Chapter 1
Transition from a Linear to a Circular Economy

Showkat Rashid and S. H. Malik

Abstract Waste production, exposure to economic hazards, resource scarcity, rapid depletion of natural capital, etc. are only some of the problems that today's global economy must contend with, all of which point to the fact that the environment in which the linear economic model functions is posing increasing challenges to it, and that our economic framework needs a more fundamental overhaul. Major economies cannot avoid changing from a linear socioeconomic system to a resource-efficient circular economy considering these obstacles. In this chapter, we aim to highlight the significance of the circular economy, which provides a more efficient and long-term solution to these persistent issues. In addition, the 'circular economy,' which is founded on the 6R system of reducing, reusing, recycling, repurposing, remanufacturing, and rethinking will be compared with the 'linear economy,' which is based on the take-make-dispose approach. In a circular economy, the idea of sustainability is viewed from a different angle than in a linear one. Eco-efficiency or reducing environmental effects while maintaining the same level of output is a primary goal of sustainability efforts within a linear economy. The time it takes for the system to become overwhelmed will increase because of this. The goal of a circular economy is to maximise its eco-efficiency so that it can operate indefinitely. What this means is that not only is there less of a negative effect on the environment, but there are really good results across economic, social, and ecological dimensions.

Keywords Renewable energy · Environment · Circular economy · Wastes · Transitions

S. Rashid (✉)
Higher Education Department, Government Degree College Tral, Pulwama 192301, Jammu and Kashmir, India
e-mail: showkatrashid1990@gmail.com

S. H. Malik
Amity School of Liberal Arts, Amity University Rajasthan, Jaipur 303002, India

S. A. Bandh et al. (eds.), *Renewable Energy in Circular Economy*, Circular Economy and Sustainability, https://doi.org/10.1007/978-3-031-42220-1_1

1.1 Introduction

Circularity has been nature's guiding principle from the beginning (Stahel 2019). It is true that many of the world's less developed regions still function based on a non-monetary circular society driven by necessity, like the one in which early man lived (Stahel 2019). The goal of the circular economy was never to maximise the manufacturing of goods, but rather to maximise their useful life. Linear Economy (LE) is the current one-way economic paradigm, also known as the "take, make, and throw away" method. As a viable alternative economic model, Circular Economy (CE) has arisen in the last few decades to address the pressing global ecological concerns brought on by LE (Gallaud and Laperche 2016; Ghisellini et al. 2016; Benton et al. 2017; Kalmykova et al. 2018; Stahel 2019). To be more precise, the circular economy is the most environmentally friendly post-industrial economic business model since its participants are motivated by necessity rather than greed. While we feel more knowledgeable and capable than ever before, we are also maintaining and perpetuating a problem that is specific to our species: garbage. Waste does not exist in nature because everything is used. Insects and, in turn, the trees themselves will use the nutrients in this year's leaf litter to create new leaves the following year. Vegetation absorbs the carbon dioxide released by animal respiration and releases the oxygen needed to sustain animal respiration in the future (Ritchie and Freed 2021). Since both population and resource demands are expected to rise, as well as the rate at which materials and products are purchased and discarded, there will be a corresponding rise in waste production.

1.2 Historical Perspective

Although the name "circular economy" has only been around for a while, the principle has been there for centuries, if not millennia, and has been implemented in a natural way whenever human beings and human cultures have been in complete harmony with nature. We used our natural curiosity and innate brilliance to improve our quality of life alongside the rest of nature back then. When people began adopting a more sedentary lifestyle, it brought about significant changes to their mentality and the social fabric of their communities, particularly regarding the natural world. When we realised how feasible it would be to domesticate the local fauna, we reasoned that there was no reason not to attempt to control nature itself. As a result, we began inventing new methods and equipment to achieve this goal, and as we succeeded in domesticating the natural world, we began to consider ourselves increasingly civilised (Sillanpää Mika and Ncibi 2019). The industrial, agricultural, and technological revolutions that began in the middle of the eighteenth century have given humanity a new "virtual power" over nature (Sillanpää Mika and Ncibi 2019). The decline of humanity's connection with the natural world and with itself was exacerbated by the rise of new political and economic ideas and new societal ambitions that

