval of BSF larvae for use in animal feed. Additionally, barriers such as limited funding, insufficient knowledge about BSF technology, inadequate infrastructure, and poor stakeholder coordination often complicate the scaling of BSF projects.

Overcoming these obstacles will require targeted awareness-raising and training for key stakeholders, alongside significant infrastructure investment. In addition, implementing financial mechanisms and supportive policies is essential to create market access for new natural alternatives to synthetic fertilizers and conventional animal feed.

Future prospects

The future for black soldier flies looks promising, with their industrial applications expanding, particularly in sustainable farming and waste management. As the global demand for eco-friendly solutions to food security and waste challenges grows, black soldier fly farming is poised to play a crucial role.

Scientists are actively exploring biobased options to optimise the growth and efficiency of black soldier flies, which could enhance their utility across various industries. Ongoing research may lead to breakthroughs in sustainability, including the extraction of valuable materials from larvae, such as chitin, which is utilised in cosmetics, pharmaceuticals, and food processing.

Conclusion

The black soldier fly exemplifies how nature's processes can be harnessed to address climate and food security challenges. From waste management to sustainable protein production, the role of the black soldier fly continues to grow. As we seek innovative solutions to the pressing issues of our time, this unassuming insect may hold the key to a more sustainable and resilient future.

About the Author

Piotr Barczak
CE Program Manager, ACEN
Council Member, EEB

Piotr is a Belgian/Polish national with over 13 years of experience in circular economy policy development. Currently he is a Circular Economy Program Manager at the Africa Circular, and a Council Member of the European Environmental Bureau. Previously he worked at the Polish Ministry of the Environment, and Polish Humanitarian Action in South Sudan as a FSL project coordinator, collaborating with FAO, WTO, UNHCR and Caritas. He holds two Master Diplomas in Spatial Management, Environmental Sciences and Geography.


3R 0-WASTE
Karma Coins
A reward platform for sustainable gestures
ESG Consulting
Achieve your sustainability objectives with our expert consulting services.
Waste Management Services
We offer a comprehensive range of services to meet your sustainability goals.
ESG
Recycling of Waste Upcycling of Waste
BRSR Reporting
Integrated Recycling Units (IRUs)
Eco Hotel
Circular Economy Strategy Planning
On Site Waste Management Solutions
Sustainable Transport
Waste Reduction Audits
E-waste Collection & Disposal
Sustainable Learning and E-Games
Resource Optimization & Sustainability Reporting
Plastic Recycling & Upcycling
E-Commerce Platform for Sustainable Products and Services
Compliance with Global ESG Standards
Bio Mining & Landfill Reclamation
3RZeroWaste Pvt. Ltd.
A CLIMATE TECH. STARTUP WITH A VISION OF BUILDING A WORLD WITHOUT WASTE.
Scan Here
KarmaCoins
To get started or learn more, visit us at *www.0waste.co.in *
or download our app on Google Play!
Plot 62 , Sector 8 , IMT Manesar Haryana - 122051
Contact: 9958690277
Info@0waste.co.in


ICCE
International Council For Circular Economy
MSME
MICRO, SMALL & MEDIUM ENTERPRISES
सूक्ष्म, लघु एवं मध्यम उद्यम
EEPC INDIA
ENGINEERING THE FUTURE
MSME CONCLAVE
8 NOVEMBER 2024
Ginger Hotel, Vile Parle East, Mumbai
The Circular Economy is
Big! ...bigger than Industry 4.0 for MSMEs
EEPC India invites leading industry experts and think tanks to the
International Conference on Embracing the Circular Economy: A must-win strategy for Indian MSMEs in global trade

Nidhin Kurian John

Ex-Head-Circular Economy and Digitization in Sustainability & Business Excellence at Aditya Birla Fashion and Retail Ltd.
Research Scholar at Indian Institute of Management, Kozhikode

A DETAILED ANALYSIS OF CIRCULAR ECONOMY AND CLIMATE STRATEGY IN FASHION INDUSTRY

FASHION

A DETAILED ANALYSIS OF CIRCULAR ECONOMY AND CLIMATE STRATEGY IN FASHION INDUSTRY

Nidhin Kurian John
Research Scholar at IIM, Kozhikode

ABSTRACT

This paper explores fashion's challenge in establishing a sustainable waste management system, exploring Circular Economy (CE) and climate strategies. CE aims to circulate garments continuously, maximizing their value and returning them to the biosphere when idle for long periods. It promotes reusable designs, extending product lifespan and benefiting the environment. The shift from linear to fast fashion brings significant environmental consequences, heavily relying on resources for cheap, short-lived clothing, worsening crises.
CE's current focus on waste overlooks earlier production phases' environmental impacts. A comprehensive assessment of CE initiatives across supply chain stages is crucial to understand their cumulative environmental footprint.

While studies explore CE in fashion, emphasizing waste management, their environmental impact in earlier supply chain stages is unexplored. This study examines CE in India's fashion industry, emphasizing sustainability through empirical research with brand founders, managers, and CEOs. It evaluates climate strategies' impact on reducing greenhouse gases, resource demands, and water/energy use. The core aim is to understand how CE and climate strategies reduce fashion industry waste.

This research examines case studies to understand how fashion brands implement CE principles, especially in fast fashion. It seeks insights into challenges/opportunities in implementing climate strategies and CE across the fashion supply chain, fostering a sustainable circular fashion economy.

FASHION

Introduction

A circular economy in fashion industry or circular fashion industry is termed as regenerative system, the garments are circulated so long till the retained maximum value and safely returned to biosphere when they not in use for longer period of time. The products are designed and established with reuse in mind. Best thing anyone can do is lesser buy and more repurpose, extending the product lifecycle. It resulted in greater positive effect on the planet. Nowadays, circular economy concept is considered as highly efficient and closed loop economy is developed as viewpoint in transformation to less wasteful and highly sustainable fashion industry. The circular economy is developed as the reason for the higher challenge handled by fashion industry. This kind of involvements at waste stage are addressing the fashion industry's environmental impact. A circular economy is defined as it can redesign the idea of materials fabrication and use the resources to make, use, and dispose in regarding recycling. While concentrating on circular economy with greater lifetime and materials reusing, full value of products are gained and waste over-generation is avoided. The circular e-fashion industry is developed by Anna Bismar, Green strategy(Shirvanimoghaddam, Motamed, Ramakrishna, & Naebe, 2020).

Before focusing on circular economy, three key steps have been followed by linear model fashion industry such as take- raw materials harvesting, garments production- make and subsequent garments disposal wearing – waste(MacArthur, 2017). A leading business model in Fast fashion industry consumes huge quantities of natural resources to yield inexpensive clothes prepared by lesser paid workers which worn for lesser period of time by consumers and disposed subsequently(Leslie, Brail, & Hunt, 2014). If the clothing production increasing then the number of times the clothing worn by, consumers decreased(MacArthur, 2017). The results shows that the different estimates produces huge amount of waste (Niinimäki et al., 2020) and formed environmental and social sustainability crisis (Bick, Halsey, & Ekenga, 2018). Nowadays the circular economy dominated both academic and policy oriented with respect to sustainable fashion(De los Rios & Charnley, 2017; Elia, Gnoni, & Tornese, 2017). With respect to uplift thinking, circular economy is sustainability context which aims to minimize the waste and maximize the resource efficiency. The concept of circular economy exhibits roots in industrial, ecological and environmental economics in which researchers are assessed the relationship between economic and environmental strategies(Geissdoerfer, Savaget, Bocken, & Hultink, 2017; Rosa, Sassanelli, & Terzi, 2019). The circular economy identifies to redirect the material and energy's linear flow, assists various production processes into closed loop or circular systems which highlights the waste residuals and resource usage(De los Rios & Charnley, 2017). By connecting consumption and production activities, circular economy resulted to new and highly sustainable business models(Witjes & Lozano, 2016), can decouple the environmental loss and economic growth(Elia et al., 2017).

