Universidade de Aveiro Departamento de Economia, Gestão, Engenharia Industrial e Turismo
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A ECONOMIA CIRCULAR
E a sua aplicação na cadeia de abastecimento e, mais especificamente, no departamento de compras

THE CIRCULAR ECONOMY
and its application in the supply chain and, more specifically, in the purchasing department

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Engenharia e Gestão Industrial, realizada sob a orientação científica do Doutor José António de Vasconcelos Ferreira, Professor Associado do Departamento de Economia, Gestão, Engenharia Industrial e Turismo da Universidade de Aveiro

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economia circular, sustentabilidade, cadeia de abastecimento, departamento de compras

resumo

O presente trabalho propõe-se a divulgar o conceito de economia circular. Os objetivos iniciais deste documento são dar a entender a razão do seu surgimento e ajudar a perceber em que consiste, como o mesmo tem evoluído e como se tem tornado importante ao longo dos últimos anos. Posteriormente, pretende-se que os leitores o vejam aplicado à cadeia de abastecimento e, mais especificamente, a um departamento de compras.

Atualmente, a economia linear é a aplicada com maior frequência. Segundo este modelo, extraem-se os recursos, fazem-se os produtos, consomem-se os mesmos e são gerados resíduos. Este funcionamento tem-se mostrado insustentável e o planeta Terra está a mostrar sinais de fraqueza. A economia circular opõe-se a este conceito e visa a harmonia entre o desenvolvimento industrial, o ser humano e o ambiente. O mesmo é visto como uma oportunidade e tem vindo a ser apoiado por um número crescente de entidades e organizações.

Pensar sobre o ciclo de vida dos produtos, tentar transformar desperdício em matéria prima, desenhando produtos tendo em conta a longevidade, o serviço, a reutilização e recuperação, envolver diferentes áreas de conhecimento durante a fase de desenvolvimento de um projeto, sensibilizar as pessoas para a importância do conceito, pensar sobre regeneração, produzir produtos duráveis e vender performance e prestar atenção ao que está à sua volta são alguns pontos fulcrais para se aplicar a economia circular.

keywords circular economy, sustainability, supply chain, purchasing department

abstract

This document aims at spreading the circular economy concept. The main objectives are to help understand why it emerged and let readers know what it is, how it has evolved and how important it has become over the last years. After that, the idea is to study how the concept may be applied in the supply chain and, more specifically, in the purchasing department.
Nowadays, linear economy is the most practiced one. According to this model, resources are extracted, products are made and used and waste is created and disposed. This has shown to be coming to an end, because planet Earth cannot take it anymore. The circular economy is opposed to this concept and has the goal of reaching the balance between industrial development, human beings and the environment. It is now seen as an opportunity and there is a growing number of entities and organizations that are trying to comprehend how to support its implementation.
Lifecycle thinking, trying to turn waste into input, designing for longevity, service, reuse and recovery, involving different knowledge areas in a product's development phase, letting people know about the concept's importance, thinking about regeneration, producing durable products and selling performance and paying attention to the surroundings are some of the key points for applying the circular economy.

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1. Introduction

1.1. Motivation

This work is the result of a study about the circular economy concept, based on the interest to understand how industries can adopt an innovative business model at the same time the environment's conservation and the equilibrium between human beings and nature is promoted. This topic clearly includes both engineering and industrial management principles and that fact was seen as a great opportunity to study the circular economy and its influence on enterprises, Portuguese ones in particular, but not only, and, more specifically, in the purchasing department.

Planet Earth is starting to show some signs of weakness, so more people try to think about how it has been treated over time. After the Industrial Revolution and bearing in mind the rapid pace at which technology and science are evolving, are we paying enough attention to what surrounds us? Are we contributing to a sustainable – or even more positive than that – development? Isn't this an appropriate time to try understanding which new business and management opportunities are within our reach?

The circular economy concept is becoming stronger over the last few years and it results from the critical analysis one can make about the way the world is developing. This idea is opposed to the linear economy concept, which is applied and unquestioned by most people and enterprises. The circular economy aims at supporting our planet and ourselves and at guaranteeing the balanced development of the world economy.

1.2. Methodology

The main objective of this work is to understand how the circular economy affects industries, considering its impacts on a general but also departmental level and, particularly, a purchasing one.

Because of that, it is necessary to review the existing literature on the topic and understand what the concept stands for, how it came up and why and how it is developing. It is important to understand what it is that makes the circular economy make sense.

The idea was then to gather the existing information on the topic, to critically analyse it considering practical examples of its application and to comprehend how an interested industry can start applying it. At first, the research was made based on published articles' analysis and, later on, the use of internet helped to fit all the information together and add different inputs to the work. In the last part, the experience of working in a purchasing department of a well-known company, Bosch, helped to build the case study.

1.3. Document's structure

This work starts with the presentation of the motivation, the methodology and the present explanation of the document's structure.

Chapter 2 is about the actual situation and the interpretation of some alarming facts regarding the way the world is developing at the moment. This analysis of what our present looks like and the identification of an improvement possibility are the aspects that give meaning to this work.

In order to understand how things can be improved in the future, our past actions are analysed - chapter 3. This chapter gives insights into the linear economy, the model practiced over the years which is being replaced by the circular economy one.

In chapter 4, we study what was in the transition between the linear economy and the circular economy. This chapter focuses on the recycling concept and is important because it helps making the bridge between two topics which are almost opposed to one another.

Because the circular economy resulted from many other concepts that have been developing over time, these concepts are also introduced, in chapter 5, and serve as a basis for the introduction to the circular economy concept itself. This chapter then goes into detail about the circular economy. We will look at, for example: what it is, how it is developing, how it is promoted, how important it is becoming and how it is being applied.

Chapter 6 is about the industry field and includes some practical examples of the application of the circular economy's concept. This chapter is about critically analysing how the concept is present at some companies that see this application as a responsibility, but also as an opportunity.

In chapter 7 of this work, we have the application of the concept to the specific case of a purchasing department. The idea is to understand a purchaser's tasks overview and identify where the circular economy can be present.

The last chapter (8) is the study's conclusion. It sums up what the work is about and aims at making readers wonder about what they can do to support this way of looking at the economy.

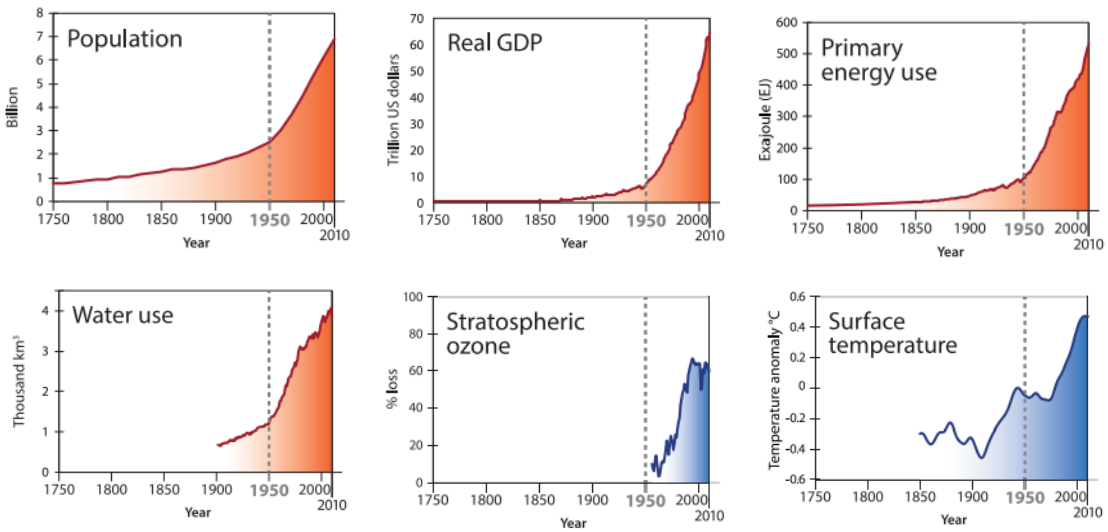
2. The actual situation

Our planet is not getting bigger, but its population is increasing as is the consumption per capita, which is leading planet Earth to an unbearable situation (Foster et al., 2016). Moreover, in a world where resources are not unlimited, prices are becoming higher and unstable and disruptions in the supply chain are more common, which brings uncertainties to many aspects of our everyday life (Geissdoerfer et al., 2016). The production model practiced from the 18th century onwards, after the Industrial Revolution, when productivity and the level of production rose substantially, has led to an alarming situation, both environmentally and financially speaking (Foster et al., 2016). Since that time, the use of finite resources has gone up only (Lacy & Rutqvist, 2015).

Nowadays, production follows a linear model of continuous depletion of natural resources; we take, make and dispose. This model is being looked at with worries and more and more we see people willing to try and change things (Leitão, 2015). In addition to population and Gross Domestic Product (GDP), primary energy use, water use, stratospheric ozone, surface temperature, ocean acidification, tropical forest loss and terrestrial biosphere degradation, besides other indicators, are also increasing dramatically (Santiago, 2016). The way we are developing socio-economically is having serious impacts in living systems and in the way the economy works.

2.1. The alarming facts

Sometimes a graph or a figure has more impact than numbers, because the visual impact is greater. Because of that, some graphs are shown below, in figure 1.



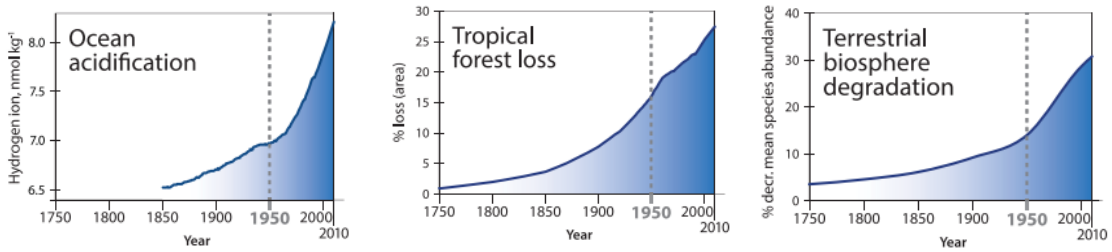


Figure 1: socio-economic development and impacts on living systems indicators (retrieved from the Ellen MacArtur Foundation)

The graphics above show some indicators of socio-economic development and the impacts in living systems, from 1750 to 2010. The aim of these figures is not to state that this is a case of a linear "cause-effect", but the numbers seem to undeniably be related to each other. The figures help understanding how these factors are dramatically changing in a brief period of time, mostly after 1950, when science and technology highly developed. Planet Earth felt this change and we are now undoubtedly facing its consequences.

It is estimated that in 2050, not so far away from the present moment, we would need 3 worlds to sustain our life level as it is today. Even nowadays, 1 Earth is not enough anymore. We are consuming at a higher rate than the planet can produce.

In around 200 years of existence, the world population rose from approximately 1 billion to 7 billion people. It is expected that we will be nearly 8 billion people in 2020, 8,5 billion in 2030 and almost 10 billion in 2050. In 50 years, GDP increased more than 10 times its initial value. In 2030, it is expected that more than half of the world's population will be middle class consumers and that around 60% of us will live in urban centres.

