# CIRCULAR ECONOMY

## BUSINESS, TECHNOLOGY, AND POLICY | PART 2

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# Circular Economy: Business, Technology, and Policy

## *(Part 2)*

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**Circular Economy: Business, Technology, and Policy *(Part 2)***

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# FOREWORD

This volume arrives at a critical juncture when humanity must reconcile economic imperatives with ecological boundaries. While Part 1 lays the foundational concepts of the circular economy, Part 2 confronts the real-world complexities of implementation - where policy meets practice and innovation meets infrastructure.

The chapters in this section address the often-overlooked dimensions of circular transition: the legal frameworks that enable or constrain circular practices, government policies that incentivize sustainable behavior, and community-led initiatives that demonstrate circularity works at the grassroots level. From eco-design principles that extend product lifecycles to digital tools that track material flows, these contributions offer concrete pathways for organizations seeking to operationalize circularity.

What distinguishes this section is its emphasis on the human and financial dimensions of the circular economy. Chapter 8 examines the critical need to reinvent employee skills for circular economies, recognizing that workforce transformation is as essential as technological innovation. Chapter 10 addresses the financing gap that often stalls circular projects, offering insights into investment strategies, green bonds, and blended finance models that can unlock capital for circular initiatives.

The inclusion of sector-specific case studies, such as the footwear industry's efforts to reduce carbon footprints, demonstrates that circularity is achievable across diverse contexts. Similarly, the focus on community-based waste management initiatives, including lessons from India's Haritha Karma Sena, highlights how decentralized, participatory approaches can drive sustainable transformation where top-down models often fail.

Business leaders will find actionable strategies for transforming operations and supply chains. Policymakers will encounter regulatory approaches that balance ecological protection with economic growth. Academics and students will appreciate the rigorous research underpinning each chapter, while practitioners will value the real-world applications and empirical evidence presented.

This section reinforces that the circular economy is not a distant ideal but an achievable reality. The transition requires collective action across sectors and stakeholders - and it begins with the insights and inspiration found within these pages. I invite you to approach this volume not only as a collection of research but as a catalyst for transformation in your sphere of influence.

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# PREFACE

The concept of a Circular Economy (CE) is rapidly reshaping how businesses, policymakers, and technologists approach sustainability and economic growth. Businesses have to move out of traditional linear models of "take, make, and dispose". The circular economy emphasizes resource efficiency, waste reduction, and regenerative systems. This book, Circular Economy: Business, Technology, and Policy, provides a comprehensive exploration of CE principles, implementation strategies, and their impact across industries.

This collection of research and case studies brings together leading experts from diverse fields, offering insights into consumer engagement, reverse logistics, manufacturing transformations, sustainable finance, AI-driven solutions, and regulatory frameworks. The chapters bridge theoretical discussions with practical applications. The book as a whole highlights how organizations can transition toward circularity without compromising economic viability or technological innovation.

Each chapter delves into crucial aspects of circularity - from the role of digital tools and artificial intelligence to government policies and grassroots waste management initiatives. Special attention is given to emerging business models, financing strategies, and the role of eco-design in prolonging product life cycles.

As we face the pressing challenges of climate change, resource scarcity, and economic resilience, this book serves as a valuable resource for academics, policymakers, and industry leaders committed to a sustainable future.

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# CHAPTER 1

# Eco-Design Principles for Product Life Cycle Management: Insights from Multi-Criterion Decision-Making

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**Abstract:** This chapter explores the integration of eco-design principles within Product Life Cycle Management (PLCM) systems through the lens of Multi-Criteria Decision-Making (MCDM). It emphasizes innovative strategies aimed at significantly reducing resource consumption and waste generation throughout the Product Life Cycle (PLC). The chapter examines key eco-design methodologies such as Design for Environment (DFE), Cradle-to-Cradle (C2C), and modular design, offering insights into how these approaches can be effectively incorporated into product development processes. Special attention is given to the role of MCDM in eco-design, highlighting how MCDM frameworks support the evaluation of multiple, often conflicting, environmental, economic, and social criteria. Tools like eco-design checklists, Life Cycle Assessment (LCA) software, and other analytical instruments are discussed in the context of aiding companies in making informed, sustainable decisions. The chapter also addresses how eco-design principles align with corporate strategies, enhancing sustainability efforts while meeting the growing consumer demand for environmentally responsible products. Furthermore, it explores how eco-design helps navigate complex regulatory frameworks, ensuring compliance while promoting environmental stewardship. Through case studies and real-world examples, the chapter showcases successful eco-design implementations, demonstrating tangible benefits such as cost savings, improved brand reputation, and increased market share. The integration of eco-design with PLCM systems, supported by MCDM tools, is positioned as a pivotal

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step toward fostering a circular economy, where products are designed with sustainability in mind, optimizing resource efficiency and minimizing environmental impact. This chapter offers valuable insights for practitioners, researchers, and policymakers striving to advance eco-design practices and promote sustainable product development.

**Keywords:** Design for environment, Eco-design, Life cycle assessment, Modular design, Product life cycle management, Sustainability, Waste reduction.

## INTRODUCTION

As concerns about the environment gain greater significance in global discussions, eco-design has emerged as a crucial approach for advancing sustainability in product development. Eco-design encompasses the incorporation of environmental factors into the design process, with the goal of reducing negative ecological effects throughout a product's entire life cycle. This methodology is closely aligned with the principles of the circular economy, which prioritize the creation of products that can be reused, repaired, and recycled, ultimately minimizing waste and lowering resource consumption (Arruda *et al.*, 2021).

The shift from a traditional linear model characterized by a “take-make-dispose” approach to a circular economy framework requires a profound re-evaluation of how products are conceived, designed, and developed. This transformation emphasizes the importance of resource efficiency, sustainability, and the creation of a closed-loop system where materials are continually cycled back into use rather than discarded. By embracing eco-design, companies not only contribute to environmental protection but also unlock new opportunities for innovation, cost savings, and competitive advantage in the marketplace. The integration of eco-design practices can lead to enhanced product performance and a more sustainable future, reflecting the growing demand from consumers for environmentally responsible choices.

The implementation of PLCM has become crucial for organizations aiming to effectively integrate eco-design into their operations. PLCM is a comprehensive and systematic methodology that oversees all stages of a product’s life cycle, starting from the initial conception and design, progressing through production and use, and culminating in end-of-life disposal. By embracing PLCM, organizations can ensure that sustainability principles are woven into every phase of the product's journey, allowing them to address environmental impacts in a comprehensive and cohesive manner (Bocken *et al.*, 2014; Giwa *et al.*, 2022). This holistic approach not only enhances resource efficiency and minimizes waste but also empowers companies to stay competitive in an increasingly eco-aware

market. As consumers become more discerning about the environmental implications of their purchases, businesses that prioritize sustainability through PLCM can differentiate themselves and build stronger brand loyalty. Furthermore, PLCM facilitates collaboration among various stakeholders, fostering innovation and the development of greener technologies. Ultimately, by embedding eco-design principles within the framework of PLCM, organizations can contribute positively to environmental stewardship while reaping the benefits of improved operational efficiency and market positioning.