FASHION

Motivation

Researchers evaluating the circular economy in fashion industry are mainly focusing on industry actions enabled by circular business models decrease the fast fashion environmental impact(Machado, de Almeida, Bollick, & Bragagnolo, 2019; Sandvik & Stubbs, 2019). The studies also assessed the developed practices like materials recycling and second hand shopping which contributes to the greater circular fashion industry.

The influences of these kind of activities on environmental sustainability is greatly challenged. If involvements at waste stage is not affect the impact created at take and make stages, the evaluations is required for assessing the circular economy initiatives which target directly at these kind of stages. Garment recycling shows its environmental implications whereas combined fashion consumption shows reflection impacts(Iran & Schrader, 2017). In addition, the waste stage overlooks environmental impact based on lifecycle assessment study from(Roos, Zamani, Sandin, Peters, & Svanström, 2016), leads to carbon footprint apparel sector in Swedish country. The waste fails to target the more environmental damage of take and make stages.

Literature Review

Swedish fashion industry has been investigated in (Abhinav, Lazarus, Priyanga, & Kshama, 2018), regarding the circular economy implementation principles. Swedish fashion brands' CEO, sustainability managers, and founders have been interviewed which leads to circular economy strategies based on 3 key points like take, make, and waste. The brands should incorporate the mentioned strategies across the supply chains instead of waste stage.

The evaluation results identifies the gaps while focusing on circular economy practices and fashion brand challenges. Moreover, scientific data from food and textiles global economy have selected in (Provin & de Aguiar Dutra, 2021), by focusing on reusable wastage from food industry to new textile manufacturing with more added value. For bio-textiles manufacturing the bacterial cellulose from pro-biotic drinks have been concentrated from the fashion industry. UN sustainable goals with circular economy areas were also covered. In(Dissanayake & Weerasinghe, 2021), circular fashion understanding based on systematic literature review is performed in order to provide a context and strategies to move from linear to closed loop fashion. Various viewpoints regarding enablers and barriers have been discussed. Better insights of researchers, innovators, designers, and businesses have been analysed for circular economy transition in fashion industry.

(Saha, Dey, & Papagiannaki, 2021) emphasized that, to deal with environmental impacts there exists lack of managerial expertise and knowledge. Global warming should be restricted within 1.5oC, the universal consent which can tackle the exceptional climate emergency facing globally. Economic sustainability in India, Vietnam and Bangladesh have been investigated to capture the waste management for recycling in the textiles and clothing industry. The available market view for the recycling textiles have been reviewed with respect to various business strategies for the textile market integrating the consumer choices modification and sustainability. Detailed discussion of specific consumer habits with respect to textile and clothing industry analysed. The barriers have been evaluated in order to attain the positivity for the economy and environment associated with fashion redefinition and textile recycling(Pandit, Nadathur, & Jose, 2019).

FASHION

Problem Description and Objectives

The major contribution of this study is the investigation of circular economy initiatives and its sustainability in Indian fashion industry based on surveys, case studies, and interviews from brand founders, source manager, designer, and CEOs provides how fashion brands are changing the circular economy principles into practice. Specifically in fast fashion industry and sustainable brands. In accordance with climate strategy, moving from linear to closed loop or circular fashion brings new significant benefits in fashion industry with respect to reducing the GHG emissions, resource requirements, and water and energy savings. Since the resources' shortage like energy and water cannot meet the fashion apparel growing demand in linear fashion. These kind of sustainable transition leads to new business ideas, sustainable consumers, and employment opportunities. Hence, circular economy in fashion industry provides the consumers with sustainable products which are designed for reuse, durability, recycle or remanufacture in repeat(Dissanayake & Weerasinghe, 2021).

Research Objectives

- To investigate the circular economy and its sustainable principles adopted in Indian fashion industry through empirical based study.
- To analyse the climate strategies in accordance with case studies of circular fashion industry with respect to reducing the GHG emissions, resource requirements, and water and energy savings.

Questions

Does the circular economy and climate strategy exhibit positive impact, which are supporting the transition of sustainable fashion industry which produces lesser waste?

Research Approach

The present study focuses on mixed approach such as Qualitative and Quantitative study to investigate the circular economy in Indian fashion industry. In addition, case study will evaluate circular fashion industry adoption of climate strategies.

Qualitative approach

Qualitative studies require the exploratory and comprehensive work which provides empirically rich complex sensation. In order to understand the circular economy and sustainability in Indian fashion industry, the reason behind business organizations, and the consumers adopting certain principles should be known. This kind of context is best examined through interviews with people who face these issues and solutions every day. The major data source can be semi-structured interviews with Indian fashion brands employees responsible for sustainability initiatives. These brands are identified from different sources, web searches, lists of industry association membership, media articles and fashion week rosters.

The fashion apparels included are the various range of industry segments comprised with contemporary, denim, outdoor or sports apparel, kids and women wear, unisex design and accessories. The respondents can be consider based on brand size with either sourcing manager or founder, head designer, CEOs or others. All the participants are strictly anonymous in order to protect the identity of brands.

The questions may be about the brand, style, and focus. Further, it examined the sustainable challenges facing, and determine the circular economy practices following. Another set of questions probed with sustainability, challenges in adopting circular economy and corporate social responsibility.

FASHION

Dominant themes can adopted for the transcripts to minimize the information obtain by sorting the responses for further analysis. This kind of exploratory process can connect to the sustainability circular economy in fashion industry.

Quantitative study

A quantitative study based on survey questionnaire is considered and obtain the responses through email, social media and other digital platform. All the responses are considered excluding the responses which are incomplete.
Here both quantitative and qualitative methodologies are applied for the incorporation of differentiate methodologies. Using the google forms the questionnaire is created with multiple choice based on Likert scale, based on participants fashion matters, preferences in clothes and discarding.

Case study

Case study can also be suggested to evaluate the climate strategies in accordance with circular fashion industry with respect to reducing the GHG emissions, resource requirements, and water and energy savings. The reports are gather from market, environmental and customer data. Further, the analysis is prepare based on the reports.

Expected Outcome

From the examination of circular economy and its sustainable principles adopted in Indian fashion industry, several adoption policies, principles, practices, challenges are identified. Further, in order to reduce the resources and GHG emissions, the climate strategies challenges and practices in circular fashion industry are identified.

References

Abhinav, M., Lazarus, T. P., Priyanga, V., & Kshama, A. (2018). Impact of rainfall on the coconut productivity in Kozhikode and Malappuram Districts of Kerala. Current Agriculture Research Journal, 6(2), 183-187.
Bick, R., Halsey, E., & Ekenga, C. C. (2018). The global environmental injustice of fast fashion. Environmental Health, 17(1), 1-4.
Bocken, N., Miller, K., Weissbrod, I., Holgado, M., & Evans, S. (2018). Slowing resource loops in the Circular Economy: an experimentation approach in fashion retail. Paper presented at the International Conference on Sustainable Design and Manufacturing.
De los Rios, I. C., & Charnley, F. J. (2017). Skills and capabilities for a sustainable and circular economy: The changing role of design. Journal of cleaner production, 160, 109-122.
Dissanayake, D., & Weerasinghe, D. (2021). Towards circular economy in fashion: review of strategies, barriers and enablers. Circular Economy and Sustainability, 1-21.
Elia, V., Gnoni, M. G., & Tornese, F. (2017). Measuring circular economy strategies through index methods: A critical analysis. Journal of cleaner production, 142, 2741-2751.