The primary energy use has increased to 5 times what it was 50 years ago, and the water use augmented 4 times during the same period. Stratospheric ozone loss, surface temperature, ocean acidification, tropical forest loss and terrestrial biosphere degradation, these all went up dramatically in the last years. From these, surface temperature, which is linked to global warming, is one of the most talked about issues now.

According to the BirdLife International, a Partnership of more than 100 national organisations (almost 50 within Europe), with more than 10 million members and supporters, "climate change is largely caused by human activities, and it presents a serious threat to nature and people". This "is extremely likely (greater than 95 percent probability) to be the result of human activity since the mid-20th century", one can read at NASA's website.

BirdLife International adds that "without ambitious global warming mitigation efforts, temperature rise this century will exceed 4 degrees Celsius above pre-industrial levels, with

catastrophic consequences for the whole planet". Because of these changes, glaciers melt, the sea level rises as well as its temperature, and many species are in risk of extinction (Shaftel et al., 2018). Changes happen fast, the weather becomes more extreme and some living beings cannot adapt to it ("What Is Global Warming?"). Droughts, as well as hurricanes, will happen more easily and there will be changes in precipitation patterns. According to the Intergovernmental Panel on Climate Change, scientific evidence for warming of the climate system is unequivocal (Shaftel et al., 2018).

Little concern has been present over the last decades, at least when compared to the required one. The use of natural resources has then been subject to tremendous changes, which are not being looked at as positive, since we are demanding from Earth more than Earth can give us. Moreover, we are probably demanding more from most things than we actually need.

2.2. The Millennials

The millennials, people born roughly between 1980 and 2000, are, in a general way, unsatisfied by nature. While some years ago people stayed in the same enterprise for years, despite its adverse conditions, for example, nowadays instantaneous satisfaction is becoming more appreciated and people leave situations that are not seen as good enough much quicker than before (Stein, 2013). That has its advantages but also its drawbacks. It makes people thrive for better and take risks, but obstacles are easily not overcome, but contoured.

This is a generation where many paths are available, and it might be easy to avoid one's difficulties by leaving it and entering a new one. If that allows people to know more paths and discover new realities more often, how deeply can that person know the chosen paths? What consequences does this person have to face after a decision is made? And with so many possibilities available, does one ever stop and think about things? Do we need all we look forward to? Do our choices harm something? Couldn't we stop, think for a while and find better solutions that last longer?

There is a story, often told amongst meditation interested people, of a man that, one morning, leaves his house and falls into an enormous hole there is in the ground. That man faces massive difficulties to get out of the hole, he suffers a lot and struggles very hard, but finally prospers and follows his way. The next day, the same man leaves the same house and, like the day before, falls into the same hole. He realizes the hole is huge and that it requires a lot of effort to get out but, more easily than the day before, he succeeds. The third day comes, the man lets himself fall into the hole once more. The hole is still tremendous, but the man has gained capacities to get out of it and does it quite easily. One day after, the

man opens his house's door, looks at the hole in the ground, does not fall into it and starts his day calmly. The day after that, the man chooses another path.

While the path offered challenges, the man kept walking through it. The first day was very hard, the others became easier to deal with. The hole on the ground was only contoured when it stopped being a problem. When no problem was left, the man left the road. To find a new one. The circular economy may be looked at as a hole, as something that is still quite new and difficult to apply, as a path we may try to avoid, but what about letting ourselves acknowledge and study it, instead of choosing another path leaving this one untraveled?

If we are more "how we deal with things" than the "things that happen to us", is it not essential to face the consequences of our decisions and make the best out of it, always taking into consideration that we want to improve in future opportunities? We should not be stuck with a decision forever, but a decision inevitably has its consequences and we should at least try to understand them and make the situation better.

Of course, millennials are different depending on the country they are from, but due to globalization, millennials across the world are more similar among themselves than they are to their own country's older generations. People became much more powerful during the last decades. They started realizing the major influence they can have on other people, in the market and in the industry environment. This power can be used in an effective way and there is more room to be creative, to have influence on others, to fight for the causes people believe in. If anything is wrong and if this generation believes this, then probably a change will come. That is why these causes need to make sense, need to be heard of.

A study from the Ellen MacArthur Foundation and the McKinsey Center for Business and Environment shows that cars are parked 92% of the time and transport an average of 1,5 people per trip. Offices are only occupied up to 50% of time of a work's day and there are 11 million empty houses in Europe (Santiago, 2016). According to the European Commission, in the European Union, each person uses around 15 tons of materials per year and creates more than 4,5 tons of waste during the same time (Comissão Europeia, 2016). At the moment, we would need to have 1 earth and a half to have enough area to supply the ecological goods and services that humans use. This is our ecological footprint and it is quite alarming (McDonald, 2015). Shouldn't we worry about these numbers?

2.3. A call to action

Are some of us overreacting or should these points be addressed? Is it too late to act? And if it is not, what should be done? What is our influence?

The Japanese repair broken pottery with material mixtures that include gold. The idea behind this art, called kintsugi ("golden repair"), is that damage should not be disguised; instead, the repair should be illuminated. Maybe something better may come because one not so good thing happened first. Flaws are embraced because they tell a story and their existence does not dictate the end, but a new beginning (Carnazzi; Jobson, 2014).

It is not difficult to find situations where, the more you know, the greater is the number of questions you have. You know more, but you also understand there is much more to learn, that you did not even imagine before. If that learning process makes you feel enthusiastic, then why not turn that into will and power?

Planet Earth is "wounded", it has a story in which we play a very important role, but it is not finished, and it is up to us to embrace it as it is now and repair it with our golden actions, it is in our hands to have not only an important, but a positive role regarding our surroundings.

It is in our hands to see this disruptive way of thinking and looking at what surrounds us as an opportunity, as a way of giving more meaning to things and of creating wealth, more jobs and new economic models. Figure 2 aims at making a parallelism between pottery recovered with gold and our planet, waiting for us to act.

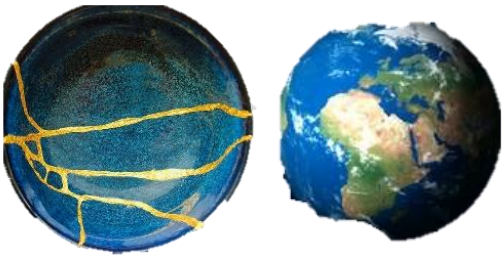


Figure 2: pottery recovered with gold and the planet Earth seen from space

This should not be only looked at as a way of not harming the Earth and becoming its "friend", but also to defend businesses, for example, from dependencies, unaffordable prices and shortages. If a country imports goods and those goods are becoming rare due to its excess of use, then that country is undoubtedly subject to its higher prices. It may become even worst if instead of paying more, there is no longer what to pay for, what to buy. Sooner or later, for distinct reasons, these worries must be addressed, and some companies are already changing its ways of working in order to create competitive advantage out of the actual situation, instead of waiting until it is no longer a choice, but an imposed necessity.

Another concept associated to kintsugi is the "Mushin" philosophy, which stands for "no mind". The idea is that the mind is not occupied by thought or emotion and is, as a result, open to everything ("Mushin"). The aim of this work is not to have non-critical readers, but I would like the most sceptical ones to open their minds and mind the matter for a while.

3. The travelled road - linear economy

To better understand the way our path must be changed or improved, we need to comprehend what brought us here. Over the last century, society has changed dramatically. The way it works is no longer the way it worked 100 years ago, and it is surely very different to the way it will work in 100 years from now.

We tend to think that evolution and technology go against nature, but is that really the case? It is easy to assume that environmental issues limit evolution and technology and even our species, but can't we evolve without causing prejudice? Shouldn't it be the challenge: to think about how we grew and how we can grow from here, taking into account what we've learned over the past years and what we are capable of doing now? Shouldn't this concern be a foundation that ultimately is transformed into a natural way of thinking?

Indira Gandhi, the first female Prime Minister of India, named "Woman of the millennium" in an online poll organized by the BBC, defended that "the environmental problems of developing countries are not the side effects of excessive industrialisation, but reflect the inadequacy of development" ("Indira Gandhi 'greatest woman'") and that goes in line with the idea that environmental protection and economic development are not in conflict. "Environmental protection is not a burden but a source for innovation. It can increase competition, create jobs, and lift the economy" (Shao, 2015). This is a crucial point to understand. Countries can develop, or continue developing, but this should be done adequately.

Up until the 18th century, production was slow, not intense and of low volumes. That did not make most of the people think about its effects on the planet and on the enterprises, themselves. From that point in time on, production grew intensely and the impact on the environment become more evident. From 1900 to 2000, the production of solid residues in urban areas grew more than 10 times. This translates into a rising danger for ecosystems and human health. The linear economy most of us knows and has not questioned, needs to be understood and interrogated. It needs to be stopped and we need to contribute to what is next.

The linear economy is associated to the geographically uneven distribution of wealth. Industrial nations, which are more developed regions, used to have an abundance of resources. Because of that, when comparing human labour to material's costs, normally human labour was more expensive, so resources were used more easily. Material was cheap and labour expensive and thinking about sustainability of resources was not present in the equation, because that was not the cause of worries. Let us look at how the linear economy basically works (figure 3).

Figure 3: linear economy overview

Take, make and dispose has been the natural flow (European Commission, 2014). Resources are extracted, goods are made and sold and everything that is not needed is disposed (both at the time of the product's creation/ development and at the end of its short lifecycle). Creation of value was associated with the maximization of products sold, so production was fierce, as was competition between firms. While resources were available, and the demand stable, there were no concerns about these topics, but demand has been increasing a lot during the last years and resources are becoming scarce.

Moreover, mankind is shifting from the densely populated and industrialized nations and is heading to the emerging markets. That means that mid class consumers are augmenting and so is consumption. Prices are going up and becoming volatile, competition is increasing even more, and companies are starting to face some serious difficulties. Some of them do not even understand why.

A linear economy is eager to invite alienation and conflict, as if our main objective is to grab what we can while it lasts. It does not encourage sharing and compassion, nor inclusiveness and cooperation. James Greyson writes that "the "more is better" economy does not need to be stimulated to grow nor constrained from growing. It needs to be entirely replaced by "positive development" in which markets work to automatically, systematically make things better both locally and globally." (Greyson, 2016). That is the idea behind the circular economy. At the end of the day, we are all connected. Everything is connected.

4. Signs of change – recycling

The concept of recycling has been a major change contributor. The basic idea behind this concept gained momentum during the last years, but it has been present for much longer than we imagine.

If we go back in time, we find the Japanese making the first step towards recycling in the 9th century. They started reusing paper almost at the same time they began producing it. Documents were recycled, and the raw material used again. The Japanese look at recycled paper as more valuable than new one, actually. There is a story of an emperor that died in the 12th century that shows how important recycling of paper was for the Japanese at the time. The emperor died, and his wife recycled the papers in which he had written her poems and letters and she wrote back to him on the recycled paper, wishing to comfort his soul. An example of a recycled paper from that time is shown in figure 4.