A key aspect of eco-design is its alignment with DfE initiatives, which prioritize environmental considerations during the design phase. DfE encourages designers to select materials that are less harmful to the environment, utilize energy-efficient production processes, and develop products that are easier to recycle or repurpose (Lee *et al.*, 2023). This methodology extends beyond product design to include supply chain management, emphasizing the need for collaboration with suppliers to ensure sustainable practices are maintained throughout the supply chain. Additionally, effective eco-design practices can help organizations anticipate and comply with stringent environmental regulations, thus reducing legal and financial risks. Furthermore, the C2C design philosophy serves as a powerful illustration of how eco-design can promote sustainability by advocating for a regenerative approach to product development. The C2C framework encourages the creation of products that positively impact environmental health rather than deplete it. It emphasizes the development of closed-loop systems in which waste is minimized, and materials are perpetually reused (Zuo & Zhao, 2014; Kong *et al.*, 2021). This regenerative strategy not only supports ecological balance but also fosters brand loyalty and consumer trust. As environmentally conscious consumers increasingly gravitate towards products that reflect their values, businesses that adopt C2C principles stand to benefit significantly in terms of market positioning. Moreover, research focusing on the regeneration and reusability of innovative low-cost adsorbents demonstrates effective methods for treating wastewater. These advancements contribute to broader objectives such as resource recovery and pollution reduction (El Messaoudi *et al.*, 2024). By integrating these eco-design principles, companies can enhance their environmental stewardship while simultaneously appealing to a growing demographic of sustainability-minded consumers. This alignment not only cultivates a positive brand image but also positions companies as leaders in the shift towards a more sustainable future.

Despite advancements in eco-design practices, significant challenges remain in their widespread implementation. Organizations often face obstacles such as high initial costs, lack of technical expertise, and resistance to change within organizational cultures (Popoff & Millet, 2017; Kong *et al.*, 2022). High upfront

CHAPTER 2

# Digital Tools for Circularity Tracking and Monitoring

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**Abstract:** The shift from linear economic models to a sustainable circular economy is progressively propelled by the incorporation of digital technologies, including the Internet of Things (IoT), Artificial Intelligence (AI), blockchain, and digital twins. These technologies provide real-time monitoring, resource optimization, and secure data transmission, enhancing the efficiency and transparency of supply chains. This chapter examines the transformative impact of digital tools on boosting circularity in several industries, emphasizing critical applications such as predictive maintenance, ethical sourcing, product lifecycle management, and resource recovery. Additionally, the chapter addresses the social and ethical considerations of digital circularity, including data privacy, labor standards, and equitable access to technology for Small and Medium-sized Enterprises (SMEs) and emerging economies. Finally, the chapter outlines future prospects for scaling digital circularity, discussing the potential of AI-driven processes, 5G-enabled IoT, and blockchain advancements. Strategic recommendations for policymakers and businesses are provided, emphasizing the need for standardization, workforce development, data security, and public-private partnerships to foster a resilient global circular economy.

**Keywords:** 5G, Artificial Intelligence (AI), Blockchain, Circular economy, Circular supply chain, Data privacy, Digital innovation, Digital twins, Equitable access, Ethical sourcing, Internet of Things (IoT), Predictive maintenance, Supply chain transparency, Sustainable resource management.

## INTRODUCTION TO CIRCULARITY IN THE DIGITAL AGE

### Definition and Importance of Circular Economy

In recent years, the Circular Economy (CE) has garnered much attention as a crucial solution to the environmental issues associated with the conventional lin-

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ear economic model, characterized by the "take, make, dispose" approach. The circular economy aims to reduce waste, enhance material reuse, and maximize resource efficiency by fostering the regeneration of products and materials throughout their existence (Geissdoerfer *et al.*, 2017) . This strategy allows enterprises and economies to diminish their dependence on limited resources while concurrently tackling critical environmental issues, including climate change and resource constraints.

The significance of shifting to a circular economy is highlighted by its capacity to markedly decrease global waste and carbon emissions. Research conducted by the Ellen MacArthur Foundation (Ellen MacArthur Foundation, 2023) demonstrates that the use of circular principles could potentially decrease global greenhouse gas emissions by 45% and diminish waste by 80%. The circular economy offers significant economic advantages, potentially generating up to $4.5 trillion in global economic benefits by 2030 through the creation of new employment opportunities in recycling, refurbishment, and renewable energy sectors (World Economic Forum, 2022).

## Limitations of Linear Economies

While the linear economy has driven industrial growth and consumer prosperity, it has created significant inefficiencies and environmental degradation. The linear model depletes finite natural resources at unsustainable rates and generates excessive waste, which contributes to pollution and climate change. As highlighted in the Circle Economy report (Circle Economy, 2023), only 8.6% of the 100 billion tons of resources extracted annually are recycled or reused, leaving the vast majority as waste. This waste accumulates in landfills and contributes to environmental degradation and increased resource costs (Circle Economy, 2023).

The limitations of linear economic systems are evident in key industries:

- **Fashion:** The fashion industry accounts for up to 10% of global carbon emissions and generates significant waste, with about 85% of textiles ending up in landfills each year (Fashion for Good, 2023).
- **Electronics:** Electronic waste (e-waste) poses a growing challenge, as only 20% of e-waste is properly recycled. This results in the loss of valuable metals such as gold and copper, which could otherwise be recovered and reused (World Economic Forum, 2022).
- **Construction:** The construction industry is responsible for approximately 39% of global $CO_2$ emissions, driven by inefficient resource use and waste from building materials (International Energy Agency, 2022).

These examples demonstrate the urgent need to transition from linear to circular economic models that prioritize resource optimization and waste minimization.

## Digital Transformation in Circular Practices

Digital technologies are essential for facilitating circular economy activities by offering tools for resource tracking, waste minimization, and lifecycle management. Technologies include the Internet of Things (IoT), Blockchain, Artificial Intelligence (AI), and Geospatial Technologies, which provide innovative methods for real-time monitoring and management of resource flows, hence improving efficiency and sustainability across many industries (Accenture, 2023).

1. **IoT and Sensor Networks:** IoT enables real-time monitoring of resources and energy use, allowing companies to optimize processes and reduce waste. For example, IoT sensors in logistics help reduce fuel consumption by optimizing delivery routes (McKinsey & Company, 2023).
2. **Blockchain Technology:** Blockchain offers secure, transparent tracking of materials through the supply chain, ensuring that products are ethically sourced and recycled. Industries such as fashion and electronics have adopted blockchain to improve traceability and support circular supply chains (World Economic Forum, 2022).
3. **AI and Machine Learning:** AI enhances resource efficiency by providing predictive analytics that help companies optimize production and minimize waste. In the recycling industry, AI-driven systems can accurately identify recyclable materials, improving sorting efficiency (Ellen MacArthur Foundation, 2023).
4. **Geospatial and Remote Sensing Technologies:** Geospatial technologies help monitor environmental factors such as land use, water availability, and ecosystem health, aiding in sustainable resource management (United Nations Environment Programme, 2022).

According to Accenture, the adoption of digital technologies could reduce material costs by up to 30% and lower energy consumption by up to 20% (Accenture, 2023). These advancements offer critical insights that empower businesses to adopt sustainable practices and adhere to global circular economy standards. As digital tools evolve, their integration into circular systems will become increasingly essential for achieving sustainability goals and reducing the environmental impact of industries.

