JOURNAL OF LIFESTYLE & SDG'S REVIEW
e-ISSN: 2965-730X

# CIRCULAR ECONOMY, SUPPLY CHAIN MANAGEMENT AND COMMODITIES: RESEARCH AGENDA IN THE SUSTAINABLE CONTEXT

**JOHANN, Daiane**[1]
**SANTOS, Ruan Carlos dos**[2]
**TUTIDA, Alessandra Yula**[3]

## ABSTRACT

**Purpose:** The research addresses the implementation of the circular economy in the sustainable supply chain, made possible through commodities in the sustainable context. The article seeks higher levels of sustainability, given the strong mobilization of society for products with better environmental performance.

**Method:** Although many studies address the concepts separately, few studies advance in the integrated view of the functioning of the supply chain of circular products. The systematic literature review sought to relate the integration of the concepts by identifying key aspects of stakeholders, processes and tools, which can be synchronized to assist organizations in implementing the circular environment in supply chain operations and generate sustainability gains.

**Results:** The evolution of the supply chain as a result of producers' competition needs, aiming at market improvements and cost reduction, the value generation along the chain is very focused on delivering specificity to the customer. Therefore, the supply chain is sustainable because it needs to perform well in traditional financial measures, including that when it comes to sustainability in the supply chain this can be formed by three dimensions: social, environmental and economic.

**Conclusion:** The work opens the way for future research and practical applications, considering the need for systemic operation of technologies that promote joint action and cooperation environment between organizations, which favor sustainability gains.

**Keywords:** Circular Economy, Supply Chain Management, Commodities, Sustainability.

OPEN DATA

**Received on:** March/06/2023

**Approved on:** July/24/2023

DOI: https://doi.org/10.37497/2965-730X.SDGsReview.v3.n00.pe01560

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Santos, R. C. dos, Johann, D., & Tutida, A. Y. (2023). Supply Chain Management, Circular Economy, Commodity: pesquisa de artigos publicados nos últimos 30 anos. In *Open Science Brazil*. https://doi.org/10.37497/opsbrazil.11

[1] Doutoranda em Administração, Universidade do Vale do Itajaí (UNIVALI), Santa Catarina (Brasil). Programa de Pós-graduação em Administração, daianejohann@yahoo.com.br.
[2] Doutorando em Administração, Universidade do Estado de Santa Catarina (UDESC-ESAG), Santa Catarina (Brasil). Programa de Pós-graduação em Administração, ruan_santos1984@hotmail.com.
[3] Doutoranda em Administração, Universidade do Vale do Itajaí (UNIVALI), Santa Catarina (Brasil). Programa de Pós-graduação em Administração, sachatutida@hotmail.com.

*ECONOMIA CIRCULAR, GESTÃO DE CADEIA DE SUPRIMENTOS E COMMODITIES: AGENDA DE PESQUISA NO CONTEXTO SUSTENTAVEL*


## RESUMO

**Objetivo:** A pesquisa aborda a implementação da economia circular na cadeia de suprimentos sustentável, viabilizado por meio dos *comodities* no contexto sustentável. O artigo busca maiores níveis de sustentabilidade, atendendo a forte mobilização da sociedade por produtos com melhores desempenhos ambientais.

**Método:** Apesar de muitos estudos abordarem separadamente os conceitos, poucos estudos avançam na visão integrada de funcionamento da cadeia de suprimentos de produtos circulares. A revisão sistemática da literatura buscou relacionar a integração dos conceitos identificando aspectos chaves das partes interessadas, processos e ferramentas, que podem ser sincronizados para auxiliar as organizações na implantação do ambiente circular nas operações da cadeia de suprimentos e gerar ganhos de sustentabilidade.

**Resultados:** A evolução da cadeia de suprimentos como um resultado das necessidades de competição dos produtores, visando melhorias de mercado e redução de custos, a geração de valor ao longo da cadeia está muito focada na entrega de especificidade ao cliente. Por isso, a cadeia de suprimentos é sustentável, pois precisa obter um bom desempenho em medidas financeiras tradicionais, incluindo que se trata de sustentabilidade na cadeia de suprimentos para formar as três dimensões: social, ambiental e econômica.

**Conclusão:** O trabalho abre caminho para pesquisas futuras e aplicações práticas, considerando a necessidade de funcionamento sistêmico de tecnologias que promovam a atuação conjunta e ambiente de cooperação entre organizações, que favoreçam ganhos de sustentabilidade.


**Palavras-Chave:** Economia Circular, Gestão de Cadeira de Suprimentos, Commodities, Sustentabilidade.

# 1. Introduction

Sustainable development consists of reconciling the laws of nature with the laws of the economy (Zak, 2015). Sustainability began to receive greater attention from environmentalists and various government authorities of the negative impacts caused over time, especially by the Industrial Revolution (TIOSSI; SIMON, 2021).

The concern for the planet, with people, and the need for prosperity mobilized scientists and governments to awaken environmental awareness. In this sense, the sociologist Elkington (1994) established the primary assumptions for the sustainable development of a business based on the idea of the Triple Bottom Line (TBL), which is based on the 'win-win-win' strategy, simultaneously benefiting the organization, its customers, and the environment. The TBL approach is composed of three dimensions: environmental, social, and economic, seeking to satisfy people, the planet, and prosperity in a balanced way, considering the three pillars of sustainability, focusing on economic prosperity, environmental quality, and social justice (3P's: Profit, Planet, and People) (ELKINGTON, 2012, RAMOA; FLORES, 2018).

Over the last decade, the circular economy (CE) has gained popularity, aiming to achieve a more sustainable society (REIKE; VERMEULEN; WITJES, 2018). In this scenario, the circular economy emerges as an attractive alternative, offering a solution for building a prosperous economic model and, simultaneously, less dependent on non-renewable resources and energies (SARKIS, ZHU

LAI, 2011, EMF, 2013). It emerges as a new paradigm, gaining momentum and promising to overcome the existing contradiction between the economy and the environment. It reinforces the idea that resources should never be turned into waste but should be kept in the process for as long as possible and with minimal loss of quality.

The Circular Economy (CE) implies lower pressures on the environment. It is a system that minimizes waste generation and emissions, mitigating material and energy ties to preserve resources and contributing to sustainability through conditional, beneficial, or commercial relationships (GEISSDOERFER et al., (2017).

Sauvé et al. (2016) state that, like environmental sciences and sustainable development, the circular economy aims to help solve environmental issues. In this sense, several theoretical studies present the circular economy as one of the possible ways to achieve sustainable development (MURRAY, SKENE HAYNES, 2017, GEISSDOERFER et al., 2018, SANTOS, SHIBAO SILVA, 2019, ANASTASIADES ET AL., 2020).

Therefore, according to Ghisellini and Cialani Ulgiati (2016), CE is a business model that leads society to more sustainable development, balancing economic, environmental, technological, and social aspects. However, it is not restricted to just that. It is more than a preventive or even regenerative approach. It is a vision that covers the entire life cycle of the product or process and seeks, in addition to the integration between the factors mentioned, the improvement of the existing economic model.

CE implies lower pressures on the environment, and it is a system that minimizes waste generation and emissions, mitigating material and energy ties to preserve resources and contributing to sustainability through conditional, beneficial, or commercial relationships (GEISSDOERFER et al., (2017).

Supply Chain Management (SCM) is composed of manufacturers, suppliers, carriers, warehousing companies, retailers, and consumers when all parties are involved, directly or indirectly, to meet customer requirements (LAMBERT; COOPER; PAGN, 1998; LUMMUS; VOKURKA; ALBER, 1998).

According to Christopher, 2009, for organizations to face the highly competitive market and thus create and deliver value to their customers, one option is participation in the supply chain. SCM is conceptualized as the strategic and systematic coordination of key business processes by a specific company, which aims to continuously increase competitive advantages and performance of the links and the chain itself (Mentzer et al., 2001).