Figure 4: Japanese piece of recycled paper

More than 500 years after the Japanese started recycling paper, the recycled paper manufacturing process was introduced. Fibre from recycled cotton and linen rags started to be used to make paper that was later used in Bibles and newspapers. Not long before 1900 arrived, England focused on collecting, sorting and recycling goods that were not wanted, and New York City started recovering material and separating it into distinct categories with the same idea.

During World War I, raw materials were in shortage, so there was even a Service (created by the Federal government) whose motto was “Don’t Waste Waste – Save It”. The Great Depression also encouraged the reutilization of resources. Wars tend to make people do their best to use the available resources because, normally, those resources are very limited. In mid-1900, however, people started feeling that, to have a modern lifestyle, single-use items were a must, so ease and convenience were highly valued and garbage highly increased.

Not long after that, fortunately, the “chasing arrows” symbol for “Reduce, Reuse, Recycle” was introduced as a result of an art contest that aimed at raising environmental awareness. Its designer was an architecture student called Gary Anderson and the mobius loop was used as an inspiration. The symbol is as follows (figure 5).

Figure 5: Reduce, Reuse, Recycle

In 1970, there was the first Earth Day, on April 22. The idea was to call attention to the importance of recycling and this day is still celebrated today. Some years after that, incentives as refundable deposits and recycling regulations started to take place and with that came much more actions, recycling ideas and green movements. In 2000, EPA (Environmental Protection Agency) confirmed global warming and waste were linked and the importance of this topic grew even more. Free recycling services were offered, laws were made and plastic bags were banned from markets.

Nowadays, we are even coming to a time when we start thinking about material that can repair itself, as if it was “self-healing” (“A Brief History of Recycling”; Bradbury, 2017). This possibility is still being studied, but, in the meantime, people try to put the concept of recycling into practice. Sometimes a small act can have a huge influence on us, like helping ourselves to recycle by keeping a recycling bin nearer to us so that recycling becomes a habit. Sometimes it is a matter of convenience. It has a lot to do with our mentality, as well, and with the way people we get along with face the subject. Some studies show that the colour and the shape of the bin, for example, can have an influence as well.

Recycling is more easily looked at as a moral obligation rather than a necessity. If it was the other way around, if it was seen as a survival subject, we would probably look at it in a different way. We crave food and water, for example, but tend to face long-term issues as less urgent when, in fact, some of these long-term issues will turn out to be survival topics (Richards, 2018).

5. The new paradigm – circular economy

Because it started to become evident that a change was needed, some people began dedicating their time to think about how we can improve our actions for the future change to come as a result. The circular economy is one of the latest concepts associated with this effort to make things better and comes as an opposition to the linear economy. The idea is not only to not harm the Earth, but to be a positive force. Sidney Sheldon believes we should "try to leave the Earth a better place than when [we] arrived" and it goes in line with Mike Huckabee's statement that "it's all of our responsibility to leave this planet in better shape for the future generations than we found it." We are not the ultimate beings here, or at least we shouldn't be, so what about bringing the best to what we can change and improve?

This idea is shared by Gaylord Nelson, the founder of the Earth Day, who alleged that "the ultimate test of man's conscience may be his willingness to sacrifice something today for future generations whose words of thanks will not be heard." Is instantaneous satisfaction all there is? What about those gestures that have consequences over time? What about those actions which have impact in the near or distant future and not "right now"? Isn't it the true sign of respect and compassion towards others? Isn't that, after all, something to look forward to?

Albert Einstein believed "our task must be to free ourselves by widening our circle of compassion to embrace all living creatures and the whole of nature and its beauty" ("Quotations about the Environment") and I agree. Not that amazing things are not possible due to the existence of development, because development is undoubtedly important and inevitable, but because one thing is not against the other. Amazing things can result from the right "use" of what we can do combined with what we should do. Should we do all we can? Or should we do what we can to achieve meaningful goals?

There is still time to act and Sara Gilbert shows her agreement by stating that "you want to keep the severity of our environmental problems in mind enough to keep yourself motivated but not enough to paralyze you into depression". Balance is very important, giving up should not be an option, but ignoring the reality should not be a possibility either. Ma Jun, named as one of the 100 most influential persons in the world by Time magazine in 2006, tries to make it clear that "the environmental issues cannot be addressed without extensive public participation, but people need to be informed because they can get involved" and this work also aims at informing people about the topic. People need to know, people need to be informed. Only after that, will we have enough capacity to address what needs to be improved. After all, knowledge is power. Closing our eyes is not included in the list of options.

5.1. The concepts behind the circular economy

The circular economy is based on many concepts which have been developed over the years and that are continuously gaining importance as well as the circular economy itself. Before going into detail about the circular economy, other related and quite recent topics will be briefly studied. These topics are referred to as the schools of thought by one of the most influential institutes dedicated to the circular economy, the Ellen MacArthur Foundation. We will go into detail about the Foundation over the course of this work, but for now let us understand what biomimicry, blue economy, cradle to cradle, industrial ecology, natural capitalism, performance economy and regenerative design are and, even before that, what sustainability stands for. These concepts are structured in figure 6.

Figure 6: circular economy's schools of thought

5.1.1. Sustainability

The word "sustainable" has to do with the verb "to sustain", or "soutenir" (in French), and it means "to hold up/ support" (Geissdoerfer et al., 2016). Sustainability reflects the capacity to endure and is about making our future the cause of our present ("Sustainability: Can our society endure?").

The concept had its origins in forestry, because of the simple thought that "the amount of wood harvested should not exceed the volume that grows again". It sounds quite simple, doesn't it? But what message is hidden behind the idea? The conceptualisation of sustainability was written down in 1713 by Carlowitz, in "Sylvicultura Oeconomica" and it was later transferred to the ecology context, giving origin to the conclusion that we should respect the ability of nature to regenerate itself, not only in the forestry field but in general.

The most commonly accepted definition of sustainability nowadays is: “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Geissdoerfer et al., 2016). Right now, we are consuming a lot at a very high rate and earth’s capacity to support us is not enough. Yet, almost 15% of us go to bed hungry every night. Sustainability and empathy need to come into place; actions need to put into place.

Al Gore, awarded with the Nobel Peace Prize, two Oscars and a Grammy, believes sustainability is the single largest investment opportunity in history, adding that “it has the magnitude of the industrial revolution but the speed of the digital revolution” (“Al Gore: sustainability is history’s biggest investment opportunity”).

5.1.2. Biomimicry

The word “Biomimicry” comes from “bios”, which means “life”, and “mimesis”, which stands for “imitation” (“What is Biomimicry?”). This discipline, that was popularized in 1997 by Janine Benyus (with her publication of the book “Biomimicry: Innovation Inspired by Nature”), sees Nature as a model, a measure and a mentor. It may, by these means, serve as inspiration, comparison and teacher (Leitão, 2015). It is a result of the understanding that nature itself has solved many issues we face nowadays and that we can learn from, instead of fiercely taking from it. The way nature is looked at from the biomimicry’s point of view follows, in figure 7.

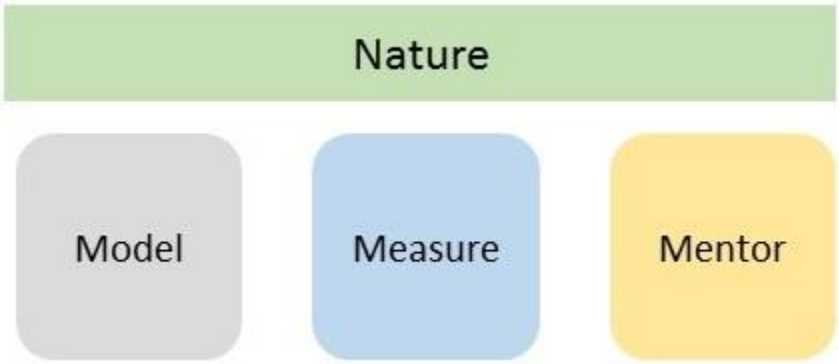


Figure 7: how nature is seen from the biomimicry point of view

Even though the term was only popularized at the end of the 20th century, the idea behind it is far from recent. One example of its application is Leonardo da Vinci, the Italian polymath born in the 15th century who, led by his well-recognized curiosity and imagination (Gardner et al., 1970), was inspired, in many of his achievements, by nature and its ways of working. He made a study of birds, entitled “Codex on the Flight of Birds”, which is a very

good example of this. Another great example is Copernicus who said that “the wisdom of Nature is such that it does not produce anything superfluous nor useless” (Leitão, 2015). There is, indeed, a lot we can learn from it.

Let’s look at a simple example. A flower needs carbon dioxide, water and light energy to live and grow. Even though oxygen is not normally looked at as “waste”, if we look at this example, here it is. Nevertheless, an animal closes the loop when added to this cycle. That animal needs oxygen, that comes from the flower, and releases carbon dioxide, which is used by the flower. These organisms have influence on each other. They compete but also collaborate, they share resources and are even able to create them, they are better together than they are when they are alone and isolated.

According to Benyus, “biomimicry is basically taking a design challenge and then finding an ecosystem that's already solved that challenge, and literally trying to emulate what you learn”. “There are three types of biomimicry - one is copying form and shape, another is copying a process, like photosynthesis in a leaf, and the third is mimicking at an ecosystem's level, like building a nature-inspired city.”

According to the Biomimicry Institute, which was founded by Benyus and Bryony Schwan in 2006, this concept is “an approach to innovation that seeks sustainable solutions to human challenges by emulating nature’s time-tested patterns and strategies”. This Institute’s main goal is to share nature’s design lessons with whoever is interested and empower people in this field. A world is envisioned where “people view nature not as a warehouse for goods but as a storehouse of knowledge and inspiration for sustainable solutions”.

In 2008, a free, online catalogue of nature’s solutions to design challenges was launched under the name “Ask Nature”. Navigating through the website one may easily find practical examples that prove how “Nature is constantly innovating, endlessly experimenting and ever reinventing itself in the face of new challenges. From materials and products to business models, biomimicry offers a fresh lens for all the dreamers and doers remaking the man-made world.”, Angela Nahikian, from Steelcase, states.

5.1.3. Blue economy

In 2010, Gunter Pauli published a book called “The blue economy: 10 years, 100 innovations, 100 million jobs”. Because of this publication, the words “blue” and “economy” started being mentioned together more often. According to the Ellen MacArthur Foundation, this is an “open-source movement bringing together concrete case studies, initially compiled in an eponymous report handed over to the Club of Rome” and it “insists on solutions being

determined by their local environment and physical/ecological characteristics". It is based on 21 principles. For example, solutions should be based on physics, we should substitute something with nothing (asking if something is really necessary), try to turn waste into resources, face diversity as wealth, do more with less, face change as a constant and risk is an innovation motivator, think about how everything is biodegradable and connected in Nature, beside others.

One of the book's aim is to help society shift from scarcity to abundance and it proposes to focus on the generation of more value, instead of blindly cutting costs. The book demonstrates how we can create economic benefits by creating jobs, reducing energy use and helping involved communities. According to the blue economy organization's website, blue economy is ZERi's philosophy in action. "ZERI" stands for "Zero Emissions Research and Initiatives" and claims to be "a global network of creative minds seeking solutions to the ever-increasing problems of the world. (…) Starting from ideas, based on science, the common vision shared by each and every member of the ZERI network is to seek sustainable solutions for society, from unreached communities to corporations inspired by nature's design principles."