FASHION

Gazzola, P., Pavione, E., Pezzetti, R., & Grechi, D. (2020). Trends in the fashion industry. The perception of sustainability and circular economy: A gender/generation quantitative approach. Sustainability, 12(7), 2809.

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.

Iran, S., & Schrader, U. (2017). Collaborative fashion consumption and its environmental effects. Journal of Fashion Marketing and Management: An International Journal.

Leslie, D., Brail, S., & Hunt, M. (2014). Crafting an Antidote to Fast Fashion: The Case of T oronto's Independent Fashion Design Sector. Growth and Change, 45(2), 222-239.

MacArthur, F. E. (2017). A new textiles economy: redesigning fashion's future. Ellen MacArthur Foundation, 1-150.

Machado, M. A. D., de Almeida, S. O., Bollick, L. C., & Bragagnolo, G. (2019). Second-hand fashion market: consumer role in circular economy. Journal of Fashion Marketing and Management: An International Journal.

Mishra, S., Jain, S., & Malhotra, G. (2020). The anatomy of circular economy transition in the fashion industry. Social Responsibility Journal.

Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., & Gwilt, A. (2020). The environmental price of fast fashion. Nature Reviews Earth & Environment, 1(4), 189-200.

Pandit, P., Nadathur, G. T., & Jose, S. (2019). Upcycled and low-cost sustainable business for value-added textiles and fashion Circular Economy in Textiles and Apparel (pp. 95-122): Elsevier.

Provin, A. P., & de Aguiar Dutra, A. R. (2021). Circular economy for fashion industry: Use of waste from the food industry for the production of biotextiles. Technological Forecasting and Social Change, 169, 120858.

Roos, S., Zamani, B., Sandin, G., Peters, G. M., & Svanström, M. (2016). A life cycle assessment (LCA)-based approach to guiding an industry sector towards sustainability: the case of the Swedish apparel sector. Journal of cleaner production, 133, 691-700.

Rosa, P., Sassanelli, C., & Terzi, S. (2019). Towards Circular Business Models: A systematic literature review on classification frameworks and archetypes. Journal of cleaner production, 236, 117696.

Saha, K., Dey, P. K., & Papagiannaki, E. (2021). Implementing circular economy in the textile and clothing industry. Business Strategy and the Environment, 30(4), 1497-1530.

Sandvik, I. M., & Stubbs, W. (2019). Circular fashion supply chain through textile-to-textile recycling. Journal of Fashion Marketing and Management: An International Journal.

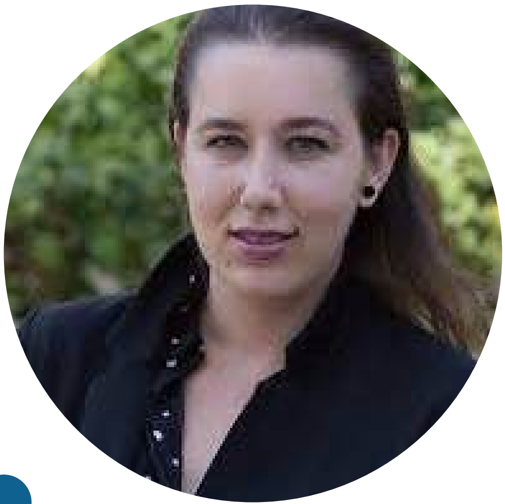
Shirvanimoghaddam, K., Motamed, B., Ramakrishna, S., & Naebe, M. (2020). Death by waste: Fashion and textile circular economy case. Science of The Total Environment, 718, 137317.

Witjes, S., & Lozano, R. (2016). Towards a more Circular Economy: Proposing a framework linking sustainable public procurement and sustainable business models. Resources, Conservation and Recycling, 112, 37-44.

About the Author

Nidhin Kurian John
Research Scholar at IIM, Kozhikode

Nidhin Kurian John is a dynamic leader with over a decade of diverse experience in retail and information technology, advancing sustainability, circular economy, and digitization in the fashion and retail sector. He previously served as Head of Circular Economy, Sustainability, and Digitization at Aditya Birla Fashion and Retail Limited (ABFRL), India's largest fashion entity. Currently a research scholar at IIM Kozhikode pursuing a PhD in strategy, Nidhin holds an MBA from IIM Kozhikode and a degree in computer science engineering. His deep expertise in sustainability and circular economy is reflected in his authored research papers, published in leading academic journals, and presented at various international conferences.



MAYA SHERMAN
INNOVATION ATTACHÉ,
ISRAELI EMBASSY IN INDIA

JUST ROADMAP TO DIGITAL CIRCULAR ECONOMY IN INDIA

TECHNOLOGY

JUST ROADMAP TO DIGITAL CIRCULAR ECONOMY IN INDIA

Maya Sherman
Innovation Attaché,
Israeli embassy in India

ABSTRACT

This article seeks to explore the potential of AI-driven interventions in addressing climate-related issues, with a particular focus on fostering critical discourse surrounding the socio-cultural implications of digital innovation across climate streams and human collectives. As a fellow in the social enterprise Karo Sambhav, this article will examine selected AI use cases that promote the development of circular economy, assessing both their potential contributions and perceived risks to future employment prospects and socio-cultural dynamics, particularly in the context of India. Critically, the article will offer a qualitative methodology, through an Environmental, Social and Governance (ESG) analysis of AI-driven waste management.
The main goal of the author is to highlight the ambiguity of digital interventions in the modern era across cultures, communities, and agile weather conditions. The article will conclude with relevant recommendations to foster responsible usage of AI in waste verticals.

Keywords: Artificial Intelligence, ESG, Waste Management, Recycling, Circular Economy

TECHNOLOGY

Introduction

The pervasive climate crisis requires a renowned approach to human action and climate resilience. Some scholars posit that the human-centric approach to climate solutions may not sufficiently address the severity of contemporary environmental challenges. In recent years, there has been a notable surge in the adoption of digital interventions within the climate domain, leveraging various emerging technologies to mitigate global environmental impacts. The paper will scrutinize the following research question:

RQ: To what extent can AI-driven interventions enhance the scope and impact of India's waste value chain?

By delving into the concepts of circular economy and core AI functionalities within waste management solutions, this article will offer a qualitative analysis of the environmental, societal, and governmental dimensions of AI-driven circular economy. Ultimately, the aim is to foster a critical discussion on the intersection of digital innovation, the informal climate sector, and human livelihoods to ensure both planetary and human welfare.

Literature Review

The notion of circular economy represents a comprehensive approach to managing the life cycles of products, acknowledging the scarcity of vital materials and advocating for the repurposing of various components to foster sustainable and responsible resource utilization across generations. This recognition of material scarcity necessitates innovative strategies for creating primary and secondary raw materials, many of which are being tested and implemented through the integration of AI, Internet of Things, blockchain and other emerging technologies.

Circular economy principles aim to minimize material waste and pollution, extend the longevity of products, and regenerate natural systems. The potential benefits of embracing circular economy models are substantial, with recent studies suggesting that the European circular economy could generate a net benefit of nearly 2 trillion euros by 2030, fostering job creation, innovation, and environmental conservation efforts. However, the long-term viability of circular economy models necessitates novel digital approaches to ensure their sustainability and resilience in the face of evolving environmental challenges (Ellen MacArthur Foundation, 2019).

This review will provide an overview of AI applications within circular economy frameworks, with a specific focus on smart waste management strategies. The insights gleaned from this review will serve as a foundation for discussions on Environmental, Social, and Governance (ESG) considerations within the Indian context. When evaluating the potential contributions of AI to human livelihoods, it is essential to differentiate between AI's utility in enhancing human capabilities and its impact on various industry verticals. This article will elucidate AI's operational significance in the climate domain, particularly in predictive maintenance and analytics within the waste value chain. While a global analysis of AI's impact on human functionality is valuable, it is the localized application across industry verticals that fully demonstrates AI's potential and its associated risks.

