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## CIRCULAR ECONOMY: A CONTRIBUTION TO THE SUSTAINABLE DEVELOPMENT

### *ECONOMIA CIRCULAR: UMA CONTRIBUIÇÃO PARA O DESENVOLVIMENTO DA SUSTENTABILIDADE*

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#### RESUMO

O objetivo deste estudo é identificar as contribuições efetivas da Economia Circular para o desenvolvimento da Sustentabilidade. Com a prática de ações sustentáveis das empresas, começaram a aparecer resultados positivos, mas mesmo com estratégias de combate e prevenção de problemas decorrentes do uso indevido de recursos naturais, essas práticas se mostraram insuficientes para solucionar os problemas da contemporaneidade. Dessa forma, novas discussões surgem com o desafio de incluir ações inovadoras, que levem ao desenvolvimento sustentável, minimizando os impactos causados pelos resultados advindos da economia linear. A economia circular aparece como uma das melhores alternativas de contribuição para a resolutividade desses vários problemas. A metodologia utilizada neste estudo foi a revisão sistemática da literatura, tendo como principal fonte de pesquisa a base ISI Web of Science. Pelos resultados, evidencia-se que Sustentabilidade e Economia Circular têm em comum o objetivo de abordar problemas ambientais, econômicos e sociais. No entanto, também é identificado na literatura científica que a Economia Circular apresenta novos itens que não são contemplados pela Sustentabilidade, emergindo como uma nova estratégia de apoio ao desenvolvimento sustentável, uma ferramenta que veio para fortalecer práticas

sustentáveis e ajudar as empresas a alcançar as metas propostas pelo TBL. Além disso, de acordo com os resultados obtidos, a Economia Circular visa explorar a eficiência do uso de energia e materiais, garantindo um crescimento econômico menos dependente dos recursos naturais, enfatizando, entre outros, o redesenho de processos que se concentram na extensão do ciclo de vida dos produtos.

#### ABSTRACT

The aim of this study is to identify the effective contributions of Circular Economy to the sustainable development. With the practice of sustainable action by companies, positive results started to appear, but even with strategies for combat and prevention of problems coming from misuse of natural resources, these practices showed themselves insufficient to solve the problems of contemporaneity. This way, new discussions appear with the challenge to include innovative actions, which lead to sustainable development, minimizing the impacts caused by the results coming from linear economy. The Circular Economy appears as one of the best alternatives of contribution to the resoluteness of these several problems. The methodology used in this study was the systematic review of literature, having as the main source of research the base ISI Web of Science. By the results, it is evidenced that Sustainability and Circular Economy have in common the aim of approaching environmental, economic and social problems. However, it is also identified by scientific literature that Circular Economy presents new items that are not contemplated by Sustainability, emerging as a new support strategy to sustainable development, a tool that came to strengthen sustainable practices and help companies to reach the goals proposed by triple bottom line. Furthermore, according to the results obtained by researchers of this area, the Circular Economy aims to explore the efficiency of using energy and materials, ensuring an economic growth, which is less dependent on natural resources, emphasizing, among others, to the redesign of processes that focus on the extension of products cycle of life.



## 1. Introduction

It is a fact that the present model of economic growth has generated serious global imbalances. While at one side, there is abundant wealth, at the other there is the contrast with increasing poverty, environmental degradation and pollution. That is why, the development of integrated actions of social, environmental and economic approaches for new business policies will be crucial for the planet. With this reality, it is necessary to adopt sustainable practices in the companies not only as a way to follow the requirements of law, but also as a way of promoting, besides economic results, the preservation of natural resources and the guarantee of worker's rights, among others (Rogers, Jalal & Boyd, 2008; Jamali, 2006).

From these factors, the sustainability stands out as a way of facing and minimizing, in special, environmental problems caused by men. According to Elkington (2001), sustainable development is proposed by governments and leader business as a possible solution to a diversity of problems involving the planet. Accomplishing what is proposed by the triple bottom line, that is, the balance between the environmental, economic and social results has been one of the most challenging tasks for the organizations.

Although it has contributed to the improvement of environment and society, Sustainability has left gaps in the resoluteness of so many environmental and social problems caused, mostly, by natural resource misappropriation and by relentless pursuit of economic results (Ellen Macarthur Foundation [EMF], 2013). In order to discuss these gaps and other problems that were not solved by Sustainability, the concept of Circular Economy is resumed, becoming important and outstanding in discussions of world political decision-makers (Brennan, Tennant & Blomsma, 2015).

Amui, Jabbour, Jabbour & Kannan (2017) reinforce this idea when they report that in the current development situation it is necessary to change the original economic model, considered as harmful to the ecological system. One of the alternatives for this change is the development of circular actions, putting into practice what is proposed by Circular Economy, considered, according to Sarkis, Zhu and Lai (2011), as part of the Ecological Modernization Theory [EMT]. To Pomponi & Moncaster (2017), the Circular Economy appears as a new a paradigm, gaining momentum and promising to overcome the contradiction between the economic and the environmental, where they also reinforce the idea that resources should never be transformed in waste, but they must surely be kept in the process as long as possible and with minimum loss in quality.

Aurdahl (2016) refers to Circular Economy as a restorative economy that uses renewable energy, worries about the elimination of toxic chemical products use and with the eradication of waste. Opposing to Linear, the Circular Economy leads to a reflection about how production and consumption of goods and services may affect the sustainable development. Markkanen (2016) reports that the concept of Circular Economy is very extensive, abstract and little known by society.

However, as pointed by EMF (2013), companies have already been noticing the opportunities offered by Circular Economy and then they started to put into practice circular action that



benefit not only the economic interests of the companies, but also bring environmental and social benefits. Perella (2015) presents that, according to The World Economic Forum, Ellen MacArthur Foundation and McKinsey, the change to Circular Economy will represent an opportunity to global economy of about one trillion dollars. Lacy and Rutqvist (2015) added that the transition to Circular Economy might be the greatest revolution and opportunity to reorganize the production and consumption in global economy in the next 250 years, considered a radical reformulation between market, customers and natural resources.