Gunter, who founded ZERI, also writes fables because he believes that "fables ask the obvious questions we never asked" and he wishes to help children realize the positive role they can play and be "ready to accept the challenge with an open mind to learn, act and make a difference". Children, who are curious by nature, who question everything, will be leading the world and our future is in their hands. Gunter believes that "brilliant ideas are not the product of a genius rather the culmination of dialogues with open-minded individuals who care to share", so communication and sharing are seen as crucial.

5.1.4. Cradle to cradle

Today, most of the "resources are extracted, shaped into products, sold, and eventually disposed of in a "grave" of some kind" (Braungart & McDonough, 2002). The concept of cradle to grave (C2G) is being substituted by cradle to cradle (C2C). Products were "born" and then "died". The idea of cradle to cradle is to change that and "rather than seeking to minimize the harm we inflict, C2C reframes design as a positive, regenerative force" that creates "footprints in delight, not lament". Benefits for society must be a result of the integration of design and science. The objective is simple: to keep material circulating with value, to look at what can be done next with what we have now. The concept of waste must be eliminated, because waste is transformed into input ("Waste equals food"), human and natural systems must be respected ("and diversity celebrated") and renewable energy must be used.

Michael Braungart and William McDonough were the ones that developed the concept and its certification process. The Cradle to Cradle Products Innovation Institute is a non-profit organization who aims to “educate and empower manufacturers of consumer products to become a positive force for society and the environment”. There is a certification process that involves the basis of continuous improvement and the commitment to sustainability and it looks at five different quality categories:

- Material health: are materials safe?
- Material reutilization: do materials come from and can safely be returned to nature?
- Renewable energy: is clear renewable energy used to empower manufacturing?
- Water stewardship: are natural systems honoured?
- Social fairness: is people honoured?

There are 5 achievement levels for every quality category and the overall mark of an enterprise is determined by the lowest achievement level of all. That means that even if the achievement level for 4 of the categories is very good, if the remaining one is low, the result is determined by it. The overall mark can be Basic, Bronze, Silver, Gold and Platinum. There are already more than 250 participating companies and more than 500 active certifications for around 8000 products.

Braungart and McDonough also wrote a book on the concept of upcycling. This term is undeniably associated to cradle to cradle and comes as opposition to downcycling. The idea is that “we don’t use or reuse or recycle resources with greater effectiveness, we actually improve the natural world as we live, create and build”. It makes us wonder about the role Humans have on Earth: “Instead of protecting the planet from human impact, why not redesign our activity to improve the environment?”. It tries to show that instead of having a material downcycling, losing value as it is used, we can upcycle it, give it more value with time.

5.1.5. Industrial ecology

Recycling waste and sub products of the productive process, minimizing the use of natural resources and adopting cleaner technologies are part of the industrial ecology concept. Industrial systems may function in an analogous way of natural ecologic ecosystems. It is vital to understand the circulation of materials and energy flows in industries. To understand how to resemble natural systems, one may ask how the ecosystem works, how it is regulated and what its main interactions with the biosphere are (Foster et al., 2016).

Industrial ecology's tools include dematerialization (which has to do with the reduction of material usage – "doing more with less"), material substitution, pollution prevention, design for environment/ eco-design and eco industrial parks (Saavedra et al., 2017). There is a focus on connections and having closed-loop processes. The Ellen MacArthur Foundation describes it as being an act of "designing production processes in accordance with local ecological constraints whilst looking at their global impact from the outset". Industrial ecology has to do with industries' role regarding its surroundings.

5.1.6. Natural capitalism

"Natural Capitalism: Creating the Next Industrial Revolution", written by Paul Hawken, Amory Lovins and Hunter Lovins, includes the desire of having an economy where businesses and environmental interest overlap. We are all interdependent and that should not be looked at as a failure nor a risk. Natural capitalism has four principles associated with it:

- Radically increase the productivity of natural resources (by changing designs, production and technology use)
- Shift to biologically inspired production models and materials (where the concept of waste is eliminated)
- Move to a "service-and-flow" business model (providing value with services)
- Reinvest in natural capital

Increasing natural resources' productivity has implications on products from the beginning of their conceptualisation. We cannot hope to increase it caring only about it after it is first used. Instead, since the beginning of the product's design, this concern shall be taken into consideration. After the material is designed, the way it is used, and the way technology is integrated are the next concerns. Production and the materials themselves can be inspired by biology. Another interesting concept is to shift from selling products to selling services. Adding value with services along with the material itself is a key point, as well as reinvesting in natural capital.

5.1.7. Performance economy

Walter Stahel was the one who coined to expression "Cradle to Cradle" and the one who worked at the development of the "closed loop" approach, even though others developed the concept much further. This notion is directly linked to the circular economy, seen that it

refers to extending product life, creating long-life goods, reconditioning activities and preventing pollution. Here we can also have the idea of how important it is to sell services instead of products, which is what almost literally gives “performance economy” its name. Performance and not (only) the good is sold. Value is added without resources being added to the equation. That is a trend easily precepted as growing in today’s days. Because performance is not as linear as a physical good, selling and buying becomes more personal, it becomes more individualized.

Services’ unique features include intangibility, heterogeneity, simultaneity and perishability. A service is not easily perceived by senses and the customer’s perception is based on his/ her experiences and expectations. The service is unique for each client because the perception of quality varies from customer to customer. Services are produced and consumed at the same time, so the just in time (JIT) concept is a necessary reality, not a choice. Moreover, services cannot be saved, stored, resold or returned. These are just some of the challenges of creating a performance-oriented company instead of a goods-oriented one.

It is common to find works related to how the supply chain management (SCM) is applied when selling goods. It is not that common to find works that study supply chain management (SCM) in the service industry. In fact, the logistic concept started being studied in 1950, in 1970 the concept had matured and in 1980 the concept of supply chain management started being studied. More importance was given to all the supply chain instead of only giving value to the enterprises individually. Only 15 years after that, did it become associated to the service industry. We are now reaching the conclusion that selling services can bring benefits if included in the selling of goods. Moreover, due to this generation’s own characteristics, this way of thinking better fits the demand of having personalized items. Figure 8 shows the evolution of the logistics concept.

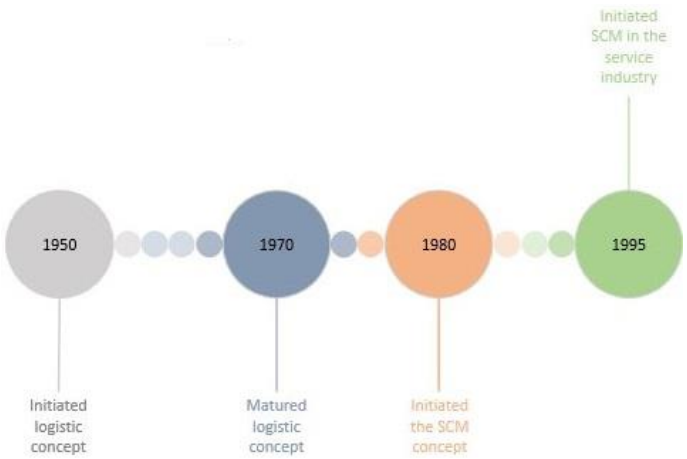


Figure 8: the evolution of the logistics concept until supply chain management was applied in the service industry

In 1976, Stahel, along with Genevieve Reday, published a research report entitled “The potential for Substituting Manpower for Energy”, which envisions economy in loops. In 1982, the Product Life Institute was formed in Geneva. This institute follows five pillars: nature conservation, limited toxicity, resource productivity, social ecology and cultural ecology. Its main focus relies “on practical strategies and approaches to produce higher real wealth and economic growth with considerably lower resource consumption”.

5.1.8. Regenerative design

John T. Lyle developed ideas on regenerative design besides agriculture and laid foundations to McDonough, who had studied with him. The “Lyle Center for Regenerative Studies” was founded in 1994 and is administered by the College of Environmental Designs (“Lyle Center for Regenerative Studies”), which aims at connecting people, places and in the environment. The objective is to improve communities at the same time we face pressing problems facing society. More much importance is given to learning by doing things.

“To regenerate” means “to create again”; a regenerative system’s output is equal or even greater than its input. While sustainability refers to something that does not degrade over time, regeneration refers to something that goes further, that makes plans for the future (“What is Regenerative Design?”). The key idea is that, while designing a product, the regeneration capacity of the possible output is considered. Products are designed to be regenerated, to be used and re-used with value. They are not only sustainable, but regenerative.

5.2. People behind the concepts

The terms we have been studying are all linked to more than one person and that ends up most probably being a good thing, because it means that a lot of people start going into detail about it. Nevertheless, some names will be inevitably related to some topics. Wouldn’t it be interesting to try finding out what the main similarities and differences between them may be? In this next section we will briefly check how both women and men are highly contributing to progress (even though men are still in the lead), how the place they come from varies a lot (even though America is the country most of them come from) and how almost all of them were born between 1940 and 1960. We can also conclude their background differs in some ways but is in other ways very alike.

For each person, the shown information will be the gender, the nationality, the year of birth and interests/ studies. Some organizations and other related topics are also present in the overview (figure 9).

These are some of the most influential people when the circular economy's schools of thought are the focus. It is due to their contribution that these terms were more deeply studied and developed. Women and men, from different countries, most of them born between 1940 and 1960. What about the rest of us? What about the millennials? What will we add to these topics? How will we contribute? The most recent topic is now the circular economy, but, after all, what is it actually?

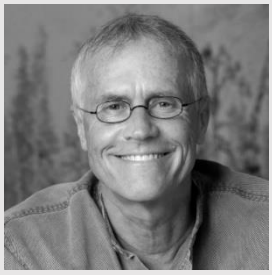
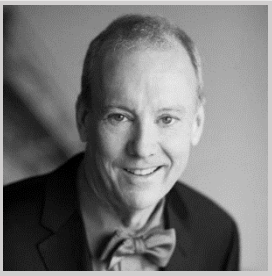
 Janine Benyus	Female American Born in 1958 Natural resources management English literature Innovation consultant Lecturer	 Paul Hawken	Male American Born in 1946 Entrepreneur Environmentalist Activist
 Gunter Pauli	Male Belgian Born in 1956 Economics Systemic design Entrepreneur Lecturer	 Amory Lovins	Male American Born in 1947 Physics Environmental science
 Michael Braungart	Male German Born in 1958 Chemist Process engineering Green peace activist Professor and master's director	 Hunter Lovins	Female American Born in 1950 Sociology Political studies Law
 William McDonough	Male American Born in 1951 Architect Designer Advisor Professor	 Walter Stahel	Male Swiss Born in 1946 Architect

Figure 9: Contributors to the circular economy's schools of thought

5.3. The concept itself

5.3.1. What is it?

Circular economy is basically the sum of all the concepts mentioned before. Outputs are transformed in inputs; waste is a resource, no longer “just waste”. This simple phrase quite well describes one of the circular economy’s principles (Lazarevic & Valve, 2017). We normally think of outputs as the final product and waste. The circular economy defends that output that is waste should be transformed into input, meaning that no waste is actually produced and so a loop is present. This is pictured in figure 10.

