SOCIAL SUSTAINABILITY IN THE CIRCULAR ECONOMY: AN OVERVIEW OF BARRIERS IN FOOD SUPPLY CHAINS

Elizabeth Margaret Centurion Cancino (UNICAMP)

Tiago F. A. C. Sigahi (UNIFAL)

Marina Gomes Murta Moreno (UNIFAL)

Erik Telles Pascoal (UNIFAL)

Fabio Ferraço (UNIFAL)

Abstract: Circular economy (CE) is a current and central concept for developing more sustainable organizations, supply chains and societies in economic, environmental and social terms. Among the sectors where CE has been studied, the food industry has high relevance since it impacts the lives of all human beings. The purpose of this study was to identify existing barriers in food supply chains for the promotion of social sustainability in the context of the circular economy. Through a systematic literature review, the main contribution of this study was the identification of ten categories of barriers, namely: Political, Information, Socioeconomic, Market, Environmental, Institutional, Knowledge, Financial, Technological and Regulatory. These categories can be used as a framework for future research to delve deeper into the topic, allowing for a better understanding of how to implement circular supply chains, particularly in the food industry.

Keywords: Circular economy, Food supply chain, Social sustainability, Barrier, Sustainable development.
1. Introduction

Circular Economy (CE) is an approach to economic systems that, by intention and design, seeks to convert the typical approach of the linear economy — take-make-dispose — to a model based on circularity, reusing resources and waste by reinserting them into the productive processes (Dossa et al., 2022; Fassio et al., 2022).

CE can be considered an efficient alternative for a better alignment to the assumptions of the triple bottom line Environment, Society and Economy, positively contributing to sustainable development through a better balancing of economic, business, and governmental factors. It focuses on waste management practices, reuse and recycling, pollution prevention, and cleaner production (Ghiselline et al., 2016).

Supply chains can adopt CE operations and circular flows of materials to integrate sustainability objectives throughout its entire length (as well as across different chains). In particular, the association of EC principles on the food supply chains can contribute to a better understanding of the main aspects to be considered to reduce the social and environmental liabilities of this economic sector, which has been a concern for consumers, governments, academia and businesses (Dossa et al., 2020).

Besides the complex network of materials and information, the management of food supply chains (FSC) may be unsustainable and not fully efficient for different reasons, such as the production of waste in the various stages of food production (Fassio et al., 2022), the large number of actors involved (Fassio et al., 2022), among other aspects. Assessing the difficulties in promoting EC precepts in this context may assist to point out what are the barriers to be overcome for the transition from linear to circular and integrated structures in the FSC.

In view of the above, the purpose of this study was to identify existing barriers in food supply chains (FSC) for the promotion of social sustainability in the context of the circular economy (CE). To achieve this objective, a systematic literature review was conducted to identify barriers. Then, content analysis of selected articles was performed to categorize such barriers and discuss contributions to understanding barriers in the context of circular food supply chains.

2. Material and methods

A systematic review (SR) was carried out in order to present the state of the art in relation to the application of CE in FSC. SR is a methodology that can help researchers to analyse the status of a field of concern (Govindan and Hasanagic, 2018). In addition, the SR is based on a
search strategy to identify most of the relevant literature, related to the research question (Kitchenham, 2004).

The SR process requires discipline and practice so that the information is recorded in an organized manner and provides the expected results (Hernandes et al., 2011). To meet all these requirements, this paper applies the five-step methodology proposed by Denyer and Tranfield (2009), which is widely accepted in the literature as illustrated in Figure 1.

![Figure 1 – Research steps.](source: Adapted from Tranfiled (TRANFIELD; DENYER; SMART, 2003)).

### 2.1. Question formulation

In the first step, the following research questions was formulated to guide the study: What are the barriers in food supply chains (FSC) for the promotion of social sustainability in the context of the circular economy (CE) and how they are discussed in the academic literatura?

### 2.2. Locating studies

Scopus was chosen as the database to conduct this study due to a number of important factors, including: its extensive global and regional coverage of academic sources (BAAS et al., 2020); the incorporation of documents from other relevant databases, including Web of Science, Emerald, and ScienceDirect (MONGEON; PAUL-HUS, 2016); its broad spectrum of knowledge areas, which is critical for the representation of transdisciplinary fields such as sustainable development and circular economy.

