

A Model for the Transition to the Circular Economy: The “R” Framework*

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Abstract

The relevance of circular economy has significantly grown in the last years, thanks to the spread of sustainability principles among companies, policy makers and practitioners. The European Union has given an important impulse to the dissemination of circular economy in business practice, with the introduction of the Regulation on taxonomy for sustainable activities. It is a regulation for the classification of sustainable economic activities, aimed at creating a common language for investors, which favours ventures that have a significant positive impact on the climate and the environment.

Starting from the theoretical background offered by the so-called “R” Framework, the paper attempts to close the gap between scholars and practitioners, providing real cases of implementation of circular economy.

Since there is no European database of circular economy interventions, the proposed cases have been selected according to their degree of innovation, their potential impact on the environment or their real possibility of implementation by companies.

Keywords: Circular Economy; R Framework; Sustainability; EU Taxonomy for Sustainable Activities; Global Markets

1. Introduction

In the last years, a growing interest in circular economy (CE) has been shown by scholar and researchers. Recently the debate on CE drew attention of policy makers, especially at United Nations (UN) and European Union (EU) levels. The sustainable development goals (SDGs) set by UN, in Agenda 2030 (United Nations, 2015), represent a scenario to drive the world on the road to sustainability (Belmonte-Ureña et al., 2021). In this path, CE is a fundamental tool for economic and environmental goals (Circular Academy, 2017; Salvioni & Almici, 2020), emphasizing the reduction of waste and stimulating the adoption of energy sources with low environmental impact. As stated in the new circular economy action plan (European Commission, 2020), the EU considers CE one of the bricks of the agenda for sustainable growth, contained in the European Green Deal (Weber & Sciubba, 2019).

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Initiating the changeover from a linear economy to a CE will favour the reduction of natural resources depletion and will create sustainable value in the medium to long term (CE Club, 2018; Ellen MacArthur Foundation, 2015; Pheifer, 2017; Stahel, 2016). Circularity is also a prerequisite to achieve the desired climate neutrality, fundamental objective for the survival of the planet (Paolillo et al., 2021).

For decades, companies have adopted a linear economic model, based on "take, make, and dispose" (Murray et al., 2017), in which goods are made by consuming raw materials, purchased, used and, at the end of their life cycle, disposed of as waste. The incessant growth of the world's population and the resulting swirling increase in consumption has shown that this traditional model is unsustainable for the planet, generating an imbalance between the supply of resources and the demand for goods (Marino & Pariso, 2020). The importance of closing material cycles (Aguilar Esteve et al., 2021), as a crucial element in a sustainable system, has shown the need to move from a "take and discard" logic (Hopkinson et al., 2018), typical of a linear economy, to "reuse, recycle, and recover" (David et al., 2019; Harrold, 2009), typical of the CE.

The awareness that the resources available are not infinite along with the need to mitigate the effects of industrial processes on the planet are stimulating companies to adopt sustainable production models (Yu et al., 2021). Water pollution, rising sea levels and extreme weather events are the effects of climate change produced by an approach that for years has not taken care of the consequences of its actions (Brinkmann et al., 2014; Masson-Delmotte et al., 2018). While the direct consequences of climate change are plain to see, the indirect effects in the future could be even worse (Bosetti, 2021). Desertification of the soil, acid rain and respiratory diseases are rapidly spreading even in those countries that historically have never faced such problems (Brondoni et al., 2020; Lucas-Pérez et al., 2015). The social consequences of the proliferation of such events could affect the full enjoyment of human rights, with unimaginable consequences. In this context, radical actions seem necessary. The most effective option is to adopt a new approach that is more respectful of the planet, ranging from sustainable production systems to the reduction of waste generated, both at the industrial and the individual levels (Rizos et al., 2016). However, to be effective and to generate the needed impacts on the planet, the shift to circular business models must be comprehensive and not limited to just the most responsible companies (Oncioiu et al., 2018).

The extensive literature on the CE, together with the crosshairs issued by the various international and national organizations (Ellen MacArthur Foundation, 2010; European Commission, 2017; Kyoto Club, 2015), represent the reference point for companies involved in circular production. In fact, as with many other issues related to sustainability, there are no mandatory rules (Schneider et al., 2018), but rather sources of soft law, best practices, and guidelines (de Cabo et al., 2019). In this context, the EU has decided to issue a regulation on the establishment of a framework to facilitate sustainable investment (European Commission, 2018): a classification system, establishing a list of environmentally sustainable economic activities. The regulation provides companies and their stakeholders with appropriate definitions for which economic activities can be considered environmentally sustainable.