CHAPTER 3

# Circular Economy and Legal Frameworks for Balancing Ecology and Economy

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**Abstract:** This research aims to: (1) identify and evaluate the challenges and opportunities of integrating Circular Economy (CE) principles into Indonesia's legal framework; (2) analyze and assess the current legal regulations related to waste management and product durability; (3) propose recommendations for reformulating the legal framework to support CE implementation. This research uses a combination of normative legal and empirical legal studies. The first objective employs a normative approach to analyze existing legislation on resource use and waste management. The second objective adopts an empirical legal approach to evaluate the application of CE principles in practice. The third objective utilizes a comparative approach to draw lessons from international CE models, such as Germany's comprehensive CE regulations. The findings reveal that: (1) Indonesia's legal framework currently lacks specific regulations on product durability and waste management, with existing laws focusing primarily on consumer protection and product quality; (2) CE principles face challenges in practice due to limited infrastructure, low public awareness, and inadequate legal support; (3) reformulating the legal framework for CE requires a holistic approach, integrating regulatory measures, stakeholder participation, and lessons from international CE models. This transition promises ecological sustainability and economic growth by reducing waste and maximizing resource use.

**Keywords:** Circular economy, Environmental sustainability, Linear economy, Legal regulations.

## INTRODUCTION

The ecological crisis is closely related to traditional economic models, also known as linear economics, which tend to follow a “take-use-dispose” pattern. Traditional linear economic models exacerbate ecological problems through unsustainable practices that prioritize short-term economic gains over long-term environmental health (Didenko *et al.*, 2018). The linear economy significantly contributes to environmental degradation. This is because the traditional industrial

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model is based on a "take-use-waste" approach, which does not consider the limited nature of resources (Guo *et al.*, 2010). It was estimated to be around 505kg of Municipal Solid Waste (MSW) per capita income in the European Union (EU) in 2020 (Puntarić *et al.*, 2022). When the industries continue t extract resources without replenishing them, it results in diminished resources (Guo *et al.*, 2010). This unsustainable consumption pattern does not take into account the finite nature of natural resources, leading to exhaustion over time (Didenko *et al.*, 2018).

A significant problem with the linear economy is the emergence of waste. Products are often designed for short-term use and disposal, leading to increased waste and pollution. This waste often ends up in landfills or natural environments, causing further ecological damage. Billions of tons of waste are produced each year, leading to severe but not fully understood consequences for the environment (Kouhihabibi, 2022). In Indonesia, 182.7 billion plastic bags are used every year (Citrarum Harum Juara, 2024). The linear economic model is unsustainable because it heavily relies on the extraction of natural resources and generates a large amount of waste (Kouhihabibi, 2022). The traditional linear economic model can lead to dysfunction in the economic system. As resources become increasingly scarce and pollution rises, the economic system struggles to maintain its functions. This can lead to economic instability and increased costs associated with resource extraction and pollution management (Guo *et al.*, 2010).

The Circular Economy (CE) addressed environmental issues caused by the traditional linear economic model. Learning from experiences, the CE offers a sustainable alternative by promoting reuse, recycling, and material regeneration. By encouraging resource efficiency and waste reduction, the CE helps create an environmentally resilient system (Scheel & Bello, 2022). The CE encourages industries to adopt sustainable practices, such as designing products for longevity and recycling, which can significantly reduce waste and resource consumption (Kouhihabibi, 2022). The CE focused on maximizing resource efficiency by promoting recycling, reuse, and remanufacturing (Scheel & Bello, 2022). This reduced the need to extract new raw materials, conserving natural resources, thereby minimizing environmental degradation (Scheel & Bello, 2022).

Regulation plays a crucial role in the implementation of a CE. The role of law is particularly important in creating a framework and facilitating the transition from a linear economy to a CE. Environmental regulations significantly enhance the performance of the CE by promoting improvements in industrial structure and regional governance (Peng & Shen, 2024). Laws can mandate the use of sustainable materials and processes in manufacturing, encouraging companies to adopt practices that reduce waste and promote recycling (Peng & Shen, 2024).

Without supportive or even mandatory policies, economic actors are reluctant to adopt practices that reduce waste and extend the life cycle of a product due to limited incentives and market pressures.

The linear economic model leads to the formation of significant waste (Kristianto *et al.*, 2023). Indonesia is the second largest producer of food waste globally, which poses significant economic, social, and environmental challenges (Waluyo & Kharisma, 2023). Many cities in Indonesia rely on landfills that have now reached maximum capacity due to the increase in waste volume, such as the Piyungan landfill, which accommodates 600 tons of waste per day and causes environmental and social issues, including unpleasant odors and the potential contamination of groundwater by leachate (Anggraini *et al.*, 2020; Hayuningrat & Rahmadyanti, 2021). The recycling efforts that have been implemented in Indonesia so far have not been sufficient to tackle the massive waste problem in the country. In Indonesia, this is exacerbated by population growth, especially in urban areas, which results in more complex waste management challenges compared to rural areas (Kristianto *et al.*, 2023).

CE has not been widely implemented in Indonesia, even though its application should encompass various aspects such as production, distribution, and consumption of goods. Each of these aspects still faces challenges, such as high waste production and the accumulation of waste in various landfills that have already reached maximum capacity. This is exacerbated by the lack of adequate legal support to encourage the transition from a linear economy to a CE. For example, regarding waste issues, this country does not yet have effective policies guiding the management of existing waste (Waluyo & Kharisma, 2023). Addressing this issue requires a comprehensive approach that involves government, industry, and community stakeholders working together to create a sustainable and economically viable CE.

However, the implementation of the CE in Indonesia remained limited due to several challenges, including inadequate infrastructure, low public awareness, and the absence of comprehensive legal regulations to support waste management, product durability, and the link between population growth and waste production. Current laws focus more on consumer protection and quality standards, neglecting the importance of extending product lifespans to reduce waste. Given these issues, this study seeks to explore how the circular economy can act as a catalyst for ecological preservation amidst the challenges of modern industry. Additionally, it examined how legal regulations can encourage companies to integrate CE principles into their operations, promoting sustainable practices for ecological sustainability in Indonesia.

**CHAPTER 4**

# Government Policies Towards a Circular Economy: The Indian Experience

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**Abstract:** In today's unsustainable era, the circular economy is the solution to address several pressing and interconnected challenges in sustainable development. The circular economy offers significant potential for advancing various Sustainable Development Goals (SDGs), specifically SDG 7, SDG 8, SDG 11, SDG 12, SDG 13, SDG 14, and SDG 15. The swift economic expansion and urban development in India have resulted in notable challenges, including resource depletion, environmental degradation, and a rise in waste generation. The Indian Government has taken significant measures to tackle this urgent issue by transitioning to a circular economy. Among these measures are the creation of the Circular Economy Cell within NITI Aayog and the introduction of specific policies and plans to increase productivity while decreasing waste. In the process of transitioning to the Circular Economy, which promotes waste reduction, proper disposal, recycling, and sustainable resource management, India has implemented programs such as the Swachh Bharat Mission, Jal Jeevan Mission, and Vehicle Scrapping Policy. A Circular Economy differs from conventional recycling initiatives by focusing on the redesign of products for durability, promoting reuse and remanufacturing, and creating closed-loop systems to reduce waste and resource extraction.

**Keywords:** Action policies, Circular Economy Cell (CE Cell), Circular economy, Environment, Extended Producer Responsibility (EPR), Indian policies, Linear production, NITI aayog, SDG 12, SDGs, Sustainable consumption, Sustainable development goals, Waste management.

