Chapter 10
Circular Economy Indicators and Environmental Quality

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Abstract Sustainable energy is integral to the Circular Economy as it leaves no waste behind and does not increase the exploitation of natural resources. Furthermore, the circular economy is proving to be a viable alternative to the linear economy, not only because it is more eco-friendly but also because it is a practical alternative to the linear economy. Various metrics can be used to measure economic circularity. Even though sustainability and the circular economy are interconnected, few indicators can be used to measure them. Circular economy metrics correlate with key economic and environmental metrics for the growth and sustainability of an economy. The manufacturers and governments of developed economies constantly innovate to boost growth and help them transition from linear to circular economies. The issue of ecosystem sustainability is being challenged by a number of factors, such as global warming, the degradation of the environment, and garbage that ends up in landfills. By implementing circular economies, we can work towards ecological sustainability and development. In addition to the many indicators of a circular economy, there is the recycling of waste packaging, biowaste, municipal waste, e-waste, trade-in recyclables, and recycling patents. In recent years, increased energy intensity, economic expansion, and urbanization have adversely affected the environment. It has been shown that using renewable energy and various circular economy techniques can significantly improve the health of our planet.

Keywords Zero hunger · No poverty · Sustainability · Economy · Sustainability · Environment

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10.1 Introduction

Additionally to the fact that renewable energy is an essential component of a Circular Economy, it is also a component that does not generate waste and does not increase resource exploitation on top of being an essential component of a Circular Economy. Circular economies are emerging as an alternative to linear economies in terms of their environmental friendliness and capacity to provide a more sustainable future. This is in comparison to linear economies. This should be considered when comparing linear economies to the one described above. It is important to keep in mind that economic circularity can be measured in a number of ways, and you need to keep this in mind. It is important to realize that there are a variety of metrics that can be used to measure it in a variety of ways. Thus, it is important to remember that the concept has a lot of aspects that can be measured in various ways. There is a number of interrelationships between sustainability and circular economy. However, few indicators can demonstrate the impact both of these concepts have on one another in terms of the impact they have on one another in terms of their impact. To be able to analyze the relationship between the selected circular economy metric, which includes the growth of the economy and the protection of the environment, it is necessary to examine the relationship between both metrics to fully understand their relationship to be able to analyze the relationship between the two metrics. For the developed economies to be able to increase the growth of their economies, they continuously innovate and implement new technologies to achieve growth, for their economies to grow. This organization's fundamental role as an organization is to provide government assistance to manufacturers, whether by providing them with government assistance or by assisting them in transitioning from a linear economy to a circular economy via providing them government assistance that will facilitate this transition in their role as manufacturers. A growing number of challenges have been created by global warming, the degradation of the environment, and the volume of garbage that ends up in landfills. All of these factors make it extremely challenging to maintain a sustainable ecosystem as a result of these factors. In addition to promoting sustainability and development, many of the key elements of a circular economy are also beneficial to the environment. They are, therefore, beneficial to the environment as well. The purpose of this paper is to investigate how the new circular economy indicators, such as the recycling of waste packaging, the recycling of biowaste, the recycling of municipal waste, the recycling of e-waste, as well as the trade-in of recyclables, will affect the circular economy in the future. Undoubtedly, urbanization, economic expansion, and an increase in the amount of energy being used daily all negatively impact the environment. Due to the use of renewable energy and a variety of circular economy techniques, the quality of the environment has been significantly improved due to the use of renewable energy and circular economy techniques. A circular economy is a concept that promotes the cyclical and appropriate reuse of resources to create an environment that is more sustainable. The circular economy has been recognized as a method that reduces the environmental burden and restores the economy at the same time as it reduces the environmental burden. In terms of the umbrella concept of the Circular Economy, it entails reducing the input of materials into the economy and limiting the generation of waste to separate the growth of the economy from the consumption of natural resources (Blomsma and Brennan 2017; CIRAIG 2015; Homrich et al. 2018). As part of their economic development plans, many countries around the world are adopting circular economies as a part of their economic development strategies. According to the Economic Model of the Circular Economy, manufacturing, planning structure, reprocessing, procurement, resourcing, and management are inputs and outputs in the production process. The goal of this model is to increase the functioning of the environment while at the same time improving the well-being of humans by considering both inputs and outputs (EEA 2016; EASAC 2016). Through the macro analysis of inputs and outputs, the macro analysis of the flow of materials, and the macro analysis of energy at a macro level, it is possible to observe the circular economy at a macro level (Kalmykova et al. 2018). In the case of a specific piece of legislation, China was the first to pass it (Cullen 2017; EASAC 2016; Paulik 2018). Circular economy literature often mentions this nation in relation to the circular economy. Furthermore, it should be noted that Japan and Germany have been pioneers in promoting a circular economy and related policies relating to a circular economy (CIRAIG 2015). Additionally, evidence supports the circular economy policies of European countries, such as the efficiency of the regulations enacted since the 1970s that deal with resources and waste (Ghisellini et al. 2016; Homrich et al. 2018). There has been a proposal by the European Commission in recent months to develop a framework for monitoring the circular economy. Even though several attempts have been made to develop a circular economy, the concept has not been widely accepted (Geng et al. 2013). As a result, there are several different interpretations of what the Circular Economy is (Blomsma and Brennan 2017), and the relationship between the Circular Economy and sustainability is not always apparent (Kirchherr et al. 2017).

