

Transition from Linear to Circular Economy through Efficient Waste Utilization

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Abstract

This paper deals with the critical question of the transition of the smart landfill management industry for enabling the transition from linear to circular economy. The shift from a linear to a circular economy offers great opportunities for businesses, governments and individuals to change their behaviour and create a more sustainable future. When adopted, the principles of the circular economy can lead to a number of benefits, such as waste reduction, increased efficiency of resources and the establishment of new business models that emphasise longevity, durability and circularity. Moreover, the circular economy emphasises the importance of recycling and reuse of resources, thus closing the loop of resource utilisation. We can transform waste into valuable resources by implementing efficient waste management systems, leveraging advanced recycling technologies, and building circular supply chains, which will promote a regenerative and sustainable framework. Not only does this reduce the adverse environmental effects associated with waste, but it also provides economic benefits, such as job creation and the potential for new businesses and industries. Collaboration and innovation are essential to achieving a full transition from a linear model to a circular economy. To accelerate the uptake of circular practices, there needs to be collaboration between governments, businesses and individuals to drive systemic change, put in place supportive regulations and invest in research and development. Education and awareness can help to promote behavioural change and a mindset that values resource efficiency, sustainable consumption and responsible production.

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Closed-loop economy is what circular economy is all about. The model is based on the theories of ecological economics and industrial ecology, which study the links between economic systems and the environment. Since industrialisation, the main indicators of welfare have been the extraction of raw material, production and distribution of goods in the linear economy, which has resulted in large consumption of resources and a dramatic decline in the quality of the environment. Conversely, a circular economy focuses on the value of products and materials and their environmental impacts. Raw materials must be used more efficiently and more effectively. Products should be designed to be more durable and waste and emissions should be reduced wherever possible. Also recycling should be prioritised or at least waste and emissions must be well managed, ensuring safe material cycles and the removal of pollutants. The circular economy is based on the natural material cycles, where waste is a resource for other organisms or is treated by bio-geo-chemical processes without adverse effects. This approach is consistently aimed at improving efficiency and at promoting a sustainable and resource-saving economy in harmony with all activities in the anthroposphere. Planetary boundaries provide a safe space for intervention in the development of a circular economy. Since the great acceleration of the middle of the 20th century we have been living in the Anthropocene, a geological epoch defined by human activity and we have already crossed this safe operating zone to a degree. This is reflected in species and genetic diversity loss, climate change, erosion, the expansion of impermeable surfaces at the expense of natural landscapes and disruption of nutrient cycles by excess phosphates and nitrates. The circular economy offers a potential framework for solutions aligned with the United Nations' Agenda 2030 for Sustainable Development. The agenda aims at achieving a balance between economic growth and social equity with the ecological limitations of the planet. The circular economy is the bedrock of sustainable manufacturing. The linear economy that prevailed until the 20th century, particularly in its operations and marketing practices, led to great economic, social and environmental devastation. The case highlighted the significance of business and marketing strategies in achieving sustainability. The first step will be to examine the 'planned obsolescence strategy' as a marketing tactic that is widely used in the linear economic model and is often used as a product strategy. Then, information will be given on the circular economy model that aims to avoid ecocide and the "cradle-to-cradle" product strategy that it

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adopts. The origins of the circular economy date back to the 19th century when a group of British textile manufacturers were against the introduction of new machinery as they feared it would lead to job losses. There was no recycling back then. Everything was either burnt or eaten. They argued that it was cheaper to recycle old materials with the new machines than to make new ones from scratch. This idea started a loop, but it took about 200 years for the idea of a circular economy to come to fruition. Before we go any further, let's take a look at the current economic framework, the Linear Economy and the future model, the Circular Economy.

Linear Economic Model

The take-make-dispose consumerism model and the world economy that grew out of the industrial revolution function in a system that incentivises endless consumption. The growth of firms has resulted in income streams and employment opportunities and thus sources of income and growth opportunities for individuals and macro-economies. The linear economy has developed an infrastructure that enhances the quality of life. The linear economy model is a one-way system in that natural resources are wasted through production. It is predicated on the assumption that resources are abundant, available and disposable; that waste is cheap and manageable. Many parts of the world have over-exploited the resources of the planet. The linear economic model starts with the basic assumption that natural resources are limitless, i.e. as long as industrial production continues, new resources will be available. The second assumption is that when resources are used, they are wasted and disappear. Both assumptions are based on a belief in unlimited resources and benign waste. This understanding dates back to the early stages of the industrial revolution and has sustained the tendency to exhaust resources and generate waste until now, influencing the development of production and consumption systems.