## INTRODUCTION

The swift economic expansion and urbanization in India have resulted in considerable challenges, including resource exhaustion, environmental

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degradation, and increased waste generation. A development model that optimizes resource utilization is urgently required. The circular economy is an economic system that organizes production methods around the reuse and recycling of inputs to minimize environmental emissions while promoting sustainable and eco-friendly production practices. It serves as a crucial mechanism in addressing the environmental crisis through the encouragement of material reuse. It additionally promotes the effective use of expired products to mitigate their adverse effects on the environment. It promotes the responsible utilization of natural resources and prolongs the lifespan of environmentally hazardous products, including plastics and various electronic devices. We mostly depend on Linear production models, which consist of extraction, production, consumption, and disposal. However, this model is not sustainable for the planet. In the circular economy, raw materials are kept for longer in production cycles and can be used again and again, which greatly reduces waste and makes production and consumption more sustainable (Mhatre *et al.*, 2020). This model fundamentally aims to retain resources within the economy for extended periods, thereby enabling the utilization of generated waste as raw materials for other industries. Consequently, the CE has emerged as a progressively significant domain within economics in recent years (Alnajem *et al.*, 2020). The circular economy is founded on three core principles: eliminating waste and pollution through design, maintaining products and materials in circulation at their highest value, and restoring natural systems (Knäble *et al.*, 2022).

India is experiencing a significant shift from a linear economic model to one that emphasizes recycling, serving as a precursor to the more advanced concept of a circular economy. This transformation is occurring as a result of various influences, including policy measures, corporate initiatives, technological advancements, and public engagement. Circular Economy is also important for achieving SDG 12, *i.e.*, Sustainable Consumption and Production.

## NEED FOR CIRCULAR ECONOMY

The global statistics on domestic material consumption per capita, categorized by type of raw material, indicate that in 2000 it was 9.22 tonnes, while in 2022 it increased to 12.04 tonnes. The consumption rate in India was 3.65 tonnes in 2000 and increased to 5.76 tonnes in 2022 (United Nations Environment Programme, 2024). From 116 million tonnes in 2022, fiber production reached a record 124 million tonnes in 2023. If present trends continue, global fiber production is predicted to reach 160 million tonnes by 2030, up from 58 million tonnes in 2000. The overall proportion of recycled fibers experienced a minor decline in 2023, dropping from approximately 7.9% to 7.7%. This shift is due to the rise in fossil-based polyester production, which was cheaper than recycled polyester. From

2022 to 2023, the amount of fossil-based synthetics made went up from 67 million tonnes to 75 million tonnes. Less than 1% of the global fiber market came from pre- and post-consumer recycled textiles (Textile Exchange, 2024). The major portion of materials extracted for economic use consists of virgin resources, while the contribution of secondary materials has been on a consistent downward trajectory since the inception of the Circularity Gap Report's measurements: decreasing from 9.1% in 2018 to 7.2% in 2023, just five years later (Circle Economy Foundation, 2023). The global consumption of some of the most widely used materials is projected to rise significantly in the coming decades. From 2018 to 2030, global plastic consumption is projected to rise by 4.1 percent. Subsequently, from 2030 to 2050, it is projected that global plastic consumption will rise by 2.4 percent (Statista, 2024) .

## UN EFFORTS TOWARDS CIRCULAR ECONOMY

UNEA 4. Resolution 1 (UNEP/EA.4/Res.1) articulates that a circular economy embodies an emerging sustainable economic framework. This framework emphasizes the intentional design of products and materials for reuse, remanufacturing, recycling, or recovery, thereby ensuring their sustained presence within the economy alongside the resources from which they originate. This strategy seeks to eliminate or lessen the production of waste, especially hazardous waste, while simultaneously curbing or diminishing greenhouse gas emissions (United Nations, 2019). UNEA 5. Resolution 11 (UNEP/EA.5/Res.11) promotes the incorporation of innovative methodologies to attain sustainable production and consumption, wherein products and materials are engineered for reuse, remanufacturing, recycling, or recovery, thereby prolonging their presence in the economy alongside their constituent resources. It emphasizes avoiding or minimizing waste generation, particularly hazardous waste, and preventing or reducing greenhouse gas emissions (United Nations Environment Assembly, 2022).

The UNEP circularity platform outlines its scope and how it promotes sustainable consumption and production. UNEP Executive Director Inger Andersen asserts that circularity, along with sustainable consumption and production, is crucial for the realization of all multilateral agreements, including the SDGs, the Paris Agreement, and the post-2020 global biodiversity framework (United Nations Environment Programme, 2024).

In 2015, UN Trade and Development (UNCTAD) began its exploration of the circular economy by collaborating with the Ellen MacArthur Foundation, concentrating on the resource-circularity opportunities within significant economies like India and China. Circularity has been incorporated into various

CHAPTER 5

# Community-based Waste Management and Societal Impact: Utilizing Demand Side Management for Sustainable Transformation of Solid Waste Management

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**Abstract:** Solid waste management is a global issue due to urbanization and changing lifestyles. Current solutions are inefficient, especially in developing countries like India. Demand Side Management (DSM) can help control waste production. A multidisciplinary approach, including reduction campaigns, recycling programs, variable waste collection charges, and smart waste monitoring systems, can reduce environmental impact and promote sustainable practices. Mathematical analysis can evaluate the efficacy of these DSM-inspired interventions. This paper explores the application of Demand-Side Management (DSM) principles in Solid Waste Management (SWM), focusing on strategies like waste reduction campaigns, incentivized recycling programs, variable waste collection charges, and smart waste monitoring systems. The study evaluates the efficacy of these DSM-inspired interventions, highlighting their potential to revolutionize SWM by optimizing resource use, minimizing environmental impact, and promoting responsible consumer behavior.

**Keywords:** Circular economy, Demand-side management, Recycling, Smart cities, Societal impact, Solid waste management, Waste collection.

## INTRODUCTION

The everyday creation of wasted products has emerged as one of the most pressing worldwide concerns in light of the aspirational reimagining of humanity,

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particularly when a significant portion of it is improperly managed. Approximately 2 billion tree-sized masses are produced annually by the planet. On a yearly basis, the municipal solid waste commodity reaches up to 1 billion tonnes, with at least 33% of this considered environmentally mishandled (World Bank, 2018). It is predicted that this volume shall multiply up to a million in the next few years. About 40 billion tonnes estimated for 2050 raises a huge problem, which poses a major threat to various aspects of human life. A lot of researchers have indicated the destructive public health effects of wrong and unwise ways of dealing with waste management.

Proper waste management *via* disposal and recycling methods is essential to avoid air, water, and land pollution. Overall, solid waste-related emissions can grow up to 2%. According to the World Bank (World Bank, 2018), such commitment could double the releases of $CO_2$ till 2050 (2 billion tons of $CO_2$ by 2050). What is more, air pollution and dialectical groundwater and ocean plastics are caused by the inappropriate waste processing ways (Skenderovic *et al.*, 2015). Very often, this disorder of poor drainage is accompanied by an undefined pollution of surfaces, which is usually due to the uncontrolled passing of liquid wastes and sewage facilities (Lestari & Trihadiningrum, 2019).

There are adjacent issues with waste management that follow from this, once the wastes are left unattended. Problems related to improper waste collection sites, like laborers who work for their living, navigating waste, are the most vulnerable groups. These people are exposed to a variety of infections from parasites and enteric infections, which may occur as a result of waste being mishandled. The health of these people therefore deteriorates with a rise in some diseases that are associated with waste processing (Giusti, 2009).

Lastly, in a way that is similar to the influence of the absence of efficient waste disposal systems, the economy suffers losses as well. Inappropriate waste handling of some sort immediately affects the tourism and hospitality industry (Zorpas *et al.*, 2015), due to the stress it places on the landscape and on the tourist sites. Sustainable waste management through conventional and unsuitable methods in the long run will dedicate the usable land areas, making it possible to build structures, resulting in a high level of economic losses to the countries concerned (Skenderovic *et al.*, 2015).