10.2 Energy and Its Importance in the Circular Economy

There is no doubt that energy is a vital component of any civilization and plays a significant role in improving a society's economic and social standing. Since the beginning of time, humans have used various resources to create energy, ranging from wood to nuclear energy (Mirza et al. 2008). A total of nine primary energy sources can be classified into two categories: renewable and non-renewable. The most significant renewable energy sources are wind, solar, hydro (water), biomass, and geothermal energy. These resources are limitless and can be renewed organically at any time, so any limitations do not limit them. Oil, nuclear power, gas, and coal are all examples of non-renewable energy sources that can be used to generate electricity. As this is a limited supply of items, it is not recyclable or replaceable in any way, and there is a limited supply of these items. When it comes to non-renewable resources, once they have been depleted, they cannot be replicated, and they cannot be regenerated in the same way they were once available. Therefore, they cannot be used indefinitely.

For even regeneration to be completed, it takes several years for the process to be completed. In the year 2100, global energy consumption appears to grow five times as compared to what it is now, with a five-fold increase in global energy consumption. The amount of energy consumed worldwide is accounted for by fossil fuels, which provide three-quarters of it. In addition, since fossil fuels are widely used, the amount of CO_2 emitted into the environment due to the widespread use of fossil fuels is also increasing (Halder et al. 2015).

Moreover, as fossil fuels become scarcer and the security of energy supplies is threatened, societies are also looking for alternative energy sources to replace fossil fuels. Renewable energy resources are increasingly being used to generate power in this environment as a source of energy. As many nations are developing, their need for energy for industrial and household use is increasing, yet insufficient energy supplies are available. The South Asian nations are densely populated, and while other conditions remain constant, the population density negatively impacts the countries' economic development. According to Ehrlich and Holdren (1971), in contemporary and technological civilization, each human has a negative influence on the environment. Increasing consumption of both renewable and non-renewable sources of energy has led to a significant increase in pollution in both developed and developing countries due to the vast consumption of renewable and non-renewable energy. It has been shown that the pace of population growth contributes directly or indirectly to the accelerated rate of deforestation (Thomas 1989).

In comparison to fossil fuels, which have a substantial impact on the environment and can even endanger human health as well as produce residues that are often not biodegradable, renewable energy can significantly minimize the environmental consequences associated with energy production, as opposed to fossil fuels, which have a substantial impact on the environment and have an impact on human health as well as the potential to produce residues that cannot be biodegradable. In addition to the obvious environmental effects of renewable energy, renewable energy can also significantly affect the environment. However, these effects can vary from one technology to another, depending on size, location, and the technology that is used. The fact of the matter is that there are a lot of examples of environmental degradation that occur, including erosion of soil, clearing of forests, disturbances of and losses of wildlife, pollution of air, water, and sounds, and problems associated with the use of land, destruction of attractive views, and so on. As far as the environment is concerned, there is no doubt that all energy sources have a negative impact on the environment because there are many types of renewable energy sources, all of which negatively impact the environment. The other side of the coin is that non-renewable energy has also been shown to be much more harmful to the environment than renewable energy (Nathaniel and Iheonu 2019) as compared to renewable energy.