were gradually being adopted as worldwide standards of living rose (19). Indeed, severe animosities emerged around the world when groups of humans thought they had the right to control the resources of other groups because of the "nearly holy" quest for happiness for themselves, their communities, their tribes, and their countries (Sillanpää Mika and Ncibi 2019). To this end, it appears that the finest formula for economic development in the current era is the pursuit of one's happiness, regardless of the pain that is imposed on others, both human and non-human. Many researchers are not happy with the progress being made toward sustainability on a global scale. And some of them even think that clinging to unsustainable forms of mass production and consumption just made things worse at the time. Many factors can lead to "odd behaviour," including the globalisation of markets, the emergence of highly populated nations, putting a strain on resources, the deregulation of the financial sector, the development of new and highly efficient extraction and processing technologies, the rising trend of offshoring to reduce production costs (and sometimes to escape environmental regulations), etc. The above-mentioned pioneering endeavour was carried out at a period (about a century and a half ago) when economic expansion, national pride, and most of all avarice seemed to have blinded humanity, resulting in severe global environmental and societal implications (externalities in the economic terminology). The primary goal for which all this "sacrifice" was intended never materialised, as ongoing and widespread economic turmoil persisted arise, as do wars stoked by hatred and competition (often for control over the extraction and sale of natural resources). To avoid this predicament, modern material lifecycle management must make a change from a linear one to a circular system (Ritchie and Freed 2021). To accomplish this shift, decision-makers in the global economy will have to reject trash as an integral part of the economy, re-evaluate the management of material lifecycles to increase product resilience and recyclability, and reimagine the way humanity handles its resource management in the near future. Because of these benefits, they have attracted widespread support and interest from governments and businesses (Laurenti et al. 2018).

1.3 Defining Circular Economy

In the current economic system, corporations produce goods, which customers then consume and discard (Michelini et al. 2017). In simple words, the linear economy is defined as the take-make-dispose approach. The maximisation of output and supply is central to this economic model. Unnecessary resource losses resulted from the linear production model due to things like production chain and end-of-life waste, excessive use of energy sources, and ecosystem deterioration (Ketelaars 2019). The conventional system, which has been in use for a long time and is known as the linear economic model, does not provide a driving force toward sustainable growth (Ghisellini and Ulgiati 2020). The only goal of this economic system is the procurement of raw material, manufacturing, and converting it into a final product and disposal (Sharma et al. 2021). Wasteful value extraction, the problem of trash, waste landfills,

a worsening environmental catastrophe, a loss of competitive advantage, and a bias against sustainable development programmes are just some of the problems that arise in a linear economy (Sharma et al. 2021; Luttenberger 2020). Due to the difficulties inherent in the linear economic paradigm, there has been a growing demand for a more sustainable economic model, and thus the Circular Economy has developed (Hartley et al. 2020). The value of products and materials is preserved for as long as possible in a circular economy, as stated by the European Commission (EC). Products that have reached the end of their usable life cycle are recycled instead of being thrown away, which has a positive impact on the environment and saves valuable resources. There could be significant economic gains from this, including increased productivity and new jobs (Kirchherr et al. 2017). The greatest possible results may be achieved with minimal waste and maximum efficiency thanks to the circular economy's focus on recycling and reusing products and materials (Kuah and Wang 2020). According to Stahel (2016), "a CE system would turn goods that are at the end of their service life into resources for others." In addition, the CE has been cited as a source of very substantial social and economic prospects (Wang et al. 2019). It is not just a way to save the planet; it is also a way to give people what they want while doing good for the environment (Zhang et al. 2019).

Although the name "circular economy" has only been around for a while, the principle has been there for centuries, if not millennia, and has been adopted organically and instinctively by human cultures wherever they have been in complete harmony with the natural world (Sillanpää Mika and Ncibi 2019). With the existing unidirectional socioeconomic model, based on the take, make, and dispose of method (Sillanpää Mika and Ncibi 2019), the circular economy model has evolved as the most trustworthy alternative economic system in recent decades to address difficulties like sustainability challenges.

Instead of the more environmentally friendly and efficient circular economy, people are turning to the more traditional and less wasteful linear economy. Since the two economic models are so opposed, the literature on the topic typically presents them side by side to clarify the similarities and differences between them (Hermelin and Andersson 2017; Sillanpää Mika and Ncibi 2019).

The circular economy has been defined as an industrial system that is restorative or regenerative by intention and design. The circular economy is based on three principles such as preserve and enhancing natural capital, optimising resource yields, and fostering system effectiveness. To replace the traditional concept of end-of-life, the circular economy brings the idea of restoration and circularity, shifting towards the use of renewable energy, eliminating the use of poisonous chemicals, and aims for the elimination of wastage through the proper design of the material, products, systems, and business models (Michelini et al. 2017; Dieguez 2020).

As stated by the Dutch Council for the Environment and Infrastructure, "the Circular Economy emphasises the following focal points: reducing raw material consumption; designing products so that they can be easily taken apart and reused after use (eco-design); extending the lifespan of products through maintenance and repair; using recyclables in products, and recovering raw materials from waste flows. The goals of a circular economy include "the creation of economic value

by increasing the economic value of materials or products; the creation of social value by minimising the destruction of social value throughout the entire system, such as by preventing unhealthy working conditions in the extraction of raw materials and reuse; and the creation of value in terms of the environment, such as the resilience of natural resources."

