



## **CIRCULAR ECONOMY AND NEW TECHNOLOGIES**

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### Summary:

The main purpose of this research paper is to know the concept and origin of the circular economy, as well as the role that technology plays in those companies that apply a circular business.

Firstly, some data on the current production and consumption paradigm will be presented, thus being able to understand the reasons why the transition to a production and circular consumption system is necessary.

Then, two schools of thought will be developed to lay the foundations for what the circular economy is and discuss how an entity can establish it in its business.

Finally, the points for and against new technologies in relation to the circular economy will be detailed, highlighting three particular cases of companies that have obtained benefits thanks to technological use as a tool to implement a circular business.

### Keywords:

Circular economy, sustainability, new technologies, artificial intelligence

JEL Classification: A13, F64, O3, Q57

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## 1. Introduction

*“La dicotomía entre desarrollo y sostenibilidad es falsa. Sin planeta, no hay economía que valga”- words of Al Gore according to Gómez Silva (2007).*

These were the words of the former US Vice President, Albert Arnold Gore, at the conference on "Energy, Municipality and Global Warming" that took place in Madrid in 2007. And it is that, currently, we live in a society based on the massive production of goods, without taking into account that raw materials have a limit. To this, it must be added that we are interdependent people, in the sense that we live in a globalized environment, where everyone ends up suffering the consequences of an uncontrolled production system.

All this has caused several international organizations to seek solutions to reduce the impact of overexploitation of resources. To raise awareness of the importance of creating a new model of production and consumption, it is necessary to know the participation of all the parties involved and thus be able to make a transition towards a new system, such as the circular economy.

That is why, the main objective of this paper is to address the most relevant problems that exist in the current productive paradigm and try to respond to them, as well as highlighting the fundamental role that companies play, hand in hand with technology. For this, a compilation and synthesis of relevant information has been carried out from both academic publications and studies and reports carried out by official institutions and institutions linked to the circular economy, and the economic-financial and general press.

The methodology to be followed throughout the paper will be as follows:

- First of all, the data at a global level of the current situation of the production and consumption model will be analyzed to try to understand the reasons why a change in a linear production system is required (buy, use and throw) towards a circular one.
- Once the current situation derived from the operation of the traditional model is known, the main conceptual foundations will be explained in order to consolidate the foundations of the circular economy, knowing the reason why it originates.
- Thirdly, a roadmap will be developed that can be followed by those companies that decide to establish a circular model in their businesses.
- Then, the points for and against the role of new technologies within the circular economy will be taken into account.
- Next, to have a more practical perspective on the circular economy, specific cases of companies that apply a circular model will be detailed and/or help other companies to apply it thanks to new technologies.
- Finally, the appropriate conclusions will be presented as a result of everything studied throughout the work, along with some recommendations that could be taken into account in possible future research.

## 2. The delicate situation derived from the current production and prevailing consumption system

To contextualize, we must know that the circular economy comes hand in hand with the Sustainable Development Goals (SDGs) proposed by the United Nations, especially with objective 12, which aims to guarantee sustainable consumption and production patterns. In 2015 the UN approved 17 SDGs in order to achieve compliance by 2030. The objective of Agenda 2030 is for countries to improve everyone's lives, respecting the planet or ending poverty, among other things.

SDG 12 (Responsible production and consumption) aims to raise awareness among the population about the limitation of natural resources and about the devastating effects that the current system is causing. The UN shows that the economic and social progress that has been achieved during this last century has caused the degradation of the environment, jeopardizing the systems we need to develop our future. In other words, we are destroying our survival.

Some of the goals that this objective seeks to achieve are: the reduction of waste through recycling, reuse or with preventive actions, the reduction of leftovers per capita from food as well as from supply chains, that is, making efficient use of resources, encourage companies to carry out sustainable practices, promote local culture and products or try to eradicate subsidies for practices that are harmful to the environment, such as aid that encourages the consumption of fossil fuels.

According to the "Informe de los Objetivos de Desarrollo Sostenible de 2021" issued by the United Nations, if we continue with the current level of consumption, we will not have enough raw materials to supply everyone's needs. This is why the need arises for a change in consumption and production.

Today's world population (2022) is 7.9 billion people. On the other hand, it is expected that by 2050 9.7 billion people will be reached worldwide, according to the issued report. This implies that in order to satisfy everyone's needs and maintain the current level of consumption, the equivalent of three times our planet would be required, in order to supply ourselves with natural resources.

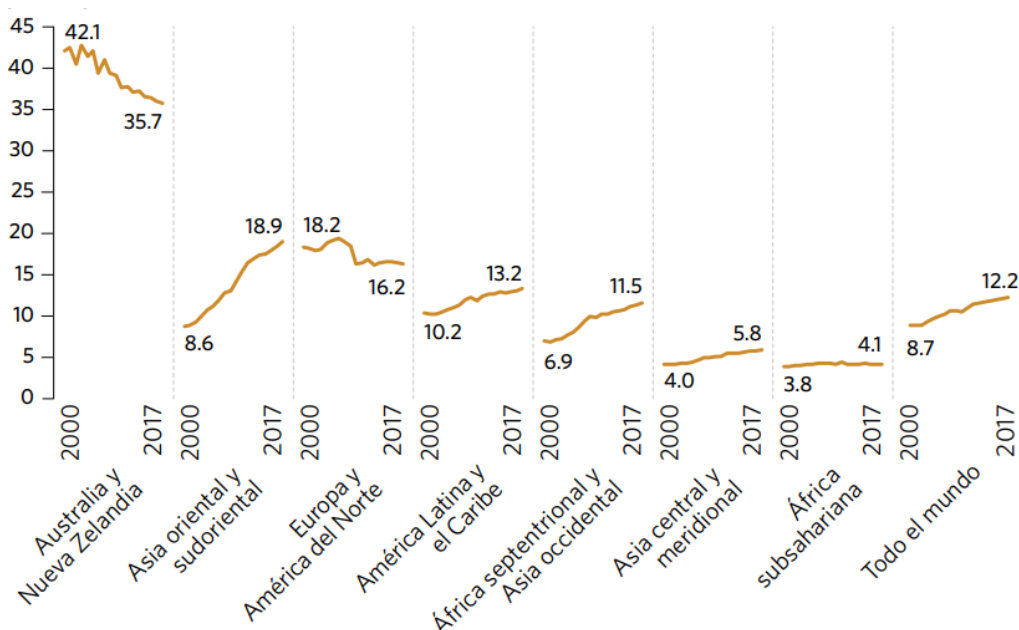
**Table 1. World Population Forecast (2020-2050).**