10.3 Indicators Measuring Circular Economy

As a result of the circular economy definition, there is a need for specialized monitoring methods to continuously monitor the progress of the circular economy regularly. At various levels of implementation, indicators can be used to assess the status of the circular economy at various levels of implementation (Geng et al. 2012; EASAC 2016). Although, much of what should be monitored in the context of a circular economy is debatable due to the fact that the definition is unclear, and indications can lead to contradictory or even incoherent results as a result (Paulik 2018). Furthermore, a dashboard was presented to compare various indicators based on the British Institutes' standards to present a more accurate picture. Even though this standard is designed to assist enterprises, systems of production, and organizations in adopting circular economies, it does not contain any compliance criteria to determine compliance with its requirements (Paulik 2018). Five BSI-recommended qualities were taken into account as part of the proposed dashboard (regeneration, restoration, preservation, and maintenance of utility), as well as existing indicators for complementing characteristics (sufficiency, resource efficiency, energy, and climate), as well as existing indicators for complementing characteristics. As Murray et al. (2017) point out, the circular economy differs from the linear economy in two ways: it slows down the flow of resources and closes the cycle of resources in two different ways (Murray et al. 2017). In other words, this happens when the loop between post-use and production is closed, resulting in a circular flow of resources, which implies that linear flows of waste are converted into circular flows of resources as a result of closing the loop between post-use and production. There is a term referred to as "closing", which refers to the process of 'closing the loop between the post-use and the production process, resulting in a circular flow of resources,' which implies that linear waste flows are transformed into circular flows (Bocken et al. 2016).

10.4 Strategies of Circular Economy

To ensure the success of the circular economy, all stakeholders must agree on a common definition of a circular economy plan endorsed by stakeholders (Reike et al. 2017). There are many examples of such examples, including the generation of trash, the intake of raw materials, the design of eco-friendly products (such as the lightweighting of products), or the consumption of resources as a whole (Kirchherr et al. 2017). In this context, various ladders or R-frameworks are used to place three or more strategies in the context of a single ladder. To promote circularity, one R-framework employs ten strategies: reject, rethink, reuse, refurbish, repair, repurpose, reduce, remanufacture, recover and recycle (Potting et al. 2017). Regardless of definition, circular economy methods may protect items, their components (modules and components), or the materials (and substances) included inside each product's part.

Furthermore, CE techniques may help to maintain the energy inherent in resources (Iacovidou et al. 2017; Ghisellini et al. 2016; Potting et al. 2017). Circular economy initiatives may also encourage the development of creative business models that go beyond product preservation. Redundancy, multifunctionality, and product usage intensification strategies enhance the circular economy by avoiding the consumption of new items or establishing new consumption patterns. Consumers may, for example, refuse to purchase new items if services or multifunctional products generate duplication in the desired function (Potting et al. 2017). Renting, sharing, and pooling via Product Service-Systems may be effective tools for promoting the circular economy since items will be utilized more intensively (Tukker 2015). It is possible to create product service systems focusing on the product, its usage, or its outcome. As the name suggests, product-oriented product service systems are concerned with extra services provided after the sale of a product (for example, maintenance), so they focus exclusively on the products themselves (Kjaer et al. 2019; Tukker 2015). However, use- and result-driven Product Service-Systems are concerned with maintaining a product's function. In a circular economy, virtualization (instead of real meetings) and discussion sharing (like car-sharing) are examples (Kjaer et al. 2019). The first example is use-oriented, while the second is result-oriented. There are two types of Product Service Systems—Product Service Systems that preserve the function of a product while it is in use and Product Service Systems that preserve the product while it is in use (EMF 2015a) (Fig. 10.1).

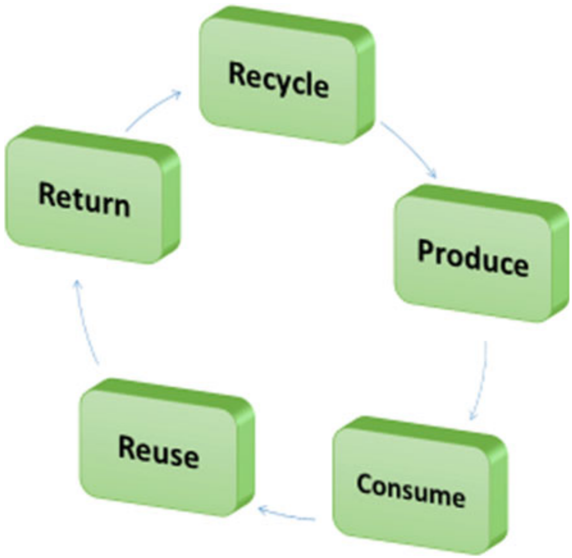


Fig. 10.1 Circular economy: an overview

10.5 Classification of Circular Economy Indicator

As a result of its LCT (life cycle thinking technique) and model level, circular economy indicators can be divided into three measurement scopes (technological cycles and their cause-and-effect chains) according to their measurement scope.