2. The “R” Framework

In 2020, the EU has launched the challenge of the European Green Deal, to combat climate change and environmental degradation (Wolf et al., 2021). It is, probably, the challenge and, equally, the most important opportunity, of our time (Haines & Scheelbeek, 2020). The objectives set are no net emissions of greenhouse gases by 2050, economic growth decoupled from resource use and no person, and no place left behind (Montanarella & Panagos, 2021). Making business in a sustainable way is the fundamental prerequisite to achieve those targets (Claeys et al., 2019). In fact, the path of sustainability is no longer an ethical direction of growth, but the only option for success in the medium to long term (Salvioni & Gennari, 2017). In this context, companies, particularly small and medium (SMEs), will have to take up this challenge and turn it into a competitive advantage (Salvioni & Astori, 2013). A further boost to the dissemination of sustainability among companies, comes from the already mentioned European regulation on taxonomy for sustainable activities (Migliorelli & Dessertine, 2019). It is a regulation for the classification of sustainable economic activities, aimed at creating a common language for investors, which favour ventures that have a significant positive impact on the climate and the environment (Beerbaum & Puauschunder, 2019). It defines, in a technically robust way, the criteria for verifying which economic activities contribute to meet EU’s climate and energy targets. The EU taxonomy introduces new and articulated principles for assessing the environmental sustainability of undertakings and new operational challenges, which are complex to implement (Giacomelli, 2022).

Due to two years articulated path, which involved scholars, practitioners, NGOs, and companies, could be identified 6 overarching environmental and climate objectives:

1. Climate change mitigation
2. Climate change adaptation
3. The sustainable use and protection of water and marine resources
4. The transition to a circular economy
5. Pollution prevention and control
6. The protection and restoration of biodiversity and ecosystems.

Thanks to these six objectives, it is possible to label an economic activity as sustainable or not, from the environmental point of view (Lucarelli et al., 2020). The conditions that an economic activity must meet to qualify as environmentally sustainable are:

1. Contribute positively to at least one of the six environmental objectives
2. Not produce negative impacts on any other objective
3. Be carried out in compliance with minimum social guarantees.

Simplifying the contents of the regulation, to qualify an activity as sustainable, it is necessary to comply with the principle *of do no significant harm*, known as the acronym of DNSH (Alessi et al., 2019). This means that any industrial activity must not cause harmful effects.

Established that the theme of sustainability is an important issue, from a strategic point of view, we must look to the needs of future generations and not only at our current wishes (Brondoni, 2009). The debate about achieving sustainability of the planet has underlined the importance of the CE as one of the main instruments to achieve the goal of delivering a sustainable world for future generations (Rodriguez-Anton et al., 2019). The inclusion of the transition to the CE among the objectives set by the EU taxonomy for sustainable activities, underlines the intention to provide the dissemination of circular production practices among European companies (Bassi & Dias, 2020).

Although there is no single definition of CE, the most shared one is provided by the Ellen MacArthur Foundation.

□ *The circular economy is one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles. This new economic model seeks to ultimately decouple global economic development from finite resource consumption. It enables key policy objectives such as generating economic growth, creating jobs, and reducing environmental impacts, including carbon emissions (Ellen MacArthur Foundation, 2012).*

Another definition widely used by scholars is that provided by the European Parliament.

□ *The circular economy is a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended. In practice, it implies reducing waste to a minimum (European Parliament, 2015).*

Regardless of the definition chosen, many authors share a type of framework, over and above different aspects of the CE, known as the “R” frameworks (Maťová et al., 2019): the 3R (Brennan et al., 2015; King et al., 2006), the 4R (Yang et al., 2017), the 6R (Jawahir & Bradley, 2016), the 9R (Van Buren et al., 2016), or even the 10R (Kirchherr et al., 2017).

Each framework is based on different principles -reuse, repair, reduce, recycle, refuse, rethink, refurbish, remanufacture, repurpose, and recover- which scholars combine in different ways, according to their research and discussion (Salvioni et al., 2022). A possible combination of these principles is the one proposed in the next table (Table 1), in which the various "R" frameworks are identified, together with the definitions of individual principles.

Table 1: *The “R” Framework of Circular Economy*

Framework				Principle	Definition
3R	4R	6R	9R 10R	Reuse	Think new products with components that can be reused in other contexts
				Repair	Build products easy to repair you don't need to replace them in case of failure
Reduce				Consumption of energy and materials during the life cycle of the product	
Recycle	Use recyclable materials for new products and design them easily to recycle at the end of the life				
				Refuse	Debris dangerous substances for humans and the environment: replace it with eco-compatible one
				Rethink	Think products and their functions to produce and use it more efficiently
				Refurbish	Repair, repaint, and redecorate products to make them look new again
				Remanufacture	Rebuild a product using a combination of reused, repaired and new components
				Repurpose	Find a new use for a product, compared to the original one
				Recover	Restore a product to become functional again after being damaged or having problems

Different “R” frameworks have been used by scholars and practitioners for decades, whereas a specific starting point cannot be traced (Sihvonen & Ritola, 2015). The most shared is probably the 6R (Kirchherr et al., 2017), as it is able to produce an effective transition towards the circular economy in a way that can be concretely achieved by companies. For these reasons, in the following discussion we will stick to the provisions contained in the 6r framework.