The concept of the circular economy is becoming increasingly popular among environmentalists and policymakers and in parts of the business community. It has been advocated for by groups like the Ellen Macarthur Foundation (2012) and included in the last two Chinese Five Year Plans (Zhijun and Nailing 2007; Sørensen 2017). Many countries around the world are presently contemplating strategies to promote recycling and more effective waste treatment considering the European Commission's (2015) proposal of an EU action plan for the circular economy. A circular stage with positive recycling that lessens the burden on the environment and slows down the depletion of natural-resource stock has been claimed to be the best development route for an economy that begins at a low point in economic development.

The difficulty in defining CE stems from the fact that it is an interdisciplinary term. The key challenge is coming up with a precise description of CE that is neither too narrow nor too broad, as such a definition of a holistic notion is impossible to create. Upon closer inspection, it becomes clear that most of the proposed definitions are merely aggregations of concepts and/or goals coming from different scientific and industrial fields. And since CE is such a crucial sustainability enabler, it needs to be characterised in a way that mirrors the tridimensionality of sustainable development (economy, environment, and society). Most existing definitions focus on the business aspect (how to make money off of circularity while protecting the planet (Sillanpää Mika and Ncibi 2019) (Fig. 1.1).

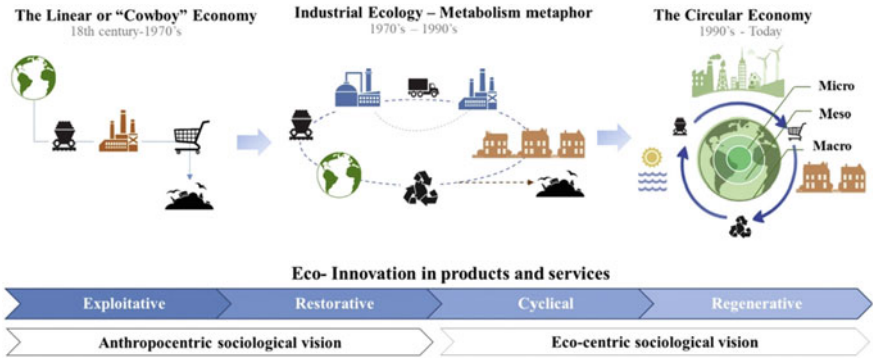

Fig. 1.1 Circular economy knowledge map proposed by Prieto-Sandoval et al. *Data source* Prieto-Sandoval V, Jaca C, Ormazabal M. Towards a consensus on the circular economy. Journal of Cleaner Production 2017; 179:605–615

1.4 What's Wrong with Linear Economy?

We know the world is at least 4.5 billion years old. We estimate that biological systems have existed for at least 3.5 billion years and will continue to do so for at least another few billion years. In contrast, human beings have only contributed to these ecosystems for the past few hundred thousand years. Humans have only been around for a relatively brief amount of time, but in that time, they have managed to disturb every single biological system on Earth. In the wild, there is no such thing as a garbage dump or the idea of trash. Everything in nature is ultimately a source of something else, whether it be sustenance, material, or power. There is nothing we need that is not already here on Earth. Sunlight is the only source of energy humans receive (and maybe the occasional asteroid or two). All living systems on earth (except humans) can live in harmony with that balance (Ritchie and Freed 2021). Species have a natural life cycle in which they reproduce, mature, and eventually perish, all while safely returning nutrients to the soil. The sun provides warmth and energy, and it all just works well, in an elegant, closed-loop—a circular approach to resources. Humans, on the other hand, take, make, use, and eventually throw away everything we create. We harvest natural resources until they are exhausted; we package items in containers that cannot be reused, and we design products that cannot be fixed so that consumers are obliged to toss them away and buy new ones. Instead of using the sun's free energy, which is constantly available, we are using what is left of the dinosaurs' energy store by burning it all up. It does not work—all the linear approach does is slowly convert our human resources into waste.

When humans use the linear method, we deplete our finite supply of natural resources and replace them with hazardous waste. We cannot continue in this manner indefinitely, and the harshest repercussions of our carelessness are still to come.

The linear take-make-waste approach to work depends on the use of a lot of materials. Raw resources are gathered by businesses, refined into a final good, and sold to customers. When a product no longer serves its purpose, it is discarded by the buyer. More than 90 billion tonnes of raw materials were fed into the linear system of manufacturing in 2020 (Jugovic et al. 2022). The sheer magnitude of all this pointless production is shocking.