(a) Scope 0: the indicators assess physical attributes derived from technological cycles without using the LCT technique, for example, the Rate of Recycling (Graedel et al. 2011).
(b) Scope 1: the indicators measure physical properties from technological cycles using a full or partial LCT approach. For example, the indicator Reusability/Recyclability/Recoverability (RRR) in mass includes the potential rate to reuse (components, products) and recover (energy) and recycle (materials) (Ardente and Mathieux 2014).
(c) Scope 2: In a cause-and-effect chain modelling, the indicators quantify the consequences (burdens/benefits) of technology cycles on environmental, economic, and societal problems, e.g. RRR benefit rate (RRR in terms of environmental impacts) (Huysman et al. 2015).

The measured strategies can be differentiated based on the indicators, and the measurement type for all the investigated indicators is Direct CE with Specific Strategies. It is important to note that most metrics in the CE approach assess the preservation of material based on the CE approach. As a rule, indicators are presented in scopes 1 and 2 of the measurement scope- that is, they are based on a set of parameters chosen according to the measurement scope, and they study a part or all of the LCT technique. There are a number of indicators included in the scope 1 that measure more than one type of technological cycle, such as the Material Circularity Indicator (MCI) (EMF 2015b), which has been introduced as a measure of the quality of products, their components, materials, as well as their potential to produce waste. There is no need to measure the outcomes of more than one approach within scope 1 or 2 categorizations. It is possible to use the Lifetime of Materials in the Anthroposphere (LMA) (Paulik 2018) as well as the Number of Times of Use of a Material (NTUM) (Matsuno et al. 2007) to measure the cascade of materials across product categories. This is because the two indicators focus on recycling and downcycling to ensure that the material residence time is considered when assessing the LCT approach. However, only strategy 4 is assessed since it also considers the material residence time, so it is evident why this is the case.

10.5.1 Indicators Focusing on Functions

There was no assessment of functions in the indicators that were analyzed. However, several tried to quantify functions by combining quantitative and qualitative data to quantify them even though none of the indicators assessed functions. It has been reported that Scheepens et al. (2016), to develop a PSS for water tourism, utilized the Eco-Cost Value Ratio (EVR) (a quantitative LCA-based indicator) alongside the Circular Transition Framework (a qualitative framework) to develop a PSS for water tourism. The purpose of this qualitative framework was to provide a deeper understanding of the procedures that would be required for the deployment of PSS, whereas the purpose of the EVR had to do with the items that would be included in PSS. Even though the function-related approach in this evaluation was unclear, the purpose of the study was to examine the possibility of replacing a PPS with a diesel engine with a PPS with an electric engine even though the function-related approach was unclear. As a result, it can be concluded that the EVR has improved the eco-design of the product positively, even though the product's functionality has yet to be demonstrated. As a result of the higher risk of affecting functionality than the other techniques, the preservation of functionality when using this technique is more challenging than when using the other techniques since it poses a greater risk of affecting functionality than when using the other techniques. There is, therefore, a need to consider some specific features of CE, such as the effects of changing customer behavior when comparing services and goods, which must also be considered when comparing services and goods (Zink and Geyer 2017) when comparing services and goods. We can gain a deeper understanding of how functions can be accessed from a global perspective to make better decisions by utilizing the Circularity Gap study (Wit et al. 2019) to assess functions from a global perspective to make better decisions (Table 10.1).

10.5.2 Indicator Focusing on Component and Product

An assessment of the strategy for a product or component should be made in light of the possibility of slowing down resource loops when assessing the strategy for that product or component. To quantify this characteristic, a number of indicators can be used, but there are two indicators, in particular, that stand out from the rest compared to the rest of the indicators. Taking into account the fact that some of the physical components of the product are not user-friendly when evaluating the quantity and quality indicators that track the quantity of the product, it is possible to take into account the fact that some of the physical components of the product are not user-friendly as a result of evaluating the quantity and quality indicators that track the quantity of the product. The Total Restored Products (TRP) (Paulik 2018) is an MFA-based metric that takes into account the end-of-life items that are refilled, reconditioned, redistributed, and remanufactured (EoL). A quality indicator, on the other hand, is an indicator that takes into account the time or the economic value of a product and is an example of a character that is affected by the user of a product. In their study, Linder et al. (2017) explain that the Product-Level Circularity Metric (PLCM) measures the relative economic value of flow recirculation compared to the total economic value of the flows at a product level. Franklin-Johnson et al. (2016) have developed a quality indicator called the Longevity Indicator that considers the