The search string was designed to focus on FSC, CE, social aspects of sustainability and barriers: ( TITLE-ABS-KEY ( "circular economy" AND "food" ) AND TITLE-ABS-KEY (}
"social" AND ("sustainability" OR "sustainable development") AND TITLE-ABS-KEY (barrier* OR challenge*). The initial search resulted in 92 documents which were submitted to a process of critical evaluation to determine their adequacy to the scope of the study.

2.3. Study selection and evaluation

Figure 2 shows the process of selecting and evaluating the studies.

Figure 2 – Steps for selecting and evaluating the studies.

To conduct the process of selecting the studies, the following exclusion criteria were formulated:

i. "Circular economy", "sustainability" or "sustainable development" (or the alternate terms) only as a cited expression, an adjective or to provide a context, with no contribution to advance knowledge on this area;

ii. Barriers are not identified or discussed in relation to circular economy;

iii. The food industry is not the focus of the study.

In the first step, the titles, abstracts and keywords of the 92 documents were analyzed based on them and 38 documents were excluded. In the second step, the remaining documents were fully read and other 9 documents were eliminated, resulting in a final sample of 21 documents.

2.4. Analysis, synthesis and reporting

The 21 selected documents served as the basis of this study. A matrix was built by synthesizing key information from each document, that is, authors, journal where it was published, year of publication, which barriers were identified and types of impacts considering the economic, environmental and social dimensions of sustainability (given the space available for this paper,
such information is not presented in detail, but readers are welcome to contact the authors for access to this material).

This matrix then allowed the categorization of barriers, as well as the identification of each study that contributes to its understanding, which is the main contribution of this study as reported in the following sections.

3. Results and discussion

3.1 Descriptive analysis of the sample

Figure 3 shows the distribution of selected documents according to the year of publication:

![Figure 3 – Year of publication of the selected studies.](image)

According to the search string in the Scopus database, the first paper relating circular economy and food supply chain was published in 2016. The studies in this area underwent a significant evolution after 2018. However, when it comes to the discussion on barriers, studies were only identified after 2019.

On the one hand, this shows that little is known about the subject, making it difficult to build a more sustainable food industry. On the other hand, this demonstrates that there is fertile ground for conducting research as well as the importance of identifying barriers as proposed in this study.
Table 1 shows the number of studies published according to each source, as well as the type of document and the JCR (Journal Citation Report) and CiteScore impact parameters.

<table>
<thead>
<tr>
<th>Source name</th>
<th>Number of documents</th>
<th>Document type</th>
<th>JCR</th>
<th>CiteScore</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal of Cleaner Production</td>
<td>4</td>
<td>Journal article</td>
<td>11.072</td>
<td>15.8</td>
</tr>
<tr>
<td>Sustainability</td>
<td>4</td>
<td>Journal article</td>
<td>3.889</td>
<td>5.0</td>
</tr>
<tr>
<td>Environmental Footprints and Eco-Design of Products and Processes</td>
<td>2</td>
<td>Book chapter</td>
<td>-</td>
<td>0.8</td>
</tr>
<tr>
<td>Journal of Enterprise Information Management</td>
<td>1</td>
<td>Journal article</td>
<td>5.661</td>
<td>8.2</td>
</tr>
<tr>
<td>Smart Innovation. Systems and Technologies</td>
<td>1</td>
<td>Journal article</td>
<td>-</td>
<td>1.1</td>
</tr>
<tr>
<td>International Journal of Logistics Research and Applications</td>
<td>1</td>
<td>Journal article</td>
<td>5.992</td>
<td>7.7</td>
</tr>
<tr>
<td>Revista de Gestão Social e Ambiental</td>
<td>1</td>
<td>Journal article</td>
<td>-</td>
<td>0.3</td>
</tr>
<tr>
<td>Business Strategy and Development</td>
<td>1</td>
<td>Journal article</td>
<td>-</td>
<td>3.4</td>
</tr>
<tr>
<td>IOP Conference Series: Earth and Environmental Science</td>
<td>1</td>
<td>Conference article</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Science of the Total Environment</td>
<td>1</td>
<td>Journal article</td>
<td>10.754</td>
<td>14.1</td>
</tr>
<tr>
<td>Journal of Business Research</td>
<td>1</td>
<td>Journal article</td>
<td>10.969</td>
<td>11.2</td>
</tr>
<tr>
<td>Bio-economy and Agri-production: Concepts and Evidence</td>
<td>1</td>
<td>Book chapter</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Supply Chain Management</td>
<td>1</td>
<td>Journal article</td>
<td>11.263</td>
<td>13.4</td>
</tr>
<tr>
<td>Management Decision</td>
<td>1</td>
<td>Journal article</td>
<td>5.589</td>
<td>7.9</td>
</tr>
</tbody>
</table>

Source: Elaborated by the authors.