This article underscores the hybridization of traditional circular economy approaches with emerging technologies to promote planetary welfare and sustainable livelihoods.

TECHNOLOGY

Against the backdrop of an escalating climate crisis, the role of AI in climate discourse becomes increasingly vital, diversifying mitigation strategies and advancing the achievement of Sustainable Development Goals (SDGs). AI, as a cluster of technologies, merits recognition for its collective potential in addressing climate challenges, enabling the expansion of human capabilities through data analysis, and predictive insights (Rathore & Malawalia, N.A).

AI-based algorithms offer support for various data processes, including trend classification, image recognition, natural language processing, and predictive analysis (Pregowska, Osial, & Urbańska, 2022). The accelerated development of generative AI in recent years holds promise for climate action, facilitating the design of circular products and mitigating human biases in circular processes. For instance, AI can provide designers with informed insights into product design and accelerate testing processes (Cornelius, 2024). Moreover, AI's predictive capabilities can forecast usage patterns and identify inefficiencies in resource management, as demonstrated by a pilot program in the UK analyzing real-time water quality to mitigate water pollution (Rose, 2023).

Furthermore, AI fosters innovation in business models through dynamic pricing mechanisms, algorithmic matching for sharing secondary raw materials, and predictive analytics for reverse logistics. From a broader perspective, enhanced AI features can establish smart infrastructure for circular cities, facilitating the efficient distribution of secondary raw materials in the global economy (Rathore & Malawalia, N.A).

The literature highlights AI's catalytic role in waste management, particularly in advancing sustainable material practices (Qu, 2021; Abdallah et al, 2020; Fang et al.,2019). Potential AI applications include automated quality assessment of materials, sorting processes, and recommendations for optimized usage (Rathore & Malawalia, N.A). Notably, studies have emphasized the development of classification robots, predictive models, and smart bins for real-time waste monitoring, predictive collection, and overall waste management facility optimization. Various countries, including Austria, Germany, New Zealand, Japan, Singapore, and South Korea, have embraced AI in waste management and recycling solutions to improve resource utilization, efficiency, and recycling opportunities (Soni et al., 2019).

Recent pilot studies have demonstrated the efficacy of AI interventions in waste management, enabling real-time supervision and material collection with enhanced safety measures. Scholars have underscored AI's capacity to enhance operational efficiency, improving waste collection accuracy and timeliness (Pregowska, Osial, & Urbańska, 2022; Gutierrez, Jensen, Henius, & Riaz, 2015). However, there remains a need to address potential challenges and ethical considerations associated with the widespread adoption of AI in waste management.

Discussion: Despite the promising potential of AI-driven interventions in the waste value chain, it is imperative to acknowledge and address the broader implications of their excessive and irresponsible usage. To this end, this paper advocates for a critical examination of the multifaceted impacts of AI within the context of waste management, emphasizing the interdisciplinary nature of digital innovation.

TECHNOLOGY

While the discourse surrounding AI often revolves around hypothetical narratives of its capabilities, supported by limited case studies, particularly in emerging economies, it is essential to explore and mitigate the potential bottlenecks and challenges associated with AI implementation in climate sectors, such as waste management.

From an environmental perspective, the widespread adoption of AI technologies is hindered by its high energy consumption and data processing requirements. Current trends favor the utilization of large AI models to accommodate diverse user audiences and broader scope targets. However, the proliferation of such models necessitates substantial energy consumption and research and development costs, raising concerns about their environmental impact. As highlighted by GlobalData (Thomas, 2024), evidence suggests that by 2026, the energy consumption of AI's datacenters is expected to double, reaching levels comparable to those of nation-states. Consequently, the substitution of climate damage caused by human activities with that generated by algorithms contradicts the principles of social innovation, necessitating a reconsideration of AI deployment strategies.

Furthermore, societal considerations underscore the need to address the digital divide exacerbated by the accelerated proliferation of AI across various sectors. Access to digital benefits remains unequal due to socio-cultural factors and accessibility barriers, perpetuating disparities among communities. In the context of India, characterized by complex caste and gender dynamics and a significant informal sector, the deployment of AI technologies must be tailored to accommodate diverse audiences and address existing inequalities.

Moreover, AI's inherent biases and alienating nature pose significant challenges, particularly for marginalized communities

The reinforcement of socio-cultural biases by AI algorithms exacerbates existing inequalities and perpetuates discriminatory practices, disproportionately affecting vulnerable populations. In the informal waste sector, marginalized groups, including female and youth waste workers, face heightened risks of exclusion and exploitation. The intersectional nature of AI further amplifies these risks, underscoring the need for proactive measures to safeguard the welfare of vulnerable communities (Sherman, 2024; Saban Ireni & Sherman, 2022). Therefore, the repercussions for the future workforce and the welfare of the informal climate sector should be considered, as the vulnerable communities are more likely to suffer the most.
The potential displacement of informal waste workers by AI-driven technologies presents a philosophical dilemma regarding societal progress and human welfare. While AI algorithms can replicate certain human actions more efficiently, they risk exacerbating social inequalities and diminishing the dignity of labor. Moreover, the erosion of informal waste professions threatens to marginalize vulnerable communities further, highlighting the need for ethical and equitable AI deployment strategies.

This scenario suggests the digital delivery of an instrument that gradually leads to the removal of the informal waste profession, containing repetitive and redundant actions. Importantly, these human actions can be easier for the algorithm to mimic but still represent some of the core functionalities of informal waste workers. Therefore, the risk of AI possibly replacing human workers increases in the waste value chain, due to the repetitive nature of human action and possible reduction in costs to the aggregators.

TECHNOLOGY

Nonetheless, climate action should serve the planet's citizens, and not its algorithms, bringing into conflict the mere positioning of AI as a suitable alternative to certain functionalities of human workers.

From a governance perspective, the regulatory landscape surrounding AI remains fragmented and inadequate, posing challenges for policymakers seeking to address AI-related risks effectively. Recently, the first AI regulation was approved in the EU, addressing the threats of deepfakes and electoral interventions, suggesting risk-based classification for the aptness of AI actions. While the European Union has taken steps to regulate AI, international efforts to establish comprehensive regulatory frameworks remain nascent. The global nature of AI necessitates contextually relevant and diverse regulatory approaches to mitigate potential harms and safeguard human rights across industries and cultures.

Crucially, any ESG analysis is more likely to vary across industries, professions, and cultures, and therefore impact the needed policies to harness the AI potential and moderate the aligned harms. Greater scrutiny should be attributed to AI literacy and adaptation of informal waste workers to the new workforce, with an increased focus on females and youth.

Moreover, it is crucial to provide increased social protection and support for those workers to pursue the profession they aspire to, under defined legal thresholds. The question of the regulatory aptness of the informal sector is ambiguous and exceeds the scope of this paper. On the one hand, the regulators are required to set legal thresholds to sustain the formal economy and guarantee equal tax payments, to ensure just conditions for all employers.

On the other hand, in such a culturally diverse population as India in rural and urban settings as one, not all can join the formal economy, and are forced to be part of the informal sector to keep their welfare. As the Indian informal sector exceeds 80 percent of the national economy, this question becomes more complex, and requires interim solutions supporting informal workers and providing the right mechanisms to become more digitally fluent and transition into the formal economy.

To conclude, this paper sought to discuss the existing AI use cases in the climate ecosystem, particularly waste management, in a bid to promote sustainable and data-driven circular economy. Despite the great promise of AI-driven tools and interventions, it is crucial to acknowledge the environmental, societal and governmental aspects of such technology in traditional and informal climate practices as waste management.