Año (July 1)	Población	Cambio % anual	Cambio anual	Edad Media	Tasa de Fertilidad	Densidad (P/Km <sup>2</sup> )	Pobl. Urb. %	Población urbana
2020	7.794.798.739	1,10 %	83.000.320	31	2,47	52	56,2 %	4.378.993.944
2025	8.184.437.460	0,98 %	77.927.744	32	2,54	55	58,3 %	4.774.646.303
2030	8.548.487.400	0,87 %	72.809.988	33	2,62	57	60,4 %	5.167.257.546
2035	8.887.524.213	0,78 %	67.807.363	34	2,70	60	62,5 %	5.555.833.477
2040	9.198.847.240	0,69 %	62.264.605	35	2,77	62	64,6 %	5.938.249.026
2045	9.481.803.274	0,61 %	56.591.207	35	2,85	64	66,6 %	6.312.544.819
2050	9.735.033.990	0,53 %	50.646.143	36	2,95	65	68,6 %	6.679.756.162

Source: United Nations (2021)

Continuing with the data provided by the report, in 2000 the amount of materials used to cover the consumption needs of an economy was 8.7 metric tons per capita compared to 12.2 metric tons in 2017, which meant an increase of more than 40%. However, this increase does not occur in all regions. If we look at the following graph we can see how in Europe and North America, together with Australia and New Zealand, there is no increase but a reduction in national consumption of materials.

**Figure 1. National consumption of materials per capita, from 2000 to 2017**

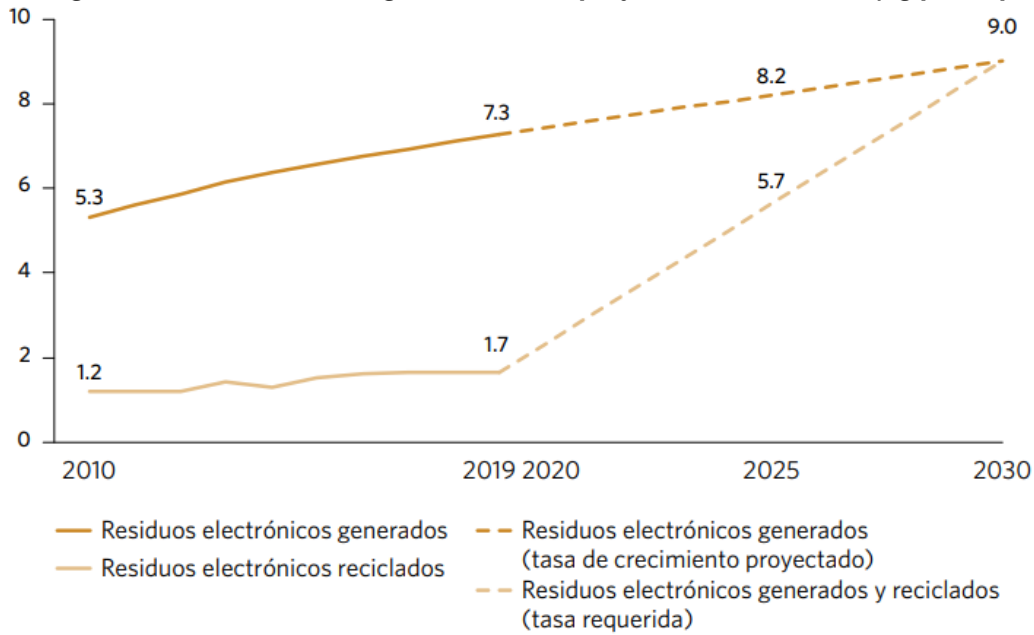


Source: United Nations (2021)

During this period, in Australia and New Zealand, consumption went from 42.1 metric tons per capita to 35.7. As in Europe and North America, where a decrease of 18.2 to 16.2 metric tons is found. However, the increase experienced by the rest of the regions is largely due to the industrialization process, as they are areas that are still under development. The great growth that has occurred in the rate of consumption of natural resources highlights the need to put the circular economy into practice in order to restore the natural environment and ecosystems. It is important to be able to regenerate natural resources to provide some stability and security when supplying the needs of each country. In this way, we see how the use of raw materials, as well as the wealth they generate and the repercussions they have on the environment, are unevenly distributed among different countries.

When it comes to pollution, electronic waste is the main contributing element to this problem. Getting rid of electronic waste incorrectly can lead to the release of toxic substances for both human health and the environment. In fact, according to figures provided by the United Nations, in 2019 the generation of electronic waste was 7.3 kg per capita, which represents 53.6 million metric tons globally.

**Figure 2. Electronic waste generation and projection, 2010 - 2030 (kg per capita)**



Source: United Nations (2021)

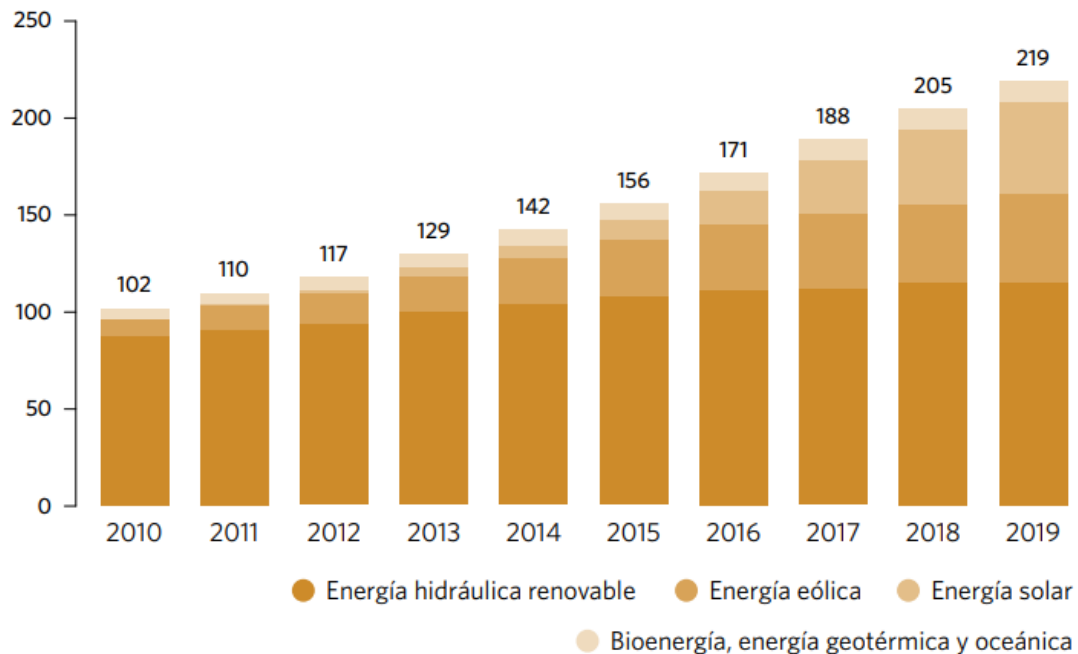
If we compare this period with the previous ones, there is a clear upward trend. More and more electrical waste is generated. This leads to losing valuable materials such as platinum or cobalt and, in addition, they are scarce resources because they have a limit. A 7 % of world gold is considered to be found in these wastes. Likewise, it is known that of the 7.3 kg of waste per capita created, 5.6 kg were not managed in an environmentally friendly way, that is, only 1.7 kg were recycled. For this reason, the UN foresees an increase of 9 kg per person by 2030, which is equivalent to around 74 million metric tons worldwide.