Table 10.1 Microscale circular economy indicators

Strategies of circular economy	Scope zero Cycle of technology without LCT aspects	Scope one Cycle of technology with LCT aspects	Scope two Modeling effect and causes with or without LCT aspects
Component (repurpose, reuse)	eDiM	TRP	PLMC
Function (reduce, rethink, refuse)			
Embodied energy (energy recovery)		MCI	SCI CPI
Product (remanufacture, reuse)	eDiM	TRP Longevity MIC	PLMC EVR SCI
Material (downcycle, recycle)	CR RR OSR RIR EOL-RR	NTUM Longevity CIRC LMA	PLMC SCI GRI CEI CPI VRE
Reference(waste generation, landfilling without energy recovery)		Longevity MCI	SCI

- eDiM (ease of Disassembly metric) from Vanegas et al. (2018)
- CR (old scrap Collection Rate)
- PLCM (Product-Level Circularity Metric) from Linder et al. (2017)
- CPI (Circular economy Performance Indicator) from Huysman et al. (2017)
- RR (Recycling process efficiency Rate)
- EOL-RR (End of Life Recycling Rate)
- RIR (Recycling Input Rate)
- OSR (Old Scrap Ratio) from Graedel et al. (2011)
- Longevity from Franklin-Johnson et al. (2016)
- LMA (Lifetime of Materials on Anthroposphere) from Paulik (2018)
- SCI (Sustainable Circular Index) from Azevedo et al. (2017)
- GRI (Global Resource Indicator) from Adibi et al. (2017)
- MCI (Material Circularity Indicator) from EMF (2015b)
- CEI (Circular Economy Index) from Di Maio and Rem (2015)
- NTUM (Number of Times of Use of a Material) from Matsuno et al. (2007)
- CIRC (Material Circularity Indicator CIRC), TRP (Total Restored Products) (Paulik 2018)

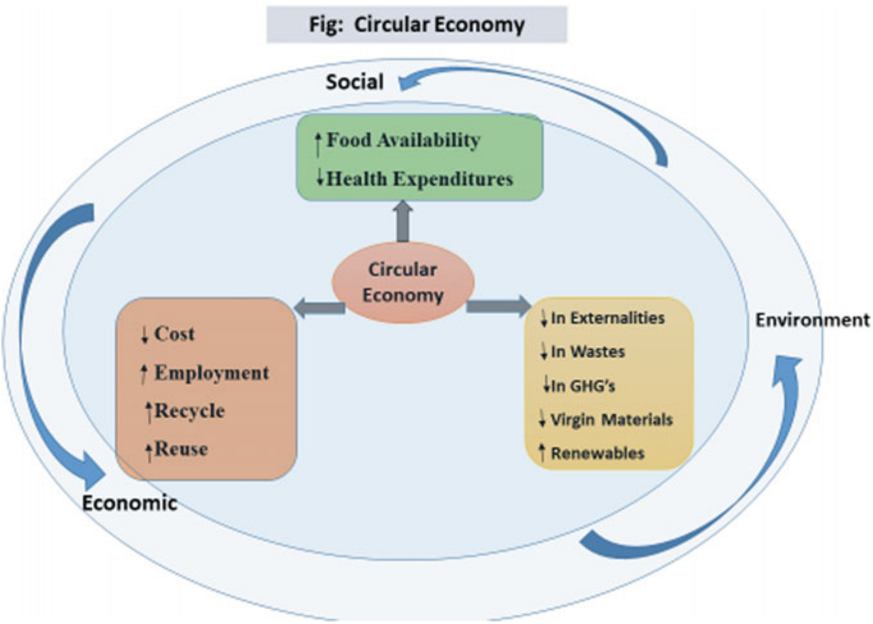
duration of time that the product will last based on statistical data and expert estimations to take into account the longevity of the materials the product is constructed from. Despite the fact that the results of the PLCM may differ in a few respects from those of the Longevity Indicator, they may be equivalent when compared to comparable items with varying lifespans (products with similar functions and recirculated flows). The Longevity indicator, however, only includes the average lifespan. Thus, it is important to consider the data variability that can be attributed to various consumer behaviours over time. In addition to that, the Material Circularity Indicator (MCI) (EMF 2015b) is an index that combines the mass of the product (raw materials, recycled materials, and trash) and the product's lifetime into a single figure.

10.6 Material Quality in Circular Economy

Material quality plays a crucial role in determining the circularity of the economy as it determines the quality of the products. Two critical qualitative elements of recycling will be discussed in this section: the quality of the recycled material and the functionality of the compounds contained within the recycled material. As a result of the recycling process, recycled materials may have a quality that is different from the original material and is often inferior to the original material in terms of quality. It will be necessary for us to be able to study this topic in depth if we can produce material of the same quality as the recycled material obtained from the main sources in order for us to be able to study this topic in depth. In order for a circular economy to function efficiently, preserving functionality "for as long as possible" is important for maximizing the utility of the compounds contained in materials. This consideration is aligned with the concept that preserving functionality "for as long as possible" is essential for the successful operation of a circular economy. It is important to address two issues when it comes to functionality:

1. There is a loss of functional compounds within the raw material due to processing.
2. To prevent the formation of dysfunctional substances in the recovered product, it is necessary to prevent their appearance.