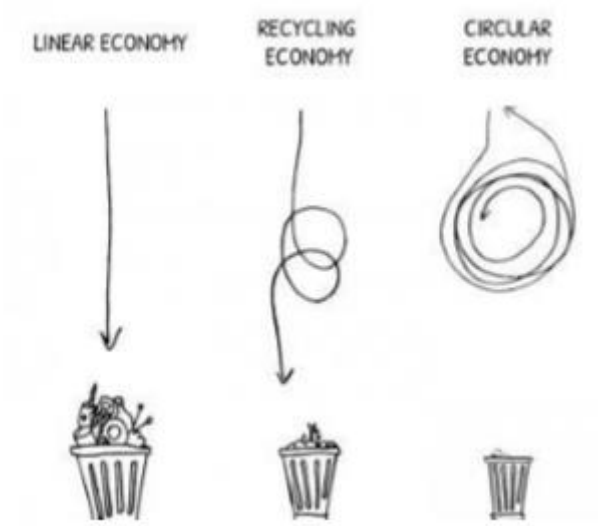


Figure 10: linear vs circular economy (retrieved from Portugal’s plan of action)

This model of economy is restorative and regenerative. It is based on the value of circles: the power of minor/ inner circles (minimizing comparative material usage), the power of long circles (maximizing the number of consecutive cycles and/ or time in a cycle), the power of cascade use (diversifying reuse across the value chain) and the power of pure circles (increasing material productivity) (Santiago, 2016). Figure below (11) pictures the idea.

Figure 11: the value of circles (retrieved from the Ellen MacArthur Foundation website)

The idea is to produce competitive and durable products and, as a result, to have less products and more services being sold. You sell or lend a product and then it is fixed or returned. The consumer is near to be “transformed” into a user and instead of the owner, he becomes the one who shares. Performance is bought and sold. Raw materials and products are kept in productive loops for as long as possible. Aristotle once said that “true wealth lies in the utilisation, not in ownership” and this is one of key points to the circular economy (Perella, 2014).

Nevertheless, not all product categories are likely to benefit from being a service-based model. One can read at Philips’ website that “a recent Guardian survey found a majority of business owners (66%) felt technology hardware/equipment offered most value as a product-service model, followed by electronic and electrical equipment (56%) and cars, tires and parts (51%)”. It is very interesting to realise that these are exactly the three categories that consumers pointed out as being desirable to have as services.

Circular economy is about effectively using materials, saving costs, developing new markets or growing into existing ones. It is about innovation and understanding that “when one tugs at a single thing in nature, he finds it attached to the rest of the world” (John Muir, Scottish naturalist and preservationist). The idea is to boost industrial competitiveness and job creation, while defending the planet and enterprises.

The circular economy is based on the importance of looking at Earth as a source of inspiration, innovation and cooperation ideas. It is based on looking at what is available and making it an advantage. It is about thinking about the future while we are at the present and looking at the past to learn from what already happened. It is about looking at each other as team members and not as people to defeat no matter what. The concept is about looking at ourselves and each other, at what we cause and what the planet has to offer us.

The Ellen MacArthur Foundation also draws attention to the “ReSOLVE” framework when it comes to the circular economy. The acronym comes from “Regenerate”, “Share”, “Optimise”, “Loop”, “Virtualise” and “Explore”, which are key aspects of the circular economy. We should shift to renewable energy and materials, taking the ecosystems’ health into consideration and returning recovered biological resources to the biosphere. Assets should be shared and reused, as well as maintained and upgraded. Performance should be optimised, and waste removed. Material should be recycled, and components remanufactured. Where possible, things should be dematerialised directly or indirectly. New technologies, products and services should be put into place.

5.3.2. Who spreads the concept?

The Ellen MacArthur Foundation is a fundamental spreader of the concept and its mission, as one can read at its website, is to accelerate the transition to a circular economy. For that, it has four principal areas of transition ("Our mission is to accelerate the transition to a circular economy"). Insight and analysis (to give robust evidences of the transition's benefits; publications are free downloadable at the website), Education and Training (to inspire to rethink the future through the circular economy's structure), Enterprises and Governments (to serve as a catalyst for innovation and create the necessary conditions for its prosperity) and Communication and Publications (to reach the global public) (Santiago, 2016). These areas of transition are shown in figure 12.

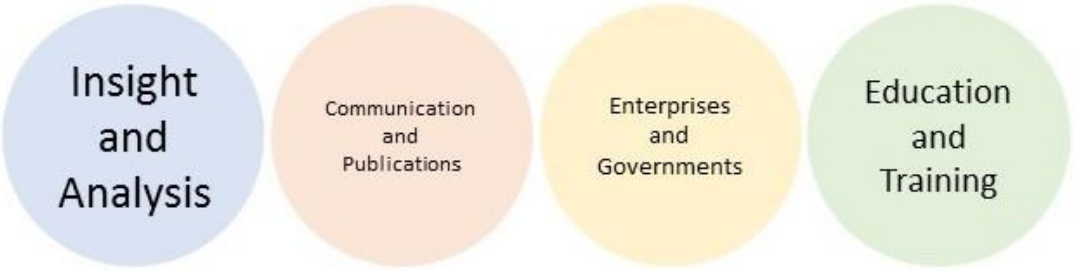


Figure 12: Ellen MacArthur Foundation's areas of transtion into the circular economy

The Foundation was created by Ellen MacArthur, who was the fastest solo sailor to circumnavigate the globe in 2005. She also founded the Ellen MacArthur Cancer Trust, a charity that aims to give confidence back to young people suffering from serious illnesses ("Who we are").

Ellen MacArthur was born in 1976 in England and feels the biggest gift her parents gave her was freedom and the chance for her to go after her dreams ("Ellen MacArthur Biography" & May, 2010). She has always been close to nature and the Foundation is one of its results.

The Foundation promotes the Schmidt MacArthur Fellowship Programme. This is an international programme on Circular Economy with a 12 months duration, for postgraduates' students in design, engineering and business ("Schmidt MacArthur Fellowship"). The Ellen MacArthur Foundation also curated an online location for news and insight on the circular economy and related topics called "Circulate". It was established in 2015 and it is supposed to provide the latest thinking on these topics ("International correspondents").

It also promotes the Disruptive Innovation Festival. "dif" is "the online festival of ideas that asks: what if we could redesign everything?". Ellen MacArthur believes "the Disruptive

Innovation Festival is about learning. It's about dipping in and out of new ideas, it's about broadening your mind". Jacob Ward, Al Jazeera science and technology correspondent, claims that "we are all going to experience, being here, what it is to think big about systems, what it is to truly blow up our ideas of what is possible." This is three weeks long, online and free festival for the global audience that takes place during the Autumn. Even though the main language is English, there are sessions in French, Spanish, Portuguese and Russian. At this festival, people "don't pretend to have all of the answers but do hope to start some kick-off conversations and conversation is all that the DIF is about" ("Disruptive Innovation Festival"). A scheme of these follow (figure 13).

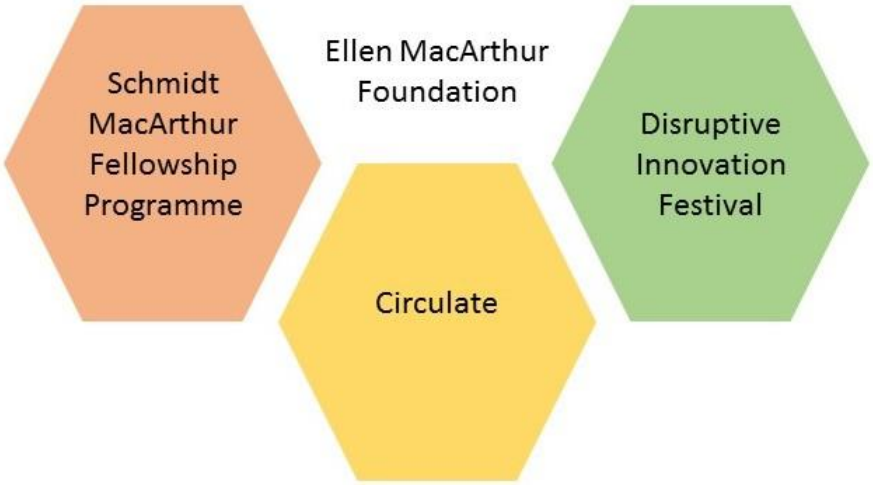


Figure 13: Ellen MacArthur Foundation's programmes, online location and festivals

The Foundation counts with the help of many partners. Google, H&M, Nike, Philips, Renault and Unilever and among them. Google's mission is to embed circular economy principals into its fabric. H&M wants to become 100% circular and be able to recycle unwanted clothes in closed loops. Nike, for example, which is associated to innovation, wishes to embed circular design principles to demonstrate the concept at scale. Frans Van Houten, Philips' CEO, states: "At Philips we strive to make the world healthier and more sustainable through innovation. Our goal is to improve the lives of three billion people a year by 2025. For a sustainable world, the transition from a linear to a circular economy is a necessary boundary condition. A circular economy requires innovation in the areas of material, component and product reuse, as well as related business models. By using materials more effectively, economic growth will eventually be decoupled from the use of natural resources and ecosystems. In such an economy, the lower use of raw materials allows us to create more value.". Renault also looks forward to reinventing the future of mobility through the application of the concept. Paul Polman, Unilever's CEO, defends that "The concept of a circular economy promises a way out. Here products do not quickly

become waste but are reused to extract their maximum value before safely and productively returning to the biosphere. Most importantly for business leaders, such an economy can deliver growth. Innovative product designers and business leaders are already venturing into this space.”,

5.3.3. How important is it?

In 2014, about 30 articles were published about the circular economy. Two years later, this number exceeded 100 articles (Kirchherr et al., 2017). This is just one more proof of how much the concept is gaining momentum. The numbers are on figure 14.