In addition to electronic waste, aid for fossil fuels is also a concern as harmful consumption and production practices which cause harm to the planet are being encouraged. The 2030 Agenda and the Paris Agreement, which aim to eliminate this type of subsidy, are being threatened since the rise in the price of fuels such as oil or gas given in 2021 can provoke government intervention in favor of these subsidies, which would cause a setback towards the transition to a more sustainable world.

During 2017 and 2018, \$ 450 billion and \$ 548 billion were allocated to this type of fuel, respectively. However, in 2019 the money used in this type of aid was reduced to 432,000 million dollars, breaking the upward trend that existed. This was due to falling fuel prices. It was also expected that in 2020 this type of aid would be reduced because during this year there was a drop in demand, but unexpected events such as the Covid-19 caused GDP to fall as well, implying that the reduction of this type of subsidy was not as great as was intended. In this way, the progress that has been made in some years has been compensated with setbacks from others, which is why we are facing uneven progress and an uncertain future.

Regarding renewable energies, a great advance has been seen since 2012, where these have surpassed non-renewable electrical energy. In fact, it was in 2018 when most of the new capacity to generate renewable electricity in emerging countries was first established. This is due to obtaining other capacities to create energy such as solar or wind.

**Figure 3. Capacity to generate renewable energy in developing countries, 2010 - 2019**



Source: United Nations (2021)

Developed countries are known to have produced 880 watts of renewable energy per capita in 2019, compared to 219 watts in developing countries, which indicates that the latter have the possibility of quadrupling their ability to generate clean energy and continue to evolve.

### 3. Circular economy: origin and main conceptual foundations

#### 3.1. Concept and origin

In order to understand this project, we must ask ourselves the following: what exactly is circular economy? When does this concept arise? Circular economy takes as a reference the biological cycle of any living being. For example, if we take a look at the life cycle of a plant, in each of the different stages it goes through (birth, growth, reproduction and death), contributes to generating a new life. So, our plant comes from the seed of another mature plant. When it matures, it will bear fruit that contains seeds from which new plants will sprout. The same occurs when it withers, the remains of organic matter will serve other living beings, that will create other raw materials, generating new life cycles.

In short, what the circular economy seeks is not only to extend the useful life of the goods produced through reuse or recycling, but once the good is useless, the remains can be used to create another new product. On the one hand, this contributes to reducing excessive dependence on natural resources that are limited and, on the other, it also helps decrease the generation of waste that is polluting the environment. In other words, the circular economy aims to imitate the biological "circle" of nature, hence the name, circular economy.

As mentioned in the preceding paragraphs, circular economics is not a unique and exclusive concept, but goes hand in hand with various environmental difficulties, it is closely related to climate change or pollution, among others. Thus, it is not intended to eliminate the current production system but rather complement it, taking into account that the human being is not only part of the environment but it is in his interest to take care of it, since without a planet there is no wealth or economy (Belda Hériz, 2018).

Another way to understand this model is through the decoupling of the property of goods. In other words, certain products can be manufactured with biodegradable resources, so that they have the facility to decompose naturally and thus reduce pollution, serving the land. However, there are other products that do not have this decomposition capacity. The idea proposed by the circular economy, among other things, is to stop perceiving goods as our property, but to get a license to use them, so that when the product becomes useless, the producer is able to separate the biodegradable components from those that are not and thus regenerate a new product (for more detail see subsection 3.2).

In this sense, the concept of circular economy is quite recent but, in reality, although it did not adopt this name, it is a topic that had been raised for a long time. However, who considers himself the father of the circular economy? The concept is not really attributed to anyone in particular but it has been observed that there are different schools of thought that are considered pioneers of what is currently understood as a circular economy. In this way, some consider Walter Stahel (Swiss architect and industrial analyst) the founder while others believe that it is William McDonough (American architect and designer).

According to the Ellen MacArthur Foundation (the main institution that works with public entities and bodies for the transition to the circular economy), the schools of thought that have managed to develop the concept of circular economy in greater detail and depth are the following: regenerative design, performance economics, industrial ecology, cradle to cradle, the blue economy, natural capitalism and biomimicry. All of these concepts have contributed to the formation and perfection of the circular economy. Despite this, since they all share the essential basis for understanding the conception of this model, I will only go into detail in the cradle to cradle and blue economy concepts since the former was one of the first concepts to emerge adopting this production system, so it has some relevance, and the second can lead to misunderstandings and people can get the wrong idea of what the circular economy is.



### 3.2. Cradle to Cradle

This theory was established in the late 1990s by Bill McDonough and Michael Braungart, along with Walter Stahel. These authors realized that the materials of the products could be classified in two. On the one hand we have technological components, such as metals or plastic. These cannot return to the biosphere and therefore it is necessary for them to be reused. On the other hand we have biodegradable components such as cork or cotton, which can be easily decomposed in a relatively short time. So the basis of this theory is to focus on the way products are designed.

They realized that the traditional production model was based on buying, using and throwing away. When the good reached the end of the useful life it was when they were trying to find solutions. Therefore, they thought that it was best to take into account the materials that had been used since their origin, not when they are faced with the problem, in order to increase the chances of success. When designing products, it should be borne in mind that the resources used should be able to be reused in subsequent processes.