Integrating CE into SCM would begin to extend its boundaries, reducing the need for virgin materials that could increase the circulation of resources within supply chain systems (ANDERSEN, 2007; GENOVESE et al., 2017). However, based on our literature review on CE, there needs to be a knowledge gap in integrating CE into SCM (AMINOFF; KETTUNEN, 2016).

The discussion of CE in SCM mainly addresses restoration options (repair, refurbishment, remanufacturing, and recycling). At the same time, the concept of regeneration has yet to be discussed in the context of SCM sustainability.

In this scenario, CE emerges as an attractive alternative, offering a solution for building a prosperous economic model and, simultaneously, less dependent on non-renewable resources and energies (SARKIS; LU; LAI, 2011; EMF, 2013). It emerges as a new paradigm, gaining momentum and promising to overcome the existing contradiction between the economy and the environment. It reinforces the idea that resources should never be transformed into waste but kept in the process for as long as possible and with minimal loss of quality. Reike, Vermeulen, and Witjes (2018) add that over the last decade, CE has gained popularity, aiming to contribute to achieving a more sustainable society.

According to information from the United States Department of Agriculture (USDA) Food Projection Report until 2026/2027, it will be necessary to increase food production in the world by 60% to meet the growth in population demand. Brazil has the mission to increase sustainable production by 40% through a green food production process, that is, sustainable enterprises that adopt productive actions based on socio-environmental development.

In the global commodities scenario, Brazil is among the world's largest producers of sugarcane, coffee, ethanol, orange juice, soybeans, and cellulose (CNI, 2019). In order to meet the demands and challenges faced in agriculture, the Food and Agriculture Organization of the United Nations (FAO, 2019) seeks concrete actions to eliminate hunger, make agriculture more productive and sustainable, reduce rural poverty, and increase the resilience of the rural population through threats and crises.

The agricultural commodity widely consumed worldwide in many forms is soybean, such as in the Grain, Bran, and Oil markets (FEARNSIDE, 2001). However, only 6% of the world's total soybean production is utilized in whole grain form, while the remaining 94% is crushed (Oliveira & Schneider, 2016). Whole soybeans can be processed for industrial use, e.g., biofuel and edible oils, or crushed to produce food products, e.g., soy milk, animal feed, and soy sauce (WWF, 2014). Furthermore, soybeans have the potential for higher resource efficiency than other crops.

Several technologies and social practices are already in operation to combat unsustainable activities in commodity cultivation, such as the implementation of certifications (GARDNER et al., 2019), sustainable supply chain management (JIA et al., 2020), and the adoption of technologies identified as Agriculture 4.0 (GAITÁN-CREMASCHI et al., 2020). However, as the results achieved are still modest (Jia et al., 2020), it is evident that the transition process toward soybean sustainability needs to be accelerated.

According to Yazdani et al. (2021), implementing the circular economy in agriculture is seen as a critical strategy to produce agricultural commodities by efficiently using resources, avoiding unnecessary waste, and generating carbon emissions.

The SCM and CE paradigms have represented separate streams of literature, but there is a growing interest in understanding the overlap between them, which could potentially reveal positive synergies (GENOVESE et al., 2017).

CE management and SCM overlap but also differ and have been pointed out by the literature, highlighting the need for studies that seek in-depth understanding and clarification so that the various concepts are demystified and understood in their broadest denomination. According to Kiefer et al. (2018), CE focuses on people and their ability to initiate technical processes to facilitate the adoption of circularity in supply chains.

In times of informational volatility, economic, social, and environmental crises, it is possible to observe a concern to seek new ways to reduce uncertainties and minimize adversities. The organizational scenario needs to be reviewed regarding its interpretations, beliefs, practices, and values to raise alternatives that minimize errors, offering new perspectives that enhance renewal strategies. Because of the above, the question is: Is there theoretical convergence between Supply Chain Management, Circular Economy, and Commodity? Two objectives are defined to answer this question: (i) to identify the scientific production on the proposed dimensions and (ii) to identify a theoretical gap in the convergence of the researched dimensions.

In addition to this introduction, the article is structured in the following sections: i) literature review addressing the main concepts and definitions about the researched dimensions, Supply Chain Management, Circular Economy, and Commodity, ii) methodology used, iii) results and discussions, and iv) final considerations and future directions.

As the world advances into the third decade of the 21st century, the dialogue surrounding economic development has shifted significantly from purely growth-centric perspectives towards those emphasizing sustainability (Perez-Carmona, 2013). This transition has been facilitated by the global commitment to the Sustainable Development Goals (SDGs), a set of 17 goals by the United Nations in 2015 (United Nations, 2015). These goals represent an ambitious plan to address the planet's myriad socio-economic and environmental challenges. Among these, Sustainable Development Goal 12 (SDG12), which focuses on promoting sustainable consumption and production, underscores the need for a systemic shift in our patterns of production and consumption (United Nations, 2015).

SDG12 is particularly important due to its profound impact on the environment and the economy. It calls for responsible management of resources and waste, more excellent resource and energy efficiency, and broader adoption of sustainable practices across all sectors of the economy (UNDP, 2018). It comprises eight targets addressing diverse aspects, from reducing global food waste and promoting sustainable management of chemicals and waste to encouraging companies to integrate sustainability information into their reporting cycles. The achievement of SDG12 thus necessitates the adoption of sustainability principles into various economic sectors and decision-making processes, ultimately contributing to creating a green economy.

This short paper delves into one of the crucial facets of SDG12 implementation: the interplay between macroeconomic policies, international trade practices, and the sustainable consumption and production patterns stipulated by SDG12. Despite the increasing attention towards sustainable development, a comprehensive understanding of this trilateral relationship remains in the existing literature.

The study aims to fill this gap by comprehensively analyzing the interconnections and potential synergies between macroeconomic policies, international trade practices, and SDG12. Past research efforts have typically addressed the relationship between sustainable development and macroeconomic policies (Fioramonti, 2013) or between sustainable development and international trade practices (Piermartini & Teh, 2016) in isolation. Consequently, the inherent interconnectedness and potential for integrated policy solutions across these domains have yet to be adequately explored.

This study also extends the existing knowledge base by proposing actionable policy recommendations that could guide nations in realigning their macroeconomic policies and trade practices with the imperatives of SDG12. These recommendations, derived from a meticulous examination of theoretical perspectives, empirical evidence, and practical case studies, add value to the burgeoning literature that underscores the urgency of reforming our macroeconomic and trade frameworks to accommodate sustainable development (Khor, 2011; Fioramonti, 2013).

The paper is structured into six sections. It begins with an introduction highlighting the shift towards sustainability and the importance of Sustainable Development Goal 12 (SDG12) in promoting sustainable consumption and production. The methodology section explains the qualitative research design and document analysis used in the study. The theoretical background section provides an overview of SDG12 and its targets, emphasizing the need for aligning macroeconomic policies with sustainability goals.

The challenges and opportunities section explores the obstacles and potential benefits of aligning macroeconomic policies and international trade practices with SDG12. The policy recommendations section offers suggestions for regulatory measures, financial incentives, international cooperation, and education campaigns to promote sustainable economic growth.

Finally, the conclusions section summarizes the essential findings and emphasizes the importance of integrated approaches for achieving a sustainable economic future. By venturing into the relatively uncharted waters of the interface between macroeconomic policies, international trade, and sustainable consumption and production, this study hopes to stimulate academic discourse and policy-oriented thinking in this pivotal domain.

## 2. Literature Review

### 2.1 Circular Economy

The modern understanding of the Circular Economy is based on different schools of thought, where the circular economic system avoids waste and tries to preserve the inherent value of products as long as feasible (European Commission, 2014). The aim is to minimize resource consumption by recycling materials and energy after the use phase to avoid leakage out of the system (ELLEN MACARTHUR FOUNDATION, 2013, Aguiar et al., 2022).