Illustration - Traditional Linear Economy

Framework Circular Economy

The principles of circular economy were always followed due to scarcity of resources and extraction was possible only on a limited scale as human labour was the source of energy. About a hundred years ago the introduction of heavy machinery and electricity made it possible for a great increase in the scale of resource extraction and use throughout the world. India's five trillion-dollar economy is dependent on the growth of manufacturing and services sectors, which are dependent on material resources and energy. Material and energy resources are from the earth and are limited in quantity. Moreover, the negative consequences of the resource misallocation are considered. The circular economy is based on the principle that natural resources are limited and that discarded items may have value as such. It aims to maximise the use and value of resources and energy in production systems during the life of a product.

The circular economy model has two goals:

Cutting down on the raw materials taken from the earth., Reducing waste sent to landfill or dumps. In India and many parts of the world, much of the circular economy work is on the second aim – recycling and waste management, both of which are very important. If this is the only focus, however, the considerable potential for transformation through upstream circular strategies such as design for end-of-life, product life extension and product as a service is not realised. In India, large companies are leading the way, embracing best practices and long-term strategies to conserve resources through circular models. If there is a market for a stream of secondary material, then the value chain will follow and landfill waste or waste-to-energy conversion will be reduced. This recognises, and protects the value of that thing, or natural resource. Like other countries of the Global South, India has developed extensive networks for waste collection and aggregation in the informal sector. We are fortunate to have systems, processes and markets that support circular economy business models including repair, refurbishment and reuse. The informal network and parts of the large trade in secondary materials lack systematic nomenclature, monetary valuation and definitional clarity. The whole system offers a great opportunity for organisations to be more organised and to grow, by using existing frameworks and being upgraded by digital technologies that help to move, trade and distribute materials to end-markets. Opportunities at a level more general than the informal can be similarly identified and met.

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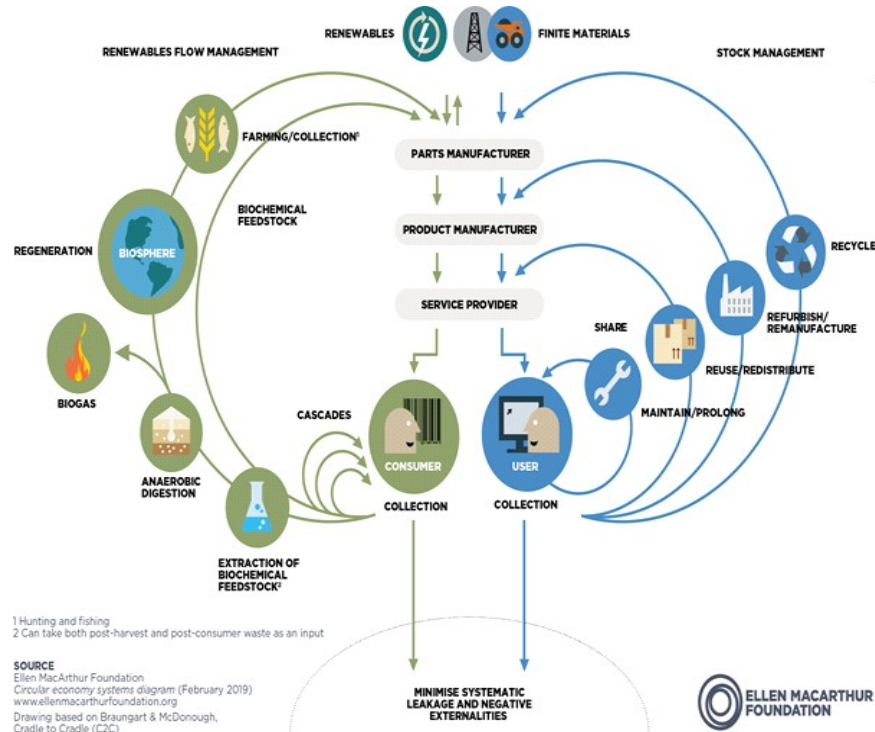


Figure – Butterfly diagram of the circular economy.