This literature review highlights the centrality of the CE in the scientific and political debate of the last years. In fact, scientific production on the subject is abundant, as well as numerous legislative interventions at all levels. However, there is still a gap in the literature, namely the formalisation of the practical experiences developed by companies (Snyder, 2019). The attempt to fill this gap is aimed at promoting and disseminating the successful practical experiences within the CE.

3. Circular Economy Practical Cases

In this section we provide some practical cases to the principles of the 6R framework of CE.

Case study research methods can be used in the establishment, testing, or expansion of theories (Eisenhardt, 1989) and to promote their diffusion. The practical cases research method can be adopted in exploratory, narrative, or explanatory research (Zainal, 2007). Data can be collected through direct observation, systematic interviews, government and private data, or media report (Leonard-Barton, 1990). For this paper we base on official websites, corporate websites, and public media CE topic interview reports.

Since there is no European database of circular economy interventions, the proposed cases have been selected according to their degree of innovation, their potential impact on the environment or their real possibility of implementation by companies. The analysis has been conducted in the period November 2021-January 2022.

The following are the practical cases, organized according to the 6R scheme. Many of these examples are based on the technologies of the Fourth Industrial Revolution.

□ *Reuse: thinking new products with components that can be reused in other contexts.*

The additive manufacturing allows the extension of the life cycle of products we use every day, like a plastic bottle. Through 3D printing and accessories production, a bottle can become a spray, a whistle, rather than a toy for soap bubbles. This is an example of the reuse of an object, extending its life cycle and consequently reducing the generation of waste.

- The Finnish RePack¹ removes trash from deliveries with reusable packaging. The company invented a returnable casing for online retail. The idea is based on reusable plastic bags: durable RePack bags are designed for soft goods and fold into letter size when empty. Once you have received your goods, you can put in the mailbox the packaging, which as a pre-franked, you can return it to Repack. At this point it can be reused for a later shipment of a different product, in another country and with another recipient. This is another example of reuse: reuse an object several times to extend its life cycle.

□ *Repair: building products easy to repair you don't need to replace them in case of failure.*

- *The predictive maintenance is carried out following the identification of one or more parameters that are measured and processed using mathematical and artificial intelligence models, to detect residual time before a failure occurs. The use in a production plant provides the possibility to reduce failures and avoid waste or related inefficiencies. In fact, being able to plan maintenance, before a failure occurs, can have very important impacts also in terms of energy efficiency and waste generation, with direct benefit to the environment.*

- *In the world of technology, planned obsolescence imposes the disposal of goods with an unsustainable frequency. Fairphone² is a company specialized in the production of sustainable smartphone. Their goal is to demonstrate the endless possibilities that exist to create a fairer future for everyone. Their phones are based on modules and are easy to fix. The modules that make up the cellular are readily replaceable by the end user, allowing easy repairs or updates from a hardware point of view.*

□ *Reduce: consumption of energy and materials during the life cycle of the product.*

- *The additive manufacturing applied to the production of a mimetic propeller: taking inspiration from nature you can produce an agitator that can maximize its effectiveness. Different companies use this kind of propeller against the accumulation of certain fluids or in agri-food production. A special propeller, produced with a 3d printer, gives the possibility to reduce the number of revolutions that the agitator needs to achieve its result, compared to a traditional propeller. A product like this requires a small amount of raw material, because additive manufacturing does not create waste, unlike subtractive manufacturing.*

- *Moloko Project³ is a group of companies and researchers that has the goal of timely knowledge of milk contamination, reducing waste. The idea is to use technology to create a system of sensors able to assess the contamination of milk directly in the production site and not in the processing one. Nowadays, milk is controlled only when it reaches the processing industry. It follows that if there has been contamination, the whole lot must be discarded. Through digital technologies, the quality of the product can be monitored directly during milking, excluding the unhealthy garment, making all the rest of the production safe. The application of digital technology in reducing food waste has direct effects on the theme of sustainability and animal welfare.*

□ *Recycle: use recyclable materials for new products and design them easily to recycle at the end of the life.*

- *Life ReskiBoots⁴ is an EU-funded project with the aim to implement a new model of circular plastic economy, in line with the European Strategy for Plastics in a Circular Economy, over the full product life cycle, including a take-back and hard-outer shell re-use service for ski rentals, to manufacture ski boots from recycled soft and hard multi plastics. One of the milestones is to create a machine that can prevent the production of undifferentiated waste generated by multi-material products. In the case of ski boots, the idea is to disassemble the polyurethane of the internal padding, from the plastic material of the boot rather than from all metal components. This process will allow the recycling chains to be given plastic, rather than metal, rather than polyurethane, properly.*