In the current development situation, the original economic model must be changed, considered harmful to the ecological system. One of the alternatives for this change is the development of circular actions, putting into practice what the Circular Economy (CE) proposes (Amui et al., 2016). For Pomponi and Moncaster (2017), the CE emerges as a new paradigm, gaining momentum and promising to overcome the existing contradiction between the economic and the environmental, where they also reinforce the idea that resources should never be transformed into waste but rather kept in the process for as long as possible and with minimal loss of quality.

The world economy has been built on a linear business model based on extracting, transforming, producing, using, and disposing of, or sometimes recycling or incinerating (BRAUNGART; MCDONOUGH; ANASTAS; ZIMMERMAN, 2003; FISKEL, 2009, ELLEN MACARTHUR FOUNDATION, 2013). This model is beginning to be threatened due to the limited availability of natural resources.

However, Geissdoerfer et al. (2017) state that there is a growing consensus that the only way forward with sustainable production and growth is to change our current industrial linear model to a CE model.

The concept of Circular Economy has been gaining momentum since the late 1970s (EMF, 2013). Several authors, such as Andersen (2007), Su et al. (2013), and Ghisellini et al. (2016), attribute the introduction of the concept to Pearce and Turner (1989), where British economists presented, in contrast to the open and linear system practiced today, a closed and circular economy, based on the interdependence between the economy and natural resources.

The emergence of the circular economy occurred by identifying the linearity of the existing economic model. Little has changed since the advent of the Industrial Revolution in the 18th century in terms of production and consumption patterns based on a production-consumption-disposal model. Given the awareness of the unsustainability of this model, the concept of CE emerged, which currently has its most accepted definition of the Ellen MacArthur Foundation (EMF) (2015) as is.

> "[...] restorative and regenerative in principle. It aims to maintain products, components, and materials at their highest level of utility and value at all times, distinguishing between technical and biological cycles. This new economic model ultimately seeks to decouple global economic development from the consumption of finite resources" (ELLEN MACARTHUR FOUNDATION, 2015, p.2),

Definitions of CE have been reviewed, and the lack of consensus on terminology and definitions among scholars, policymakers, and practitioners investigating trends pointed out gaps and convergence in the literature (SACCHI HOMRICH et al., 2018; KIRCHHERR et al., 2017). For a long time, there has been a notable need for more effort by academics to shape the concept of CE. Hardly any specific definition has presented itself. Instead, articles elaborated on CE requirements (Zhu et al., 2010; GENG DOBERSTEIN, 2008) regarding its scope and levels (SU et al., 2013), contrasted it with linear economics (PITT HEINEMEYER, 2015), or explained its related concepts (MURRAY et al., 2015; GHISELLINI et al., 2014).

According to Stahel (2016), at the end of its useful life, the consumer good is reintroduced as a resource in a new production chain, closing the product life cycle and minimizing waste generation. This industrial logic reuses primary elements and obsolete components, replacing the primary resource with the secondary one and transforming elements previously considered waste into productive matter.

The primary roots of CE are based on Ecological Economics, Environmental Economics, Industrial Ecology, and the Systemic Approach, according to the researchers Ghisellini et al. (2016), who carried out an extensive literature review on the subject in order to understand the characteristics and perspectives of CE through the prism of science and to identify its theoretical bases. CE is widely presented as an alternative model of production and consumption, a growth strategy that allows the 'decoupling' of resource use from economic growth, thus contributing to sustainable development (GEISSDOERFER et al., 2017, REIKE; VERMEULEN; WITJES 2018).

A key element to promote the decoupling of economic growth from increased resource consumption, thus disconnecting from the linear economy, focuses on the valorization of products, materials, and resources and the minimization and reconversion of waste and reduction of gas emissions, which is beginning to be threatened due to the limited availability of natural resources and the limits of the planet in terms of capacity to assimilate the pollution generated (EMF, 2013).

Waste conversion is critical to support the decoupling of economic growth and human well-being from primary resource use, and to avoid pressure on land, causing adverse effects on biodiversity and compromising global food security (DONNER et al., 2021). Geissdoerfer

et al. (2017) address the relationship between Sustainability and CE, presenting a strict definition. They place business activities at the center and describe CE as

> "a regenerative system in which resource input and waste, energy emission and leakage are minimized by slowing down, closing and narrowing material and energy circuits. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, reconditioning, and recycling" (Geissdoerfer et al., 2017, p. 579).

From a market perspective, value creation for SE is about keeping resources in productive economic cycles as long as possible. "For business, this means transforming waste into wealth" (LACY; RUTQVIST, 2015, p. xvii). It does not deal with waste in its material form, natural capital waste, but also with life, capacity, energy, and other resources involved in producing disposable goods. Implementing CE principles is increasingly recommended as a convenient solution to meet sustainable development objectives (Saidani et al., (2019). According to the Ellen McArthur Foundation (EMF) (2013), CE is based on three shared principles, which can be summarized as follows: (i) eliminate waste and pollution, (ii) keep products and materials in use, and (iii) regenerate natural systems.

The CE paradigm pushes the boundaries of environmental Sustainability by advocating a more holistic goal of a production system that is restorative and regenerative by design (MOREAU et al., 2017). Restorative and regenerative design minimizes resource use, waste, emission, and energy leakage by narrowing, slowing down, and closing material and energy loops (GEISSDOERFER et al., 2017). CE proposes limitation strategies, that is, the rationalized use of the environmental system, and, in contrast, Sustainability is concerned with the good use of environmental resources to guarantee their future existence. CE and Sustainability - seek in common the equity of the three dimensions, environmental, social, and economic (TIOSSI; SIMON, 2021).

Integrating CE with SCM can provide advantages from a sustainability perspective (GENOVESE et al., 2017; NASIR et al., 2017). Therefore, there is enthusiasm and a growing interest in SCM for CE (YING; LI-JUN 2012; AMINOFF; KETTUNEN, 2016; DAROM; HISHAMUDDIN, 2016; BATISTA et al., 2018; BRESSANELLI et al., 2018; DE ANGELIS et al., 2018; GOVINDAN; HASANAGIC, 2018, KAZANCOGLU et al., 2018; LIU et al., 2018). However, Supply Chain Management research is still at an early stage when conceptualizing to advance supply chain theories and practices to help realize the vision and potential of the Circular Economy.

### 2.2 Supply Chain Management (SCM)

Ballou (2006) and Seuring et al. (2008) define SCM as a one-way linear path that considers all activities associated with the flow and transformation of products, from the extraction of its raw material, through the end user and its disposal. The traditional supply chain needs to integrate the concern that natural resources are scarce and that the current economic model of extraction-use-disposal is declining.

A central paradigm of the literature on supply chains was to promote a better understanding of the elements "that characterize the strategic decisions that lead to the development and structural performance of the supply chain" (DEFEE; STANK, 2005, p.28). The traditional Supply Chain Management for Beamon (1999) defines an integrated production process in which raw material is transformed into final products and then delivered to customers via distribution or retail.

The supply chain could be more accurately defined, according to Christopher Holweg (2011), as a network of connected and interdependent companies working together in the form of cooperation, seeking to control, manage and improve the flow of raw materials and information from suppliers to end customers, generating more customer value at a lower cost for the supply chain as a whole. Considering SSC in the last decades, sustainability issues related to SSC operations have been occupying a prominent space (Batista et al., 2018). For Chin, Tat, and Sulaiman (2015), a company's sustainability degree is limited by how other organizations with which they relate in the supply chain act. De Angelis et al., 2017, add that efficiency-based supply chains are at risk of disruption in industries facing turbulent and volatile markets, especially commodities and raw materials.

#### 2.2.1 Green Supply Chain Management (GSCM)

The literature on GSCM began to develop as organizations and researchers realized that the management of environmental programs and operations does not end at the organization's boundaries (ZHU; SARKIS; GENG, 2005). However, there still need to be convergent definitions of the subject. Thus, this topic aims to bring and group the various definitions and concepts existing on GSCM in the literature reviewed so that, with this, a better understanding of the essence of the theme can be drawn. Green Supply Chain Management differs from traditional Supply Chain Management, defined mainly by Mentzer et al. (2001).