Ghisellini, Cialani & Ulgiati (2016) and Murray, Skene and Haynes (2017) report that the concept of Circular Economy is of great interest to both scholars and professionals because it is seen as an opportunity for companies to implement what is proposed by sustainable development. According to Elia, Gnoni & Tornese (2017), the Circular Economy has been widely explored by researchers as a possible alternative to increase Sustainability. On the other hand, Su, Heshmati, Geng & Yu (2013) mention that the Circular Economy is presented as a strategy of sustainable development and meeting this idea, Awuah & Booth (2014) mention that Circular Economy and Sustainability present some similarities in their principles, since they find support and foundations in each other.

However, despite the relation between the terms, literature brings a reduced volume of studies that link Circular Economy and Sustainability, not evidencing the contribution between them. Among the studies that refer to the themes, Geissdoerfer, Savaget, Bocken & Hultink (2017) mention that the conceptual relation between the terms Circular Economy and Sustainability is not clear, what may lead to possible negative complications to Science advance in this field, mentioning further that the relations between sustainable development concepts and Circular Economy are not explicit in literature.

This study aims to identify the effective contributions of Circular Economy to the sustainable development. Therefore, the following research question is investigated: What are the new requirements of Circular Economy compared to Sustainability?

The contributions of these study are: i) present, from Works of renowned researchers in this field, clear definitions that allow a comparison between Sustainability and Circular Economy in order to identify the contributions between them; ii) provide information that allow companies to analyze if their present practices are according to what is proposed by Circular Economy; iii) enlarge the research field in this area, providing, from the results, information that arouse interest on researchers in furthering the study.

The work is structured in the following way: in section 1, the introduction of the theme, in section 2, review of literature about Sustainability and Circular Economy, presenting relevant concepts about each topic, section 3 describes the methodological procedures, section 4 the results, section 5 the discussion of results and finally, the final considerations with future study proposals.



## 2. Literature Review

This section is about the presentation of theoretical concepts of sustainability and circular economy. It does not aim to end the literature about the topic, but present a reference that helps to reach the objectives initially proposed by the study.

### 2.1 Sustainability

It has been a long time that sustainability has been in the spotlight at different means of action for human beings. Companies that produce goods and services are gradually incorporating sustainable actions to their business plans and the management of their processes (Amato, 2011). Elkington (2001) considers that the expansion of the sustainable development concept around the world approaches in explicit way the importance and necessity of preserving the environment. However, the sustainability, in its initial concept, considered only the preservation of natural resources. With its evolution, the environmental concern also embraces social and economic aspects. As presented by the Brundtland Commission, the interconnection of these three dimensions is widely used when society development is discussed. When overlapped, these dimensions meet the criteria to sustainable development (Elkington, 2001).

Veiga (2008) presents that sustainable development appears as a new way to arrange the economic growth with environmental preservation. This new proposal is reinforced in the report “Our Common Future”, released in 1987 by the World Commission on Environment and Development that arouses to a new ethical and political posture front to the impacts caused by slowed production. With the Conference of United Nations about Environment and Development [CUNED], in 1992, in Rio de Janeiro, also known as ECO-92, the sustainability stands out and takes part in world discussions with greater intensity, encompassing its three important dimensions: the environmental, the economic and the social. Further, at this Conference, The Agenda 21 is set (Sustainable Development Agenda), signed by 179 countries (Marquardt, 2006; Amato, 2011).

Anand, Khan & Wani (2016) described that the development through industrialization is indispensable to socioeconomic growth of a society, but it is necessary to preserve its economic, environmental and social objectives.

Against the constant charges and growing environmental and social concerns, the organizations have been incorporating to their business models actions aimed at sustainability. It has been a way of renewing their business, serving specific laws and at the same time, contributing to sustainable development (Rajala, Westerlund & Lampikoski, 2016).

In a general and growing way, the theme sustainability has gotten more attention and importance; it may be from companies, academy or society. Teles, Dutra, Ribeiro and Guimarães (2016) affirm that sustainability is reached through the promotion of sustainable development and it only happens through the interaction of a set of subjects. Warodell & Lindholm (2016) mention that, besides the three dimensions of sustainability, there may be a fourth dimension: the cultural that enlarges its perspective. From this point, it is argued that sustainability supports itself on these four dimensions: ecological, economic, social and



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cultural. However Sachs (2002) presents that sustainability supports itself on eight dimensions: social, cultural, ecological, environmental, territorial, economic, national politics and international politics.

Nikolaou, Evangelinos & Allan (2013) consider that the practices of corporate social responsibility are considered very important and necessary for business, providing efficient solutions to a greater future sustainability. Besides, there are different definitions with different meanings, but most of the academy believes that the concepts of corporate social responsibility, corporate sustainability and triple bottom line are similar promoters of economic efficiency, environmental managing and social justice.

For conquering business excellence, many organizations have committed to the identification of areas of improvement, which may be from the development of their leadership processes to actions that guide their services to reduce day-to-day waste. For an organization to keep its competitiveness, it is necessary to use a holistic approach in its performance (Dubey, 2016). According to Amui, et al., (2017), sustainability needs to take part in business strategies. M. Maletic, D. Maletic & Gomiscek (2016) present that corporate sustainability challenges the companies to develop actions that equate environmental, social and economic objectives.

The promotion of sustainability as a dynamic organizational capacity becomes one of the challenges that the organizations will have to face to become competitive, naturally embracing in their actions the social responsibility, among others, and for that to be possible it is important to understand the factors that boost sustainability as a dynamic capacity (Amui, et al., 2017).