Principles 10 Rs of Circular economy for circular economy

1. Refuse

We consume more than what we need. We add 25 billion tonnes of stuff to the amount we own every year – the equivalent of 93,000 Empire State Buildings. Much of this lies dormant: cars are inactive 92% of the time and offices are empty 58% of the year. We can turn that around by not having such unnecessary and unsustainable products through solutions that maximise use of fewer goods.

2. Rethink

‘Every product, every system has to be reimagined with a view to how to reduce its impact on the environment. And the investor community is stepping in to lend a hand. Sustainable Ventures in London invests in innovative startups working towards sustainable goals in the transport, food and clothing industries, amongst others. By investing in innovative projects and supporting rethinkers, we can accelerate towards an eco-driven society.

3. Reduce

We need to adopt the principles of a circular economy. The basic premise of a circular economy is ‘doing more with less’ or dematerialisation. We need to use and create smarter products to do that. Opportunities we have seen include, among many others, carbon fibres, bio-plastics, bio-based chemicals, low-impact steel and aluminium processes that could benefit a range of industries. Take US company Eastman Chemicals, for example, which provides smart solutions to everyday products. It started commercial scale recycling of a range of waste plastics that would otherwise go to landfill last year.

4. Re-use

We have to move beyond the take-make-waste extractive industrial model to achieve zero-waste and reduce carbon emissions. One worry is fast fashion, which is accelerating – consumers buy 60% more clothes than in 2000, but hold on to each garment for half as long. But consumers are also becoming more sustainability-minded, and the sharing economy is growing. Vinted, an online marketplace, is a prime example of this shift. Vinted is a person-to-person service for buying, selling and swapping second-hand clothes. The platform is now live in 12 countries and has crossed USD 1 billion in valuation, becoming Lithuania’s first tech unicorn.

5. Repair

Planned obsolescence and a throwaway culture is a dark reality of society today. Some 50 million tonnes of e-waste are discarded every year – heavier than all the commercial airliners ever built. On the other hand, the “right to repair” movement is gaining momentum, advocating for affordable repair solutions and better product manufacture. In October 2019 the EU passed an eco-design law which means that makers of phones, tablets and laptops will be required to make their products easier to repair.

One company is the leader. Repairability is one of the pillars of French Groupe SEB’s sustainable development policy as a leading small appliances manufacturer. It’s about extending product life cycles; it’s about saving not wasting.

6. Refurbish

Refurbishing is the process of taking a thrown away or old product and making it work again for the purpose it was originally made for . Damaged components are replaced, making for an overall update, and

leaving the product looking brand new and fresh. Better refurbishment of products can reduce the demand for new materials, cutting down on waste and carbon emissions. Two e-waste specialists, the French Black Market and the Austrian Refurbed, have solutions.

7. Remanufacture

Reconditioning or remanufacture is the refurbishment and reuse of parts of a discarded product in a new product with the same function. Aircraft components, engines, office furniture and medical equipment are among the items remanufactured in many areas. For example, Canon has been remanufacturing devices with more than one function since 1992, in keeping with its ethos to maximise resource efficiency.

8. Repurpose

What if you could repurpose an old ladder into a brand-new bookshelf? Upcycling – taking a discarded product and turning it into a new product with a different function – is a growing trend. And the fashion industry is at the forefront. The Swiss brand Freitag makes iconic and highly functional bags from used truck tarpaulins. In partnership with top designers, the airline Lufthansa has launched its Lufthansa Upcycling Collection to upcycle parts of its Airbus A340-600 D-AIHO into a home and accessories collection.

9. Recycle

9% of our used materials are recycled today. Could we add to this number for less than the equivalent virgin materials would cost? With public opinion turning against single use plastics, companies want in on the action. For example, the cellulose that holds roads together in Australia is made from paper, plastic and lids that were headed for landfill. And Loop, an online shopping service that delivers products in reusable packaging has also recently launched in the UK.

10. Recover

What if waste was not waste? Anaerobic digestion allows microorganisms to break down biodegradable waste into materials we can use to generate energy, and reduce pollution, water acidification and carbon emissions. Europe is leading the way in this practice, and the largest biomethane plant is located in the technological park of Valdemingómez in Madrid. There are many benefits to this process, however it is important to ensure bio-waste is sustainably sourced and is the last resort after all the other “10R” options of the circular economy have been exhausted.