- *Celli Spa is an Italian company, for years active in the beverage dispenser sector, that has designed a small house for the supply of purified smooth or sparkling drinking water, that municipalities can install in their territory. The structure was produced entirely in stainless steel, so with a guaranteed durability. If the municipality decides to change its destination, it would be enough to remove the water distribution panel and the house could become a bathroom for disabled people, rather than a kiosk for information. This example shows how useful it is to think about how to reuse a product at the end of its life cycle, even when it has been designed to last for a long time.*

□ *Refuse: debris dangerous substances for humans and the environment: replace it with eco-compatible one.*

- *The use of paper packaging, which is easily recyclable, rather than plastic packaging. Lifecycle and environmental impact of a plastic packaging compared to that of paper are considerably higher. Choosing to reject plastic, preferring recycled paper, is a simple change that companies can introduce for their products and in their processes. Considering, for example, the quantity of packaging that the delivery sector alone produces, it is quite clear that eco-compatible packaging is necessary for the protection of the planet.*

- *Life Zero GWP project⁵ is coordinated from Innova, an Italian company that produces domestic air conditioners that use natural gas, instead of cooling climate-changing gas. The environmental impact of disposing of an air-conditioning split that does not contain any climate-changing gases is much lower than a traditional product. Choosing this product positively influences the climate change mitigation.*

□ *Rethink: the product and its functions to produce and use it more efficiently.*

- The Italian start-up Isinnova has turned a diving mask into a respirator for people affected by covid-19. This is an example of rethinking a commercial product, transforming it into a medical device, through the application of a new technology, employing this technology to counter a pandemic.

The previous examples represent only some of the virtuous behaviours adopted by companies with a view to circularity. However, these are situations that highlight the sensitivity to sustainability on the part of companies, which however imply the involvement of customers, suppliers, and many other stakeholders.

4. Conclusions and Emerging Issues

In this paper we presented some practical examples of CE application, with the aim to promote the diffusion of sustainable practices, to bring companies closer to the principles of the European regulation on taxonomy for sustainable activities.

At regulatory level, the Green Deal and the Eu Taxonomy establish objectives and technical screening criteria that the business arena must achieve or respect. Today, on the one hand, it is quite clear what are the objectives to aim for, but, on the other hand, it is not clear at all where the starting line is located for companies and in particular SMEs. In this context, the 6R model represents a valid simplification for identifying a starting point for a correct definition of a sustainable growth strategy.

Regulatory scenario radically transforms the objectives of each individual company. Operating in the first continent that has declared to halve its emissions by 2030, simultaneously represents the greatest challenge and the greatest opportunity of our time. SMEs today are not called to raise awareness of sustainability, but rather to move quickly to action.

The proposed examples highlight the importance of use and life cycle issues. This can be further clear through some examples. A stationary car has an impact equal to 0 on the environment, without consuming or producing pollution. The plastic of a disposable cup has some impact on the waste chain and, consequently, on the environment. A PVC window is made of plastic as a cup, but it will last some decades, therefore the life of the same raw material can be optimized, assuming a completely different effectiveness.

CE-related principles and practical examples can be applied by businesses and consumers based on their individual sensitivity. With the new European regulation, less discretion will be allowed in the financial sphere. Investors who choose sustainable activities will need to understand the environmental impact of specific activities and will need to measure it. The European Green Deal has imposed quantitative criteria, which will become increasingly common.

Contrary to what one might think, this regulation already finds concrete applications. For example, in Italian National Recovery and Resilience Plan funds. The Italian Government has committed itself to distributing at least 37% of the funds

received, in accordance with the principle of the DNSH, which is a principle of the taxonomy regulation. Therefore, even if companies have not yet touched about taxonomy, the measurement of the environmental impacts of an economic activity and the related financeability of an enterprise is already in place. Thanks to the taxonomy, it is now possible to accurately measure environmental impacts, also in the foresight of greenwashing, that is, fake commitments to the environment aimed at deceiving sustainability-conscious stakeholders.

Currently the operational provisions of the taxonomy concern, as said, the environmental and energy aspects. An emerging issue is the social criteria: the second key factor of the ESG. It is not enough to specify that minimum social safeguard thresholds, but it is necessary to draw up social criteria to be integrated in the definition of sustainable activities.

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Notes

¹ <https://www.repack.com/>

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³ <https://www.moloko-project.eu/>

⁴ <https://www.lifereskiboot.eu/>

⁵ <https://www.lifezerogwp.eu/>