A new view has appeared leading them to actions that contribute to sustainable development in a way to contribute to long term growing. This action meets what Yu, Geng, Dong, Fujita & Liu (2016) affirm, when they report that the natural resources are important materials for the technology, economic development and human well-being, but due to fast industrialization, these resources have been quickly used. The authors (Maletic, et al., 2016) further affirm that without the support of organizations in general, society will not reach sustainable development, because the companies are the main responsible for favorable proliferation of economy. Therefore, sustainability has an important role in a development process, since raw material extraction to the final stage of reuse and/or recycling (Anand, et al., 2016). It is considered that, even with the evolution of companies neither on environmental aspect nor on social and economic these companies are prepared to reach sustainability, being observed the search for the development of tools to help them with the effective practice of sustainability (Teles, et al., 2016).

## 2.2 Circular Economy

It is possible to consider that the 20<sup>th</sup> century was the period of the fastest development that society has ever gone through, on which nature was much more influenced than in any other century (Shen & Qi, 2012). Result of excessive legislative charges for protection and conservation of natural resources, the companies have directed greater attention to conservation and protection of natural resources (González, Sarkis & Diaz, 2008). It is



common that in a capitalist economy of market is centralized on financial value, but it is necessary to focus the attention on the depletion of these resources (George, Lin & Chen, 2015).

With the economy development, men started facing several problems, such as resource exhaustion, energy scarcity, ecological destruction, environmental pollution, global warming and many species extinction. With this, the system of linear development began to be rethought, trying to establish a new system of economic development that preserves, among others, the nature (Shen & Qi, 2012).

Companies, government and people in general are trying to leave for the future generations a better planet, treating the products with more respect, to guarantee they can be used in the future. This way, the circular economy indicates a better alternative to substitute the present industrial model - "take-make-waste" (Lacy & Rutqvist, 2015). The circular economy, in its concept, presents origins that cannot be tracked to only one date or author (EMF, 2013). Its roots can also be found in Systems General Theory and Industrial Ecology (Ghisellini, et al., 2016). However, it was along the last decade that the concept of circular economy stood out became popular both in academic and professional fields, aiming to contribute with the reach of a more sustainable society (Reike, Vermeulen & Witjes, 2018).

Shen and Qi (2012) describe that the circular economy emerged in the 1960s, in the United States, arising from environmental protection movements, which searched an integration to close the material cycles. To D'Amato, et al., (2017), the circular economy triggers ideas of industrial ecology and metabolism, which led, in the 1970s and 1980s, to the rethink of industrial processes. However Ghisellini, et al., (2016) present that the concept of circular economy starts on clean production and from different schools of thought and it was from the 1970s that these schools started to emerge focused on circular economy, but they started to stand out and become popular only after 1990.

These schools of thought triggered its development and among them, we may name the economy of services (or economy of performance), the philosophy cradles to cradle, the biomimetic, the industrial ecology, the natural capitalism e the approach of Blue Economy Systems (EMF, 2015; Braungart, McDonough & Bollinger, 2007). Further, according to D'Amato et al. (2017), the circular economy covers 6 emergent topics, considered the principal: sustainable development in industrialization and urbanization; recycling of products cycle of life to reduce waste; industrial symbiosis, evaluation of efficiency in management systems; CO<sub>2</sub> emission; green supply chain.

Iung & Levrat (2014) present that the circular economy supports itself on concepts of industrial ecology from the analysis industrial systems operation and their optimization, aiming to establish a new model of economic development, of production and products appreciation. This idea is reinforced when D'Amato, et al., (2017) mention, among others, the necessity of redesigning the life cycle of a product aiming to have a minimum output of waste at the end of the process.



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According to the economists and environmentalists David Pearce e R. Kelly Turner, the circular economy consists of a closed system proposing that the open system can and must be converted into a circular system, when it is considered the relation between the use of resources and waste, in a way the circular system starts to be seen as a pre requirement to a maintenance of sustainability in the planet (Ghisellini, et al., 2016). Before environmental problems and products scarcity, these environmentalists wake up to a necessity of contemplating the Earth as a closed economic system: process on which economy and environment must not be considered by linear interconnections, but by a circular relation.

Another serious consequence caused by the linear system is the way how it degrades the ecosystem capacity of offering its resources to the planet, both for the fact that men consumes more than the environment can offer and for the contamination caused by the misuse of these resources (EMF, 2012). Through an analysis of the relation between economic policies and the natural systems, they proposed a material closed cycle, named as circular economy. Su et al. (2013) reports that the circular economy appears as an answer to serious environmental problems. According to Korhonen, Nuur, Feldmann & Birkie (2018), professionals see the circular economy as a way to adapt production processes aiming to induce regenerative industrial transformations that will lead to the reach of sustainable production and consumption.

Aurdahl (2016) refers to circular economy as a restorative economy, with use of renewable energy, the elimination of toxic chemicals and the eradication of waste. Opposing to linear, the circular economy leads to a reflection of how production and consumption of goods and services involve the use of renewable energy in contrast to the present use of available resources.

To Kopnina & Blewitt (2015), "the model of circular economy uses the ecosystems working as an example to the industrial processes, emphasizing the change to ecologically healthy products and renewable energy". On the same search line for alternatives, in special, for the planet preservation, Ellen Patricia MacArthur created, in England, in 2010, the Foundation Ellen MacArthur that studies and stimulates the adoption of an economy named "circular economy" (EMF,2015). Through the creation of this foundation, the circular economy appears as a model that aims environmental protection, pollution prevention and sustainable development. (Li, 2012).

The circular is able to reflect some basic characteristics, such as new economic benefits. Energy consumption reduction and pollution decrease (Shen & Qi, 2012).