Unfortunately, humans are harvesting materials that are limited in supply and difficult and expensive to extract—and the materials are not designed to be replenished. Throwing these items in the trash will not miraculously turn them back into their parts. As a result, materials become significantly more difficult (when we can even discover a sufficient supply) to extract safely and inexpensively, harvest a meaningful supply, and maintain quality. For instance, it has been more difficult to find enough oil and natural gas as easily accessible supplies have dwindled. To get the last of the energy reserves, firms have had to dig deeper, go further offshore, and use riskier methods like fracking. Therefore, the oil and gas they now extract are of poorer grade, purer, and more expensive to find. Products become more expensive and labour-intensive to make as practically all linear systems rely on fossil fuels for either their power source or the raw materials used in their creation. The false premises on

which the linear economy is based are an infinite and cheap supply of raw materials and energy. Companies are beginning to re-evaluate their founding assumptions as the transition from a linear to a circular economy becomes increasingly apparent.

That "it's working good now, thus there's no need to change" is a familiar refrain from those who would rather not see anything altered. However, the diminishing resources, overflowing waste, and rising environmental problems show that the linear system is not foolproof. Beginning to draw out some of the assumptions of the linear economy and emphasise how they are not working is a fantastic approach to kick off the dialogue about making changes. Realizing the linear economy's fundamental flaws makes room for a more circular alternative. In experimenting with these two distinct models, you can begin to see why the circular economic approach is superior.

Many people think trash "disappears" because that is what they were taught as kids. When you toss your waste in a large, diesel-powered truck, your white plastic trash bag disappears into a foreign nation. However, this is a fundamentally flawed way of thinking about garbage, and one that is largely to blame for the current situation on a global scale. There is no need for a landfill a mile in diameter to hold all the garbage people produce or the energy that must eventually depart any system.

Humans can eliminate pollution and the natural inclinations of entropy if we rethink what trash is, recognise that it is unnecessary, and redirect it as nourishment for another system, like how energy flows occur in nature. That garbage equals nourishment is a principle that can be seen everywhere in nature. For instance, a leaf collects sunlight energy for the tree before gently falling to the ground, where it serves as shelter and food for a broad range of microorganisms. Soil insects digest the dead leaves, recycling the material into nutrients the tree can use to produce new leaves. The current linear economic system is stuck in a take-make-waste cycle. Understanding the environmental, economic, and social effects of this linear style of thinking has led us to the point where it can no longer be sustained. The linear economic model's grip on the economy is beginning to loosen. The concept of circularity, along with the demand for a truly circular economy, is gaining support. To businesses all around the world, it is no longer a novel idea but an integral part of strategic planning (Ritchie and Freed 2021).

1.5 Externalized Costs and Benefits

Waste prevention is priority number one in the circular economy. To accomplish this, you will need to consider and reduce externalised costs, such as wasteful by-products of producer–consumer interactions. A third party affected by this contact could be another human being, an organisation, or even the environment itself, in the form of the air, water, or soil. When resources are jointly owned, or when ownership is unclear, there is a higher chance of incurring external costs. Consider oceans as an example. Despite their vast size, the world's seas are not owned by any nation or organisation. As a result, anyone responsible for polluting the oceans cannot be held accountable for cleaning it up. In other words, the existence of externalised costs

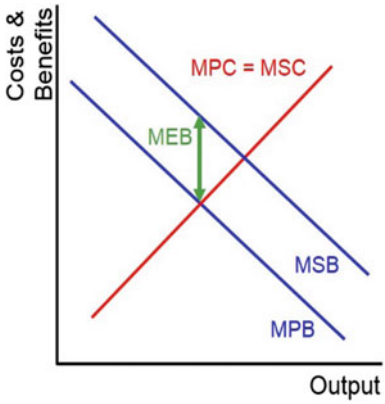

Fig. 1.2 Marginal private benefit and marginal social benefit

indicates a breakdown in the system or a failure of the market. When the market's flow of resources is not distributed efficiently enough to equalise the costs and benefits of a transaction, we have a market failure, and the inefficiency of the market's failure is transferred to a third party (Fig. 1.2).

1.6 Transition Towards Circular Economy

Markets around the world are beginning to show signs of shifting away from the linear economy toward the circular model (Ethirajan et al. 2020). The European Commission sees the shift from LE to CE as crucial to the EU's efforts to create a low-carbon, resource-efficient, and competitive economy because "the transition to a more circular economy, where the value of products, materials, and resources is maintained in the economy for as long as possible, and the generation of waste is minimised" (Jones and Comfort 2017). Reducing waste and fostering new value-creation opportunities are two other goals of the CE strategy (Ranta et al. 2019). Most industrialised and developing economies are displaying a significant interest in the development of the CE as a viable replacement for the LE, and this desire is justified (Mathews and Tan 2011). Economic "regeneration" and "restoration" are fundamental goals of CE, as they contribute to more efficient use of resources (Jones and Comfort 2017). It has become clear that the existing LE is unsustainable and poses a long-term threat to human and non-human life on Earth, hence a change to CE is necessary (Bassi and Dias 2020). However, the expanding need for resources is incompatible with the LE model (Buchmann-Duck and Beazley 2020). The European Commission cites the CE's ability to preserve the long-term economic worth of a product or material as one of its most distinctive features. Reduced waste and increased availability of materials for manufacturing are the results of this phenomenon (Barquet et al. 2020). Though the CE's successful outcomes are enticing, the route from LE to CE is not without its challenges (Cramer 2020). According to research commissioned