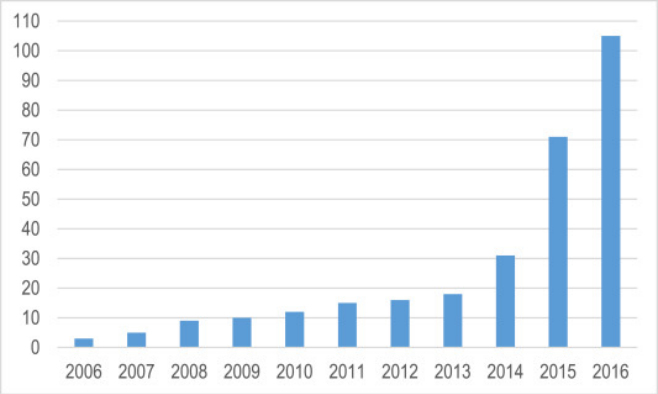
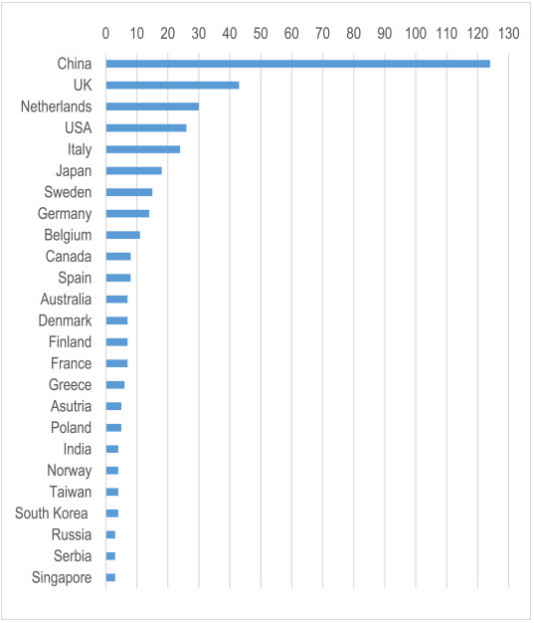


Figure 14: number of articles published about the circular economy (retrieved from Geissdoerfer et al.)

The most common geographical locations of authors of reviews and articles are shown in the graphic below, on the left (figure 15a), and we can see China’s far ahead of the second country of the list (more than doubling the number of publications), the United Kingdom. Why is this the reality? Considering China’s large population and environmental problems, do the Chinese dig deep into this topic to face the present problems?

In terms of publications per journal of reviews and articles, as one can see in the graphic on the right (figure 15b), the Journal of Cleaner Production is the one who comprises more results related to the Circular Economy (Geissdoerfer et al., 2016). This Journal’s articles are a relevant source of information for the present work.



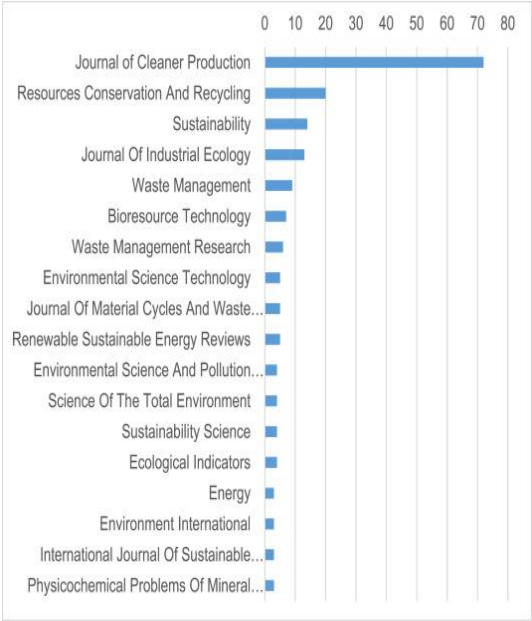


Figure 15a: number of articles published by country

Figure 15b: number of articles published by journal

(retrieved from Geissdoerfer et al.)

When we search for reviews and articles on the Circular Economy, some of the most important keywords that come associated with it are China (which comes as no surprise given the number of articles and reviews written by Chinese authors), industrial symbiosis, industrial ecology and sustainable development. Therefore, we will look at what industrial symbiosis stands for, seen that the other topics have already been addressed.

Industrial symbiosis is an association between industries which aims at helping to reduce costs as well as pollution, waste production and the extraction of natural resources. This association may be referred to as “industrial symbiosis”. Enterprises, normally geographically close to each other, can be organized in industrial parks that take collective actions to improve the efficiency of resources used inside the park (Foster et al., 2016). It is an integrated model that aims to optimize the consumption of raw material and energy as well as reducing waste creation. Actions are taken collectively looking at all enterprises as a whole, not separately.

5.3.4. What are its main advantages and constraints?

It is not so easy to transform the circular economy into a reality. Some political, social, economic and technological issues need to be addressed carefully; it is necessary to make enterprises aware of the topic and provide them the knowledge and the capacity to apply it. Some systems, infrastructures, business models and technologies may block the economy

in a linear one; new business models are often seen as risky and too complex; behaviour changes are frequently hard, and prices do not normally reflect the real utilization of resources and energy (Comissão Europeia, 2016).

Because of the distinct cultural, social and political systems, the concept developed differently around the globe. Germany worried about environmental policies, but China, for example, cared more about the creation of eco-industrial parks and “harmonious societies”. The United Kingdom, Denmark, Switzerland and Portugal raised awareness about waste management. Korea and Japan tried to increase consumer’s responsibility regarding material use and waste. North America focused on ideas concerning reduction, reuse and recycling programs.

Having differences is not a dreadful thing by nature, but sometimes the concept can be looked at as a little too vague, as a theoretical dream, a blur concept. To overcome this, transparency is needed. What is the current understanding of the concept? What do relevant stakeholders have to say? What are the written definitions? In articles, for example, the authors tend to write about what is most important to the article’s topic and, sometimes, the definition of the circular economy is not so wide but applicable to that context. Nevertheless, it is indeed an extensive concept which may be approached from different perspectives.

There are still not specific nor global guidelines to sectors on how to implement the concept, nevertheless a lot has been done recently to this extent. Companies can improve by having less direct material cost and less dependency. Components are probably going to be of a higher quality and durability. Price fluctuations can be reduced, and the efficient use of resources improved.

Reduced material bills and warranty risk, improved customer interaction and loyalty, less product complexity and more manageable life cycles, reduced premature obsolesce, increased choice and convenience are some of the advantages that companies may have if the circular economy is applied. Interaction can be improved not only with regards to customers, but also suppliers and other companies.

In Portugal, for example, a change is very hard to be implemented. According to Hofstede’s study on cultural dimensions, in a scale of 0 to 100, Portugal’s uncertainty avoidance is 99, while the long-term orientation does not even reach 30. Hofstede is a Dutch social psychologist that studied six dimensions of a country’s culture. The aim was to understand how values in the workplace have a lot to do with the culture. With the “uncertainty avoidance index”, he tried to study “how a society deals with the fact that the future can never be known” (“The 6 dimensions of national culture”). He also measured the existential goals of one’s culture, making a comparison between long term orientation versus short term normative orientation.

Belgium's uncertainty avoidance index is close to Portugal's (94), but long-term orientation is higher (82), almost the same as Germany's (but Germany's uncertainty avoidance is lower – 65). China, for example, is very different to these countries when it comes to avoiding uncertainty, having a score of 30 (while the long-term orientation's value is 87). Japan avoids uncertainty very much (92) and has its long orientation highly rated (88).

It is interesting to think a little bit about how these factors may have influence on the will people have to face change, considering the final goal of that change. This also allows us to understand why different countries face topics like the circular economy differently and how important it is that the concepts are clear.

5.3.5. How it is developing

The circular economy concept, as mentioned before, is being studied differently among the world's countries. However, the main direction is similar, and it is interesting to find out how one's country is facing it. At the same time, it is also interesting to find how it started, on a bigger scale, in the world and in Europe, for example. For this reason, in this section we will take a slight look at how the concept started to be studied in the world, in Europe and then, Portugal.

5.3.5.1. In the world

In 1983, the United Nations created the World Commission on Environment and Development (WCED). According to its report "Our Common Future", ""a global agenda for change" was what the World Commission on Environment and Development was asked to formulate. It was an urgent call by the General Assembly of the United Nations" ("Report of the World Commission on Environment and Development: Our Common Future"). The idea was to make countries work together towards sustainability and this came up still in the 20th century.

Japan and China were among the first countries to have national laws regarding the circular economy's principles. Japan with the Basic Law for Establishing a recycling-based society and China with Circular Economy Promotion Law of the People's Republic of China (Geissdoerfer et al., 2016). These countries are still some of those who develop the concept deeply, as we already had the chance to study.

5.3.5.2. In Europe

Europe is very dependent on imported resources. Around 40% of all the resources used in this continent is imported from outside of Europe (Fant 2016 & Salmela 2016). If the circular economy is put into practice, that number may be reduced, and dependence also decreased.

There is an European platform for the efficiency of resources utilization and this platform identified various promising areas to be explored by the industry. Among them, improving information about the resources used in each product, improving information on how to repair and recycle the products, finding new financial and controlling pictures and exploring the obligation's market potential (Comissão Europeia, 2016). These areas have a lot to do with information, with making people aware of the concern behind the CE.

Germany was the first country to have a national law integrating the circular economy idea, in 1996, with the "Closed substance cycle and waste management act" (Geissdoerfer et al. 2016). Still today, the North of Europe highly focuses on the topic and a lot of efforts have been made to spread the concept. It is interesting to note that 3 European countries are working with the Ellen MacArthur Foundation to share international best practices to develop new markets' circularity. These countries are Belgium, Germany and Scotland ("This is the future for business").

In 2008, the European Union established a waste hierarchy (figure 16), the Waste Framework Directive, and it comprised 5 stages (European Comission). First, is the idea that we should try preventing. That is the most favourable action. If that is not possible, then we should try to re-use. After that recycle and recover and only at the last instance, dispose.

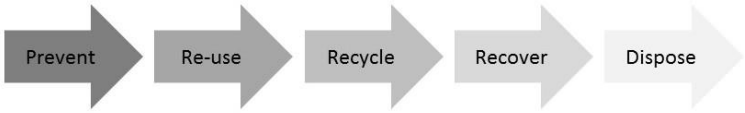


Figure 16: Waste hierarchy according to the Waste Framework Directive

In 2014, the European Commission, led by Barroso, launched a legislative proposal known as the Circular Economy Package: "Towards a circular economy: a zero-waste program for Europe". This proposal included various objectives but did not last long. Juncker's Commission decided to remove the proposal before the end of 2014. Nevertheless, the Commission ended up assuming the compromise of publishing a new proposal, at least as ambitious as the last, before the end of 2015. In December 2015, the "Closing the loop – An EU action plan for the Circular Economy" was released (Lazarevic et al., 2017; Leitão, 2015).

5.3.5.3. In Portugal

Based on European Union's policies, Portugal developed, and the Environmental Portuguese Agency implemented, a plan called "National Plan of Waste Management". Two of the main strategical objectives to be achieved until 2020 are closely related to the circular economy concept: promoting the efficient utilization of natural resources and preventing/ reducing the environmental negative impacts waste management creates.

In November 2017, the action plan for the circular economy was published in Portugal's government website. The plan resulted from a year of work between various ministries: environment, economy, agriculture, forests and rural development and science, technology and higher learning. It is aligned with the European policies, like the EU action plan for the circular economy. It comprises 3 principles of the CE:

- Make products, services and business models that exclude the production of waste and pollution
- Keep products and materials in utilization, at their highest economical value, for as long as possible
- Guarantee the regeneration of material resources and subjacent natural systems

Matos Fernandes, the Portuguese minister of the environment, is having a crucial role in this field and believes this is the right time to reinvent our economy for a more efficient and productive model, based on the circular economy. "We are living on credit", he explains, adding that the last time that society consumed inside the limits of its ecosystems capacity was at the beginning of 1970. On the 8th of August 2016 we started to consume 2017's resources and that was the "Global Overshoot Day". According to Diário de Notícias, in mid-June, we (Portuguese) started consuming 2019's natural and renewable resources. According to the same Portuguese journal, Portugal is the 69th world nation with the highest ecological footprint. "We need to make more with less", we can read in the plan of action (DN/Lusa, 2018).