Sustainable waste management offers an interesting solution, which not only considers but also helps solve the problems caused by the illegal disposal of waste. Proper management of waste can catch such a valuable resource, since the major role of the solid waste is the recovery of energy for recycling and production purposes (Demirbas, 2011). Besides, energy recovery, frequently

known as waste-to-energy, prevents waste and supports environmental and human condition associations by the usage of waste energy as fuel (Brunner & Rechberger, 2015). In matters of ecology and the well-being of human beings, however waste management is managed, a properly chosen waste management has proven to be an indispensable tool when it comes to environmental protection and working towards the maximum utilization of resources (Izvercian & Ivascu, 2015).

The current approach to waste management in the circular economy is limited and fragile, with resource recovery primarily through global recycling networks. The potential of the circular economy to move from a linear to a circular economy is highlighted, with fruit by-products being valorized through antioxidant extract production. The circular economy can reduce food loss and waste, contribute to resource conservation, and optimize the consumption chain of materials and waste. However, there are knowledge gaps, including empirical research on practical implementation and social, economic, and policy implications of transitioning to a circular economy approach. Thus, the current experience with waste management in a circular economy does present a range of difficulties and missed opportunities, and the dependence on the global recycling network for resource utilization is certainly a significant part of them. Although it is a relatively recent development, the circular economy is already revealing its potential to transform various approaches prescribed by the linear model of "take-make-dispose", while there remains a lot to be explored and improved as well. Digitalization's potential for waste prevention, reduction, reuse, and recycling is also explored. Here are some areas in waste management and the circular economy that require further study and development:

1. **Resource Recovery and Valorization**: Think about the possibility of applying the novel methods for upcycling, *i.e.*, obtaining antioxidants from the vegetable by-products. This converts a wasted facility into a revenue generator and economic resources stream and promotes conservation.

2. **Food Loss and Waste Reduction**: The Circular economy offers a route to improve the system of input and waste production by optimizing material and resource circulation. These responsibilities can be best achieved by bringing up the levels of supply chain efficiency, distribution of excess food, and setting sustainable patterns of consumption.

3. **Knowledge Gaps and Practical Implementation:** In addition to the advantages, there are many issues that need to be addressed along the way to shift towards the circular economy model. An experimental investigation is necessary

# CHAPTER 6

# Empowering Community-Led Waste Management: Lessons from the Haritha Karma Sena (HKS) Initiative

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**Abstract:** This chapter enlists the transformational possibilities that the decentralized, community-led initiative called Haritha Karma Sena holds in sustainable rural waste management. It has to do with its operating framework, the impact of environmental sustainability, and its role in socio-economic empowerment. It brings all such critical elements to the forefront as participation by communities, capacity building, and integrating advanced technologies along with improvements in the collection, segregation, and processing of waste. The report has found that the program has been successful in engaging households and institutions, reducing social stigma, and improving the livelihoods of waste workers, though with some gaps, such as infrastructure gaps and income instability. Discussion on policy implications involves investment in infrastructure, targeted training programs, and innovative financial mechanisms that can ensure scalability and sustainability of the program in the long run. This chapter addresses the initiative of Haritha Karma Sena and underlines that decentralized models are useful to tackle the global problem in waste management while simultaneously developing community resilience and stewardship of the environment.

**Keywords:** Community waste management, Haritha Karma Sena (HKS), Socio-economic empowerment, Sustainable environment.

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## INTRODUCTION

Ridding rural India of all types of waste is marred with several problems, such as infrastructure deficit, lack of awareness, and community participation deficits. The increasing population, thereby growing waste generation, has intensified these problems and posed adverse environmental, social, and economic consequences. Segregation at the source and efficient waste disposal mechanisms and recycling mechanisms are not adequate and add to the worsening situation.

In this respect, one such beacon of hope from the district of Ernakulam is the HKS initiative. In fact, it was a community-driven program that solved these problems by incorporating grassroots efforts in the waste management processes. It was also a means of socio-economic development for the marginalized population, besides environmental sustainability.

This program is decentralized because local people, primarily women, collect, sort, and process the waste. It empowers its members by providing them with an employment opportunity and skill building, and makes them own the waste management process and increase community participation. HKS further emphasizes awareness creation and changing behaviors among residents, ensuring the principle of sustainability is deeply in place in community practices (Equator Initiative, 2024). This chapter explores the multi-dimensional impacts of the Haritha Karma Sena program, focusing on their model of operation, the experience and challenges of members, and the implications for rural sustainability. Discussion of these issues puts forth the relevance of community-led approaches to waste management in India toward meeting the country's needs as well as the global sustainability agenda.

## THE HARITHA KARMA SENA PROGRAM AND ITS DECENTRALIZED APPROACH

The Haritha Karma Sena program is predicated on the principle of decentralization, which is an aspect relatively well known in the annals of academic literature as having a significant impact on managing solid waste at the local level. Decentralized waste management puts a premium on local solutions; collection, segregation, and processing usually take place either within the community that generated the waste or close by. Thus, the environmental footprint on transportation of waste is low, and community ownership can be fostered for local waste management practices (Vinti & Vaccari, 2022).

According to research, community-based waste management can significantly improve source segregation of waste, which is a critical factor in the achievement of efficient recycling and composting (Abubakar *et al*., 2022). The Haritha Karma

Sena fits into this finding because it integrates local communities into the chain of waste management, thus creating a sense of responsibility and participation among residents. Studies in similar contexts have revealed that with the active involvement of the community, there is a marked improvement in waste collection efficiency and reduction in waste-related environmental hazards (Ferronato & Torretta, 2019).

Second, employment generation for most of these groups, mainly comprising women and low-income households, aligns the objectives with SDGs (Shevelkova *et al*., 2023). Indeed, by incorporating vulnerable populations into initiatives targeting waste management, this contributes to better improvement of livelihoods while offering improvements in social equity (Suresh *et al*., 2024). The work of Haritha Karma Sena's model of working supports the same by means of creating job opportunities alongside giving specific skill development skills aligned to the requirements for their workers.

Another strong support for the compatibility of this initiative with global sustainability goals lies in promoting organic farming practices. Organic farming is highly dependent on the compost produced from biodegradable waste, and it has been identified in recent research that decentralized systems for managing waste can ensure the smooth supply of high-quality compost in agriculture (Ayilara *et al*., 2020). The Haritha Karma Sena promotes local farming use of compost, thus supporting the sustainable environment while improving rural area soils and agricultural productivity (Shameerdas & S. B., 2024).