by the European Commission, businesses and consumers are two of the most important stakeholders in the shift toward CE (Barreiro-Gen and Lozano 2020). Many obstacles must be overcome in a new firm as it makes the shift to CE (Stewart and Niero 2018). Recovery, recycling, repurposing, remanufacturing, refurbishing, repair, reuse, reduction, rethinking, and rejection are all common CE strategies (Morseletto 2020). Value creation, value transfer, and value capture are the three pillars of the circular business model that are essential for creating a competitive advantage through CE (Centobelli et al. 2020).

Figure 1.1 shows how the general perception of LE and CE. The later relies on closed-loop systems and the former follows a linear "take-make-dispose" model (both symbolised by bold arrows). In this sense, the structure of LE can be summed up as the three simple steps of "production," "consumption," and "disposal," wherein raw materials are obtained, processed into finished goods, and then consumed, wasted, or burned. As a result, it hampered efforts to lessen the impact of or find uses for wastes generated during production and consumption (Sillanpää Mika and Ncibi 2019) (Fig. 1.3).

In contrast, a circular economy (CE) is based on a "production-consumption-recycling/recovering" structure that is more resilient, dynamic, and environmentally friendly because it keeps resources within the same process or network of processes, turning one process's output into another's input while preserving product value and minimising environmental impact (Kiyoka and Koichi 2017; Potting et al. 2017; Sariatli 2017; Rood and Hanemaaijer 2017).

The only term to describe this pivotal time in human history is "change." It may sound over the top, but it is not. Already too much is at risk due to our inability to recognise and effectively respond to major warning signs, such as catastrophic weather, breaches in planetary boundaries, geopolitical tensions over the allocation of scarce resources, etc. Some would argue that we were still unable to see the forest

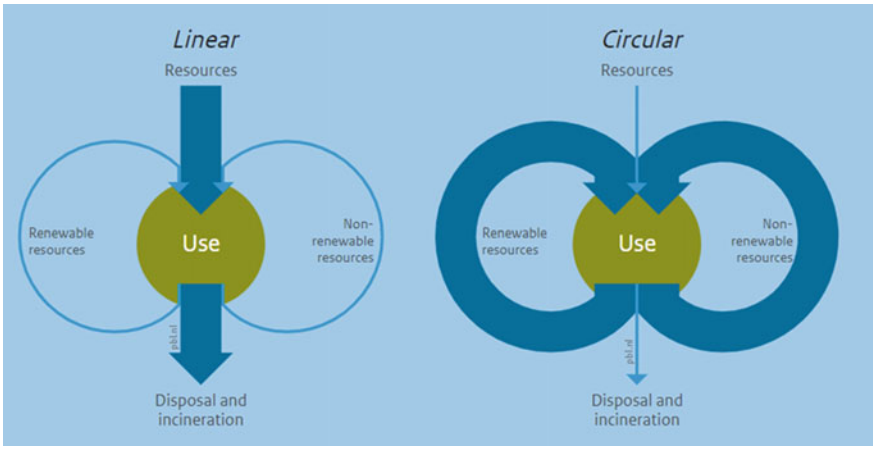

Fig. 1.3 The shift from a linear to a circular economy. *Source* Rood and Hanemaaijer (2017)

for the trees in our reckless quest for economic expansion (Beniston and Stephenson 2004; Humphreys 2005; Rockström et al. 2009).

From a psychological perspective, most people are terrified of change and will actively fight against even the most fundamental alterations to their lives. Even if the Circular economy is a regenerative and sustainable model developed to replace an unsustainable one, it is still a challenging task facing the circular economy since the fear of transformation is profoundly embedded in the psychological perspective of individuals, society, and some conservative firms. To be more specific, the current linear and fossil-based economic approach is viewed as the most effective means of achieving economic growth. Thus, no green or sustainable alternative economic model will be able to take over until it is at least as effective as the status quo. Unless appropriate efforts are taken, including incentive and remedial measures, this natural fear of transition will significantly hold down the implementation of CE. In general, when it comes to making a paradigm shift, some people are willing to make small concessions but none of us is willing to make serious concessions; thus, CE should involve the players that need to take the seriousness seriously, particularly in the policy-making process, the media, and the education sectors (Sillanpää Mika and Ncibi 2019).