GSCM presents some specific characteristics regarding the insertion of environmental criteria in the decisions and activities of the organization and in its long-term relationships to improve the environmental performance of its products and processes (DIABAT; GOVINDAN,

2011; LU; WU; KUO, 2007; TUZKAVA et el. 2009; ZHU; SARKIS, 2007). However, GSCM has its roots in both environmental management literature and supply chain management. Adding the "environmental" component to supply chain management involves addressing the influence and relationships between supply chain management and the environment. Similar to the concept of supply chain management, the SCM boundary depends on the researcher's objective (SRIVASTAVA, 2007).

Srivastava (2007) also includes in this definition, product design, material sourcing and selection, manufacturing processes, the delivery of final products to consumers and end-of-life management of the product after its useful life, so that they are carried out in an environmentally friendly manner. Sarkis et al. (2011) state that GSCM is the integration of environmental concerns into inter-organizational supply chain management (SCM) practices and reverse logistics.

The scope of GSCM varies from reactive monitoring of general environmental management programs to more proactive practices that incorporate innovations through various techniques such as Redesign, Reduction, Reuse, Recovery, Recycling, Remanufacturing, and Reverse Logistics. Thus, in the reactive approach, companies commit minimal resources to the management environment, starting with labeling products that are recyclable and using end-of-line initiatives to reduce the environmental impact of production (Srivastava, 2007; Van Hoek, 1999; Zhu; Sarkis, 2004).

GSCM practices, therefore, comprise a series of inter-organizational activities arising from two very different options for managing environmental improvement: mutual problem-solving and risk inspection and minimization, which are termed environmental collaboration and environmental monitoring, respectively. Practices related to environmental issues encompass the performance of both internal and external activities related to pollution prevention, waste recycling, product expenditures, resource and raw material extraction, and capture of harmful pollutants followed by proper disposal (VACHON; KLASSEN, 2006; ZHU; SARKIS; LAI, 2008a).

### 2.2.2 Sustainable Supply Chain Management (SSCM)

Carter and Roger's (2008) seminal Sustainable Supply Chain Management (SSCM) framework was the first to demonstrate the relationship between environmental, social, and economic performance within an SCM context. Based on Elkington's (2004) sustainability tripod concept suggests that at the intersection of all three factors, there are activities in which

organizations can engage that not only positively affect the natural environment and society but result in long-term strategies and generate competitive advantage for the firm.

Carter and Rogers (2008, p. 368) define SSCM as "strategic and transparent integration and achievement of the organization's social, environmental and economic goals in the systemic coordination of inter-organizational business processes with the aim of improving the long-term economic performance of the firm and its supply chains." According to Pagell and Wu (2009), for a supply chain to be considered sustainable, it needs to perform well in traditional financial measures, also including the social and environmental dimensions in its strategic measures. Social, environmental, and economic dimensions can form sustainability in the supply chain.

Nascimento (2012) explains each of the dimensions: the environmental dimension implies that the model of production and consumption must be compatible with the material base on which the economy rests, and the economic dimension supposes the increase in the efficiency of production and consumption with the increasing economy of natural resources, and the social dimension, provides that all citizens have the minimum necessary for a dignified life and that no one absorbs goods, natural and energy resources that are harmful to others(TAVARES DE LIMA; DE BENEDICTO; RICARDO SIANI; JACINTHO BITTENCOURT, 2022).

SSCM is recognized as a term in its own right (CARTER; ROGERS, 2008; SEURING; MÜLLER, 2008) and includes a range of associated topics, including environmental objectives. (GOVINDAN; SOLEIMANI. KANNAN 2015), the need to understand value creation as opposed to damage limitation (KRIKKE, HOFENK; WANG, 2013) and the importance of partnerships with strategic suppliers in creating this value (SARKIS; ZHU; LAI, 2011; BELL; MOLLENKOPF; STOLZE, 2013; INSANIC; GADDE, 2014).

SSCM and the integration of sustainability into supply chains is a significant but evolving field, evidenced by a current bias in the literature toward theory development and highly qualitative research methods. The literature better represents the environmental dimension through specific processes at all supply chain stages. The social dimension is recognized but less emphasized than expected, given the focus of SCM on interaction, relationships, and communication (ASHBY; LEAT; HUDSON-SMITH, 2012).

Despite some overlaps, CE fundamentally differs from SSCM in that transitioning from linear to circular supply chains (CSCM) ensures a radical change in existing business models and practices (BATISTA et al., 2018). Hofmann (2019) conceptualized SSCM as an incremental and CE as a radical innovation aimed at sustainability. According to Kiefer et al., (the conceptualization of radical innovation of CE brings the focus on people and their ability)

to initiate the technical processes to facilitate the adoption of circularity in supply chains (KIEFER et al., 2018). There is a need to enhance the existing sustainability concepts in SCM for a CSCM.

### 2.2.3 Circular Supply Chain Management (CSCM)

Womack and Jones (2003) stated that supply chain designers could no longer assume a stable operating environment, shifting to more flexible methods that integrate environmental, economic, and social objectives. With systemic thinking, considering in their decisions the entire reverse cycle of products, materials, and components, the Circular Supply Chain (CSCM) emerges in this scenario.

Implementing CSCM results in better waste management, more efficient resource allocation, improved environmental conditions, increased supply chain efficiency, and higher production rates (LAHANE, 2020). The use of emerging technologies also helps remove potential obstacles in implementing CSCM (DE SOUSA JOBBOUR et al., 2018).

Farooque et al. (2019) state that enhancing the existing sustainability concepts in SCM by integrating CE towards a CSCM and advancing the thinking is necessary.

> "Circular supply chain management is the integration of circular thinking into supply chain management and its surrounding industrial and natural ecosystems. It systematically restores technical materials and regenerates biological materials towards a zero-waste vision through system-wide innovation in business models and supply chain functions, from product/service design to waste and end-of-life management, involving all parties' stakeholders in a product/service lifecycle, including part/product manufacturers, service providers, consumers, and users. "

CSCM aims to lead to circular supply chains. Figure 1 contrasts a circular supply chain with a traditional supply chain. A linear supply chain extracts resources from the geosphere and biosphere and discards products, packaging materials, and waste from various supply chain stages. Unwanted items are often deposited in landfills.

A circular supply chain goes further, recovering value from waste by collaborating with other organizations within the industrial sector (open loop, same sector) or with different industrial sectors (open loop, cross-sector) (WEETMAN, 2017).

**Figure 1** - Traditional supply chain versus circular supply chain

| Chain types | Features | Authors |
|---|---|---|
| Traditional | • operational efficiency<br>• price focus<br>• linear and open structure<br>• Inflows and outflows<br>• Large-scale production<br>• There is no reverse flow of materials and information.<br>• Remanufacturing and reuse rate is low.<br>• Extraction of virgin raw materials.<br>• Overall scope | DE ANGELIS et al., (2018); YANG et al., (2018); SCHENKEL et al., (2015); PROSMAN and SACCHI (2018); |
| Sustainable | • Use of Triple Bottom Line approaches to achieve long-term sustainable performance.<br>• Focus on cost of ownership.<br>• Partially enclosed structure.<br>• Focus on customer effectiveness.<br>• High to medium production volume.<br>• Global and regional scope. | BATISTA et al., (2018); DE ANGELIS et al., (2018) |
| Circular | • Logistics and supply chain structure and configuration support the flow of used and recovered products.<br>• Integration of traditional supply chain and reverse supply chain to achieve the full product cycle.<br>• Restorative supply chain models that include recovery, remanufacturing, recycling, refurbishment, etc.<br>• Rental of the product to the consumer and provision of technical services.<br>• Closed, smaller and cascading cycles.<br>• Material flow in technical and biological cycles.<br>• Medium to low production volume.<br>• Minimizing resource use and emissions.<br>• Collaboration and proximity with stakeholders.<br>• Resource sharing.<br>• Regional and local scope. | BATISTA et al., (2018); DE ANGELIS et al., (2018) ; GEISSDOERFER et al., (2018) ; YANG et al., (2018) ; LARSEN et al., (2018) ; MANGLA et al., (2018) ; MISHRA et al., (2018) ; VLAJIC et al., (2018) ; GNONI et al., (2017) ; SCHENKEL et al., (2015a) ; SCHENKEL et al., (2015b) ;DU et al., (2010). |

Source: Adapted from Farooque, (2019).