Consequently, the paper recommends the establishment of supporting mechanisms for the informal waste sector in India, providing them with the right fluency skills to cope with the AI revolution and cater for their personal and collective needs. Due to the ambiguous request from regulators to support informal and non-regulatory practices, which do not align existing waste regulations, there might be a need for separate societal schemes that are supported by the regulation, to strengthen the Indian informal sector and not reduce it drastically. This can be supported by the work of multilateral organizations and civil society, in similarity to the existing work of the Global Partnership on Artificial Intelligence, established by the OECD (GPAI, n.d.).

TECHNOLOGY

While AI offers promising solutions for improving waste management efficiency and sustainability, its deployment must be guided by ethical considerations and a commitment to inclusive development. By addressing the environmental, societal, and governmental dimensions of AI deployment, policymakers can harness the potential of AI to advance sustainable development goals while mitigating its associated risks. Ultimately, the responsible integration of AI into waste management practices requires collaborative efforts from governments, industries, civil society, and academia to ensure that no individual or community is left behind in the pursuit of a more sustainable future.

As the frequency of artificial and non-human phenomena increases, there is a tendency to separate the human element from them. Algorithms receive greater scrutiny, due to their potential advancement of humanity and Darwinist evolution. Yet, this article posits that humans are and will always be the main benefactor of any innovation, and no individual should be forgotten. The design of AI-driven interventions should be environmentally, socially, and governmentally modified to accommodate the needs of all human collectives, including marginalized communities. Every person has the right to be seen and acknowledged, and algorithms should not discriminate against individuals due to the formality of their profession.

References:

- Abdallaha, M., Talib, M. A., Feroz, S., Nasir, Q., Abdalla, H., & Mahfood, B. (2020). Artificial intelligence applications in solid waste management: A systematic research review. *Waste Management, 109*, 231–246.
- Cornelius, R. (2024). Building a digital circular economy: Harnessing technology for sustainability. *SLR*. Retrieved from: Building a digital circular economy: Harnessing technology for sustainability (slrconsulting.com)
- Ellen MacArthur Foundation. (2019). *Artificial intelligence and the circular economy - AI as a tool to accelerate the transition*. Retrieved from: artificial-intelligence-and-the-circular- economy.pdf (mckinsey.com)
- Fang, B., Yu, J., Chen, Z., Osman, A. I., Farghali, M., Ihara, I., Hamza, E. H., Rooney, D. W., & Yap, P.-S. (2023, May 9). Artificial intelligence for waste management in smart cities: A review. *Review of Environmental Chemistry Letters*. Advance online publication. https://doi.org/10.1007/s10311-023-01604-3
- Global Partnership on Artificial Intelligence. (N.D). Working Group on the Future of Work. Retrieved from https://gpai.ai/projects/future-of-work/
- Gutierrez, J. M., Jensen, M., Henius, M., & Riaz, T. (2015). Smart waste collection system based on location intelligence. *Procedia Computer Science, 61*, 120–127.
- Ireni-Saban, L., & Sherman, M. (2021). *Ethical Governance of Artificial Intelligence in the Public Sector* (1st ed.). Routledge. DOI: 10.4324/9781003106678
- Rathore, A. S., & Malawalia, P. (N.A). Deploying Artificial Intelligence for Circular Economy and its Link with Sustainable Development Goals. *International Journal of Policy Sciences and Law, 1*(4).
- Rose, E. (2022). Big Data has a big water problem - is AI the answer? *Diginomica*. Retrieved from: Big Data has a big water problem - is AI the answer? (diginomica.com)
- Soni, U., Roy, A., Verma, A., & Jain, V. (2019). Forecasting municipal solid waste generation using artificial intelligence models—A case study in India. *SN Applied Sciences, 1*, 162.
- Pregowska, A., Osial, M., & Urbańska, W. (2022). The Application of Artificial Intelligence in the Effective Battery Life Cycle in the Closed Circular Economy Model—A Perspective. *Recycling, 7*(6), 81. https://doi.org/10.3390/recycling7060081
- Qu, D. (2021). Application of Artificial Intelligence in Waste Classification Management at University. In H. Sharma, V. K. Vyas, R. K. Pandey, & M. Prasad (Eds.), *Proceedings in Adaptation, Learning and Optimization, Proceedings of the International Conference on Intelligent Vision and Computing (ICIVC 2021)* (pp. 23–25). Qingdao, China: Springer.
- Sherman, M. (2024, January 23). Intersectionality of AI-Powered Deepfakes: Lessons from Bollywood. *Fidutam*. Retrieved from Intersectionality of AI-Powered Deepfakes: Lessons from Bollywood | by Fidutam | Fidutam | Medium
- Thomas, E. (2024, March 14). How “energy-hungry AI” is straining grids and spreading climate disinfo. *Power Technology*. Retrieved from How “energy-hungry AI” is straining grids and spreading climate disinfo - Power Technology (power-technology.com)

About the Author

Maya Sherman
Innovation Attaché,
Israeli Embassy in India

Maya Sherman is an AI Policy Researcher, Board Member, Lecturer and Ethicist, with an MSc from Oxford Internet Institute. She serves as the Innovation Attaché at the Israeli Embassy in India, WTM Ambassador of Google, and MTE Ambassador of the World bank Group Youth Community. Maya is also an AI Expert and Project Co-Lead at the Future of Work Committee, co-leading national AI literacy programs for the informal sector. She served as Banyan Impact Fellow, by the American India Foundation, supporting digital transformation strategies across climate NGOs.

Ojaswini Rao Ayde **Trisha Singhal** **Yashasvi Aggarwal**

Miranda House, Delhi University, Economics Major

SUSTAINABLE PACKAGING SOLUTIONS IN INDIA: NAVIGATING THE TRANSITION TO A CIRCULAR ECONOMY

SUSTAINABLE PACKAGING SOLUTIONS IN INDIA: NAVIGATING THE TRANSITION TO A CIRCULAR ECONOMY


Ojaswini Rao Ayde


Trisha Singhal


Tejaswini Aggarwal

INTRODUCTION

Packaging is one of India's fastest-growing industries, contributing to technological advancements across various manufacturing sectors, including agriculture and fast-moving consumer goods (FMCG). The India Packaging Market size is estimated at USD 84.37 billion in 2024. It is expected to reach USD 142.56 billion by 2029, growing at a CAGR of 11.06% during the forecast period (2024-2029) (India Packaging Market Insights, n.d.-b). In 2019, India produced around 17 million tons of plastic, among them approximately 59% was used in packaging, of which only 15% was effectively recycled with the rest either incinerated or dumped in landfill (UNEP, 2021). The trend of plastic consumption in packaging in India is higher compared to the global average, accounting for approximately 59% of total consumption of 19.8 million tonnes in 2020. (Hossain et al., 2023)

PACKAGING

CIRCULAR ECONOMY PRINCIPLES AND THE INDIAN PACKAGING MARKET

The high usage of plastic in packaging is of great concern. Indian packaging industry consumes the majority of the nation's plastic consumption, with 42% of total consumption used in flexible packaging and 17% used in rigid packaging. This adds up to 8.37 kg of plastic packaging consumption per capita. A circular economy for plastics aims to reduce wasteful usage of plastics, utilize renewable sources of production, reuse and recycle plastics within the economy without environmental leakage, and generate minimal waste. Over the past years, the concept of circular economy has gained consensus as a new perspective covering waste management, supply chains, and packaging as an important element for achieving circularity. Traditionally, the packaging industry operates on a linear model of design, production, consumption, and disposal, generating significant waste that poses environmental concerns. The shift to a circular system requires fundamental changes in packaging design to minimize waste and promote sustainability.