## EXAMPLES OF SIMILAR PROGRAMS GLOBALLY

Many programs globally share the same rationale and goals as the HKS. These programs establish that community-led waste solutions can be effective:

- Waste Wise Cities (Kenya), launched under the auspices of the UN-Habitat, Waste Wise Cities involves working with cities in less-developed countries to improve conditions through community-based and capacity-building services (Ozoike-Dennis *et al*., 2019). It focuses on sorting at source, recycling, and composting, similar to the HKS model.
- Green Dot Program (Germany) This is one of the very successful decentralized waste management schemes in Germany. The local businesses and communities are engaged in segregating and recycling the packaging waste, and it helps to reduce their dependence on landfills. (Ramasubramanian *et al*., 2023).
- Barangay Solid Waste Management (Philippines) This program enables the barangays, which are the village-level administrative divisions, to manage their own waste within their communities. The program aims to educate residents on

# CHAPTER 7

# Economic and Social Implications of the Circular Economy

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**Abstract:** Circular Economy (CE) is the long-term economic model that guarantees environmental sustainability and resource efficiency. The main goal of the value shift from the existing model to the circular one is to achieve responsible consumption and production across different sectors. The changes regarding industrial processes, increasing reuse, repair, remanufacturing, and recycling will bring many business opportunities in the case of products, as well as certain shortcomings, such as changes in business models. CE represents a transformation from a linear value chain into "closed" loops, and as one of the primary expressions, it emphasizes cooperation among different industrial stakeholders, also sparing post-sales services. Rethinking patterns of production and consumption has become a critical priority to assure sustainable development, particularly for food, textiles, synthetic and chemical products, electrical and electronic equipment, and waste management, which together represent around two-thirds of solid waste in most countries. There are at least three claimants to regard several aspects of CE. From the economic point of view, teams of professionals try to redefine the existing economic model. One of the reasons to enrich the prism through this sector, even though a CE can have positive effects on aspects other than income, is that successful implementation relies strongly on management decisions made by trained economists. Also, different principles of CE are well known under the umbrella of integral ecology, which should be seen from the perspectives of economic, social, and environmental imperatives compatible with sustainable development. The third aspect embedded in the CE concept is the one related to the degree of economic development, as economic domains show some quantitative estimations, such as sustainability, economy, financing, consumer prices, industrial domain, transportation, waste, agriculture, fishery, food industry, tourism, and marketing. This list can be a reasonable basis for periodical multi-disciplinary empirical studies that should strive to improve the existing index, identify other

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essential variables, and validate the existing index by using different methods. In the first part of this study, the social and economic implications are discussed separately, regardless of the existing close relationships between them, among others.

**Keywords:** Circular Economy (CE), Models and strategies, Recovery and efficiency, Strategies and regulations, Sustainable development, Technology and policy.

## INTRODUCTION

Today, we live within an economic model that is based on a continuous supply of raw materials to sustain constant growth in production and consumption. Nevertheless, physical resources are finite, and it is apparent that the current use of the world's resources is beyond sustainable levels. The logic of a linear economy enables global consumerism. The shift from a linear economy to a CE[1] is therefore seen as the new narrative to frame sustainability through the core economic model in a globalized world. The vision and evidence are growing that the building of this narrative is critical for the transition to sustainable economies and societies. A CE represents an economic model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended (Kandpal *et al*., 2024). Materials are recovered from products, sometimes hybrid and composite materials, and can return to the economy instead of being "consumed" and left as waste. A circular approach can thus reduce both the need for using new raw resources and the total system waste. 1. It can contribute to a shift of the fragile balance of the world back towards long-term equilibrium in sustainable levels of production and consumption. Conducting a transition from a linear to a CE model involves rethinking production systems, consumption patterns, and adaptation of business models, and may result in a reorientation of renewed economies. These changes have social, economic, and ecological implications. Household and consumer behavior have begun to shift towards a preference for sustainable products and services tangentially (Serrano-Arévalo *et al*., 2024).

Over the past decade, a number of cornerstones have emerged that have informed civil economy development. In the late 1980s, the notion of moving away from the traditional economic system to a zero-waste economy gained traction. Among the pioneers of the CE is Walter Stahel[2], who has had a significant impact through his publications. His most comprehensive study offers insight into how a CE has developed since the publication of his first book. Michael Braungart[3] supports Stahel in the development of CE. Currently, CE is a stream with an extensive international and interdisciplinary community involving researchers, industry

experts, policymakers, and practitioners (Pusz *et al*., 2024). There are also area-specific initiatives, such as building and electronics.

The CE principles aim towards the minimization of waste via the redesign of resource life cycles. The core of CE is the concept of the "Closed Loop Cycle[4]", where resources are reused, repaired, and recycled for as long as possible. The principles of CE thus enable the implementation of an ecological economic model characterized by harmony between ecological sustainability and regenerative economic processes. In this context, the concept of CE requires changes in the behavior of not only the business sector but also consumers, which can be labeled as the entire society. An essential goal of the principles of CE is also the concept of value retention, products, components, and materials should maintain their value over time. Individual authors and organizations emphasize some principles of CE more than others (Skalli *et al*., 2024) . In this chapter, we focus mainly on some of the key principles of CE in the manufacturing of durable products. When these principles are appropriately implemented, CE ensures the minimization of waste and the decrease of primary resources, fosters innovation, creates new jobs, and makes products and processing more resource- and environmentally efficient.

## Historical Development

The concept of CE is neither new nor original but a derivative of earlier ecological and environmental movements. Representative authors of the CE point out the "zero emission" concept in the zero emissions systems[5] of the early 1980s. However, it is imperative to realize that the historical approach to the problem was a result of the then and current driving forces. The early 1980s were marked by the first demonstration of the physical superiority of systems not driven by fossil fuels, whereas the first decade of the 21st century was characterized by the growing urgency of coping with climate change and resource depletion (Shafik, 2024a). A history of CE provides a long-term and, therefore, indicative view of how the nascent era of resource abundance that saw waste as an asset slowly gave way to an economy that promoted present possessive acquisitions and resource monopolies. Neither globalization nor the dramatic reduction of consumption of agricultural commodities, facilitated by the increase in energy efficiency, indicated an imminent crisis of resource availability. European success stories from the 18th and 19th centuries did not involve trade in newly acquired technological, economic, and cultural monopolies with the rest of European countries. Instead, these countries adapted existing joint systems to the changing technological conditions of the time (Hahladakis *et al*., 2024).

**CHAPTER 8**

# Reinventing Employee Skills for Building Circular Economies

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**Abstract:** In today's era, a circular economy calls for a great transition towards sustainable development, and these circular economic models or frameworks are crucial in combating resource depletion and environmental degradation. This chapter explores the strategies and practices for developing talent to thrive in circular economies. This chapter outlines the reinvention of employee skills and capabilities to support the transition from a linear to a circular economy. It explores the competencies and knowledge required for employees to succeed in circular economies, including thought processes, innovative problem-solving, and proficiency in sustainable practices and technologies. The chapter also highlights practical strategies for upskilling and reskilling the workforce. The chapter concludes by discussing the challenges and opportunities associated with workforce transformation in circular economies, emphasizing the need for collaborative efforts among stakeholders to achieve a sustainable and resilient economic future.

**Keywords:** Circular economy, Competencies, Reinventing skills, Sustainable goals.

## INTRODUCTION

The focus on the circular economy has intensified in today's businesses, governments, and communities, as they strive to adopt more sustainable economic models. Transforming a traditional linear economy into a circular one requires technological expertise, skill, and a mindset shift. Employees must have the necessary knowledge and skills to initiate this transformation. Initiating this process can be challenging, so the organization must focus on developing the required skills.

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The organization focuses on understanding the principles of the circular economy and innovation that can adapt and utilize digital technologies to develop sustainable practices (Rodríguez-Espíndola *et al*., 2022). Formulating and implementing various strategies and approaches will help the organization continually learn and encourage innovation, emphasizing circular principles. This method can implement a new economic paradigm.

## INTRODUCTION TO CIRCULAR ECONOMIES

A circular economy emphasizes the importance of a resource-efficient model that promotes waste reduction through recycling and innovative practices. This method will promote sustainable development and lead to economic growth. The transformation process will not only lead to a reduction in waste but also a shift in the skills and proficiencies of the personnel. The essential resource required for the skill shift is a diverse group of people with various skills. Hence, the organization must equip its employees with the necessary competencies through regular analysis and training methods.