Li (2012) defines that the circular economy can be considered as a model of economic growth searches for environment protection, followed by pollution prevention and sustainable development. In this perspective, he complements that the resources, technical or biological, are used with higher level of efficiency, reused and recycled, when possible, aiming to minimize the impacts of environmental pollution. Still in this area, Ghisellini, et al., (2016) complemented that the circular economy is already seen as a new business model in a way to lead to a more sustainable development and to a more harmonious society.



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In this line of reasoning, Zhou, Chen & Xiao (2013) describes that the circular indicator highlights the income ratio of the added value with the recycling proportion or product reuse, incorporating the recycling principles to the use of waste.

Lacy & Rutqvist (2015) complement the idea affirming that the circular economy development generates competitive advantages to the organizations that adopt its principles as a central element of growth strategies.

Considered a development strategy that supports itself on restorative thoughts, the circular economy seeks to maximize the efficiency of existent resource use and minimize the waste production. This way, started to get involved in not only the conception and production of their products, but also in the use process and posterior elimination and market removal (Ghunmi, Abu-Ghunmi, Kayal & Bino, 2016).

Zhou, et al., (2013) mention that the circular economy is considered a model of innovative economy in the XXI century and it has grown quickly in the world. With the circular economy implantation, EMF (2015) describes that "the set of new and higher profits, higher offer security and new business service demand with the consequent resilience increase" it will be the biggest opportunity to companies.

It is important to highlight the fact that companies inserted in the circular economy seek for the creation of value based on market resources management, in opposition to linear economy, that seeks for resource management exclusively in production (Lacy & Rutqvist, 2015). Since circular economy associates with materials use at the end of its lifespan, the term waste stops existing, treating of an approach cradle-to-cradle. (Braungart, et al., 2007; EMF, 2012). To Velte & Steinhilper (2016), the ideas of circular economy respect the sustainability conditions. Bakker, DenHollander, VanHinte & Zijlstra (2014) complement the idea when they report that the circular economy is seen as the main alternative to the transformation of the sustainable system.

Mentioned by Lacy & Rutqvist (2015), the industries, government and even the consumers are in constant and increasing way recognizing the inherent and intuitive value to circular principles, adopting practices that may contribute to reach the circular advantage, that is, the competitive advantage acquired by the companies that adopt in their growing strategic practices the principles of circular economy.

### **2.2.1 Principles and objectives of circular economy**

Ripant, Fan & Tjahjono (2016) present that the circular economy principles were elaborated with the purpose of helping with the concept comprehension, considered a fundamental truth. They also report that the circular economy principles were identified in different contexts.

According to EMF (2015), the circular economy is substantiated in three principles:

- Principle 1: Preserve and enhance human capital controlling finite stocks and balancing the renewable resources flow.

The process begins with the so-called dematerialization of products and services, seeking, whenever possible, the virtual delivery. If resources are necessary, the selection will be made





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by the circular system, always involving technologies and processes that use renewable resources or that propitiate better performance. Still in this principle, it is considered that a circular economy also enhances the natural capital, seeking to stimulate nutrients flow inside the system in a way to create conditions to the regeneration of varied natural resources, such as soil, for example.

- Principle 2: Optimize the resource income making circular products, components and materials in the highest level of utility all the time, both in technical and biological cycle.

According to the proposed, it is necessary to prioritize the projection of products with a view to remanufacturing, renovation and recycling, in a way that technical materials used circulate as much as possible contributing to the economy development. It is considered that circular circuits use the smallest internal circuits, preventing energy consumption and preserving other types of values embedded in the components and materials, in a way to extend the products lifespan and intensify their reuse. It is still important to highlight in this principle that “the circular systems also stimulate the safe reinsertion of biological nutrients for decomposition in the biosphere, in a way to transform them into valuable raw material for a new cycle” (EMF, 2015, p. 7). Just like in the linear system, there is the constant search for circular system of productivity gains in all the processes, but its effectiveness still requires continuous improvement, even because, in a circular system, there is no commitment to effectiveness like there is in the linear system.

- Principle 3: Stimulate the effectiveness in the system revealing and excluding negative externalities from the beginning.

The effective use of resources tends to reduce damages caused by misuse, preventing bad management from interfering in a negative way in the circular economy development.

According to Aurdahl (2016) and Bocken, Pauw, Bakker & Grinten (2016), the circular economy is considered a restorative economy that presents, among its objectives, the elimination of toxic chemicals use and the eradication of waste as a way to promote together, the development of environmental and economic actions. It is also considered a promising approach to help reduce environmental and social problems and restore nature wealth (Bocken, et al., 2016) besides stimulating economic growth that is intelligent, sustainable and integrator seeking for reuse and recycling of resources preventing as much as possible the extraction of virgin materials (EMF, 2015).

Still according to EMF (2013), the circular economy presents as objectives:

- stimulate the economic growth that is intelligent, sustainable and integrator;
- eliminate toxic chemicals use;
- restore nature wealth, reusing and recycling resources preventing as much as possible the extraction of virgin materials;
- improve the quality of product;



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- reduce the raw material cost, in a way to explore the resources in their capacity maximum level;
- keep products, components and materials in their highest level of utility and value all the time, distinguishing the technical and biological cycles.

### 2.2.2 Circular economy characteristics

According to EMF (2015), the circular economy presents the following characteristics:

- losses are excluded from the beginning: in the circular system, there is no waste because the nontoxic materials return to the soil and the technical materials are designed in a way they can be recovered, renewed and updated always seeking for the maximization of economic value retention of resources;
- Diversity brings strength: the circular system strengthening happens with diversity valorization. The same happens to the several types of business that, before different situations, seek for alternative models for survival;
- Renewable energy sources move the economy: meeting the circular principles, it is necessary for circular economy to be moved by energy, which are constantly renewed, reducing resource dependence and increasing the systems resilience;
- Systemic thought: fundamental for circular economy development. Before the existing different sceneries, people, companies or plants compose complex systems that interrelate with each other, and this relation is strongly considered in the circularity of processes;
- Prices or other feedback mechanisms must reflect real: to be effective, the prices need to reflect all the costs in circular economy. In this economy, the total costs of negative externality must be taken into consideration and the factors which are considered perverse subsidies must be removed. If there is not transparency in the externalities, it may act as a barrier to transition for circular economy.