In this theory some aspects such as the following should be taken into account:

- a) **Components.** As mentioned above, we can find biodegradable materials and others that are not, such as technological ones. Both follow different cycles. The first follows the cycle of nature, while the second follow a technical cycle. The latter, in one way or another, end up in landfills. The idea of cradle to cradle is that with the correct design any good that is produced can serve to generate new production cycles. Ideally, technological components should not be converted into waste, since unlike biodegradable ones, these are the ones that pollute the most, but resources are considered indefinitely during the manufacturing process of any product. Therefore, it is essential that the materials that are reincorporated into production cycles do not emit toxic or carcinogenic substances.
- b) **Eco-efficacy.** In the current situation, the measures taken in response to try to extend the useful life of a product can be considered eco-efficient. For example, if we think of a plastic container, it may have been made from recycled materials or even try to use less plastic to obtain the container, but in the long run it will end up in a garbage container because it has not been designed from the beginning to be infinitely recycled. However, a product is considered eco-effective when, in principle, the design of the good has been done thinking that it can be decomposed and can serve as a new production material in the future, and using the materials perpetually. In other words, the objective of eco-efficacy is to reduce serious cradle processes and encourage cyclical flows cradle to cradle.

In this sense, this school of thought proposes that technological products are not sold, but used as a service offered to customers and consumers. The sole owner would be the manufacturer, so that when the useful life of the good is over, the producer can dismantle the product and re-manufacture the same or a different one and thus be able to rent it again. For example, if we needed an oven to cook, instead of buying it and making us a holder of the good, the idea would be to acquire a license or right of use during the useful life of the property or during a pre-established time.

c) **Upcycling.** Currently, recycling consists of taking the materials used, decomposing and reprocessing them in order to generate a new product. The problem is that most of the time, the product that is obtained at the end has a lower quality than before. In this way, the authors of this theory describe this type of recycling as downcycling. They defend the idea of upcycling, which is based on creating new products that have a higher quality, exclusively using recycled elements. Here we can find all kinds of examples, from creating a robot with canning cans to turning an adult's socks into baby leggings.

### 3.3. Green economy vs blue economy

The data provided by the Ministry of agriculture, fishing and food, in the report of "Análisis de la caracterización y proyección de la producción ecológica española en 2020", show how the consumption of organic products in Spain during 2020 has increased around 7 % compared to the previous year (see Table 2).

*Table 2. Evolution of the consumption of organic products in Spain*

AÑOS	GASTO EN PRODUCTOS ECOLÓGICOS (millones de euros/año)	POBLACION ESPAÑOLA (millones de habitantes)	Gasto en P. Ecológicos per cápita (euros)
2012	995	46,82	21,25
2013	1.020	46,73	21,83
2014	1.205	46,51	25,91
2015	1.510	46,45	32,51
2016	1.670	46,44	35,96
2017	1.960	46,55	42,11
2018	2.180	46,93	46,45
2019	2.363	46,94	50,34
2020	2.528	47,33	53,41
(%) 2020 s/2019	6,98%	0,83%	6,10%
(%) 2020 s/ 2012	154,07%	1,09%	151,33%

Source: Ministry of Agriculture, Fisheries and Food (2020).

In addition, per capita spending this year was 53.42 euros/year. This represents 6.10% more than in 2019. In total terms, from the period 2012 to 2020 you can see a great increase in the consumption of organic products. However, this is not enough since Spain is still well below other countries such as Switzerland, Denmark or Sweden, where per capita consumption is 313, 312 and 231 euros/year respectively.

This shows that, although there has been an increase in the consumption of "green" products, their social impact is not enough. Consumption of sustainable products compared to others remains relatively low. As in Spain, this logic can be applied to other

countries. However, why is this system not working? A study on consumer habits in the US, published in the GFK Roper's Green Gauge Report, shows the results where a 58% of consumers believed that the prices of organic goods were too high compared to other products (Belda Hériz, 2018).

Despite this, why are organic products more expensive? Organic goods are normally considered to have higher quality; therefore, they last longer. In addition, it is common for these types of products to be manufactured in an artisanal way, not on large scales, as can happen with others where they are produced on a larger scale. This causes a longer production process since less technology is used. All this leads to an increase in the price. Although these are some of the reasons that can lead to rising prices, there are also green products that are affordable for consumers.

What can be done about it? Pauli (2010) tried to explain why the green economy was not working. He defends that the high cost of the production of ecological goods ended up being transferred to the consumer through prices. This, more than an incentive for consumers, achieves the opposite effect.

To correct the increase in the cost of organic products, the economist proposes a new concept, the "blue economy". This idea is based on 21 principles, which share very significant similarities with the circular economy, since the blue economy tries to imitate the behavior of natural systems. So that the waste generated in the production process of one good serves as raw material to manufacture another.

The economist defends that it is necessary to take advantage of those local resources that are available to the producer, that is, use those that are closest, in order to reduce the cost of transportation, of production and therefore lower the price of the product.

In summary, Pauli (2010) believes that acquiring organic products is for the wealthy. That the green economy does not work, since its attempt to be implemented for many years and they do not see a result. He thinks that the solution is to imitate the biological cycle of nature in order to reduce costs, reducing the price of goods so that it can be affordable throughout the world.

However, according to the UN Environment Program (UNEP), the green economy can be defined as an economic model that aims to be resource efficient and socially sustainable, reducing environmental risks. As we observed, these are the fundamental principles of both the blue economy that Pauli defends (2010) and the circular economy. So, one could say, that the green economy is a concept that encompasses the circular economy, but that on a practical level has left aside the "circular" aspect that it implicitly assumes. And if we take into account that the concept of blue economy, as defined by Pauli (2010), seeks the same as the circular economy (because they share the same base and criteria), we cannot say that they are two completely different concepts, but that it can be understood as the same concept. In other words, the blue economy and the circular economy aim to emphasize the partially forgotten aspect of the green economy in its practical application.

#### 4. How to apply circular economy in companies

As mentioned previously, the role of entities, especially large companies and multinationals given their great impact, is essential not only to be able to establish the circular economy as a production system but also to allow the survival of future generations.

Despite this, how can a company apply a circular model? Implementing the circular economy in business is a great challenge for many entities, but at the same time it offers new opportunities and benefits. To integrate a circular vision, we must bare in mind that there is no single path, since the characteristics of the company must be taken into account: the sector in which it operates, how the value chain is formed, what is the approach you want to give to the business, the materials or resources available to the company or those available to it and the area where the company is located or where it is intended to be established.