As a result of chemical partitioning and leftovers from the material manufacturing, the chemical functionality of the material can be lost as the chemicals from the material become separated. For example, it may be conceivable that the proportion of functional alloying elements such as Mn, Nb, and V lost to the slags is significantly higher than the percentage of functional Fe lost to the slags in the process of remitting recycled steel. In a study by Iacavidou et al. (2017), it has been reported that functionality loss can occur when a chemical has functionality in the main product but not in a secondary product.



10.7 Renewable Resources and Circular Economy

A successful CE must have a worldwide approach to resource efficiency to ensure that raw materials and energy sources are used effectively. To put it another way, renewable energy sources should be used to generate energy. There is no doubt that CE, renewable energy, and energy efficiency are all intertwined for long-term development to be possible. There is no doubt that global resource-producing companies are increasingly looking for ways to ensure that they meet market demands while reducing the amount of energy they consume and the amount of environmental impact they have on the planet. As a way to connect their operations with a sustainable closed system that is based on the CE, many businesses are attempting to "mix the CE with the bio-economy" in their efforts to come up with a way to combine both elements in their operations in a sustainable manner. Putting it another way, the CE's goals may be better served by a growing reliance on renewable energy sources. For carbon dioxide to be absorbed into the atmosphere, it is necessary to expand renewable resources. Unlike fossil-based goods that contribute to greenhouse gas emissions in the atmosphere when converted into trash (through consumption), renewable resources serve as carbon sinks in the atmosphere when they are converted into trash (by burning). They are not a source of greenhouse gas emissions in the atmosphere when converted into trash (by burning). In addition to being a renewable resource, forestation also contributes to the bio-economy as a source of carbon sequestration. One billion people lack a reliable source of electricity, which is why renewable energy solutions are dependable and expand access. Recent research has shown that in the past five years, there has been an increase of 1.3% in energy-related emissions, which can be reduced by modifying lifestyles, such as reducing, reusing, and recycling resources, as well as recycling virgin materials and water, all of which could reduce emissions related to energy use. It is also possible to improve the structure's efficiency through structural modifications. The relocation of industrial units and the modification of public transportation (such as public transportation and shared passenger vehicles) are examples of such developments that are taking place today (IRENA 2019).

10.8 Circular Economy and Environmental Quality

One of the most significant components of CE is to reduce the externalities (waste and pollution) and to use limited resources as efficiently as possible. It has been shown that CE reduces the depletion of natural resources and enhances the performance of natural resources (Moraga et al. 2019a, b; MacArthur 2013). As well as that, the CE's primary objective is to disentangle economic growth from the limited (finite) resources in the economy and to design institutions that can foster the development of economic, social, and natural capital so that the economy can grow in a sustainable way (Ellen MacArthur Foundation 2019; Elia et al. 2017). It is a central theme of the CE to enhance resource efficiency to minimize the environmental effects and, at the same time, increase the well-being of future generations by reducing the environmental impact they have on the environment (Magnier 2017). It has been suggested that a shift from linear CE to restorative, reproductive, and cyclical CE could be beneficial for the sector, the organization, the nation, and even the international boundaries. Since it is cost-effective, reduces the costs associated with the production of new products, does not produce waste, and can decrease product losses across the value chain (Korhonen et al. 2018). As CE is based on the closed-loop concept, it reduces the consumption of virgin materials since it is based on a closed-loop system, which is based on a closed-loop concept. For a transition to a CE to be successful, it must be evaluated beyond just a material point of view, as it may also affect the quality of the environment and climate change in the long run (Demurtas et al. 2015). It is expected that the use of CE practices will reduce energy consumption and emissions due to its application (IRENA 2019).