To achieve the circular economy goal, packaging waste reduction and material recovery suitability are critical. Strategies include minimizing packaging material, reusing packaging, utilizing bio egradable materials, and incorporating recycled materials into packaging design. The circular economy principal banks upon the fact that plastic never becomes pollution. To create a circular economy, a three-pronged approach needs to be followed-

Eliminating problematic plastic materials, innovating reusable and recyclable materials, and disposing of the items out of the environment. Building a circular economy requires a collaborative approach involving various stakeholders: packaging companies, government, non-profit groups, and informed consumers. This collective effort is crucial for keeping recyclable plastic packaging circulating within the economy, reducing plastic waste and pollution, and significantly lowering greenhouse gas emissions.

CHALLENGES FACED IN ADOPTING CIRCULAR PACKAGING

Transitioning towards circular packaging presents a multifaceted challenge, necessitating cohesive efforts across various departments within a company, changes in consumer mindsets, cultural shifts, and advancements in technology and infrastructure. To effectively address these challenges, it's imperative to delve into them comprehensively and take proactive measures to overcome them.

One significant hurdle lies in the lack of accessible, reliable, and omprehensive data. Companies often struggle to obtain the necessary information required for making informed decisions regarding sustainable packaging practices. Complete data sets are essential for establishing frameworks, standardized tools, and methodologies across the industry, thereby facilitating a streamlined approach to the adoption of circular packaging solutions. Another obstacle is the presence of competing priorities. Testing the reliability of materials produced for circular packaging can be challenging. There's uncertainty regarding whether these materials will meet circular packaging standards, and reduce carbon footprints, and greenhouse emissions while also upholding safety standards and consumer health requirements. Balancing these diverse priorities requires careful consideration and possibly iterative testing and refinement processes.

Moreover, attention must be given to the product's lifespan and the packaging's ability to maintain product integrity throughout its intended use.

PACKAGING

Packaging should contribute to prolonging the product's shelf life and ensuring its quality and safety until consumption. Inadequate infrastructure poses yet another significant challenge. Waste management practices vary widely between countries and even within the same country across different municipalities. This results in inconsistencies and inefficiencies due to varying infrastructure and processes for handling packaging waste. Effective management of packaging materials throughout their lifecycle and beyond is crucial for realizing the circular economy's potential. Without robust support for collection, processing, and conversion infrastructure, achieving a circular economy centered around reusable, recyclable, or biodegradable packaging solutions become unattainable.

MAJOR CONTRIBUTING INDUSTRIES WITH CASE STUDIES

➔ INDIAN PHARMACEUTICAL INDUSTRY

The Indian Pharmaceutical Industry (IPI) plays an important role in India's economy, ranking third globally by production volume and fifteenth by production value. Packaging plays a crucial role in the pharma industry, where its function extends beyond serving as a branding aid and providing barrier protection to products for the shelf-life period. In response to environmental concerns and the growing demand for pharmaceutical products, the industry is shifting towards sustainable packaging strategies. This shift involves embracing biodegradable materials like Polylactic Acid (PLA) and Polyhydroxyalkanoates (PHA), derived from plant-based sources, to replace traditional plastic or metal-based packaging. These materials decompose naturally over time, reducing environmental impact and waste accumulation. However, challenges remain in ensuring these materials adequately protect products and meet regulatory standards.

The Meghmani Group exemplifies leadership in sustainable packaging solutions within India's pharmaceutical industry, emphasizing innovation, sustainability, and customer satisfaction. With over 40 years of experience, the company's diverse portfolio and commitment to technological advancements position it as a frontrunner in delivering superior quality, environmentally friendly products.

➔ E-COMMERCE INDUSTRY

The rise of e-commerce in India has indeed transformed the shopping landscape, offering unparalleled convenience for consumers while posing new challenges for the packaging industry. Sustainability has emerged as a crucial consideration amidst growing environmental consciousness among both businesses and shoppers.

In response to this shift, the Indian e-commerce sector has been actively embracing eco-friendly packaging solutions. Corrugated boxes have gained prominence for their durability and eco-friendly credentials, being crafted from recycled materials. Moreover, there's a trend towards adopting compostable packaging materials like cornstarch-based packing peanuts and paper-based bubble wrap, which decompose naturally, lessening the burden on landfills. Empower India, a prominent think-tank, recently conducted a comprehensive study on the retail industry's sustainability practices, with a particular focus on e-commerce giants operating in India. Among the key findings, Amazon emerged as a leader in sustainability efforts within the sector.

Amazon has been at the forefront of sustainable packaging initiatives, with a commitment to reducing single-use plastic and embracing eco-friendly alternatives. Since 2020, Amazon has eliminated single-use plastic from its India network, replacing it with eco-friendly paper alternatives. This initiative has resulted in the avoidance of 97,222 metric tons of single-use plastic in 2021 alone.

PACKAGING

Amazon has reimagined traditional packaging design by actively embracing reusable packaging solutions. Collaborating with industry professionals, the company has developed durable, eco-friendly alternatives that can be used multiple times before being recycled. This shift challenges other market players to follow suit. The company has committed to incorporating sustainable materials in its packaging, including biodegradable, compostable, and recycled materials. Through collaboration with packaging experts and leveraging cutting-edge technology, Amazon is pioneering environmentally conscious materials, reducing the burden of non-biodegradable waste. Apart from this, Amazon aims to empower its vast customer base to participate actively in sustainable shopping practices. Plans for an educational campaign are underway, providing consumers with easy-to-understand information about eco-friendly packaging options. By empowering buyers with knowledge, Amazon envisions a shift in consumer behavior towards sustainable packaging choices.

FOOD AND BEVERAGE INDUSTRY

Packaging plays a crucial role in the food supply chain, yet there's a significant lack of understanding and attention to implementing extended producer responsibility for packaging. The environmental impact of food packaging, particularly plastic, has garnered increased concern due to its contribution to waste and CO_2 emissions. Nearly all plastic packaging is petroleum-derived and has persisted in the environment for centuries, with around half being single-use. While packaging serves to protect food from contaminants and maintain quality, its environmental consequences are significant. Various functions of food packaging, such as containment, preservation, and communication, dictate the choice of materials.

The emergence of new concepts like active and intelligent packaging has facilitated improvements in the food supply chain, storage life, and consumer knowledge.

Technological advancements allow for enhanced functionality in packaging, including real-time detection of food quality. However, embracing these changes requires shifts not only in technology but also in consumer behavior, regulations, cultural perceptions, infrastructure, and market dynamics. Re-usable fast food packaging: Burger King Takeaway food is big business -- but the packaging for those meals poses a sustainability challenge. Global takeaway brand Burger King has unveiled a solution in the form of reusable packaging intended to reduce the amount of waste it generates. Customers in New York, Tokyo, and Portland, Oregon will soon be able to buy burgers and drinks in reusable packaging. The plan, one in place for next year, features a small deposit charged initially and then refunded when the customer returns with the boxes and cups, which are taken away for cleaning and processing via the zero-waste e-commerce system Loop.

GOVERNMENT POLICIES FOR SUSTAINABLE PACKAGING

The Indian government has implemented various policies and initiatives to promote sustainable packaging practices. For example, the Plastic Waste Management Rules 2016 mandate the use of compostable plastics and encourage the adoption of recyclable materials in packaging. Additionally, initiatives such as the Swachh Bharat Abhiyan (Clean India Mission) emphasize waste management and environmental sustainability, creating a favorable regulatory environment for sustainable packaging investments.

PACKAGING

Policy/Rule Description Plastic Waste Management Rules (PWM), 2016

Introduced by MoEFCC to reduce plastic waste and promote recycling. Mandates Extended Producer Responsibility (EPR) for producers, importers, and brand owners. Specific targets are set for waste collection, segregation, and recycling. States are required to achieve a minimum of 25% recycling of plastic waste by 2021.