Several existing practices must be adopted to successfully implement CSCM (BATISTA et al., 2019) in developing countries due to increasing consumer demand and increased waste generation due to population growth.

The nascent literature on barriers and drivers for SCMR classifies improved technologies and information sharing across the value chain as a manifestation of effective industrial symbioses (GOVINDAN; HASANAGIC, 2018). According to Patricio et al. (2018), identifying opportunities for industrial symbioses requires new process discoveries and mapping inputs and outputs of various supply chain stages within the industrial ecosystem.

For Tura et al. (2019), this data-intensive process is facilitated by increased information sharing and coordination into the broader supply chain network. Bresanelli et al. (2018) also identified information exchange in global settings as a critical facilitator of collaboration in the supply chain network. The final step in establishing industrial symbiosis partnerships also relies heavily on technology. Using low entropy waste and by-products as substitutes for virgin

resources often requires new and innovative transformation processes that warrant substantial research and development efforts. Adopting innovative technologies such as the Internet of Things and big data analytics also helps monitor, track, and automate the circular flow of products (BRESSANELLI et al., 2018).

Collaborative relationships within the value chain to develop the knowledge base and expertise in identifying and implementing industrial symbiosis opportunities is a crucial process facilitator for transitioning to CSCM (HERCZEG et al., 2018; PATRICIO et al., 2018 In a review presented, Farooque et al. (2019) showed that CSCM is still an emerging research field, with most of the relevant publications being conceptual papers and case studies, which is typical for a research field still in its early stages. There are many technical, process, and incentive problems to overcome to make CE a reality. Therefore, research in the following directions that are important for CSCM, but have yet to receive much attention, are suggested.

Many studies have focused on the importance and priority of discovering the factors, but more attention needs to be paid to the mutual relationships and the level of effects of one factor on the other (LUTHRA et al., 2019; FAROOQUE et al., 2020). These gaps are evidenced in the research and show the need for work. A framework is needed to help develop an understanding of the various practices in adopting SBCC and the interrelationships between them.

## 3. Methodology

This research has a mixed approach, both qualitative and quantitative. The use of qualitative research methods is booming. As Godoy (1995, p. 21) states, "[...] nowadays qualitative research occupies a recognized place among the various possibilities of studying the phenomena that involve human beings and their intricate social relations, established in various environments", which are closer to the truth of the phenomena.

The operationalization in adopting a qualitative method is anchored by analyzing the phenomenon chosen to be studied. There is no need or concern to record frequencies related to the phenomenon. What is sought is a constructive, active involvement of the researcher in the entire research process, from formulating the research question to analyzing the findings (FLICK, 2004).

The quantitative research method has the questionnaire as one of its great tools. Through the results obtained in this data collection technique, inductions are made, which at times confirm the assumptions initially raised by the researcher and refute them. Because it does not have its research instruments, it is "forced" to use tools from other fields of knowledge, and as

a result, biases arise. However, one must recognize all the knowledge produced by quantitative research in social sciences. Demo (1995, p. 133) states, "In quantitative terms, the social sciences already have a considerable amount of empirical research and, however much there are vices, limitations, and mystifications, it is a product of particular methodological significance."

Exploratory research was adopted, aiming to substantiate the field of study, through a literature review, from the analysis of secondary data, aiming to develop, clarify, and modify concepts to formulate more precise problems for future studies. In qualitative terms, the meta-analysis technique was applied, a systematic investigation where it is possible to regroup a more significant number of studies by associating results and allowing the representative scope of a given phenomenon (Beaucher; Jutras, 2007). In addition, the meta-analysis was treated in a double path, macro analysis and microanalysis, a methodological model based on Pereira et al. (2019).

The research was developed through a literature review to identify the theoretical gap that contemplates the convergence of the analyzed dimensions of "*supply chain management*," "*circular economy*," and "*commodity*," aiming to confirm the novelty of the research. The survey was carried out from secondary data in articles published in international journals, being carried out documentary research, which according to Cooper and Schindler (2011), aims to characterize the study in its context.

In the macroanalysis, it is possible to establish an overview of the research area's structuring, where the field's academic production profile is identified. Initially, the search was carried out in the Scopus database, using the term "*circular economy*" to analyze the available publications, associating it with four other terms, "*supply chain management*" OR "*commodity*," chosen for having shown a strong link with the theme through the literature review. For the search of the terms, filters were used as a time cut of twenty years, from 2001 to 2021, in the area of *Business, Management, and Accounting*, only articles in English.

For this reason, the meta-analysis technique is historically linked to systematic reviews, helping them to synthesize the results obtained in a macro and micro way, providing directions on the variables studied, whether in the construction, development, or explanation of theories (PEREIRA et al., 2018). VOS viewer version 1.6.8, mining software, was used for data appreciation. It creates network maps to explore bibliometrics visually (VAN ECK WALTMAN, 2010).

Within the micro analysis, it was necessary to carry out some steps. The first is the construction of the data corpus following the three rules of completeness, representativeness,

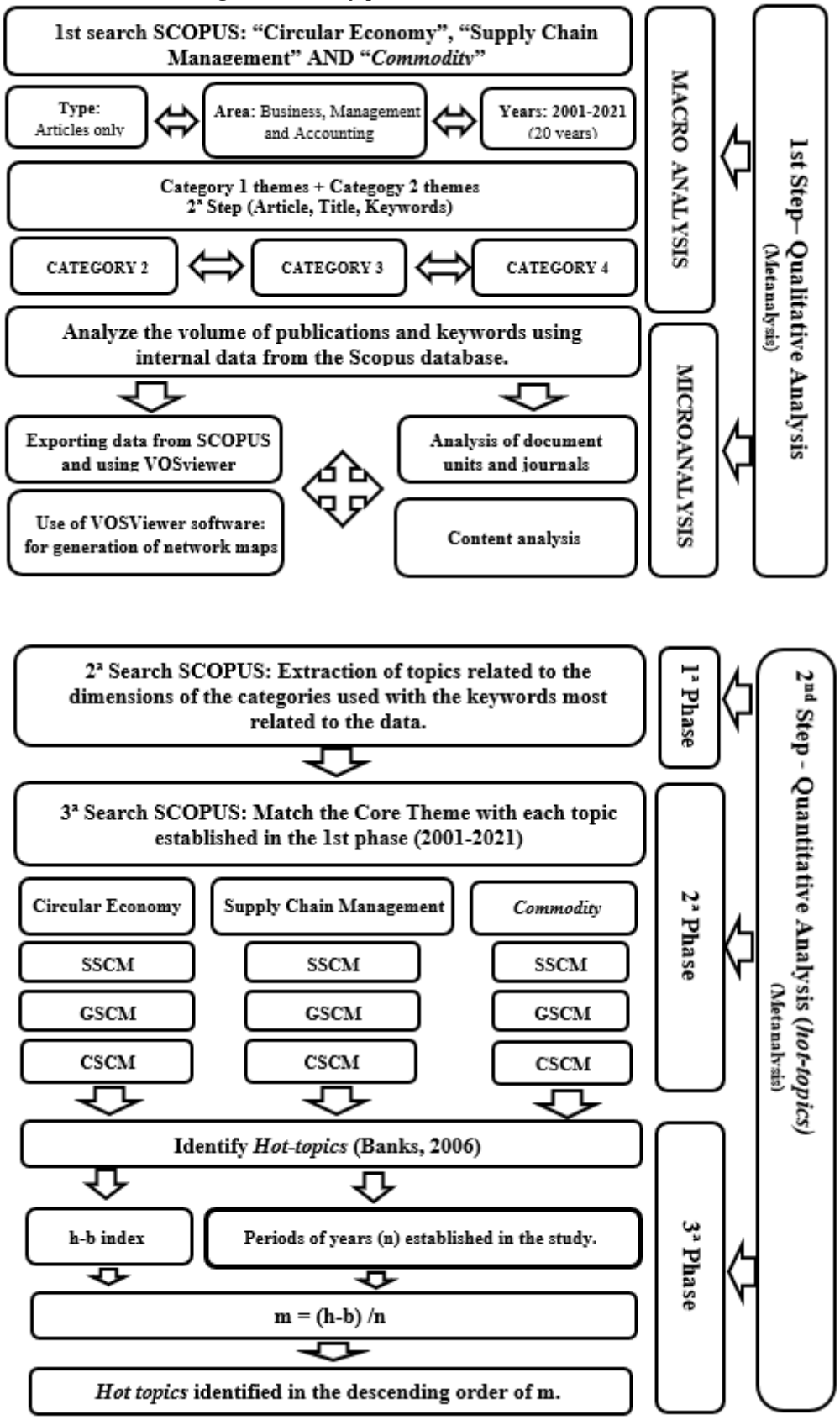
and relevance. These rules were met before the analysis with the software through the search in the BDTD database (Brazilian Digital Library of Theses and Dissertations). Atlas Ti comes into play from the floating reading, as its interface allows organizing all the analyzed documents in a continuum, facilitating reading and navigation between different documents (MUHR, 1991).