10.9 Implications for Theory and Policy

Using renewable energy minimizes the extraction of fossil fuels, the emission of greenhouse gases as a result of fossil fuel combustion, the amount of trash that ends up in landfills, water pollution, and the effects of climate change associated with the use of fossil fuels. Recycling garbage is similar to using renewable resources in that it contributes to reducing the deterioration of the environment, just like using renewable resources. Essentially, this can be attributed to the fact that it does not undermine the system's regenerative abilities and allows resources to be utilized for longer. In addition to contributing to the protection of the environment, the recycling of biowaste and municipal waste helps to reduce pollution. In addition, there is an improvement in the quality of the environment due to the increase in patents in recycling and secondary raw materials that have been issued. This is because when resources are used more effectively, there is also a presence of "ecological modernization and eco-industrial growth". Although technological backwardness and inefficiency in resource use initially degrade the quality of the environment as economies grow and industrialize, awareness of the development and technological advancement arising from innovation will improve the quality of the environment and enhance the relationship between the environment and mankind. The government of every economy should strive to enhance the circular economy, including the use of renewable energy, to ensure energy security as well as shift the reliance away from non-renewable finite resources to those that can be sustained and are readily available in all countries, regardless of their level of income. The use of renewable energy promotes the concept of conservation of energy by shifting dependence away from virgin resources. This shift favours renewable resources that have no negative impact on the environment. There is a greater impact on the environmental quality of a company's competitiveness and innovation than a company's compliance with other CE criteria (Schroeder et al. 2019).

10.10 Innovations and Competitiveness in Circular Economy

In terms of competitiveness and innovation, patents which are associated with the recycling of raw materials or the use of secondary raw materials, the gross investment in tangible items, the number of people employed, and the value added at factor cost are examples of competitiveness and innovation (Ekins et al. 2019). As a result of technological advancements and innovations, there has been an increase in the efficiency of resources and a reduction in the rate of environmental degradation. As a result of the advancements made in the industrial sector, CE has been able to reduce energy consumption by lowering energy consumption to decrease the amount of energy consumed by CE. More specifically, CE has decreased energy consumption by decreasing energy consumption. In the last several decades, the advent of "digital and communication technology" has resulted in greater connectivity, which has led to a reduction in the energy consumption associated with the transportation of heavy cargo (Majeed 2018). When buildings are constructed to meet zero energy standards, it will reduce the amount of energy used in high-temperature zones. As technology progresses and is introduced into the marketplace, many modern cooking gadgets, such as electric stoves and liquefied petroleum gas (LPG), are eroding the dependence on traditional bioenergy sources, thus reducing the dependency on traditional sources of energy. As new models were launched, manufacturers were encouraged to produce vehicle components that could be used for a longer period of time, preserving value and encouraging the use of electric vehicles. It is estimated that almost 16,000 electric buses serve the city, which contributes to a reduction in noise pollution and heat and noise. Increasing the efficiency of secondary manufacturing may have a “rebound effect.” This could lead to a reduction in the cost of the end product and its end value, eventually leading to a rise in consumption and stimulating economic growth. This translates into further expansion, potentially jeopardizing increased efficiency and environmental improvements (Millar et al. 2019). This study emphasizes the importance of CE and its numerous characteristics for the quality of the environment in the context of the preceding research.

10.11 Secondary Raw Materials and the Circular Economy

A number of examples of secondary raw materials can be provided, such as end-of-life recycling input rates, circular material use rates, and trade-in rates for recyclable raw materials as examples of secondary raw materials. There are many characteristics of a circular economy, including the recycling and reusing of goods throughout the value chain, as well as the conversion of trash into a resource through the management of waste to further promote the circular economy (Elia et al. 2017). As one of the most important aspects of the CE, the use of recycled materials is of great importance since it supports the use of natural resources in a sustainable manner. A critical aspect of CE is the notion of industrial symbiosis, which refers to the use of one company’s waste as a resource by another company while at the same time attempting to limit the amount of waste produced within the latter company. To extend the life of a product by improving manufacturing methods and maintaining the product properly in order to reduce the number of replacements and the number of resources used, the aim of this project is to extend the life of a product. For the CE to work, the three Rs (reduce, reuse, and recycle) must be followed (Murray et al. 2017). As a result of the MacArthur Foundation’s research, the Ellen MacArthur Foundation believes that the replacement of single-use bottles with “refill” designs in the packaging, personal care, beauty goods, household cleaning, and transportation sectors could result in a reduction in greenhouse gas emissions of 80–85% (Ellen MacArthur Foundation 2019).

10.12 Agri-food Sector Circular Economy

In order to protect biodiversity as well as use natural resources responsibly, agriculture and the food industry play a crucial role. Furthermore, it is believed that compared to other options, it has a significant potential for alleviating climate change and segment of the economy compared to other options. It is indeed true that the expansion of agricultural activities has important negative environmental effects: the overexploitation of natural resources, the pollution of soil and water, the change in land use, the loss of biodiversity, as well as CO_2 emissions, among others. The perspectives for the future emphasize that these effects will be exacerbated in the future. On the other hand, it is also necessary to increase agricultural production in order to meet the food demands of the rapidly growing global population. Changes in food demand, on the other hand, cause changes in agricultural output. These tendencies will have a greater impact. The amount of intensification of natural resource pressures.