The circular economy involves changing the product or design and transforming the personnel's skills and capabilities (López, 2021). The organization must invest in developing new skills and encourage a culture of innovation and collaboration that creates sustainable transformation. Circular economies benefit society and the environment, leading to the organization's success and global sustainability.

Circular economies create numerous job opportunities in various sectors, including refurbishment and remanufacturing. Economic resilience is achieved by fostering local manufacturers and reducing product imports. The environmental benefits of the circular economy include reducing pollution and waste in landfills, as well as promoting the materials that can be reused, repaired, and recycled. This approach enables resources to be used more efficiently and sustainably (Ogunmakinde *et al*., 2022). The circular principles reduce the extraction and processing of raw materials, resulting in lower greenhouse gas emissions and helping to mitigate climate change. Organizations can save costs through more efficient resource use, minimizing waste disposal, and potentially lessening the cost associated with materials. The shift towards circular business can enhance a company's reputation, create demand for sustainable products, and drive higher creativity in product design, manufacturing, and the way the company is approached.

Circular economies aid in many UN SDGs, including consumption patterns and production, climate actions, *etc*. (Ogunmakinde *et al*., 2022). By keeping materials in use for an extended period, circular economies help preserve

resources, reduce environmental degradation, and foster international collaboration, which is essential for addressing global environmental challenges.

## Principles of Circular Economies

Reducing waste and maximizing resource efficiency are paramount, essential principles of a circular economy. Certain principles are established to transition the traditional linear economy model to a regenerative approach. Some principles are discussed below (Velenturf & Purnell, 2021).

1. **Eliminate waste and pollution:** Products must be designed to curtail waste and pollution. Non-toxic, recyclable, and biodegradable materials should be preferred to remove waste and reduce pollution generation.
2. **Maintain products and materials in use:** The material should be selected and planned to be durable and upgradable for long-term product usage. Maintain the standard to allow the product to be reused, repaired, and recycled.
3. **Regenerate Natural System:** The organization can use renewable energy and resources to maintain a sustainable system and take necessary steps to maintain the ecosystem. It can also protect the soil and biodiversity by using farming practices.
4. **Foster Systemic Thinking:** Develop innovative methods to adapt to the changing environment through network connectivity across various businesses to exchange ideas and materials, and foster better development
5. **Transparency and Traceability:** Transparency in the supply chain will facilitate the tracing and improvement of resource management and accountability. Through digital mechanisms, sharing and storing relevant information is easy and fast.

## Comparison between Linear and Circular Economies

A “Take-make-dispose” framework characterizes the linear economy model. In this system, raw materials are extracted and transformed into finished products, which are subsequently marketed to consumers. Once these products have fulfilled their intended purpose, they are discarded, often resulting in waste. This model reflects a one-directional flow of resources, lacking considerations for sustainability or the recycling of materials.

The circular economy aims at sustainable development through the cycle mentioned above. It operates by minimizing the use of materials, implementing proper planning, and designing a waste management mechanism that incorporates reuse and recycling processes. Circular economies create sustainable practices that, in turn, build economic growth (Rashid & Malik, 2023).

# CHAPTER 9

# Greening the Footwear Industry: Sustainable Approach to Reduce the Carbon Footprint

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**Abstract:** Shoes are a widely used commodity universally owned by individuals worldwide. However, excessive quantities of shoe waste are detrimental since the shoe industry has numerous environmental consequences that cannot be disregarded. The increasing awareness of health and fitness among individuals is driving the expansion of the footwear market. In 2022, the worldwide footwear market was valued at USD 389.23 billion. By 2031, the projected value is expected to reach USD 568.54 billion, with a Compound Annual Growth Rate (CAGR) of 4.31% throughout the projection period from 2023 to 2031. Significant quantities of carbon dioxide are emitted throughout the production process. It accounts for 1.4% of global Greenhouse Gas (GHG) emissions. Over 300 million pairs of shoes are discarded annually in the United States, with 95% ending up in landfills. The emission of chemicals into the soil and groundwater results in environmental contamination. Dyes emit toxic heavy metals, whilst soles undergo decomposition to become compounds such as polyurethane. The manufacturing process of shoes is also harmful to the environment. Manufacturers utilize fossil fuels or coal as the primary energy source for their facilities. Carbon dioxide and several other greenhouse gas emissions are produced by combusting these fuels. Greenwashing in the footwear industry is also a serious concern. As defined by the United Nations, sustainable development entails meeting the present generation's demands while safeguarding the future's requirements. This necessitates the application of systems thinking, which involves comprehending the interconnectedness and interdependence of Environmental, Social, and Governance (ESG) factors. The research methodology employed in this study is normative legal research with a conceptual approach. It involves the analysis of diverse reports and policies concerning the footwear industry and its environmental and social impacts. This method aims to critically examine and interpret the normative frameworks and regulations associated with fast fashion and its environmental and societal consequences. The study's objective is to explore the effect of greenwashing within the footwear industry and examine the repercussions of unsustainable manufacturing processes on the environment and society, including the international and national efforts for a sustainable footwear industry.

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**Keywords:** Carbon footprints, Climate policies, Environment, Environmental contamination, ESG, Footwear industry, Footwear market, Fossil fuel emission, Green Washing, Greenhouse gas mitigation, Sustainability, Unsustainable manufacturing process.

## INTRODUCTION

The shoe business is undoubtedly quite profitable. Demand for socially and environmentally sustainable footwear is rising along with it. According to recent Certilogo research, over 70% of consumers are worried about the sustainability of their fashion purchases, and 1 in 3 people are prepared to spend an extra 25% on average for sustainable products (Certilogo-commerce, 2022). Regrettably, numerous footwear companies have been sluggish in embracing sustainable methods. Footwear is an essential requirement for life. However, the number of discarded shoes continues to increase every year. The issue of shoe waste on a global scale has reached a critical juncture that demands our immediate attention. According to experts, the worldwide footwear industry is projected to reach a value of USD 568.54 billion by the year 2031. Advertisers persuade consumers to purchase more products, augmenting the demand for production. In 2019, the footwear industry in Bangladesh witnessed a significant production of 378 million pairs of shoes. Notably, a substantial portion of these shoes, ranging from 200 to 250 million pairs, were purchased by local consumers. The demand for local and international footwear is experiencing a steady and upward trend (Kumar *et al*., 2019). Annually, almost 20 billion shoes are produced (DiNapoli, 2024a).

Furthermore, the footwear industry has significantly contributed to foreign exchange (Moktadir *et al*., 2019). The observed trend of footwear exports to foreign countries is on the rise, suggesting its significance in relation to the developmental rates of various nations. Based on data derived from the financial years 2018-2019, it has been observed that the revenue generated by leather-based footwear items amounted to 607.88 million USD. Therefore, it can be inferred that the footwear industry is experiencing growth, as evidenced by the upward trajectory of its foreign currency earnings. In addition to its notable impact on foreign currency earnings, the industry is currently encountering challenges in benchmarking its practices to enhance its overall performance (Moktadir *et al*., 2021).

As per the data available in The World Footwear Yearbook 2023, China is the leading consumer of footwear and shares 17.9% of the world's consumption. The United States and India hold 2nd (12.2% share) and 3rd (11.5%) rank, respectively. Other countries under the top 10 are Brazil, Indonesia, Japan, Pakistan, Germany, the United Kingdom, and France. These top 10 consumer

countries collectively represent 59% of worldwide footwear consumption. Footwear Distributors and Retailers of America (FDRA) defines shoe sustainability as "shoe design, development, manufacturing, distribution, and selling processes that minimize negative environmental impacts, conserve energy and natural resources, are safe for employees, communities and consumers, and are economically sound" (Shoe Sustainability, 2025). Shoes are integral to the fast-fashion industry, known for their affordability and fashionable appeal. Occasional purchasing transformed into regular purchasing. The affordability of shoes comes with a cost for both the workers who create them (exploitative labor) and the environment (chemical and waste pollution).