In the referencing stage, Atlas.Ti is essential because it speeds up and optimizes the researcher's role by quickly creating indexes and their indicators through the Code function. Similarly, in coding the units of record and context, the software allows one to quickly explore the entire corpus, navigate between pre-categories, organize the codes into similar groups (economy function), and manage the analysis through conceptual maps called networks (HWANG, 2008).

The data analysis of this work followed the following proposal developed by Minayo (1994): i) Data sorting: At this moment, a mapping of all data obtained in the fieldwork was made, involving the transcription of the audios of the interviews, the rereading of the material, the organization of the reports and the data of the participant observation; ii) Data classification: in this phase, specific categories were elaborated to determine the set or sets of information collected in the interviews; and iii) Final analysis: in this step, articulations were established between the data, formulating relationships between the concrete and the abstract, the general and the particular, theory and practice.

Figure 2 shows the summarized framework of the procedure employed in the research, with the terms used in the search kept in English. The intention is that, methodologically, this can help replication the procedure in other research with the theme of Circular Economy as an interest.

**Figure 2** - Survey procedure in terms of outcome




Source: The authors (2023).

In the quantitative approach, the present study used the analysis of hot topics in order to estimate the productions within the study area, measuring research to guide future researchers about the themes that are being worked on within the theme and keywords, "circular economy," "supply chain management" and "commodity." Hirsch (2005) presents the h-index as an impact and influence evaluator of a given author, document, or area under the umbrella of the most cited productions.

**Table 1** - Definitions for hot-topics classification

| **Topic** | Index |
|---|---|
| They are considered a "*hot topic*": they reach beyond their own research topic and establish application effects or unique features. | m>2 |
| Can become a hot topic in a research field: these are widely covered topics that have very interesting features. | 0,5 < m <_2 |
| These are topics that may be of interest to researchers in a specific field of research, encompassing a small application community. | |

Source: Banks (2006).

Subsequently, it was carried out in the Scopus database to illustrate the magnitude and breadth of the theme. It is a choice justified by the fact that the availability of data in the area (MONGEON; PAUL-HUS, 2016) is considered one of the largest and most comprehensive databases, as well as by the availability of access to the researcher. A time frame of twenty years was decided, from 2001 to 2021, emphasizing that the research's time frame was considered to identify the theoretical gap. For this purpose, Boolean combinations of the study dimensions were used according to Figures 4, 5, and 6.

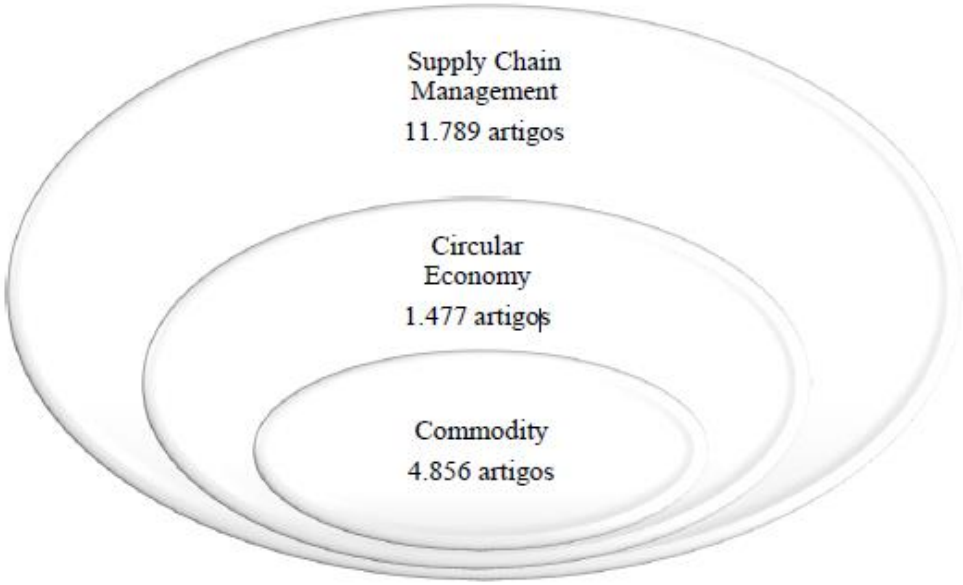
Therefore, documents from 2001 to 2021 were compiled, and only articles already published or in the final publication stage were chosen. Although limited to one database, Scopus provided adequate tools to meet the purpose of the study since

1. it provided search methods that meet the proposed study,
2. it enabled the compilation of bibliometric data efficiently,
3. it provided access to the full texts of the articles searched and, finally,
4. it provided a more significant number of findings due to its daily update.

## 4. Results and Discussion

The Supply Chain Management theme may be significantly more explored than Circular Economy, evidenced by the reduced number of publications. When researching the term Commodity, a significant amount is observed. Figure 3 represents the number of results extracted from the Scopus database from the search expressions: "supply chain management," "circular economy," and "commodity."

**Figure 3** - Publications on the expressions used in Scopus.




Source: Scopus (2023).

From a broad interest, to better characterize a phenomenon and to delimit a problem, it is suggested to carry out a maximum refinement around the object of study (STRAUSS, CORBIN, 2008). New expressions were combined for this, as seen in Table 1, and the number of publications. VOS viewer version 1.6.8 was used for data appreciation, a text mining software that creates network maps to explore bibliometrics visually (VAN ECK; WALTMAN, 2010). Table 2 shows the categories summarizing the procedure employed in the research, with the terms used in the search kept in English. The intention is that, methodologically, this can help the replication of the procedure in other research that have the theme of "circular economy," "supply chain management," and "commodity" as interest.