According to Pope Francisco, the idea that we can indefinitely grow is passed very easily and is not true. Goods are not unlimited in our planet and we are coming to that alarming conclusion. Population is growing, natural resources extraction is becoming higher, demand is rising, dependence on other countries is elevated, prices become unstable and high and the environment is paying, as are enterprises.

The goal is then to have products, processes and services that are efficient, durable, reparable and recyclable. In addition, business models should include collaborative platforms, proximity systems, models of product-2-service and system of inverse logistics to recover components and material. Matos Fernandes believes the circular economy is an

abundance model and that it is possible to spare 1,8 billion euros, create more jobs and less emissions if it is applied. We should do more with less, share, repair and reutilize, remanufacture and recycle.

The plan includes three action levels: macro (considering EU's measures), meso (sectorial in scope) and micro (territorial in scope). Some Portuguese enterprises are now introducing circular aspects to their business model, like MEO, Coolfarm, Amorim, Gomos by Farcimar, Shareacar, Glartek, Monverde and Jinja. MEO spared 32 million euros repairing and reutilizing digital boxes, Coolfarm specializes in producing locally, paying attention to sustainability and efficiency, adapted to the urban reality. Amorim focuses on having 100% product and 0% waste by focusing on industrial symbiosis and biomaterial. Gomos by Farcimar helps construction in modules come to reality. Shareacar shares cars offering an Allianz assurance. Glartek drives attention to the maintenance in IOT and augmented reality. Monverde is a certified hotel for energetic efficiency, reutilization of materials and components and use of local raw material. Jinja produces home objects made from textile waste (República Portuguesa, 2017).

These are some examples of Portuguese enterprises that take the circular economy into account. So, what are the behind scenes to apply this concept? What is needed to reach this?

6. How can the circular economy be applied in the companies?

6.1. Activity sectors and the supply chain

There have been many revolutions throughout history, with the introduction of coal machines in the production (replacing manual work and improving timings within enterprises), with the scientific and technological development, with the increasing knowledge about informatics and robotics. The world is changing and so are jobs.

Economic activities can be divided into three major sectors, according to Allan Fisher, Colin Clark and Jean Fourastié. These are the primary, the secondary and the tertiary sectors. The primary sector refers to the raw materials industry. In this group we have workers like farmers and fisherman. The secondary one has to do with manufacturing and construction and involves the raw materials' transformation into goods. The last one is related to the service industry and includes jobs like shopkeepers and bus drivers.

Countries with a lower income per capita have their national income achieved mainly through the primary sector. This was the case of Europe in the Middle Ages. Countries with a higher income per capita are normally associated to the tertiary sector. With development comes the shift from the primary sector to the tertiary's importance. The circular economy can be applied to all of these sectors.

Over the last years, it has become evident that enterprises no longer work alone; they are connected to each other and the integration level between them is becoming higher with time. That is why it is becoming common to refer to the supply chain and not only to a certain company nor its own logistics' processes. That is also why the influence is so high between different companies that need to buy and sell material to each other. Nevertheless, each one is supposed to make some efforts, so that the mutual goal is achieved. It is something each company must apply, taking its relationship with other companies into account.

6.2. Key points to apply the circular economy

Businesses must face the circular economy as pivotal. There are simple things that can be promoted easily, like recycling or promoting reutilization of old things, but there is more to it than this. Contests can be held, for example, where people are encouraged to use a set of things to create something else. The company could organize an annual competition and see their employee's creativeness be applied, for example, trying to make it more usual to think outside the box.

Lifecycle thinking is needed, and designers should be more involved with material experts, scientists, manufacturers and recyclers to develop designs that include the circular economy concept. Knowledge is clearly power and different expertise is needed.

Designing for longevity, service, reuse in manufacture and material recovery are the four design models proposed by The Great Recovery Project and that might help to focus on what enterprises can do. Greater transparency is needed across supply chains to ensure that material can be tracked and recaptured successfully.

One enterprise should look at their surroundings and really pay attention to what is available locally, at what is possible to reach if a collaboration with other enterprises is begun.

Manufacturers should think about themselves as collaborators and deliverers of performance and not only as product makers and sellers. Science, technology, engineering and mathematics need to work together, more than ever. People need to be informed about the advantages of the application of the concept, so it is valued and seen as crucial.

Marketing reaches people, good marketing can make a difference. It is important to inform about what is behind the decisions a company makes.

6.3. The importance of leading

It is undoubtedly very important for an enterprise to know how to apply the circular economy, but this will not be totally successful unless customers value the idea. It is crucial to work in both things: the application itself and the acknowledgment of its importance.

Not so long ago, recycling started to be taught at school in Portugal. It was natural to witness kids teaching their own parents about its importance, about how important it is to not throw garbage into the ground, for example. A lot of importance was given to the subject and it was even shown on TV. Another great trend that is rising has to do with vegan choices. People believe it is good for the animals (by preventing their exploitation), for the health, the environment and for the people (Baginski, 2011). Because people believe these things, they are changing their habits, they are changing things.

The way people see the topic is a key point. Applying the circular economy concept in businesses (huge potential contributors to its application), is becoming more linked with competitive advantage, security and survival, not only with reputation and trust (Elkington et al., 2016). That means that the circular economy is now more eager to be studied and developed. Value can be created, enterprises are realizing, cost savings can be achieved and developing new markets and helping others grow is seen as a very interesting opportunity (Comissão Europeia, 2016) (Potocnik, 2013).

We are influenced by many aspects which need to be addressed. The behaviour of others, the way the information reaches the consumer, the immediate costs and benefits, the promotion of sustainable ways, among others, are crucial factors. Consumers, who have a

huge influence on each other, need to be informed and understand the advantages of applying this concept.

We should look at this relatively new way of thinking not only as a way of minimizing negative environmental impacts, reducing ecological footprints, neutralizing emissions and improving resources' efficiency, but also as a radical innovation that does not aim only at transferring problems into the future by slowing the pace of our actions. The objective is more ambitious: the idea is to bring benefit, operational and strategical, micro and macro economically and at the product, process and business model levels (Leitão, 2015). 3 R's (reduce, reuse and recycle) are no longer enough; we should instead think about reducing, reusing, recycling, redesigning, remanufacturing and recovering (Winans et al., 2016).

Even though companies play an important role in the application of the circular economy, governments have a big influence on it as well and laws and regulations strongly help to put some actions into practice. Policy interventions become crucial enablers. Today it is still much more attractive to most of the companies to follow a linear model economy and that is why many governments start to promote incentives to make that financial advantage less pronounced (Lacy & Rutqvist, 2015).

6.4. Some more practical examples

In the United States of America, we may find the "Ecovative Design" enterprise. These are producers of packaging that can be totally composted at home by the buyer. Its founders found inspiration observing the way mushrooms bond the wood chips together and now sell packaging based on that. Eco-design is the basis of the enterprise ("Growing alternatives to petroleum-based packaging").

In Denmark, there is an Industrial Symbiosis (Kalundborg Symbiosis) made up of 9 partners. This is the first example of a global successful industrial symbiosis case. Enterprises sell and buy each other's waste in a closed cycle. The environmental benefits are not alone; along with this symbiosis, came economic ones. This kind of examples makes it a challenge to try and make the symbiosis wider into circular cities, for example.

Mud Jeans is the pioneer in the renting of jeans. It is situated in Holland. Consumers may rent jeans for a month for one year, after which he/ she must decide between exchanging it for a new one, use the jeans for as long as he/ she wishes by paying an extra amount of money or return the jeans. If it is in a good condition, another consumer may use it; if it is not it may be fixed or sent for recycling.

Re-Tek is a Scottish enterprise that acts on repairing and remodelling electronic and IT products. It offers a financial incentive for those who return their used products, that are later resold. Of all the received equipment, around 80% is sold again (Leitão, 2015).

Phonebloks, invented by Dave Hakkens, is about building your own smartphone. It is a Lego-inspired concept that allows users to replace, add or remove component parts that make the modular mobile platform. It is customized and can follow one's preferences over time, without leaving the user with the intention of buying a new phone because of a new feature; he can add the feature to the actual phone.

Fashion label Elvis & Kresse reclaims industrial waste products and upcycles it into luxury accessories. The company freely receives waste from other institutions and donates 50% of its profits to charity.

Ford and Heinz are trying to understand if it is possible to use tomato skins to serve as the basis of materials to be used in vehicles. Testing on the durability of tomato fibre is being performed to look for its potential use.

Philips is selling light as service, having customers paying for the performance of lumens and measure of light output and not for the light bulb or fitting itself. The company refers to this as "paying per lux" and states that energy savings are already being noticed.

IKEA is considering the idea of leasing kitchens instead of selling them. Steve Howard believes this is the way to reach a smarter consumption path in the retail sector, while it makes people less attached to ownership.

Over the course of this work, a lot of examples have been given of enterprises, Portuguese and others around the globe, that are looking at the future as an opportunity to be creative, to be innovative, to be aware of the environment and our connection to it. These last examples were retrieved from Phillips' website.

7. A real example analysis

Circularity, as we have understood so far, can be applied in industries. Departments are not the same in all enterprises. It is quite common to find different departments when comparing companies, but, in a general way, they are quite similar. In the secondary sector, for instance, we may find, beside others, the departments of human resources, finance, marketing, logistics – internal and external, purchasing, research and development, maintenance, supply chain management, manufacturing operations and engineering, quality, sales, facility and information management and technology.

After all we have been studying regarding the circular economy, it is easy to understand that the concept has implications in most of those departments. Human resources need to be able to recruit people who value the topic and also encourage people to think about it. Marketing has a key role making customers aware of the advantages of the circular economy. On the other hand, suppliers who follow these principles should be valued and the maintenance team should be prepared to this new way of thinking. Research and development is crucial to this topic.

These are some examples of potential applications, but what can the purchasing department, in particular, do to improve one enterprise's circularity? At Bosch Building Technologies, for example, there is more than one purchasing department. Let us then look at the purchasing engineering one, where technical buyers work, but, before, let us quickly find out a little more about Bosch.

7.1. Bosch

Robert Bosch, who had a wide range of interests and who was always actively looking for knowledge, was the founder of the company. His first Workshop, which lead the company we know today, opened in 1886 and innovative strength, social commitment and quality have been part of its characteristics since the beginning.

The Bosch Group is now divided into four core business sectors: mobility solutions, industrial technology, consumer goods and energy and building technology. In 2017, the share of total sales (almost 80 billion euros) for each was 61%, 8%, 24% and 7% (respectively). 52% of the total sales' share was achieved in Europe, 18% in America and 30% in Asia Pacific. The Bosch Group, where people believe growth is achieved though innovation, has more than 400.000 associates worldwide and more than half of these is working in Europe.