## 3. Methodological procedures

This research is qualitative; because it aims, according to mentioned by Shah and Corley (2006), collect and analyze data, which may be used for a description or construction of a theory or even, refine an existing theory. It will also use the Literature Systematic Review method [LSR], according to what was proposed by Levy & Ellis (2006) and Littell, Corcoran & Pillai (2008). According to Littell, et al., (2008), the LSR seeks to localize and synthesize the literature a particular topic, following organized procedures in each step of the process. Besides, it is method that aims to present tendencies and detect existing gaps in scientific literature, in a way to build the state of art and show contribution with something new (Levy & Ellis, 2006).

Still according to Denyer & Tranfield (2009), the LSR starts with the formulation of the research question, which will effectively direct the following stages. This way, to investigate the research gap, the following question was made: What are the new requirements of



Circular Economy front to Sustainability? From this question, it was defined as objective to identify the effective contributions of Circular Economy for the Sustainability development. According to literature, a LSR may follow several stages. Aiming to establish a unique way, for the development of this LSR it is used the technical procedure proposed by Levy & Ellis (2006) that proposes three different stages: entering, processing and exit.

At the entering stage the initial steps of the research were developed, such as the keywords definition that guided the setting of criteria for the result inclusion and exclusion; the research base definition; the research scope; and finally, the search performance. Each one of these steps is described in the result presentation.

At the second stage, the phase of processing, it is made the approach of literature quality, following 6 distinct steps: 1. Know the literature, without worrying about subject domain; 2. Understand the literature, going further into the subject, summarizing and interpreting it in a way to understand the meaning of the information; 3. Apply the literature, identifying the main relevant concepts for the theme; 4. Analyze the literature, separating and identifying why the material is important; 5. Synthesize the literature, involving activities like combining and reorganizing the publications, gathering material of interest; 6. Evaluate the literature, implying in the decision, selection and judgment of the material found.

The last phase of the model by Levy & Ellis (2006) points to the exit, to the development of the study itself. It is in this stage that research objective results are produced, that is, the literature review and after that, the identification of effective contributions of circular economy for the sustainability development. As a source of support to reach the proposed objective, it was used a bibliometric, considered a quantitative analysis technic of literature characteristics and considered as a mean to evaluate the products of Science and Technology (Scott et al. 2010), besides providing a mapping of scientific literature about the subject.

Data were collected in January 2019 and the search base chosen was ISI Web of Science because it is promptly updated and it provides more detailed reviews when compared to other bases (Falagas, Pitsouni, Malietzis & Pappas, 2008). The time period defined was between 1999 and 2018 by the fact that the studies of circular economy have been started, according to the database of the research in these two decades. After the literature review, it started the identification of new requirements for Circular Economy front to Sustainability, raising, this way, the contributions from that front to this one.

#### 4. Results

This section is about the presentation of results through the detailing of steps described by systematic review of literature proposed by Levy & Ellis (2006). Performing what was proposed by the phase of entering (1<sup>st</sup> stage) in the systematic review of literature, it was defined the keywords, inclusion and exclusion criteria, the base, the research filters and the covered period, according to Table 1. Using the base ISI Web of Science, the published studies about "Circular Economy", Sustainability and "Circular economy" and "Sustainability" were identified. These searches showed the sample of documents to have, at first, a general view of publications about each topic in an isolated way.



Table 1. Phases of the research

Keyword	Inclusion criteria	Exclusion criteria	Research base	Covered period	Initial quantity presented	
"Circular economy"	Present the word "circular economy" either in title, or in the abstract or even in all situations. Publications of Ellen MacArthur Foundation e WCED.	Books, books chapters, books reviews, meeting abstract, editorials, proceedings. Any publication prior to 1998.	ISI Web of Science	1999-2018	Proceedings paper	1.058
					Article	1.513
					Review	211
					Editorial material	83
					Meeting abstract	8
					News item	5
					Book review	3
					Retracted publication	2
					Book chapter	1
					Correction	2
					Letter	2
					Sustainability	Present the term "sustainability" either in title, or in the abstract or even in all situations. Publications of Ellen MacArthur Foundation e WCED.
Article	88.221					
Review	7.340					
Editorial material	3.285					
Book review	1.429					
Meeting abstract	905					
News item	262					
Book chapter	243					
Correction	142					
Reprint	25					
Retracted publication	13					
Biographical item	12					
"Circular economy" AND "Sustainability"	Present the term "circular economy" AND "sustainability" either in title, or in the abstract or even in all situations. Publications of Ellen MacArthur Foundation e WCED.	Books, books chapters, books reviews, meeting abstract, editorials, proceedings. Any publication prior to 1998.	ISI Web of Science	1999-2018	Bibliograph Article	3
					Article	430
					Proceedings paper	130
					Review	85
					Editorial material	12