**Table 2**: Combined expressions for the refinement of the search in the Scopus database

| **Keyword interaction Category 1** | **Total articles** |
|---|---|
| 1. “supply chain management” | 11.789 |
| 2. “circular economy” | 1.477 |
| 3. “commodity” | 4.856 |
| Total | 18.122 |
| **Keyword interaction Category 2 (Analysis with the Boolean formula)** | **Total articles** |
| “supply chain management” AND “circular economy” "circular economy" AND “sustainable supply chain management” | 90<br>25 |
| “circular economy” AND "green supply chain management” | 13 |
| “circular economy” AND “circular supply chain management” | 14 |
| Total | 142 |
| **Keyword interaction Category 3 (Analysis with the Boolean formula)** | **Total articles** |
| “supply chain management” AND “commodity” | 110 |
| “circular economy” AND “commodity” | 8 |
| “supply chain management” AND “circular economy” AND "commodity" | 0 |
| "green supply chain management” AND “commodity” | 0 |
| “sustainable supply chain management” AND “commodity” | 0 |
| “circular supply chain management” AND “commodity” | 0 |

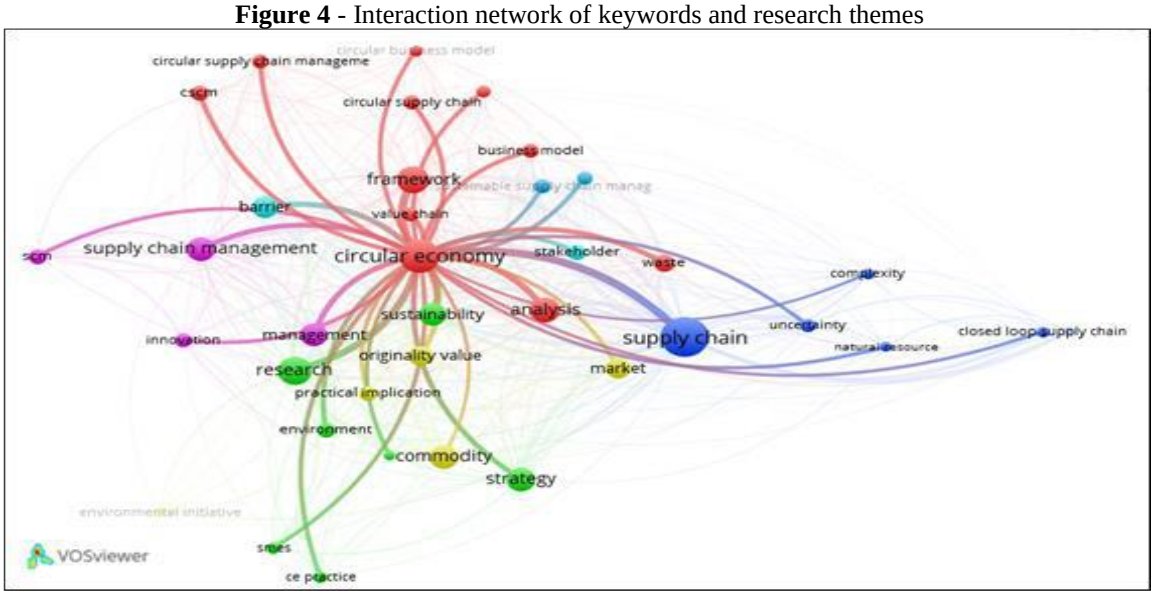
| Total | 118 |
|---|---|
| **Keyword interaction Category 4 (Analysis with the Boolean formula)** | **Total articles** |
| “circular economy” AND “commodity” OR “soy” OR “soybean” | 0 |
| “supply chain management” AND “commodity” OR “soy” OR “soybean” | 112 |
| "green supply chain management” AND “commodity” OR “soy” OR “soybean” | 0 |
| “sustainable supply chain management” AND “commodity” OR “soy” OR “soybean” | 0 |
| “circular supply chain management” AND “commodity” OR “soy” OR “soybean” | 0 |
| “circular economy” AND “supply chain management” AND “commodity” OR “soy” OR “soybean” | 0 |
| Total | 112 |

Source: The authors (2023).

For its analysis, VOS viewer created a network map set that exposes this relationship through the lines and nodes (ties) and the distance between them. In addition to the co-citation analysis pointing out the most influential documents, journals, and authors, it is also possible to obtain - through the links - a pattern of their interrelationships (ŽUPIČ; ČATER, 2015).

We found 18,122 articles that appear individually for each keyword: 1) "supply chain management," 2) "circular economy," and 3) "commodity" in the interaction network of the Scopus database collection. From there, and to strengthen the relationships, we opted for the terms that appear at least 1000 times, which resulted in an above-normal number justified because the research had a time frame of 20 years of analysis. In this sense, Figure 4 shows three categories related to the most correlated keywords extracted from the title, abstract, and keywords.

**Figure 4** - Interaction network of keywords and research themes

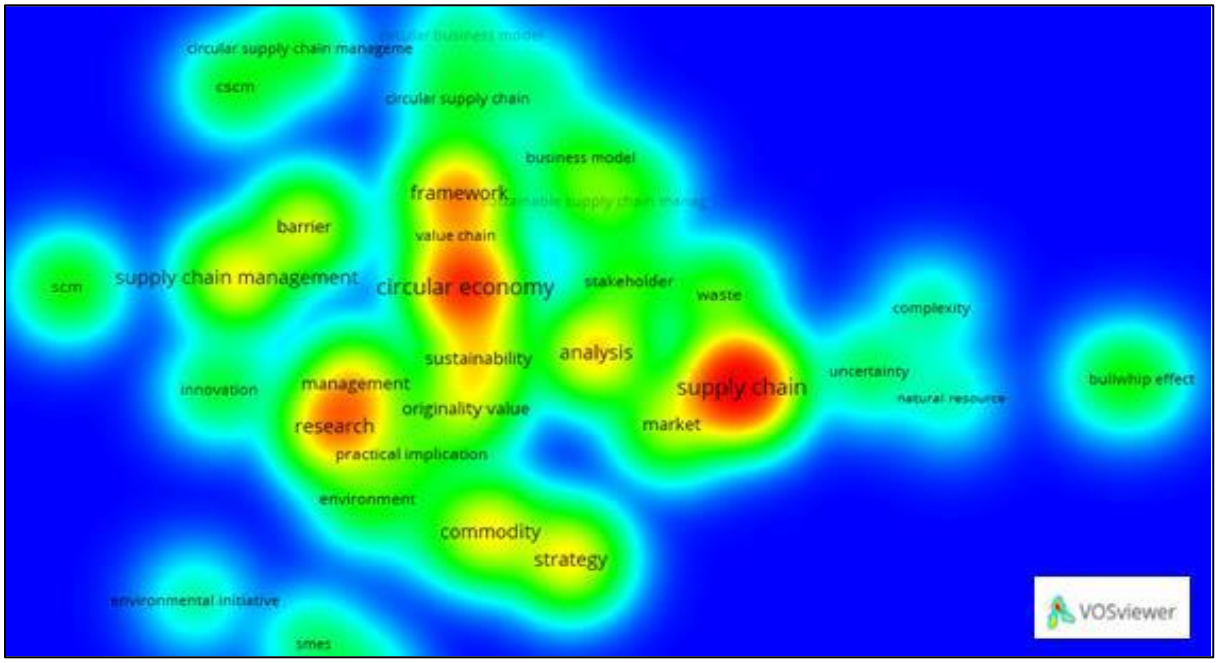



Source: The authors (2023).

While each node represents a term, its size indicates the number of times the term co-occurred in the documents, the distance and thickness of the lines indicate the link between the terms, and the colors of the nodes indicate which cluster the term belongs to. At this juncture, the network., and the density of the categories - in red, yellow, and blue - defines the more outstanding commitment of the keywords with themes related to circular economy, circular

supply chain management, supply chain, supply chain management, commodity, business, market, and sustainability. Although all other clusters also have similar terms, it is possible to notice that this cluster strongly focuses on circular economy and supply chains, as shown in Figure 5.