Here are some steps to follow that can be useful as a basic guide to implement the circular economy in a company, based on the approaches of Grupo de Acción Forética (2018):

- **Step 1.** To start, the ideal would be to carry out a **SWOT analysis** of both the linear economic model and the circular model. This analysis can uncover threats and weaknesses derived from the linear model of which the company was not aware, and at the same time show opportunities and strengths offered by the circular model. To do this, we can ask ourselves questions such as: what is the value of products that is being lost? Is there a way to reduce or eliminate waste that comes off the value chain? If I consider the points in favor, do I get benefits in the short term? And in the long term?

It should be noted that there are tax incentives for those companies willing to innovate, in addition to being able to benefit from specific aid aimed at promoting this type of business. It can also help to draw inspiration from the practices carried out by other companies and thus have a benchmark. For example, there are several platforms such as “Circular Economy Club” or “World Business Council for Sustainable Development (WBCSD)” from which you can get ideas to carry out sustainable practices.

- **Step 2.** Once the analysis has been carried out and the points in favor of a circular model have been taken into account, it is convenient to fix the vision and mission of the company. Establish business values and achieve the **commitment** of both senior management and the rest of the organization. This shows the intention of the company, as well as the clear opportunities that this new economic model has.
- **Step 3.** The next question a company must ask is how it should be planned to establish a circular model. Setting the objectives and goals that the entity has set is a key aspect to be able to carry out a correct **planning**. On the other hand, it is important to find the most suitable suppliers and distributors, that is, that have environmental consideration and training in order to guarantee reusable and respectful raw materials with both the natural and social environment.

Another key aspect during planning is thinking about the design of the product or service to be offered, not only for the present but also for the future. Following Cradle to Cradle philosophy, the good must be thought of so that the useful life of the resource can be extended as much as possible, so that waste does not become worthless elements but are seen as a potential new matter. To do this, using new technologies can serve as a new opportunity to achieve such planning.

- **Step 4.** The next step is to **act**, to put into practice what has been previously planned in all the departments of the organization, from the marketing department to the purchasing department. It should be noted that participating in projects with other companies, seeking allies, adhering to new plans or finding out if there are aids for this type of practice creates a growth opportunity for the business.
- **Step 5.** It is important to **monitor** the actions that have been carried out in order to assess the effectiveness of what we are doing. Knowing if we are doing correctly what we have planned from the beginning helps us to be able to rectify and improve. Measuring the entity's progress in circularity can be done through indicators. However, there is no common frame of reference that allows following specific indicators and thus being able to compare growth at the global level, but it is the different organizations that finally decide to define their own criteria to follow up. For example, the Ellen MacArthur Foundation has a tool known as Circulytics that provides a list of indicators depending on the characteristics of the company. To follow up, this tool raises questions such as: Is the strategy applied by the company aligned with becoming more circular? Are there measurable circular economy objectives?
- **Step 6.** Finally, it is ideal for the company to make itself known. The **dissemination** of sustainable practices carried out by the entity is a key business management to be successful. New technologies play a fundamental role here. Social networks, the creation of a blog or web pages, or even collaborating in a forum are some places where the company can promote its actions and show its commitments. Making yourself known can be an opportunity derived from the circular model, since it shows a very good image of the company, as well as reducing production costs, which means that the company can apply a strategic synthesis of differentiation together with that of cost leadership.

## 5. New technologies: advantages and disadvantages for the circular economy

Industrial revolutions have been key to the development and evolution of the economy. During the first industrial revolution, inventions such as the steam engine marked a turning point in people's lives, allowing the transformation of production processes. If we think of the second industrial revolution, where thanks to advances in transport such as rail, it was possible to trade between towns that had no contact until then.

Therefore, we cannot ignore the third and fourth industrial revolution. The third is characterized by computing. Automation and information and communication technologies (ICT) have brought about a change in the way companies deal with

consumer demand. The same is true of the fourth industrial revolution, also known as Revolution 4.0, where concepts such as "the internet of things", the cloud, robotics, or cyberphysical systems, determine the present (Selva Belén, 2016).

We cannot deny that the digital revolution has come into our lives. And not only that, but there is no going back. Therefore, the best thing a company can do in this context is adapt to the new situation, using new technologies in its favor.

If a company wants to implement the circular economy in its business, the digitization of the different phases indicated above (section 4), such as using big data or artificial intelligence, they can be determining elements of the success or failure of a company. Therefore, the rest of the section will try to identify the possible advantages and disadvantages of using new technologies in the circular economy, they must be taken into account given their current relevance.

Among the various contributions of new technologies to the circular economy, we will see some of the most significant. On the one hand, we must think about the consumption of fossil fuels. Thanks to new technologies, great advances have been made, developing new types of cleaner and more sustainable energy. For example, biomass is a type of renewable energy that uses organic matter, that is, waste of biological origin, as an energy source, thanks to the technological process used, which allows the extraction of less raw materials, thus contributing to a circular and environmentally friendly system.

Another advantage of new technologies is their ability to give value to waste, allowing its reduction or even its disposal. The key is in the design of the good to be manufactured. Using new technologies to properly design a product helps transform waste and waste into raw materials more easily.

On the other hand, if we think about the business world, we find endless advantages that the digital revolution is providing us with. For example, the use of social networks can be very important if what the company is looking for is to make itself known or spread its practices in sustainability. The same goes for ICT. The rapid communication that exists today thanks to technological advances allows companies to save time, since it facilitates feedback with suppliers, distributors and customers. This clearly implies a reduction in costs, in addition to representing greater comfort and improvement in the quality of life for all (Jiménez Bermejo, 2013).

If we focus on the value chain, improvements in production processes provide greater efficiency to the company, improving its competitiveness, and reducing prices. All this contributes to economic growth.

In addition, both in the social and business spheres, digitization can be seen as a way of creating employment, there is favouritism towards the emergence of new professions related to innovation, creativity, data analysis or commercial tasks for example (Selva Belén, 2016).

However, not all arguments are in favour of computing and digitization. Paradoxically, the use of technology is one of the main problems faced by the circular economy because, as mentioned above, According to different reports issued by the United Nations and other organizations, electronic waste is one of the main causes of pollution and, therefore, of climate change on our planet. Also, since many of the products that exist today have not been designed from the beginning to be reused in the future, but rather to end up in a dumpster, once their useful life is over, these e-waste are more difficult to transform as new resources.