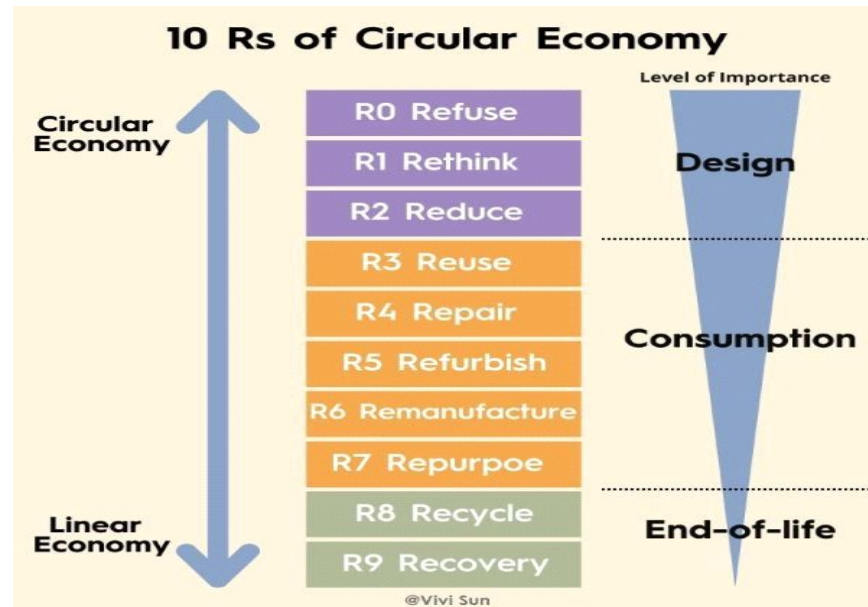


Figure – 10 Rs of Waste Management for Circular Economy

Government Initiatives to Promote Circular Economy

a) Governments have a crucial role to play in setting policies and frameworks that encourage sustainable habits and discourage wasteful behaviours, to promote the Circular Economy. The Government of India is very keen on policy formulation and implementation for creation of circular economy. Steps have been taken in this direction. The Ministry of Environment, Forest and Climate Change (MoEFCC) has notified rules to deal with the rising menace of handling electronic waste (e-waste) in the country. The regulations are intended to prevent illegal disposal of electronic products and promote sustainable management of e-waste.

b) Plastic Waste Management (Second Amendment) Rules, 2022: The Union Environment Ministry has directed that the thickness of plastic carry bags should be more than 120 microns effective December 31, 2022 and that certain single-use plastic products should be eliminated from July 1, 2022. The Battery Waste Management Rules, 2022 are based on the principle of Extended Producer Responsibility (EPR) that states that battery producers are responsible for the collection and recycling or refurbishment of waste batteries and the use of recovered materials from waste batteries in the production of new batteries.

c) Swachh Bharat Mission – Urban 2.0 (SBM-U2.0): This programme aims at ensuring safe sanitation in urban areas by making all cities “Garbage Free”, managing grey and black water in all municipalities not covered under the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and ensuring that all urban local bodies are free from open defecation. The mission will focus on waste segregation at source, 3Rs principle (reduce, reuse, recycle), scientific processing of different types of municipal solid waste and reclamation of old dumpsites for efficient solid waste management.

d) Waste to Wealth Mission: The goal is to identify, develop and implement technologies for waste treatment that can generate energy, recycle materials and recover valuable resources. The mission will also seek to identify and promote the advancement of contemporary technologies that can help build a clean and sustainable environment. The mission will optimise waste management in the country by leveraging science, technology and innovation to develop financially sustainable circular economic models for waste management, which will enhance Swachh Bharat and Smart Cities initiatives.

Challenges for Circular Economy in India:

Indian society is one of the earliest to have adopted the idea of the 7 Rs of the circular economy even before its formal inception. Take the example of the Indian homemakers from the 1940s to the 1980s they would use all the waste produced in their households for various purposes. Wastewater will be used for gardening and vegetable peels and food waste can be fodder for local cattle. People would happily turn their beautiful but old saris into bed linen. Then the bed linen would be turned into kitchen or basin napkins or door mats. Over time, these napkins would be turned into car dusters or table wipes before ending up in the trash. Such practices are common in rural India today. Therefore, homes have many uses for each non-food item, truly exemplifying the 7 Rs of the circular economy through history.