Plastic Waste Management (Amendment) Rules, 2018

Amended regulations for plastic packaging, including phasing out non-recyclable multi-layered plastic (MLP) packaging within two years. Promotes the use of recyclable alternatives.

Single-Use Plastics (SUP) Ban

Various states and union territories in India implemented bans on single-use plastics (e.g., bags, cutlery, straws) to reduce plastic pollution. Maharashtra implemented a ban in June 2018.

National Packaging Policy (NPP)

Under consideration by the Indian government to address packaging waste issues and promote sustainable packaging practices. It aims to establish standards and promote recycling, and eco-friendly materials.

EcoMark Certification Scheme

Implemented by BIS to certify environmentally friendly products, including packaging materials. Products meeting specified criteria for environmental performance and sustainability are eligible.

ROLE OF CONSUMERS IN ADOPTION OF CIRCULAR PACKAGING

Consumers play a crucial role in the adoption of circular packaging practices. Their behaviors, preferences, and demands have a significant influence on the packaging choices made by companies and ultimately drive the transition toward more sustainablepackaging solutions. Here are several key ways in which consumers impact the adoption of circular packaging:

1. Demand for Sustainable Products: Consumers increasingly prioritize sustainability and environmental responsibility in their purchasing decisions. They actively seek out products packaged in materials that are recyclable, reusable, or biodegradable.

2. Feedback and Consumer Awareness: Consumer feedback and awareness campaigns can raise awareness about the environmental impacts of packaging and the benefits of circular packaging solutions.

3. Support for Recycling and Reuse Programs: Consumers play a vital role in recycling and reuse initiatives by properly sorting and disposing of packaging materials.

4. Pressure on Brands and Retailers: Consumer activism and advocacy can put pressure on brands and retailers to prioritize sustainability and adopt circular packaging practices.

5. Education and Awareness: Educating consumers about the importance of circular packaging and providing information about how they can make more sustainable choices empowers them to drive change.

CONCLUSION

India is increasingly moving towards sustainable packaging solutions to reduce the environmental impact. India is promoting circularity through waste management reforms and eco-friendly waste regulations. The future of sustainable packaging in India looks promising due to growing consumer awareness and regulatory support. Scaling up sustainable practices requires collaborative efforts across industries and government intervention and control. Embracing circular economy principles, leveraging AI, and aligning with supportive policies are key strategies for a greener future in Packaging.

MR RAHUL NAINANI
CEO & Co-Founder
Recircle

TÊTE-À-TÊTE
with

SHALINI GOYAL BHALLA
Managing Director
International Council for
Circular Economy

IN FOCUS

What inspired you to start ReCircle, and what was the initial vision behind the company?

When I was growing up, I never thought I'd make a living in the field of waste management. It happened as a result of a few pivotal experiences; in 2015 my co-founder, Gurashish Singh Sahni and I participated in Google's Startup Weekend where we birthed the concept of an 'Uber for Raddiwalas' app, securing us victory in the competition. This achievement heightened our awareness regarding waste segregation and resource recovery, ultimately paving the way for ReCircle (formerly known as Raddiconnect).

A huge wake up call was the massive Deonar fire that took place in 2016 which raged in the largest dumpsite in Asia.

The smoke from the landfill fire was visible in NASA images. Days later when we visited the location, we learnt that the life expectancy of people living around the dumpsite was 38 years of age!

We also learnt that India imports 465 crore plastic bottles annually, just to keep its recycling industry going, and we found that unacceptable given India is literally drowning in waste. 'Is our trash someone else's problem?', this is the mindset that we set out to change when we launched ReCircle in 2016.

How has the mission of ReCircle evolved since its inception?

When we did our on-ground research in 2015-16, the ecosystem was in disarray; there were several players from collectors to scrap dealers and municipal workers and there was disjointedness in the ecosystem. We realised that we needed to view waste in a different lens — from a circularity and systems approach and look at it as a valuable resource. We went from building a largely B2C waste management system to a B2B-first model and rebranded to ReCircle in 2021.

Today, our mission is to create a robust waste management ecosystem and create a world where no resources are wasted by pursuing and promoting ethical circularity.

Transforming the ecosystem means we work with all stakeholders within it — right from brands to collectors, processors as well as informal waste workers or Safai Saathis, the often-destitute citizens forming the backbone of municipal cleanliness around the world.

Applying traceability and transparency to the largely unseen and shadow supply chain of waste can be a game-changer not just for the lives and livelihoods of informal waste workers, but also brands, collectors and processors. We launched ClimaOne last year to bring in end-to-end traceability into the ecosystem for plastic credits, live data tracking, non-duplication of plastic credits, etc.

IN FOCUS

Can you explain how ReCircle's waste management services work, particularly the dry waste recycling and composting programs?

The collected dry waste materials are generally collected and sent to ReCircle's Advanced Material Recovery Facility in Dahisar, Mumbai. The waste is segregated by ReCircle's Safai Saathis where it is cleaned, processed and bailed. This processed waste is then sent out to recyclers who convert it into plastic granules. The granules are then converted to new products.

What are some of the biggest challenges ReCircle has faced in promoting responsible waste management?

One of the biggest operational challenges we face is contamination of dry waste with wet waste or with hazardous substances or non-recyclables. This makes the entire sorting process challenging and not to mention dangerous in some cases. It also reduces the value of recycled materials or unsuitable for future use. We encourage people to segregate waste and execute proper waste segregation in conjunction with Safai Saathis and thereafter recyclers. Proper segregation of waste at the source (like homes, businesses, etc.) in wet, dry and reject makes the downstream processes more efficient.

Can you share any upcoming technological advancements or projects ReCircle is working on?

We're constantly looking at innovative ways to digitise the waste supply chain and having established circularity for plastic waste it was a no brainer for us to look at textiles as another waste stream for us to work with. After plastic and paper, textiles are the third-largest source of waste in many Indian states. That is why we recently launched Project Extra Life to tackle India's textile waste problem and build a more circular future.

What advice would you give to other businesses looking to engage in sustainable practices?

I think consumers are really steering the conversation in the right direction. For brands, it's important to listen to consumer needs and shifts in demands and make the right changes towards sustainability, be focused on meeting those goals, and lastly, use better product design keeping circularity in mind.

IN FOCUS

How does ReCircle engage with communities to educate them about waste management and recycling?

We organise waste collection drives across the city of Mumbai (where we are headquartered) on a monthly basis as well as beach clean ups to prevent waste from entering our landfills and waste bodies. We enforce proper waste management at the local level. As an example, during our Diwali Dry Waste Collection Drive in 2023, we collected more than 20,000 kgs of waste (equivalent to 714,286 chips packets) and this impact wouldn't have been possible without conscious citizens' support.

Further, we work as waste management consultants for events — in 2023, we partnered with the Narendra Modi Stadium in Ahmedabad for the cricket world cup in October. It's extremely important for us to move towards zero waste events. We also work with offices and corporations to enable them to become zero waste work spaces.

How do you measure success at ReCircle, and what milestones are you looking forward to achieving in the near future?

We measure our success by the impact of our work; we channel waste away from landfills and oceans, formalise the marginalised and fragmented waste industry in India and enable a circular economy.

ReCircle has diverted over 169,000 MT (equivalent to the weight of 28,166 elephants) of waste from landfills and our oceans across 270 cities & towns in India with the help of 45+ processing partners who have a pan-India network of 400 collection partners all while impacting the lives of over 3100 informal waste workers or Safai Saathis.

We are committed to evolving and expanding our impact through a series of strategic initiatives such as achieving end-to-end circularity for plastics, exploring new supply chains, further leveraging technology, strengthening ClimaOne (our revolutionary tech-enabled platform), forging more partnerships across the sector, awareness and capacity building while building capacities with our Safai Saathis and collection partners.