As with Industry 4.0 new jobs are created, it should be noted that the jobs that are created now require higher qualification by staff. In fact, some people are reluctant to use digitization and robotics, as many think they are the main elements causing job loss, being replaced by machines that perform repetitive tasks. The mechanization of routine activities mainly affects low-skilled workers. However, this remains a matter of debate as some see technologies as a substitute while others believe that workers should complement and supervise machines performing their duties correctly, without failures in the manufacturing process.

Although for many sectors and industries, technology has managed to increase its productivity, an excessive dependence on it can cause an immediate drop in performance. If we think, for example, of a factory machine, if it stops working well, it breaks, a loss of efficiency will be generated due to the interruption of the value chain together with the loss of time until it is repaired and the production process can resume, generating high costs for the company (Today's economy, 2019).

Nor can we forget that technology is advancing faster and faster. This can be inconvenient since it is difficult for there to be policies, regulations and regulations that keep up with digital developments. Therefore, when there are conflicts for technological reasons, it may not be known how to proceed from a legal point of view in this type of situation. In addition, with technology we are more exposed to cyber-attacks, piracy, theft of intellectual property or other threats such as viruses in the software or hardware of a computer, so that, privacy, data protection, security and individual rights are at increased risk.

So do new technologies help integrate a circular economy? It could be said that it is a "double-edged weapon". To achieve a circular system, new technologies and digitization are not enough. García Gil (2021) points out the lack of awareness and environmental commitment of the members of the value chain, from suppliers to distributors. The same occurs with customers and consumers, who show problems in accepting this type of production system.

In short, we have just verified that the same topic can have points for or against, depending on the approach with which you look. Thus, the loss of employment caused by mechanization in manufacturing processes can be seen as an inconvenience, or, it can be thought that the mechanization of these phases generates greater efficiency, in addition to requiring more qualified and competent personnel, therefore, it can be interpreted as an advantage for the company.

From here we can conclude that it is the actions we carry out together with our use of technology and science that determine if the development of a system is possible circular and sustainable.

## 6. Business experiences in circular economics

Once we already know the main conceptual foundations of circular economy and how to apply it, we only have to know what are the results that are achieved thanks to it. This new production model causes new business opportunities that allow finding solutions to mitigate the difficulties generated by the current linear production system.

For this reason, this section will try to expose, in a more practical way, some particular cases of companies that have decided to integrate the circular economy into their business, making use of new technologies, thus choosing to maintain a business policy committed to society and the environment, and/or have helped other companies apply the circular economy through technology.

### 6.1. ECOALF

“Because there is no planet B”. This is the motto of Ecoalf, a Spanish company in the textile sector that originated in 2009 and that dedicates its activity to creating clothes, shoes and accessories. The idea stems from the desire that Javier Goyeneche, president and founder of Ecoalf, has to establish a sustainable fashion brand. In addition, it has the B Corp certificate, another of the company's achievements, which certifies compliance with standards and criteria of social and environmental responsibility, according to Carol Blázquez, Director of Innovation and Sustainability at Ecoalf.

After several years dedicated to R&D, they managed to launch their first collection of clothing with recycled materials in 2012. However, the company began to take on real importance from 2015, with the creation of the Ecoalf Foundation, a non-profit organization that aims to support the Upcycling the Oceans project. The objective of this innovative project is to collect garbage from the oceans with the help of the fishing industry, to be able to transform plastics and other waste into fabrics that can be used to create clothing and accessories, thanks to the use of technological knowledge.

Despite the fact that Upcycling the Oceans was born in Spain, Ecoalf already works with other countries such as Greece and Italy to clean the Mediterranean Sea, in addition to having also expanded to Thailand. Since then, the company has won several awards. Among others, we find the following: “Prize for the best initiatives in eco-efficiency” (2016); “Red Cross Gold Medal Award” for social commitment and solidarity work (2018); “Maritime Salvage Award” (2021).

It currently has the help of more than 2,500 fishermen (Table 3) along with 573 boats, of which 96% use trawling. Thanks to this method, they have recovered around 190 tons of garbage from different ports in Spain.

Since the project began, in Spain alone they have managed to collect around 800 tons of garbage from the ocean. The company began taking action in 2015 only in 9 ports, thanks to the collaboration of 165 boats and 743 fishermen. However, over the years this aid has been increasing, taking a great leap between 2016 and 2017, where the number of fishing workers involved grew, going from 700 to 2,000 fishermen, thus increasing waste collection.

In fact, it was in 2016 when ECOEMBES, a non-profit entity specialized in recycling, joined this initiative to ensure proper management of recovered waste.



**Table 3. Collection of marine litter in Spain, 2015-2021 (tonadas)**

	2015	2016	2017	2018	2019	2020	2021
BASURA MARINA (T)	23	54	113	140	152	180	190
PUERTOS	9	9	32	37	40	40	40
BARCOS*	165	165	462	546	550	573	573
PESCADORES*	743	743	2079	2534	2600	2575	2581

\* La flota de arrastre representa el 96% de los participantes del proyecto.

*Source: Ecoalf Foundation*

In this way, once the fishermen arrive at the port, they throw the waste that has been trapped in the fishing nets in specific containers that, later, they are transported by truck from the dock to recycling plants, to classify these wastes according to the type of material they are made of and thus be able to work better on their transformation.

The main materials with which Ecoalf works to generate its garments are the following:

- a) **Recycled polyester.** Polyester is a plastic material that is obtained from oil through various chemical processes. Although there are several variants, PET is the best known. According to the foundation's data, recycled polyester comes from plastic from water bottles, so that these are transformed into high quality threads through the mechanization of the different production phases. Thanks to this, more than 250 million plastic bottles have been recycled today.
- b) **Recycled nylon.** Nylon is a sturdy, elastic material that is primarily used to create yarns and fabrics. Since the company has dedicated many years to research and development, it has been able to make important advances in technology that have increased the quality of nylon, even being a recycled material, made with fishing nets thrown into the sea. The main impact that the use of this resource has had is the reduction of CO2 emissions and water consumption, since unlike recycled nylon (which can be reused once its useful life is over), many more production processes are used to manufacture conventional nylon.
- c) **Recycled cotton.** Cotton is one of the main problems in the textile sector, since cotton crops require a large amount of water for irrigation. Furthermore, most cotton plantations are found in underdeveloped countries, where water is a scarce commodity. Therefore, Ecoalf believes that the solution to this problem is recycled cotton. During the recycling process, the fabric waste that comes from the weaving and cutting phases go through various mechanized processes where they are crushed and crushed, thus becoming fiber that, later, it will change to thread.
- d) **Coffee grounds.** The entity uses coffee grounds to replace chemical treatments and thus be able to give specific properties to the clothing garments they create,

such as protection against UV rays, odor control or quick drying. This is possible thanks to the collaboration with S.Café, which gives Ecoalf, on a daily basis, the coffee grounds they use in the different restaurants, and from which thread can also be created. The process is quite simple. It consists of removing the moisture from the grounds through a pressing and drying process. The coffee grounds are then divided from the oil (this is used to create cosmetic products). Finally, once separated, it is crushed and mixed with nylon or PET, in order to generate thread.