When applied to the countries of the developed world, especially those of North America and Western Europe, the term "transition" can be understood to represent the efforts of those regions and peoples to achieve economic growth and development to improve their social and economic well-being. There is no reason why the term "change" should be associated solely with the underdeveloped countries that are striving for the goal. The goal of wealthy nations is to improve the quality of life for their population by creating the best possible conditions for social and economic growth. The economies of certain nations, however, have resisted the shift and provided a counterexample with which to examine and re-evaluate the neoliberal notion. The term "transition" refers to an "improvement process" that, on the one hand, involves the departure of the linear economy concept and, on the other, does not take refuge in a new concept until the final large economic, environmental, and climatic crisis in 2008. At that time, a new concept of the so-called circular economy becomes more visible. However, a shift in perspective around social responsibility, including sustainable development, is essential for a successful implementation of the circular economy.

The core principle of CE is that we can no longer "sustain" our current economic paradigm of "take-make-dispose" any longer because we just do not have enough resources left over to do so. A corporation (A) extracts and/or harvests resources, B uses those resources as feedstock to produce products, and C sells the product to customer X. This linear model has been the foundation of the economic system since the advent of the industrial revolution. X will get rid of a product once it has served its purpose. Eventually, the resources required to make this product vanish from the supply chain, and firm A continues to absorb more of it until the consequences of resource depletion become apparent to customers. As a result, commodity price volatility increases, and people become more worried about a potential shortage of essential materials. Eventually, customer X is no longer able to afford the product,

and the slowdown in economic growth has caused him to fear for his job, while companies A, B, and C struggle to remain profitable.

With billions of tonnes of raw materials entering the global economy every year, it makes sense to abandon the conventional economic model. As a result, the potential of our resources is truly astounding if we continue conducting business in a linear fashion (Potocnik 2013).

Leaving the linear economic strategy involves adopting a non-linear economic model, such as the Circular Economy, which promotes resource recovery, product reuse, and material recycling. To abandon the idea of a linear economy, one must adopt an economically non-linear model, such as CE, which allows for the recovery of resources and the reuse and recycling of objects. The real advantage of moving toward a global CE is that it will encourage a gradual uncoupling of economic outcomes (such as growth, employment, prosperity, social and economic welfare, etc.) from factors beyond our control (such as limited resources, oftentimes especially in other countries) and a recoupling with factors we can influence (renewable resources and wastes).

Various measures aimed at the sustainable and efficient management of resources and goods need to be implemented on a worldwide basis to bring about this goal, which can only be achieved if CE methods are first adapted to local economies (Blok et al. 2016).

- Conserving resources by using less scarce or unspoiled commodities, maximising the value of what we already have, and decreasing waste.
- In the realm of materials, emphasising strategies for recovery and reuse, elongating useful life, fostering sharing and service models, creating a circular design, and leveraging digital platforms are all recommended.

1.7 Future of Circular Economy

Industry and the public also profit monetarily from CE, but its primary goals are the reduction of waste and pollution (Demirel and Danisman 2019). Adopting CE has long-term benefits, as shown by research and industry perspectives; it not only decreases waste but also maintains resource availability, two key factors in eco-friendly growth (Stewart and Niero 2018). Opportunities and benefits of implementing CE techniques have been the focus of various research across various industries (García-Quevedo et al. 2020). Prospects for CE include reducing waste, increasing energy efficiency, protecting the environment, and boosting the economy (Bastein et al. 2013; Singh et al. 2018). Benefits of CE strategy implementation in industries include preserving the economic value of raw materials (Morseletto 2020). Small-scale factories and enterprises can opt for CE since it is more practical than LE, and the government and other stakeholders are prepared to recognise CE's importance (Ferronato et al. 2019). The CE is critical for businesses since it fosters the expansion of product diversification strategies, which in turn aids in securing competitive

advantage (Franco 2019). Successful adoption of CE is being facilitated by government intervention and the neo-technical idea in the production system (Barquet et al. 2020). The CE-based business model results in resource conservation, which, with the right kind of strategic leadership, can allow for long-term sustainable development (Kirchherr et al. 2018; Pla-Julián and Guevara 2019). CE measures, such as reuse, have been shown to reduce the price of scrap sheet metal by about 40% in the automotive industry, making it not only environmentally friendly but also a fiscally sensible practice (Ali et al. 2019).

Any place a difficulty can arise also has a remedy. In addition, there is always a solution to any problem. Everything in the business world revolves around this. Within the circular economy framework, the answers are already available, but they need the backing of enterprises, non-profits, and other organisations to be fully facilitated at a global level. Look around and you will observe an abundance of problems needing resolution: depletion of resources, scarcity of materials, and the continual demand for recovering, extending, and sharing products and resources. Problems on a planet with a growing population and limited resources require creative, flexible approaches (Ritchie and Freed 2021). We are familiar with that spiffy-looking triangle made up of three green arrows—the one that can usually be found on recycling bins and signs referencing the Reduce, Reuse, Recycle slogan. Although a focus on waste reduction, reuse, and recycling is a good place to start, it does not account for everything that has to be done to establish a truly circular business model. It takes you only halfway there. If you want to completely accept the circular economy as a strategy for designing out waste and pollution, keeping products and resources in use, and regenerating natural systems, you need to adopt three extra steps beyond these three well-known ones. Add the three new phases to the initial trio and you end up with six total steps to account for, in this order: Refuse, Reduce, Reuse, Repurpose, Recycle, and Rot.