Source: The authors, elaborated based on ISI WOS

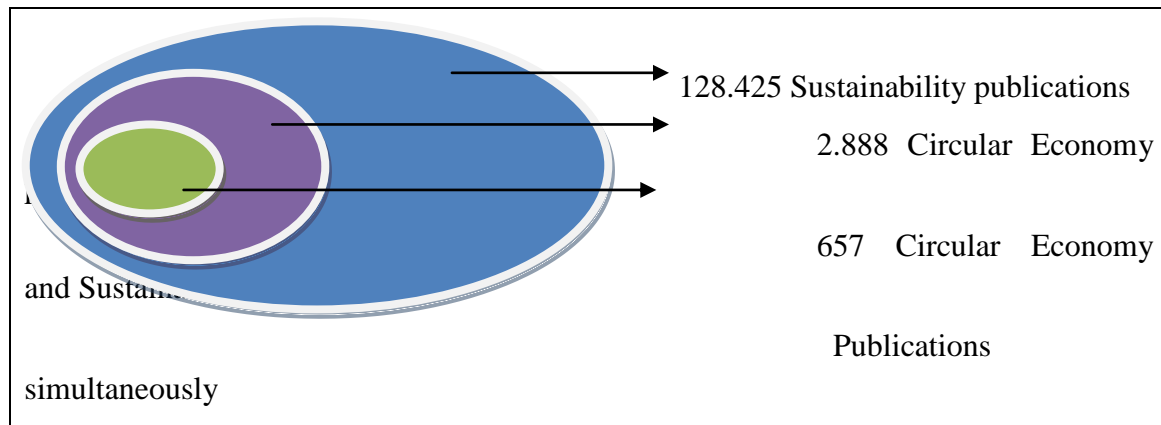


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According to the search results, it is evidenced that the studies aimed at circular economy show themselves in initial phase, when compared to sustainability. And this affirmation gets sharper when the search is made at both times together: “circular economy” AND sustainability. At this moment, only 657 results are found.

One of the points that call attention is that at this very moment of search, it is clear that sustainability presents a high volume of publications when compared to circular economy. It is important to mention that, besides the scientific publications that were found, world renowned and non-profit organization materials were also used, such as the Ellen MacArthur Foundation and the WCED.

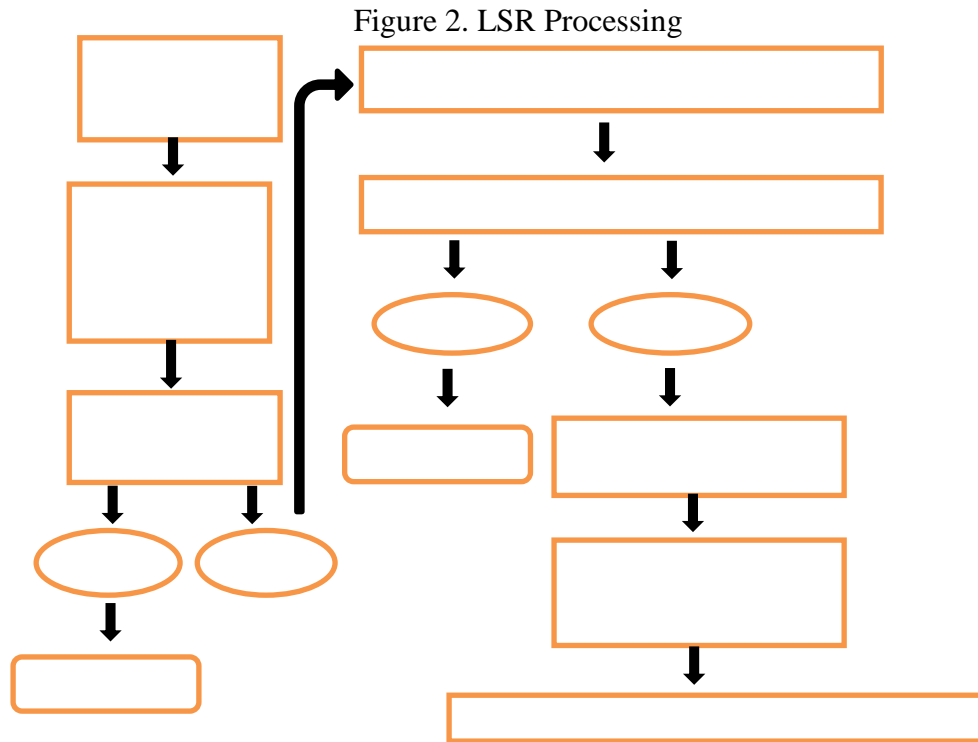
Figure 1. Search results from the base Web of Science



Source: Elaborated by the authors

As the focus of this research is aimed at the studies about Sustainability and Circular Economy simultaneously, were selected for the study, among all results presented in Table 1, scientific articles and reviews because they represent more serious research works with the objective of contributing with the knowledge, besides being validated by the scientific community through review processes by pairs (Murray, et al., 2017). After the collection of the initial sample and having as main base the publications about “circular economy” and sustainability, the 2<sup>nd</sup> LSR stage indicated by Levy & Ellis (2006) was initiated, with the partial reading of the 515 materials found (articles/reviews), seeking to identify which publications could provide the necessary knowledge to perform according to the primary objective of this study. The 2<sup>nd</sup> stage detailing is described in Figure 2.





Source: Elaborated by the authors.

With the article pre-selection, first the reading of the title, abstract and keywords of each text was made, evaluating if each publication could or not contribute to the building of the theoretical base pertinent to the research objective. If negative, the material was automatically excluded, but if there were contribution, the next step would be the reading of introduction and conclusion, repeating the phase of the material relevance or not. Having a new selection only of texts with contribution to the proposed objective, the articles were completely read. With this, 125 articles relevant to the area were analyzed.

In this phase, it was initiated an exploratory process searching for, besides the concepts for the theoretical base, the identification of new requirements of circular economy that can complement the sustainability, performing according to the 3rd LSR stage mentioned by Levy and Ellis (2006).