As we have just verified, the result of these processes is the reduction of CO2 emissions, water and oil consumption, an improvement in the efficiency of production processes, the use of resources, the increase in the quality of recycled materials, or the management and reduction of waste. It could be said that this is a clear example of a circular economy, where the collaboration of all is necessary for the proper functioning of society, the economy and the planet.

## **6.2. WINNOW**

Every year in the UK an amount of food equivalent to £ 13 billion ends up in a dumpster, of which 2,500 million come from food in the restaurant and hospitality sector. For this reason, in 2013, Marc Zornes and Kevin Duffy created Winnow, a London startup that allows other businesses, hand in hand with technology, reduce food waste (Cassidy, 2018).

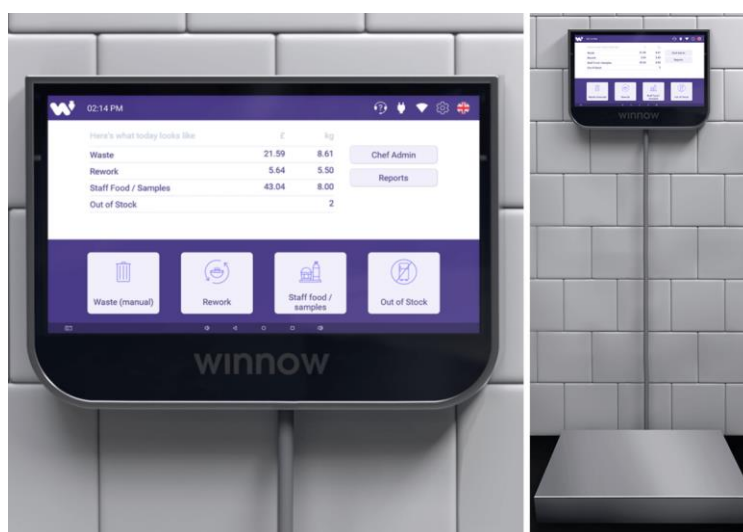
The company has been certified B Corporation since 2017, indicating that it is committed to social and environmental requirements and standards. It also has the collaboration of IKEA that, despite not dedicating itself to the hospitality sector, it has several restaurants in most of its stores. Thanks to this, Winnow has been able to promote itself and has been favoured by the financing provided by IKEA (Lora, 2020).

Often, catering companies, as a forecast, are forced to produce more in the event of increased demand, that is, for fear of running out of stock. However, the result is dire. The fear of running out of dishes to offer means that at the end of the day there is a lot of food leftover that could have been served. These foods end up in the garbage, being a waste for establishments since the money invested in these foods could have been used for other purposes (Ramírez, 2018).

Furthermore, the inaccuracy of the forecasts is not the only problem. During meal preparation, a lot of food is wasted as instead of throwing them away they could be given a second use. For example, in the case of using fish on the menu, use the remains to make broths or soups (Ramírez, 2018).

These are some of the reasons why Winnow Vision was born, a tool that allows you to automatically identify leftovers, thanks to artificial intelligence. This product is equipped with a scale on which the garbage can is placed, in order to accurately calculate the exact amount of food that is thrown away. This is connected to an electronic device or tablet, which allows you to configure the establishment menu. In addition, it has a camera next to the bottom of the tablet.

**Figure 4. Winnow Vision product**



Source: Winnow

However, how exactly does it work? Every time food is thrown in the trash, the system takes a picture, breaks it down in detail, and analyzes the ingredients. In this way, it allows the company to know what is the amount of food discarded and, therefore, its cost.

This system is designed in such a way that the more photographs you take, the greater the precision and ease of recognizing each food, since it becomes smarter. In fact, you need 200 to 1,000 photos to be able to accurately identify the ingredients.

As pictures are captured, Winnow Vision offers suggestions to kitchen staff about the types of food that can be and that they simply need to confirm (semi-automation). Once you have the necessary images, the electronic device no longer needs the approval of any worker, since it has reached the maximum level of automation, thus saving time and reducing human failure when entering data.

Another advantage of Winnow Vision is that once you have been trained, you are able to distinguish between foods that have a similar appearance and that perhaps the human eye can confuse. In addition, thanks to this innovative invention, reports can be obtained periodically, thus being able to monitor waste levels or customer preferences, improving its management and decision making.

The result of merging the catering sector with new technologies is positive, as it offers multiple benefits. On the one hand, thanks to artificial intelligence, possible deficiencies can be detected in the preparation, storage, and customer phase ... On the other hand, it allows measuring and managing the establishment's resources, achieving greater efficiency, improving production and saving food costs.

In the short term (from 6 to 12 months), a reduction of 40 % to 70 % has been observed in the generation of food waste in those kitchens that have used this technology. This indicates that businesses are able to save between 2 % and 8 % on food costs. In other words, thanks to Winnow the average garbage saved is 10,500 kg, which is equivalent to 26,000 meals. Regarding the environmental impact, it is estimated that around 43 tons of CO<sub>2</sub> have stopped emitting. In short, for a restaurant, the average annual savings is \$ 35,000 (Lora, 2020).

### 6.3. TOO GOOD TO GO

Continuing with the theme of the previous case study (section 6.2.) And, knowing the problems that have been discussed at the beginning of the work (section 2), all that remains is to know a third business inspired by the circular economy, which is accompanied by technology: "Too Good To Go", an application created to reduce the food surplus of establishments.