## FOOTWEAR INDUSTRY AND UNSUSTAINABILITY

Akin to the textile industry, the footwear business exerts a substantial environmental impact. According to a study, a standard pair of running shoes made of synthetic materials emits approximately 14 ± 2.7 kg of $CO_2$ throughout its lifespan. The shoe composition consists of a total of 65 distinct components, necessitating a total of 360 processing steps for the assembly process (Cheah *et al*., 2012). All the stages in the production of shoes pattern creation, cutting, sewing, lasting, and finishing are linked to various kinds of health risks (Mahmud *et al*., 2020). However, the most harmful substances are the noxious organic solvents, which are especially found in the adhesives, as well as in the hardeners, cleaning solutions, and degreasers utilized during the shoemaking procedure (Gangopadhyay *et al*., 2011).

A large amount of carbon dioxide is released into the atmosphere during the production process. It is responsible for 1.4% of the total emissions of greenhouse gases (GHG) worldwide. A pair of sneakers generates 30 pounds of carbon dioxide ($CO_2$) emissions, which is equivalent to the amount of energy that would be consumed by a light bulb with a power output of one hundred watts if it were left on for a week (DiNapoli, 2024b). The manufacturing of trainers is highly carbon-intensive, accounting for 1.4% of total global greenhouse gas emissions (Fashion, 2022).

The escalating growth of footwear factories has been observed to exert adverse impacts on both the environment and human health. The manufacturing stage of a shoe's life cycle is widely recognized as one of the most significant contributors to its environmental impact. During the manufacturing stage, the production of shoes necessitates the utilization of a substantial quantity of machinery and chemicals. In order to operate these machines, a substantial quantity of fossil fuels is required, which, upon combustion, emit greenhouse gases. Coal, as a prominent energy source, is frequently employed in the operation of factories due to its cost-

CHAPTER 10

# Financing and Investment for the Circular Economy

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**Abstract:** The transition from a linear to a circular economy is imperative to ensure sustainable resource utilization and environmental preservation. This paper delves into the critical role of financing and investment in advancing circular economy initiatives. It explores the challenges of aligning traditional financial systems with circular economic principles, emphasizing the need for innovative financial tools, public-private partnerships, and regulatory frameworks. The study highlights the benefits of circular economy practices, such as resource efficiency, waste reduction, and socio-economic advantages, while addressing barriers like high investment risks and limited financial accessibility. Through a comprehensive analysis of financing instruments, investment strategies, and case studies, the paper provides actionable insights into fostering a circular economy. It underscores the importance of integrating circular economy principles in financial training and education, advocating for global cooperation to overcome structural and regulatory hurdles. The findings aim to guide policymakers, investors, and businesses in adopting sustainable financial practices to facilitate the global shift toward a circular economic model.

**Keywords:** Circular economy, Environmental sustainability, Investment strategies, Public-private partnerships, Resource efficiency, Sustainable financing.

## INTRODUCTION TO CIRCULAR ECONOMY

Industrialization has been the driving force of the modern revolution, making possible the improvement of the quality of life. The advance is commonly achieved by producing as much as possible. The maximization of production, however, places the planet at risk of resource exhaustion and environmental destruction. Although economic benefits are important considerations, the considerations of resource exploitation and environmental destruction, if not the

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most important, are equally significant. There is a need to manage economic activities to achieve a balance between the pursuit of economic value and resource preservation and environmental protection. To create such a balance, the concept of circular economy has been proposed (Velasco-Muñoz *et al*., 2021).

In the circular economy, economic activities are managed to create circular loops in the utilization of resources. Products are produced to have minimal environmental impact. When no longer in use, products are disposed of in a manner that can minimize the impact on the environment. Resource utilization is optimized, aiming to extract the full economic value of the resources. In the utilization, the value of products is preserved. The management of economic activities calls for changes to current corporate finance practices. Businesses, if they aspire to improve overall sustainability, may face trade-offs between financial and non-financial performance. In this chapter, the financing and investment practices that can facilitate the advancement of the circular economy are discussed (Vernimmen *et al*., 2017).

## Definition and Principles

The principle of circular economy is reducing production losses and benefiting the value of each product at the highest level. This involves viewing existing materials as resources and minimizing waste as much as possible. The phenomenon, which is called dumping scrap, refers to the production residues and losses that are disposed of because they are not potentially valuable. Increasing raw material costs necessitate a transformation from a linear production-consumption-waste chain to a cyclic economy. The raw material to be used in order to obtain the desired value from the product to be produced is defined as the net material. In general, the productivity of the product value that is produced by the total material during its life cycle is inevitably associated with social, environmental, and economic factors. You can formulate the equation that provides a direct model with net materials. The equation is as follows, and the values are expressed in kilograms (Roy *et al*., 2022).

Through this equation, value generation through a product that is more efficient both in terms of minimum wastage and outstanding resource planning over the entire life cycle of the product is aimed at. The circular economy concept, which covers waste prevention, reuse, recycling, potential recovery, and energy recovery, evaluates the planning of a broad category of departments together. The production activities that are included within the scope of the circular economy aim to plan the products and production processes in such a way as to minimize loss as much as possible. Circular economy practices allow companies and consumers to benefit from available resources. The basic model is to reduce raw

material consumption, recycle supplies that have lost their use, and continue the cycle of resources. Thus, the main purpose is to implement the continuous value-added model. In this respect, the recycling process alone is not enough. Establishing a network in which all the elements of waste, minimum preparation, and recycling are taken into consideration in a series of diagrams in the context of the resources of the economic model is essential. The characteristics of circular systems are being further analyzed in their social and economic aspects. The weighted system of the circle may require less labor and material use than linear structures, but it may change the use of all production resources in such a way that it is necessary to change production methods. Reuse, preventing waste, and promoting consumer awareness are important benefits of the industry (Kowalski *et al*., 2022).

## Importance and Benefits

Financing and investment in the circular economy are crucial, as the topic for the implementation of circular economy projects is complex, and the missing resources are one of the most common barriers to the circular economy. Circular economy projects are often associated with a higher level of risk, longer payback periods, and lower returns. These characteristics make it difficult to attract private investment, even though circular economy projects offer numerous long-term benefits for the economy and its citizens. Benefits of the circular economy include the reduction in materials, water consumption, and pollution, creation of jobs, cost and energy savings, and a competitive advantage. The circular economy is also recognized as an important sector for reducing security risks and preventing socio-economic problems. In addition to the EU-wide policy measures, national and European measures can be implemented to improve access to financing, especially for small and medium-sized enterprises. The EU's regional funds, development banks, guarantee and risk-sharing mechanisms, venture capital, green bonds, tax incentives, and green public procurement are some of the measures that can be used (Salmenperä *et al*., 2021).

In the context of this study, the work aims to highlight the drivers and the associated actions for the circular economy to be more effectively and adequately financed. This is especially important when circular business models are more capital and knowledge-intensive and have a dynamic relationship with the economic, social, and environmental impacts of the sector. In order to achieve the present work, several methodologies were used, such as the development of a business model based on a set of 24 drivers and 53 actions associated with monetary and socio-environmental impact structures. These drivers and associated actions take into account market competitiveness, environmental compliance, and

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