1.7.1 Refuse: Just Say "No" to Unnecessary Things

A single person has some power to impact the world, but a collection of people has a much greater capacity to influence the world and create the change they want to see. That is why the first R—Refuse—is all about the ultimate power of decision-making: Does the consumer want to support your product or service? What if they decide to reject it, though?

As a potential business owner, you surely realise how enormous the research-and-development (R&D) sector has become. Corporations on a global scale spend a lot of money surveying consumers to learn what features they want to be included in their wares. In total, the top 1,000 most profitable firms in the world—including big names like Alphabet, Amazon, Microsoft, Samsung, and Volkswagen—spent a collective 858 billion USD on R&D in 2018. Finding out what people want to buy is an important part of the first stage of developing a product. Recognizing that the industry sees the value of serving consumer demand means that the consumer can stimulate a

positive change and encourage the move to a circular economy (Benmoussa 2020). If your business is to thrive, you must adapt your product to meet the evolving demands of your customers. Customers can influence your organisation to adopt more sustainable practices by choosing not to buy goods that are not produced, distributed, and consumed within a regenerative economic model.

1.7.2 Reduce: Get by with Less Over Time

The second R emphasises conserving resources, whether it means cutting down on spending, cutting back on how much of a given material is utilised, or cutting back on the environmental damage done by a substance's lifecycle. You, as the company's intellectual leader, are tasked with coming up with foolproof methods that require no effort yet yield the greatest profit. With ride-sharing services like Lyft, for instance, not only does the number of cars on the road decrease but so does the cost of transportation for the average person. By switching to electric vehicles exclusively by 2030, Lyft stands to avoid tens of millions of metric tonnes of carbon dioxide emissions and more than a billion gallons of gasoline over the following decade. In the end, Lyft has created a unique programme called Lyft Up, which employs a variety of activities and products to drive change within underserved communities, such as linking people with the resources and health services they need through reduced or donated trips.

1.7.3 Reuse and Remanufacture: Extend Product Life

Some items, like engines or cell phones, are frequently too complicated for the entire product to be remanufactured after a single component breaks; but, if built properly from the beginning, new generations of these products can be crafted in a way to make them easily repairable. In addition, when manufacturers learn which parts of their products are the most likely to break, they may design the items such that the broken parts can be swapped out quickly and easily. This gives the owner more control over the product, allowing them to fix it rather than tossing it out because of a little problem.

1.7.4 Repurpose: Identify Alternative Uses

Sometimes items can fulfil purposes you never imagined they might. The idea of repurposing a waste source into a valuable one involves imagination and can frequently result in an evolutionary conclusion. Consider Toasted Ale Brewery as an illustration. Because of the widespread problem of food waste in the United States,

the brewery works with local bakeries to turn their surplus of bread into beer ingredients. Toasted Ale's inventive minds realised that a lot of food goes to waste because of stale bread, so they came up with a solution to use the bread differently. Toasted Ale Brewery has been around for a while, and in that time, it has saved hundreds of thousands of slices of bread from going to waste, while also contributing to the reduction of food waste overall.

1.7.5 Recycle: Return Materials for Rebirth

Recycling is the final step in the lifecycle of technical materials. Dismantling technical goods into their parts and recycling the raw materials they are made from into new products is a common practice when they reach the end of their useful lives. The soles of Timberland Shoes and Boots are made using recycled rubber from used tyres, capitalising on the value of recycled materials. By doing so, Timberland has helped to extend the life of this raw material and has diverted vast volumes of garbage from landfills at the same time.

1.7.6 Rot: Return It to the Earth

Akin to how technical materials reach their destination in the form of recycled products, biological materials reach their destination in the form of decomposition (or, more euphemistically, "returning materials to the earth"). If you consider the two concepts—recycling and rotting the same for two distinct types of materials, you can see that the method and advantages are comparable. The objective of recycling is to break down a technical material into a form that can be reintroduced to the global economy so that a new material lifetime can commence. This is also true for biological substances when they are let out to rust; allowed to deteriorate. When organic waste is returned to the ground, it undergoes a chemical and physical transformation that allows it to be recycled back into the economy. The value of any product created from biological materials—such as wood, cotton, or vegetables—can be harnessed and reinvested in the natural landscape to produce new resources. The common, mutually beneficial relationship that has developed between brewers and farmers is a good illustration of this idea in practice. Breweries typically sell (or give away for free) their leftover grain to farmers, who can use it to supplement their soil with nutrients. The leftover grain is subsequently used by farmers to feed their animals. This pulp is fed to livestock, and once they have digested it, it is composted and added to the soil. This collaboration between brewers and farmers prevents tonnes of garbage from ending up in landfills while simultaneously providing food for livestock and revitalising soils.