#### 4.1 Points of Circular Economy that complement Sustainability

From the Circular Economy, an analysis of literature was made trying to verify what it brings as new in a way to complement sustainability. For this, the works of several authors that approach circular economy were analyzed (EMF, 2012, 2013, 2015; Geng, Sarkis, Ulgati & Zhang, 2013; George, et al., 2015; Lacy & Rutqvist, 2015; Ghisellini, et al., 2016; Ghunmi, et al., 2016; Li, 2012; Shen & Qi, 2012; Su, et al., 2013, among others) and sustainability (Dubey, 2016; Elkington, 1994, 2001; González, et al., 2008; M. Maletic, et al., 2016; Pisani 2007; Programa das Nações Unidas para o Meio Ambiente [Pnuma], 2011; Rajala, et al., 2016). However, in view of the amplitude of studies presented by the term sustainability, it is highlighted that this research does not exclude the possibility of finding new questions that are not mentioned in these results.



#### **4.1.1 Principles and objectives of circular economy: what is new for sustainability?**

Authors who approach sustainability (Pisani, 2007; Rogers, et al., 2008; Jamali, 2006) report, in unanimous form, the contemplation and integration of three dimensions: economic, environmental and social by circular economy. The operational costs reduction, the natural resources preservation and the welfare of the team and the work environment are some of the main factors that guarantee the practice of sustainable actions by the companies that are also considered by circular economy. On the other hand, even presenting similarities in their concepts, it is observed, from the authors such as Bakker et al. (2014), EMF (2012, 2013, 2015), George, et al. (2015), Warodell & Lindholm (2016) that circular economy presents new points that complement sustainability.

In the subject of circular economy principles, proposed by EMF (2015), it searches to preserve and improve the natural capital controlling the finite stocks and balancing the renewable resources flow, dematerializing products and services whenever possible. The optimization of resources yield and the stimulus to effectiveness of the system in a way of revealing and excluding the negative externalities from the beginning are also new points of circular economy in relation to sustainability.

In the analysis through their objectives, the new points that deserve highlight are the fact that circular economy is a necessary condition for sustainable economic growth; it is focused on the improvement of product quality; on the raw material cost reduction; and the maintenance of products, components and materials in their highest utility level, in a way to differentiate them between technical and biological products.

Founded in the literature, it is still noticed that, while one of the purposes of sustainability is to produce without attacking the environment. The Circular Economy also motivates the same process, but in a way, the products are durable and, at the end of their lifespan, reused, defending and supporting the creation of products with multiple functionalities, minimizing the waste production.

#### **4.1.2 Characteristics of circular economy: what is new for sustainability?**

Analyzing the subjects from the characteristics of circular economy, it is noticed that it presents new points when compared to sustainability.

Through a comparative analysis of the Works aimed at the subjects (among them Sachs, 2002; Pisani, 2007; Rogers, et al., 2008; Jamali, 2006; George, et al., 2015; EMF, 2012, 2013, 2015; Geng, et al, 2013), it is perceived that sustainability does not approach some of the points pointed by circular economy. The materials reuse at the end of their lifespan; the concern of being a regenerative and restorative industrial system, in a way the products are passive reform, fixing and remanufacture are new matters of circular economy that are not contemplated by sustainability. The concern about biological aspects where the products, after maximum use exploration, can be reincorporated to the bio-geochemical cycles constituting a new natural capital, the same practiced by circular economy is also presented as an important additional point for sustainability.



The loss exclusion from the beginning, as well as the creation of resilience through diversity and the thought in cascades are attributes approached by Circular Economy but not by Sustainability. Several other characteristics are also highlighted in the comparison. Among them, sustainability does not approach in its practices a systemic thought, in a way that different parts will have to be strongly connected to each of the others. It is not considered a restorative economy yet; neither considers the development of actions taking into consideration the technical and biological cycles of products. The replacement of the end of lifespan concept and from consumer to user still deserve highlight as new points of circular economy for the sustainability.

The Table 2 presents, in summary, an approach from the characteristics, objectives and principles of Circular Economy proposed by EMF (2015). By the points mentioned, it is made a comparison in a way to evidence what Circular Economy and Sustainability have in common, explaining the new points of Circular Economy in relation to Sustainability.

Table 2. Comparison of characteristics, objectives and principles of CE in relation to the dimensions of Sustainability.

<i>Characteristics of Circular Economy</i>	<i>Dimensions</i>					
	<i>Environmental</i>		<i>Economic</i>		<i>Social</i>	
	<i>CE</i>	<i>SUST</i>	<i>CE</i>	<i>SUST</i>	<i>CE</i>	<i>SUST</i>
Efficiency in materials and energy use, ensuring an economic growth less dependent on natural resources and the reduction/elimination of waste generation.	√		√			
Move to the use of energy from renewable sources, reducing the dependence on new resources.	√	√	√	√		
The power of cascade use, diversifying the reuse of a product in all the value chain, in a way the same product can be reused many times by many users until it is explored to the maximum, After that, it is safely returned to the biosphere.	√		√			
Systemic thought, in a way that different parts will have to be strongly connected to each one of the others.	√		√			
Restorative economy, with the use of renewable energy and the elimination of toxic chemicals.	√					
Elimination of waste in all production processes, in a way all materials can be reused resulting in reduction of costs with raw material.	√		√			
Noiseless design, making products that are designed to remanufacture, renovation and recycling.	√		√			
Generation of competitive advantage for the organizations through new Market possibilities and the creation of new business.			√	√		