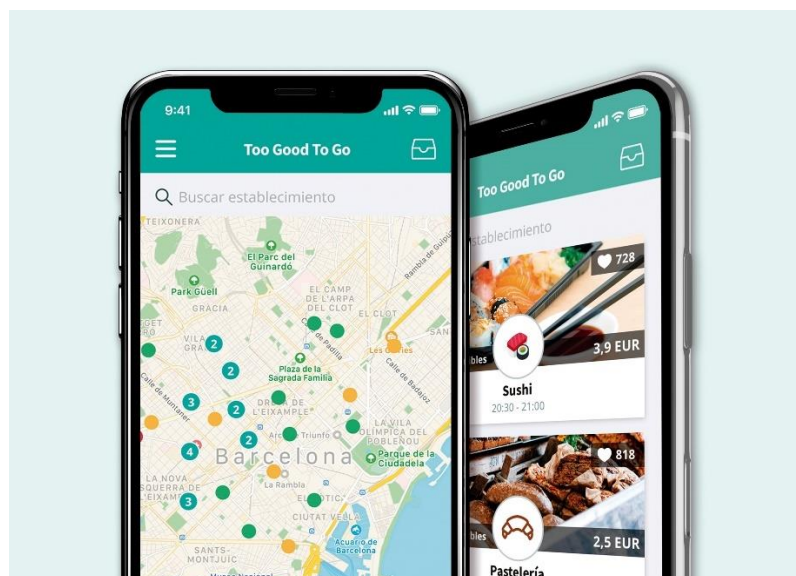
This initiative was born in Denmark, in 2016, when the creators of the app, during a meal in a free buffet, saw how the food they had left was thrown away, even if it was in good condition (Bermejo, 2019). After being aware of the situation, they decided to create a movement on social networks under the motto "food is not thrown away".

The app connects hotels, restaurants, greengrocers, supermarkets or bakeries, among other businesses, with users of the platform to sell the daily food waste that is generated.

Consumers are willing to buy surprise packs with quality food at a reduced price. Usually it is around between 2 and 5 euros. In addition, what is contained in the pack that is acquired is unknown since, as the app points out, it is not possible to know what type of leftovers will finally be produced in the establishment. However, the content should be fresh food, prepared mostly the same day, to avoid low quality, with the only exception that they could not be sold throughout the day (Bermejo, 2019).

The operation is easy, the only thing to do once the mobile application has been downloaded and installed is to register in order to place the order. In general, the platform tells you which establishments are closest to your location through a map. Once the business is selected, you only have to place the order, pay through the application and pick it up at the agreed place and time (Sacristán, 2018).

**Figure 5. Map and list of establishments of Too Good To Go**



Source: Too Good To Go

Despite being a Danish brand, Too Good To Go started working with Spanish companies in 2018. It currently operates in 14 European countries, USA. and Canada. More than 44 million users use the app, thanks to the stocks provided by more than 111,000 establishments in the food sector. So far, in Europe alone, more than 91 million food packs have been saved.

Like the two companies developed in the previous subsections, Too Good To Go also has the BCorp certification, to demonstrate its business commitment. Similarly, the founders have created a section within the application in which clients can make donations to the NGO Action Against Hunger, a non-profit foundation that fights against child malnutrition in 50 countries (Sacristán, 2018).

In addition, other initiatives are being carried out to demonstrate Too Good To Go's business ethics. Works in 4 fields of action:

- 1. Education.** With the aim of teaching both children and young people the importance of reducing food waste, these entrepreneurs have decided to provide some tools to new generations such as: educational games, questionnaires, educational talks or workshops.
- 2. Households.** The main idea is to carry out awareness campaigns giving advice on how we can avoid wasting food from home. For example, avoid getting carried away by discounts and offers from supermarkets so you don't buy food that isn't really necessary.
- 3. Business.** It currently collaborates with major brands such as Carrefour or Alcampo. The platform helps them discover where and why food waste is occurring and how to address the problem. In the case of supermarket chains, the reasons for waste may be due to, among other things, the excess food on display, to the misinterpretation of the product's useful life or to the poor design of the packaging, which may be unattractive to consumers.
- 4. Politics.** Cooperate with public administrations to try to create policies and regulations both nationally and internationally that help drive change towards a more sustainable food industry.

A priori, the most direct consequences of this innovative technology have been savings for consumers and users of the app, who purchase the cheapest products; and the decrease in leftovers, thus contributing to one of the main goals of SDG 12, halving food waste worldwide.

It should also be noted that it not only helps to reduce the environmental impact, through a reduction in food scraps, but waste is also reduced in the production processes to prepare food, from water to dedicated work hours (Bermejo, 2019).

## 7. Conclusion

To conclude, I would like to stress the different aspects that have been addressed throughout the paper, highlighting the most relevant results and the reasons why the transition to a circular model is necessary.

As we have already seen, the linear production system that is currently in place causes social, economic and environmental problems. Thus, despite the fact that there are many individuals committed to the circular economy, the data (section 2) show that it is not enough. However, several companies have managed to discover innovative processes that offer solutions to the problem of pollution and waste.

Technologies can be a great ally of social commitment, since they contribute wealth both at the business level and to consumers. As seen in the analysis of specific cases of companies inspired by circular economy, the added value generated by the use of technology has been far above those drawbacks that it may have caused.

The benefits that companies obtain when applying a circular model have been demonstrated, including reducing costs or improving production processes.

Despite the fact that there will always be that duality between advantages and disadvantages of new technologies (as well as any other topic), it has been shown that everything depends on the point of view with which you look, since the final result will vary depending on the use that is given to the tools that we have available, that is, to the technology.

However, for a company to take advantage of the benefits of new technologies, it is essential to invest in research, development and innovation. In fact, with the case studies seen in the previous section, it has been verified that implementing a circular business has been possible thanks to the capital allocated to R&D, a key factor for the success of entities.

Furthermore, it should be noted that it is the most industrialized countries together with large companies that have the best position to innovate and invest in the circular economic model, leaving behind the traditional production model. This leads us to wonder if there really are incentives on the part of governments and public administrations that promote this type of activity or if the opposite is really being achieved with certain actions.

In closing, I would like to comment on a possible line of future research that is closely related to circular economics, such as programmed obsolescence. On the one hand, it should be noted that to achieve a circular system it is necessary to alleviate this problem. On the other hand, it is necessary to highlight the fundamental role of regulations to face this situation, try to extend the useful life of goods and promote everyone's participation towards a more sustainable economy.

However, living in a globalized world is not always advantageous, since there are structural differences between different countries, it is necessary to create an international institution that generates common guidelines to be followed by each of the states, because the involvement of all social agents is necessary to achieve this transition of production and consumption, such as the circular economy.

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