IN FOCUS

What motivates you to continue driving change in the waste management sector?

For me it's about waking up everyday knowing that we are positively impacting the environment, businesses and livelihoods with the work that we do.

I'll give you an example, during the first month of the pandemic in 2020, we were contemplating running our material recovery facility in Dahisar, Mumbai because we were worried about the health of our informal waste partners or Safai Saathis who work at the centre. However, to my surprise, everyone in the team, including the Safai Saathis suggested we keep operations running because if we didn't there might be another pandemic looming right around the corner.

Waste isn't only an environmental problem but also a human and societal issue, and while our efforts might be pan-Indian, the mission to create a circular economy truly impacts the globe. After all, it is the little things that matter. This is what drives me every single day.

This made me realise the importance of what we do. We are building something here that adds value to people's daily lives, and that all our employees, Safai Saathis included, are equally passionate about our work and mission. At ReCircle, we've always been driven about building a culture driven by care and collaboration and this was evident at a most crucial time.

Over the years we have diverted over 169,000 MT of waste from landfills and our oceans. And it doesn't stop there — like I mentioned earlier, we're also empowering 3100+ Safai Saathis, across a massive pan-India collector network to create a revolution; originating in India, spreading across the world. We want to be at the forefront of formalising the waste sector and play an active role in the transition to a circular economy.

Mr Rahul Nainani
CEO & Co-Founder

ReCircle
Recover. Recycle. Rethink

Mr Rahul Nainani is a distinguished alumnus of the CFA program, Rahul excels in strategy, branding, business development, finance, and fundraising. He has forged long-term collaborations with industry giants, including HUL, UNDP India, Hindustan Coca-Cola Beverages, Mondelez, Tata Starbucks, and others, aiding them in accomplishing their sustainability objectives. As an innovative leader, Rahul prioritises sustainable growth, creating mutually beneficial outcomes for employees, partners, clients, and society.

A 'Purpose fuelled by Passion and Profit' mindset enables Rahul to function as a Social Entrepreneur with a proactive, hands-on leadership style; his energy is contagious.

LICO MATERIALS

Pioneering Sustainable Solutions for Lithium-ion Battery Recycling and Refurbishing in India's EV Transition

Gaurav Dolwani
CEO
LICO Materials

LICO, a recycling and refurbishing company was founded in 2021 with focus to create a sustainable circular economy solution in the lithium-ion battery supply chain for recovery of critical materials such as lithium, cobalt, manganese, and nickel to be given back to battery manufacturers to give the materials a second life. Batteries received from consumer electronics and energy storage go towards recycling whereas batteries received from electric mobility is tested and the cells that can be used for refurbishing are given a second life by being used in an energy storage application.

By 2030, India plans to convert 30% of its fleet to EV. India does not have any of the critical minerals for making a lithium-ion battery and needs to import them. By reusing the same minerals, LICO helps in contributing to India's journey of becoming Energy Independent by reducing dependency on foreign countries and impacting in the reduction of imports. At LICO, till date, we have processed end of life Lithium-ion batteries equivalent to 10,000 small electric cars or approximately 26 million mobile phones. By 2027, LICO is poised to recycle batteries from 200,000 small electric cars annually which relates to a saving of 100 million litres of water equivalent to 40 Olympic size Swimming Pools and saving of CO2 emissions equivalent to CO2 absorption by 37 million trees.

LICO has pioneered its mechanical separation process to ensure that the Black Mass-produced during recycling is of the highest purity grade which enables us to have partnerships with global giants. The consistency in quality over long term has helped in gaining confidence from our customers.

CASE STUDY

The global industry standard Recovery Rate from mechanical separation is at 75-80% but at LICO, we have achieved recovery rate as high as 92% in our mechanical separation process. In the short term, LICO is expanding its mechanical operations to its second facility being built in Bengaluru with a much larger capacity than Mumbai.

With our 2nd facility in Bengaluru to be commissioned by October 2024, LICO is positioned to be one of India's largest battery recyclers, expanding up to of 25,000 tons annually by 2026.There are some more advancements in the process that will be used in Bengaluru to ensure that our Black Mass can achieve even higher purity levels. For long term, LICO has completed its feasibility study and is finalizing downstream project to build the Hydrometallurgy plant in India for recovering metal salts from the back mass currently produced. The objective is to recover metal salts at battery grade purity to give back to anode and cathode manufacturers and close the loop.

Image: Lico Materials recycling plant in Mumbai

CASE STUDY

Message to the Readers

Every day, we are faced with choices that impact our environment. Recycling is not just a responsible action; it is a critical practice that helps reduce waste, conserve natural resources, and lower greenhouse gas emissions. Through effective recycling, we can minimize our environmental footprint and ensure that materials are used efficiently and sustainably. This is not just a corporate responsibility; it is a collective effort that involves every individual and organization. We encourage each of you to embrace recycling in your daily lives, from sorting waste at home to supporting businesses that prioritize eco-friendly practices. Let's commit to making recycling a fundamental part of our lives and work towards a sustainable future and play an active role in the transition to a circular economy.

Mr Gaurav Dolwani
CEO
LICO Materials

Mr. Gaurav Dolwani, Founder and CEO of LICO Materials Pvt. Ltd., is a visionary leader in the end-of-life battery recycling & refurbishment industry. Operating from Navi Mumbai, LICO boasts a designed capacity of 3000 MTPA for battery recycling including refurbishment, which gives second life to cells for non-critical energy storage applications. With a future minded approach, LICO is expanding to Bengaluru with capacity expanding up to 25,000 tons annually by 2026.

With over two decades of experience in the metal and commodities sector across Asia and Africa, Mr. Dolwani envisions creating a recycling & refurbishing ecosystem, venturing downstream with a hydrometallurgy plant for metal salts extraction.

LICO
Powering Your Future

ABOUT US

The International Council for Circular Economy (ICCE) is India's premier think tank dedicated to advancing the principles of the circular economy. As a leading organization in this space, ICCE is committed to driving the transition from a linear to a circular economy by fostering innovation, collaboration, and education across industries and sectors.

Our work spans across India and the globe, where we engage with policymakers, businesses, and thought leaders to develop strategies that promote resource efficiency, waste reduction, and sustainable economic models. Through research, advocacy, and capacity-building initiatives, ICCE plays a pivotal role in shaping policies, creating awareness, and enabling industries to adopt circular practices.

From designing circular cities to developing certified educational programs and collaborating on cutting-edge projects, ICCE's efforts aim to achieve long-term sustainability and resilience. By aligning economic growth with environmental stewardship, we help our partners and clients stay ahead in the global shift towards a regenerative economy.

ICCE is a member of Ellen MacArthur Community, Climate and Clean Air Coalition (CCAC), and Global Partnership on Plastic Pollution and Marine Litter (GPML). ICCE has also collaborated with European Environmental Bureau, REVOLVE Circular, PREVENT Waste Alliance, ISO, BIS, OCCE, Close the Loop along with other major organizations working towards boosting circularity.

Please visit our website for further details and follow us on LinkedIn page. If you want to stay updated about our work please subscribe to our newsletter HERE

CONTACT US

We would like to thank our team of Concept and coordination, Researchers, Writers, Designers, Colleagues, Partner organization, Contributors and donors.

Thanks to our editorial team, reviewers, advisory board for their time and effort in making this journal possible.

Each one of you have contributed in making the journal a possibility.

We thank you for your continued support in our efforts to make a transition towards a Circular Economy.

PUBLISHED

307, 3rd Floor
Avanta Business Centre
Ambadeep Buildling, KG Marg
New Delhi- 110001
India

WWW.IC-CE.COM
INFO@IC-CE.COM
ICCE.JOURNAL@GMAIL.COM