Continuação

<i>Characteristics of Circular Economy</i>	<i>Dimensions</i>					
	<i>Environmental CE</i>		<i>Economic CE</i>		<i>Social CE</i>	
	<i>SUST</i>	<i>SUST</i>	<i>SUST</i>	<i>SUST</i>	<i>SUST</i>	<i>SUST</i>
Generation of new jobs, result of the increase in consumption motivated by lower prices in all sectors and to intensive use of labor for recycling and remanufacture activities.					√	
Promising approach for the reduction of social and environmental problems, ensuring better quality of life to the society.	√	√	√	√		
Development through a technical cycle, in a way the consumption is substituted by use and the materials are recovered and restored, what was earlier considered waste, becomes raw material in another process.	√		√			
Development through a biological cycle, where, after the use or consumption, part of the material returns to nature as source of nutrients, so that they are transformed into biological nutrients.	√		√			
Regenerative and restorative system by nature making it possible for the industrial operations to develop according to the biological cycle of nature, considered a cyclical flow, reducing the search for raw material, the excessive consumption of energy and, consequently, the production of non-reusable waste, it can be in technical or biological ways.	√		√			
Approach of 3 dimensions: environmental, economic and social so that all of them work simultaneously.	√	√	√	√	√	√
Suffer direct influence through the change of consumption patterns.	√	√	√	√		
Supports itself on the concepts of industrial ecology, in the sense that industrial production happens in a way to preserve the environment.	√	√				
Integration of reduction, reuse and recycling activities during the production, , change and consumption exploring the potentialities of each product to the maximum substituting the concept of lifespan end.	√		√			
Resilience development through diversity.					√	
Substitution of consumer to user concept in a way to rethink the property, following a model on which the products start being rented to consumers that, this way will become users of a service.	√		√			



Continuação

Objectives of Circular Economy	Dimension					
	Environmental		Economic		Social	
	CE	SUST	CE	SUST	CE	SUST
Motivate the intelligent, sustainable and integrator economic growth.	√	√	√	√	√	√
Eliminate the use of toxic chemicals.	√	√	√	√		
Restore nature wealth, reusing and recycling resources the maximum possible, preventing virgin materials extraction.	√	√	√	√		
Improve the quality of product.	√		√			
Reduce costs with raw material, in a way to explore the resources to the maximum capacity.	√		√			
Keep products, components and materials in their highest level of use and value all the time, differing the technical and biological cycles.	√		√			
Preserve and improve natural capital controlling finite stocks and balancing the renewable resources flow, dematerializing products and services with virtual delivery whenever possible. When it is not possible, the resources must be selected in a way to present higher renewability.	√		√			
Optimize the resource yield making the circulation of products, components and materials in the highest level of use both in technical and biological cycles, in a way to Project remanufacture, renovation and recycling increasing to the maximum the circulation of products.	√		√			
Stimulate the effectiveness of the system revealing and excluding the negative externalities from the beginning, what includes the reduction of damage to systems and areas such as food, housing, education and health.	√		√		√	

Source: Authors

## 5. Results discussion

According to the research results, it is noticed that the studies aimed at the Circular Economy get more attention from the creation of Ellen MacArthur Foundation, in 2010, but the impulse to scientific research came in 2015, with considerable increase in the publications. By quantifying the studies that simultaneously approach Sustainability and Circular Economy; they start in a very limited way in 2006 with high advance in 2016. Prior to 2006, the great attention of researchers was aimed at the field of Sustainability. Viewing that this study aims to present what the contribution of Circular Economy to Sustainability is, the results show that Circular Economy can contribute for the reaching of Sustainability in its three dimensions, bringing new questions in a way to enlarge the potentialities to reach sustainable development.

In Table 2 are presented the characteristics, objectives and principles of Circular Economy according to what was proposed by EMF (2015). In total, 28 different points are identified



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that can serve simultaneously the 3 sustainable dimensions. Aiming to present which of them complement the Sustainability, a comparison between the dimensions of each theme. Of the total, 68% represent new circular questions front to Sustainability.

By the results, the Circular Economy brings 19 new questions that are not contemplated by Sustainability, which can be seen as complementary strategies, of support to reach the sustainable development. They were identified taking into consideration the fact that it was not found in literature about Sustainability, the similarity of characteristics, objectives and principles of Circular Economy. So, these questions refer to the effective contributions of Circular Economy to Sustainability, confirming what was exposed by Su et al. (2013) when they mention that the Circular Economy presents itself as a strategy for sustainable development, or, a tool that will strengthen the sustainable practices and help the companies to reach what is proposed by triple bottom line.

## 6. Final Considerations

This study aimed at identifying how the Circular Economy can contribute to the sustainable development, searching for in what questions the Circular Economy can complement the Sustainability in its 3 dimensions. By literature, it is evident that the existing relation between the terms is little explored and with it, it becomes possible to confirm that, when comparing them, Sustainability is wider than Circular Economy, making it clear that, there is still a lot to research about Circular Economy, showing the subject away from being common theme to science.

With the purpose of answering the research problem initially presented – What are the new questions of Circular Economy front to Sustainability? – the study presents considerations about the theory and, from them, an approach in a way to evidence what the Circular Economy brings as new to Sustainability. The results identify complementary questions from Circular Economy to Sustainability. From the characteristics, objectives and principles of Circular Economy proposed by EMF (2015), 28 questions are discriminated in total, among which 68% are considered complementary to Sustainability, representing new ways of contribution to sustainable development. It is possible to mention, among them, the practice of actions through technical and biological cycles, besides the substitution of lifespan concept, the concern about reuse and recycling. The fact that the Circular Economy is presented as a possible alternative to increase the Sustainability in its three dimensions deserves highlight.

Both – Circular Economy and Sustainability – search in common for the equity of three dimensions (environmental, social and economic). The Circular Economy proposes strategies of limitation, that is, the rationalized use of the environmental system and, in counterpart, the Sustainability concerns about the good use of environmental resources in a way to guarantee its future existence. It is important to mention that this study did not aim to deplete all the results, but bring to light new considerations in a way to stimulate the development of future research that further explore the objective of this research. It is expected that this study can be useful to enlarge the knowledge of the world, besides being a reference, not only to



researchers but also to companies and community in general in a way to better direct their practices. As a future research proposal, stays the suggestion of furthering about the influences of Circular Economy in relation to Sustainability, aiming to evidence new circular strategies that contribute to the sustainable development.

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