In this case, in this sense, more external inputs (nutrients, agrochemicals, etc.) will be used. More polluting outputs (sub-products, etc.) will be created. Organic and inorganic wastes, nitrates, and so on). The food industry is growing. Inextricably related to agriculture, it provides several opportunities for increasing its circularity by recycling resources and valorizing by-products. In addition, the cascade use of biomass can also help to reduce food loss and waste through the reduction of food loss and waste.

For example, by-products and food industry waste can often be used in agriculture, as feedstuffs and fertilizers. A range of CE indicators must be developed and utilized for a wide range of agricultural systems (intensive/extensive) and settings (urban/rural) to assess agricultural systems' circularity. However, despite this progress, reliable indicators for measuring and documenting the progress towards CE principles are still lacking, particularly in the agri-food sector (Kalmykova et al. 2018). For the transition to a circular economy in agriculture and food systems to be successful, it is vital to evaluate the circularity of such indicators to achieve tangible actions and quantifiable outcomes throughout the process. Likely, the pledges made by agrarian firms and food producers to the CE will remain unspecific and idealistic in the absence of clear metrics. It is also possible that the development of these methods of measuring may result in producers and consumers being able to distinguish between food and agricultural goods that are truly circular from those that are not. A number of other sustainability indicators are required as well as circularity indicators, to determine whether CE techniques contribute positively or negatively to the United Nations Sustainable Development Objectives (SDGs), especially in a sector like agri-food, which is critical to achieving a number of the SDGs (e.g. zero hunger and clean water and sanitation) (Moraga et al. 2019a, b). New socioeconomic indicators at various levels to assess the agri-food sector's circularity. Examine the synergies and trade-offs between agri-food CE plans and the SDGs (Paulik 2018).

1. New criteria to assess the potential of CE regeneration techniques for land used for agriculture.
2. New metrics for evaluating the resource and sustainability savings of agri-food cascade processes.
3. Metrics indicating the use of CE concepts and techniques in food production and consumption systems.
4. Quantitative and qualitative comparisons of novel CE tactics with conventional linear agri-food practices.
5. Systems for monitoring agroecosystems and agro-food linkages.
6. SDG-derived sustainability metrics for assessing bio-economy systems.
7. New data derived from case studies or successful practices demonstrates CE techniques' positive and negative effects with wide implications in the agri-food industry.

10.13 Conclusion

There are a number of indicators that have to do with the preservation of material. There is no doubt that material-focused strategies, which include recycling, are well-established activities, but they are just some of the available options for promoting a circular economy. Recycling, although important to the economy, is not the only feature of an economy that is sustainable in the long run. There are two types of indirect CE indicators, on the one hand, waste and material indicators, on the other hand. On the other hand, the indirect circular economy indicators based on recycling rates use waste data to present information on feasible measures to preserve materials in the future. An estimated portion of the trash will be upgraded as a secondary resource due to the 'circular economy monitoring framework'.

The materials side of the 'Circular economy monitoring framework' may be crucial since only a portion of the trash produced for recycling will be converted into recycled material. However, the efficiency and quality of those materials are crucial to their overall success. When it comes to evaluating functionality, the process is difficult because it affects customer behaviour in a variety of ways. For example, sharing platforms may encourage customers to use items with less caution than they would if they owned them (Tukker 2015). It has been suggested that high-level CE plans require socio-institutional changes in the product chain, which increases the complexity of the evaluation process (Potting et al. 2017).

Research and development of innovative and efficient energy sources in order to promote economic growth rapidly and actively, as well as a reduction in the production of CO_2 emissions. Renewable energy sources are environmentally friendly and reduce emissions. To ensure that our environment stays clean and pollution free, we must implement policies that rely on renewable energy sources in order to boost our economic development and maintain a clean environment. Incentives that encourage businesses to go green should be provided. Technology has been developed in order to reduce carbon emissions by giving incentives such as tax breaks and financial incentives. However, while these policies are being implemented, the governments of these countries should focus on preserving the natural resource pool by establishing public property rights in the form of public–private partnerships. As a result, there may be a decrease in the use of fossil fuels and an increase in the use of renewable energy, which will lower the emissions of greenhouse gases. Although authorities should gradually implement this transition from fossil fuel to green energy solutions, the economic growth pattern may be hindered throughout the course of this transition.

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Conflicts of Interest None.

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