The sector of energy and building technology offers solutions related to video-surveillance, intrusion and fire detection systems, voice-alarm systems, access-control

systems, software management systems, professional audio and conference systems. It has 5 manufacturing sites: 2 in Europe (Germany and Portugal - Ovar), 2 in the Americas (Mexico and USA) and 1 in Asia (China). In 2017, it had around 9.000 associates and sold for airports, railways/ metros, governments, besides others. (retrieved from Bosch's websites)

7.2. The technical buyer's role

The technical buyer's department makes the bridge between engineering (that is integrated in the research and development centres) and suppliers. The department where technical buyers work is called "purchasing engineering". When a new project is conceptualized, this department becomes responsible to guarantee that the different tests that assure the future good functioning of the product can be made; for that, it needs to make sure that the correct material is available when necessary and in the right quantity in the plant where the tests are made (that place normally coincides with the plant the product will be produced in when in mass production). A series of different tests are made and each one of them has a specific aim (dimensional check, functional check and so on). Besides that, the department is also responsible for choosing the suppliers for each component for mass production, agreeing the conditions in which the material will be bought in the future.

It is important to clarify that, for a new project, it is usual to work with catalogue components and customized ones. These must be considered differently, due to their own specific characteristics. A catalogue component is already produced in the market and has a supplier part number associated to it. A customized component is made specially for the project and technical specifications are needed to specify the needs of that precise part. For these, the quality department has an increased importance. Technical buyers ask for their support for product and process validation and approval.

In the development phase, catalogue components are normally bought from distributors because, even though prices are slightly higher when compared to buying directly from suppliers, this resource more easily guarantees lower lead times (LT). When a company works in technological products, time is a crucial factor, because the company needs to make sure that the product is of higher value at the time it reaches the market. Because of this, its development must be complete as soon as possible. Moreover, it is easier to find minimum order quantity (MOQ) values that fit the actual demand in the distribution and not from suppliers directly. Because the department deals with testing phases, the needed quantities are smaller than the ones predicted for mass production and if a very high quantity was to be ordered, inventory costs would go up as well as the risk of having obsolete material in house.

Customized components involve, in most of the cases, the construction of tooling and machines that, being the company's property, are in the supplier's facilities. To make sure

that these are used for the company only, a contract of loan is signed, where it is left clear that the material is the company's but is located outside of its installation so that the supplier can build the part.

Suppliers receive a technical specification, which must be analysed, and then have the possibility to quote it and/ or propose small modifications. The better the final application is known by the supplier, higher the chance of allowing the supplier's knowledge to be included in the process. That is also why suppliers need to sign a template in which they compromise not to disclose confidential information concerning the project. Even though analysing alternatives is not always possible, due to the time needed to do so, the company highly values receiving it because very good ideas can result from the cooperation between the company and its suppliers.

Requests for quotation (RFQ) are sent to a certain number of suppliers (the number depends on the purchasing volume of the part) and are then received and analysed. The company has an official platform to receive quotations. That way, all quotations are gathered and accessible to those of right and it is easier to prevent hackers to intercept information exchanged between the company and suppliers.

Based on the estimated price and forecast for a certain part, it is known in advance that the purchasing volume is within some values. Requests for quotations are made based on the annual forecast and normally include several MOQ options, because, that way, it is easier to reach the best relation price-quantity. It is important to note that some material has an expiry date and that the costs of keeping stock also count.

With the most competitive suppliers for each reference, buyers must try to negotiate, mainly when talking about customized references. Based on the results and the total cost of ownership (TCO), the best option is selected, and the supplier is awarded. In most of the cases, the buyer tries to add possible second sources, so that if something happens with the main supplier, another can supply the material. Because of that, the basic conditions must be ensured. This includes the compliance with REACH and ROHS, norms that refer to the control of substances used in a certain product. REACH stands for Registration, Evaluation, Authorisation and Restriction of Chemicals (and aims at protecting human health and the environment as well as promoting alternatives) and ROHS has to do with the restriction of certain hazardous substances and includes recovery and disposal of waste topics (European Comission).

Each reference has a material group associated to it. This way, RFQs are sent to potential suppliers for that material group that are listed in a shared file. That file is maintained by strategical buyers. Strategical buyers are divided into commodities and are responsible, among others, for the development of suppliers and for, annually, negotiating prices with

them. A technical buyer cannot award a supplier without the approval of several entities. This way, impartiality is assured, and all interested parties are informed of the official award.

This concern is also present in the process of buying material. Buying it cannot result from one person's work alone. When it is necessary to buy something, one person does a shopping cart (SC), that is approved by one or more people (depending on the total value) and another person must convert the SC into a purchase order (PO). Moreover, if the PO is altered afterwards, this change needs to be approved as well. The four-eyes rule is, this way, applied. One person cannot buy material alone.

When all suppliers are selected and approved, the conditions (like price, lead time, minimum order quantity, standard packaging quantity and incoterms) are established and the environmental compliance assured, another department becomes responsible of placing orders, based on the forecast of the product. The technical buyers' department is only responsible for the development phase of the project.

Purchasing engineering members are divided into projects. Projects may be completely new or a change of an already existing product. In the first case, it is more common to deal with more new references, but in both cases, it is natural to have a bill of materials (BOM) with a lot of material that is already used in the plant. To understand if the reference is new or not, one shall look at its status in SAP. The status indicates if the component exists or not in the plant, if it can be ordered, if it is awarded to a certain supplier, if environmental compliance is checked and assured, if it is in the tool building phase, blocked, to be discontinued and so on. Depending on the status of the material, the tasks to overcome are different. The status which normally implies more work is when a material is new, because technical buyers need to start from the very beginning of the sourcing process.

Even though the BOM has its origin in the engineering department, technical buyers are the ones that contact the suppliers directly, so new suggestions may come from suppliers that must be transmitted to the engineering department by the technical buyers. The suppliers and the technical buyers have, then, an influence on the materials used, even though that influence is somehow reduced. The interests of engineering and technical buyers are also different because the perspective is not the same as well. It is important to make sure the relationship is a good one, so it is possible to balance interests and objectives, seen that the main goal is similar: to achieve the best option possible.

For the reasons explored before, it is extremely important to align expectations and have a common vision inside the organization. If the circular economy is to be put into practice, all the involved people must be informed and understand its importance. The leadership question is crucial. People need to understand its advantages and work towards a common goal. It is not enough to have managers acknowledging something if the workers

on levels below do not value it. On the other hand, it is not sufficient to have workers that believe in something if managers do not do it.

Each department has its set of responsibilities and tasks, but they are all interconnected and able to influence each other. Even though there are rules, norms and ways of working, it is still possible to add a little bit of ourselves to the enterprises we work at.

7.3. How could the circular economy be included?

In the purchasing engineering department, concern about the environment is already present; the company asks for compliance regarding REACH, ROHS and ROHS Future. In fact, sustainability has been a main topic for many years at Bosch and the environmental concern is easily visible. One way to include the circular economy concept is to add it to the compliance report. This does not mean it should be mandatory for every supplier to have a certificate, for example, but to have an idea of those who are trying to apply it and briefly comprehend how.

That could also have impact in the decision of what suppliers to contact for a certain reference. Imagine that for a certain reference, we look at the material group and find out there are 15 potential suppliers. Let's also imagine that, taking the expected purchasing volume into account, 3 suppliers must be contacted. The decision of which suppliers to contact is not random, and the suppliers are rated according to a lot of aspects. These aspects include lead times, prices, quality records, environmental compliance, incoterms, conditions of payment and so on. Circular economy could also be added to the equation here, giving enterprises that apply it a better value when compared to others.

Another way to show how the concept is given importance is to actually apply the concept, giving the example. Taking the influence power that the technical buyer can have, it would also be interesting to, in a positive way, challenge the engineering responsible to follow the concept. We have, over the course of this work, understood that there are simple things we can do that are related to the circular economy, but it is also clear that major changes will inevitably be needed, and those changes affect the development phase in the early phase, even before the technical buyers are involved in the process. The product itself must be thought of considering its immediate use and all that follows it.

The department of Research and Development has a very crucial role here. A new product must be thought of taking this concern into account since the very beginning of the development. On the other hand, the company shall be prepared to give incentive to repairing the equipment sold. The whole mindset must be changed, and departments need to

understand the contribution they can have to the successful implementation of such a new mentality and way of thinking and doing things.

Now, there is still not a global nor an European certification regarding the circular economy, specifically. However, that could be an interesting part of the solution for the future. A platform would exist to clearly inform all the concerned public about which enterprises include the circular economy into their processes and products and how they do it (this could also be a source for inspiration for other enterprises). This way, environmental aspects could be improved and, more than that: belonging to the platform could become a competitive advantage.

Every department has the chance to apply the concept, at very distinct levels. Some actions are simple, other more complex, but overall, it is a mentality question. Global awareness is a crucial point and enterprises will, sooner or later, need to adapt to the changing world we live in.

8. Conclusion

The circular economy is a rapidly growing concept which is gaining momentum in a lot of everyday aspects, including the way enterprises work. It includes a mentality change and the understanding that sooner or later, we will need to adjust the way we are developing.

Our consumer reality is changing. People look for personalized products. Millennials buy online very easily and look for specific things, making the goods selling world come closer to the service providing one. Moreover, there is a growing trend of people being concerned with the environmental and with the way they influence it.

According to the George W. Bush Institute, “at 77 million strong, they [millennials] are now the largest generation in the electorate, workforce and population”. They have the chance to change things and to bring huge improvements to our world.

Maybe, forces that seem opposite or contrary are, in fact, just complementary, interconnected and interdependent, like Yin Yang, the Chinese philosophy, defends. The natural world is made of this; it is made of things that may look contrasting, but that are, in a matter of fact, in harmony. We just need to find out how. We need to be open in order to understand how. The dynamic system that these forces create makes us understand that the forces are greater together than they are alone. Moreover, some things would not even exist if others were not present; they are all important.

We need to somehow reach a balance and to understand the connections of the world we live in, because these connections exist. Some things definitely need to be questioned, changed and improved. People need to believe they can make a difference, one step at a time, because, as Steve Jobs once said, “the people who are crazy enough to think they can change the world are the ones who do”. This idea is sometimes forgotten, but there is so much uniting us. It is a complete misfortune that sometimes we forget it.

8.1. The work done

One of the objectives of this work was to underline how it is not only a matter of maintaining the environment healthy, but also a way of increasing competitiveness, reducing risks, dependency and unaffordable price. It is a way of creating more jobs and preparing for the future, considering the unsustainable way human race is evolving.

A brief explanation was given regarding the way we developed over the last years and then some facts were presented. These facts were supposed to give a clear idea of how crucial it is to change our path. The circular economy concept is a result of the gathering of

many concepts that have been developing over time. The circular economy is their culmination.

Another aim of this work was to show how global measures are being considered to support this cause and how Europe and Portugal (in particular) are choosing to support it, starting to launch official plans to reach it. It is important to note that it is becoming easier to practice the circular economy and the country is trying to give enterprises what they need to pursue it.

Some practical examples were given, with the aim of inspiring towards this idea and a practical case was presented, with the goal of critically analysing how one's job may include this disruptive way of thinking.

8.2. Future developments

Interesting future developments of this work would be the clear application of this concept in a company and the critical analysis of its result. This would be a challenge affecting all departments and would give more data about the circular economy.

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