Throwaway ideology has replaced traditional concepts due to the prevalent linear development and hence circular economy practices face significant challenges in implementation: a) Lack of Awareness and Understanding: Most of the people in India are unaware of the concept of circular economy and its benefits, which prevent them from supporting the principles of circular economy. b) Lack of a Clear Vision: There is no

clear vision about the ultimate goals of India's circular economy mission, despite policy initiatives and hence confusion and deficiencies in the execution of related policies and initiatives.

e) **Industrial Reluctance:** Industries may be reluctant to adopt the circular economy model due to reasons such as lack of awareness, supply chain constraints, lack of incentives for investment in circular practices, and the complex nature of recycling and remanufacturing processes. d) **System Integration:** Circular economy initiatives in India often concentrate on the terminal stages of the value chain. To achieve the best possible impact, circular practices need to be integrated throughout the entire product life cycle and aligned with existing systems. e) **Infrastructure Challenges:** The existing infrastructure in India may not be conducive to supporting a circular economy. Additionally, the lack of recycling facilities and waste management systems hampers the efficient recycling and reuse of materials.

f) **Cultural Challenge** In India, the ideas of reusing and recycling products face cultural resistance, so it is difficult to change the consumer behaviour and move to a circular economy.

Industries Enabling the Circular Economy –

Industry is the backbone of an economy, and its existence depends on industrial activity. Industry and economy are closely related. Industry plays a vital role in economic dynamics. The proliferation of industry across the globe has created many challenges. One of the main concepts to deal with these challenges is Sustainable Manufacturing, which involves waste reduction in the manufacturing process and improvement in product design. Sustainable manufacturing practices reduce energy consumption and conserve natural resources, leading to a lower carbon footprint and higher productivity.

The implications of sustainable manufacturing will be examined through the prism of two dominant agro-based industries - sugar and bamboo. This analysis may be extended to other agro-based industries like edible oil, cotton and paper based on the observations of the two industries.

Case Study 1:

The Sugar Industry extracts sugar from multiple sources like sugar cane, beetroot and corn. Cane sugar is dominant in India. All parts of sugar cane are used for manufacturing of different products. The waste generated during processing and its applications are detailed below: a) On harvesting

sugar cane it is transported to factory. The green waste is further used as feed to livestock and the dry waste is used for mulching in the field. This mulching ser

(b) The cane is crushed on arrival at the factory. Juice is extracted after crushing and bagasse is a by-product. Bagasse is used in the power plant as fuel.

A cogeneration power plant supplies steam and power to the sugar plant. Figure 13.2 shows the products and by-products of sugar cane. After the sugar manufacturing process is complete, molasses or sludge are left as CO₂ by-products with a total reducing sugar (TRS) content of 50-55 . Molasses are used as a raw material for distilleries to produce alcohol and/or ethanol. Products and by-products obtained from molasses are shown in Figure 13.3 b

- a) Petrol is mixed with ethanol.
- b) Carbon dioxide is a by-product from the distillation process and has industrial uses.
- c) Spent wash is a liquid left after the distillation process is over and contains 1.5-2% alcohol and can be used as fuel to run a small boiler or as a soil conditioner.
- d) The thick material produced at the end of the whole cycle is called press mud, and is a very good bio-fertilizer. It can be directly applied to fields or can be further processed to make organic manure.



Main and By-Products of Sugar Cane

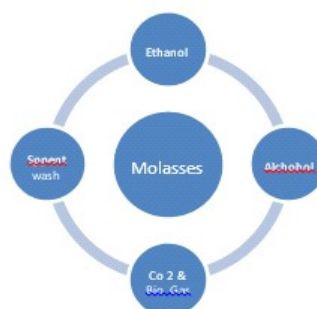


Fig. 13.3 - Products of Molasses

The above analysis shows that all sugar economics are cyclic and their sustainability depends on being a Zero Waste Industry and an advocate of the circular economy.



Figure - Main and by-products of bamboo processing

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