1.8 Obstacles to the Circular Economy

The move from LE to CE has various acknowledged and proven barriers that present hurdles in efficiently executing it. The obstacles to CE have been the subject of several research. Recovering value from used or obsolete materials is a central focus of the CE, which is why waste management and recycling are its primary topics. However, several developing countries are unable to manage trash because of several obstacles. These include a lack of funding, a misunderstanding of the issue, a fuzzy policy framework, and a lack of information (Ferronato et al. 2019). Adopting the reuse and remanufacturing processes in CE requires sound technology, outstanding design, and technical experience with a professionally educated human resource, all of which can be seen as significant roadblocks (Barquet et al. 2020). Other important hurdles for adopting CE include huge capital requirements, the larger initial cost for updating capacity, risk and uncertainty, and a lack of institutional and legal backing (De Jesus and Mendonça 2018). Managers' negative attitudes toward CE implementation can be traced back to a lack of regulatory pressure and environmental understanding at the corporate level (Zhang et al. 2019). Betancourt Morales and Zartha Sossa (2020) conducted a comprehensive literature review to identify key challenges for industries transitioning from LE to CE. These challenges were found to include legislation, economy, education, training, availability of finances, and the attitude of management towards CE.

Savings from less extraction of virgin resources, additional jobs, and redesigned value chains are just a few of the economic benefits of the shift to circularity. In terms of global GDP, it has enormous potential and might add $4.5 trillion by 2030 (Lacy and Rutqvist 2015). Businesses and governments alike are advocating for a move to a circular economy as a means of boosting sustainability and fostering long-term human progress. Reusing materials and goods after they have served their initial purpose is central to the concept of a circular economy (Arthur et al. 2022).

Most of the materials and goods utilised in society are still part of a linear economy, despite the well-documented benefits of a circular economy. Therefore, one of the greatest challenges of the twenty-first century is making the shift from a linear to a circular economy (CE). A linear economy is one in which raw materials and finished goods are created from scratch, used only once, and then thrown away. As a result, natural resources will be depleted, and the practice will be essentially unsustainable in the long run. A circular economy offers an alternative by focusing on the development of reuse, recycling, and industrial symbiosis to maintain material resources within the economic cycle. Part of this process involves figuring out what is standing in the way of a fully circular economy so that corrective measures can be taken. It has been widely stated that there may be economic benefits to adopting a circular economy company model (Dieckmann et al. 2020).

1.9 Conclusions

Some have called the concept of a "circular economy" a "new revolutionary concept of the 21st-century economy" that provides a "high-quality response" to the world's environmental crisis and climate change. The circular economy takes a new tack on all aspects of the economy, including resource conservation and the distribution of wealth. Because of its high cost and inability to maintain long-term competitiveness, the linear economy paradigm is being discarded in this way.

The essential tenet of the transition from linear to circular economy is the existence of a feedback circle that incorporates recovered materials back into the production process. It is possible to recycle the same trash multiple times and reuse it in different manufacturing cycles, depending on the properties of the recycling technology.

The notion of the circular economy rests on the recycling of garbage, a part of the environment that formerly had a negative effect on the environment but is now returned to the production process as a valuable material resource, or raw material. In the end, just a tiny fraction of trash that cannot be recycled is disposed of sustainably. This idea underpins economic growth. The use of raw materials, waste management, recycling, and reusing output are all fundamental tenets of this philosophy. The circular economy is based on the notion of waste reuse, which includes efficient energy use, and mimics the logic of natural cycles. This method returns the consequences of consumption to the manufacturing process, rationalising and enriching the production and consumption cycle. When the by-products of one manufacturing cycle are incorporated into the next cycle as raw materials, the former junk no longer pollutes the environment and is instead a valuable material resource. 11 The production process is repeated in cycles to maximise the reuse of materials and prevent waste. That is, in a circular economy, products are used for longer until they reach the point of diminishing returns and are discarded. It occurs when a product reaches the end of its useful life but is still put to productive use in the form of recycled waste, in the form of raw material, in the next cycle of production. It is undeniably crucial to lessen the strain on the environment caused by the exploitation of resources to switch from a linear to a circular economy's pattern of production and consumption. Products that would have otherwise been thrown away in landfills or cremated can be reused, recycled, refurbished, and remanufactured with the use of the circular economy's reverse logistics, performance, and sharing economy. Sadly, the understanding of the circular economy is still blurred. Bringing the circular economy into the mainstream requires raising awareness on a local, regional, and international scale. Corporations should infuse circular thought into their product and process design from the very beginning. Additionally, the government should offer incentives and rules to support the development of a circular economy so that jointly we can move towards sustainability.

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