**Figure 5** - Density network on keywords

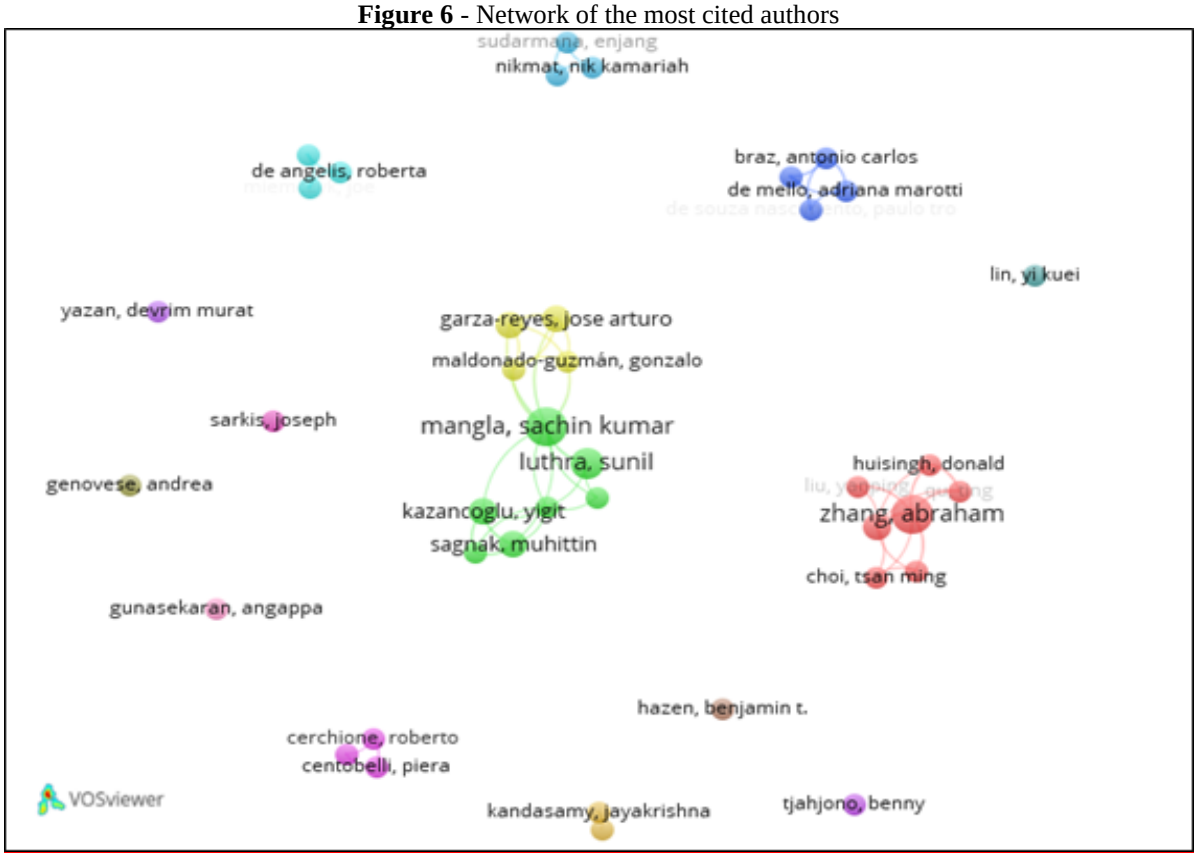



Source: The authors (2023).

Based on the extracted data, there are a total of 18,122 articles cited in Table 1 about the category. Parameterizing a minimum number of 112 articles in Category 4, in Category 3, we had 118, and in Category 2, with 142 articles. Of this total, only the references that are connected were refined. Each document must have been cited at least 40 times for inclusion in the network map and present lines of connection between the other groupings. Thus, Figure 5 shows ten documents that meet the criteria.

Examining authors who cited other authors and the way the documents appear grouped; it is emphasized that there is a similarity between the research. Therefore, the groupings are established based on the strength of the connection of each node, where the authors are associated according to the link and proximity. Although the network map shows the documents with the most significant emphasis on the analysis of authors and their articles, showing the correlation between them on the keywords "circular economy," "supply chain management," and "supply chain management" (between 378 and 40 citations), highlighted in figure 6.

**Figure 6** - Network of the most cited authors




Source: The authors (2023).

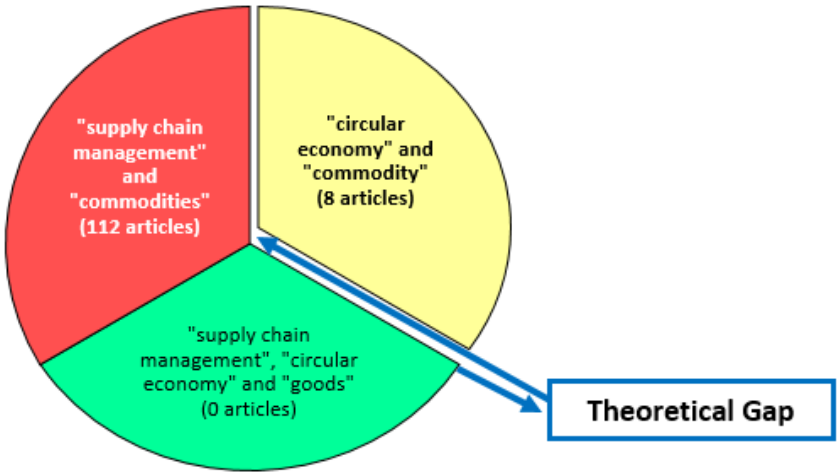
The results of the analysis corroborate the literature, which points to CE (YUAN, BI; MORIGUICHI, 2006; GENG et al., 2012; Su et al., 2013; GHISELLINI; CIALANI; ULGIATI, 2016; MURRAY; SKENE; HAYNES, 2017; MERLI; PREZIOSI; ACAMPORA, 2018) as a sustainable business model that encompasses the entire life cycle of the supply chain process (GOVINDAN; HASANAGIC, 2018; LEWANDOWSKI, 2016), sustainability (COMMON, 1991; ELKINGTON, 2012) and commodity (SU et al..), 2013; GEISSDOERFER et al., 2018; KLERKX et al., 2019; PARENTE et al., 2020), however, these three dimensions are not always approached jointly or equally, with priority given to the sustainability factor, leaving the market and business strategy in the background (GOSWAMI et al., 2018; ALFRED; LAURA, 2016; KHANNA; PALEPU, 2000; MANIMALA; WASDANI, 2015; GUERREIRO; URBANO, 2017; ARRUDA et al., 2013; DEVECHI; GUNTHER, 2022).

About the estimated periodicity, Figure 3 shows that scientific production in Circular Economy and its sub-themes presented a low volume between 2009 and 2015, having in 2018 its most fruitful period in terms of several publications. During the decade studied, production did not follow an annual average or express a heterogeneous result. However, the increase in publications coincides with the experience of Economy 3.0, which combines old and new elements and is a time when society seems to awaken to an actual depletion of resources (REIKE; VERMEULEN; WITJES, 2018).

## 5. Final Considerations

Considering the evolution of the supply chain as a result of the producers' competition needs, aiming at market improvements and cost reduction, the generation of value along the chain is very focused on delivering specificity to the customer. Thus, there needs to be a higher commitment to a systemic vision, which adds much more than the productive sector. In this sense, the TSC model used, as much as it meets market requirements and is updated around the challenges imposed on the sectors, needs to be restructured to consider another model other than the extraction-use-disposal model, but the circular model.

The resilience of the circular model, and consequently of the SSC, is much greater. Its effectiveness is based on CE principles of smaller and longer cycles, such as reuse, recycling, and remanufacturing, given that the linear business model is no longer viable and new initiatives considering a systemic vision must be foreseen. More is needed for markets and producers to find economic attractions that lead them to follow these circular trends. There needs to be more support from leaders and decision-makers, more significant fiscal and legislative incentives from governments, and a broad base of research and information on the issues, which can be encouraged across academia. In terms of future research, the authors share the need to research the concepts of circular chains in more depth and seek to develop the concepts in a natural context in a practical and applied way according to the flow of the theoretical gap in the figure below.




Although a perfect circularity of products on a large scale is practically impossible, CE principles represent opportunities to bring environmental, social, and economic benefits to supply chains. Theoretical contributions such as the present one symbolizes an incentive for further research on the challenges and possible benefits of the Circular Economy in Sustainable Supply Chain Management to be carried out, especially in the Brazilian context.

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