It is possible to observe that 16 of the 21 studies (76.2%) that comprise the final sample are articles published in journals. An important issue that emerges is that the journals dealing with this subject mostly have high impact factors, both in the area of sustainability (e.g., Journal of Cleaner Production and Sustainability), supply chain (e.g., International Journal of Logistics Research and Applications and Supply Chain Management) and business management in general (e.g., Journal of Business Research and Management Decision).

The studies selected can be classified as follows:

- 4 are systematic reviews (ATANASOVSKA et al., 2022; CHIARALUCE; BENTIVOGLIO; FINCO, 2021; MEHMOOD et al., 2021; SALIM; GUARNIERI; LEITÃO, 2021);
13 are case studies or applications (ACHILLAS, 2021; ADA et al., 2021; DOSSA et al., 2022; FAROOQUE; ZHANG; LIU, 2019; FASSIO et al., 2022; FORMENTINI et al., 2022; GEDAM et al., 2021; GKOUNTANI; TSOUFLAS; RACHANIOITIS, 2021; KHAROLA et al., 2022; KUMAR MANGLA et al., 2021; KUMAR et al., 2022; KUMAR; PRAJAPATI; PARAMBIL, 2021; SHARMA et al., 2019);

4 are frameworks to analyze the relation between circular economy and food supply chain management (BARATSAS; PISTIKOPOULOS; AVRAAMIDOU, 2021; KUMAR; PRAJAPATI; PARAMBIL, 2021; LUO; OLSEN; LIU, 2021; OKORIE; RUSSELL, 2022).

3.2 Barriers categorization
In the 21 documents selected, 10 categories of barriers were identified. Table 2 shows the number of articles and the references that discuss each type of barrier category.

<table>
<thead>
<tr>
<th>Category</th>
<th>Number of documents</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political</td>
<td>3</td>
<td>Fassio et al. (2022), Ada et al. (2021) and Sharma et al. (2019)</td>
</tr>
<tr>
<td>Information</td>
<td>3</td>
<td>Formentini et al. (2022), Atanasovska et al. (2022) and Kumar Mangla et al. (2021)</td>
</tr>
<tr>
<td>Socioeconomic</td>
<td>2</td>
<td>Chiaraluce, Bentivoglio e Finco (2021) and Luo, Olsen e Liu (2021)</td>
</tr>
<tr>
<td>Market</td>
<td>4</td>
<td>Kharola et al. (2022), Kayikci et al. (2021), Kumar et al. (2022) and Farooque, Zhang e Liu (2019)</td>
</tr>
<tr>
<td>Environmental</td>
<td>2</td>
<td>Kumar, Prajati e Parambil (2021) and Farooque, Zhang e Liu (2019)</td>
</tr>
<tr>
<td>Institutional</td>
<td>2</td>
<td>Okorie e Russell (2022) and Mehmood et al. (2021)</td>
</tr>
<tr>
<td>Knowledge</td>
<td>3</td>
<td>Dossa et al. (2022), Gedam et al. (2021) and Ada et al. (2021)</td>
</tr>
<tr>
<td>Financial</td>
<td>5</td>
<td>Salim, Guarneri e Leitão (2021), Mehmood et al. (2021), Gkountani, Tsoufas e Rachaniotis (2021), Baratsas, Pistikopoulo e Avraamidou (2021) and Achillas et al. (2021)</td>
</tr>
<tr>
<td>Technological</td>
<td>5</td>
<td>Mehmood et al. (2021), Gkountani, Tsoufas e Rachaniotis (2021), Gedam et al. (2021), Ada et al. (2021) and Sharma et al. (2019)</td>
</tr>
<tr>
<td>Regulatory</td>
<td>2</td>
<td>Chiaraluce, Bentivoglio e Finco (2021) and Ada et al. (2021)</td>
</tr>
</tbody>
</table>

Source: Elaborated by the authors.

3.3.1. Political barriers
This category was mentioned in three articles from three different years. For Fassio et al. (2022), the large number of actors involved, the complex network of materials and information, and the
socio-political importance of these systems make more complex issues related to them true perverse problems, for which the proposal of any alternative only entails visible long-term consequences, without immediate evidence of the effectiveness of the actions undertaken. In the case of Ada et al. (2020), concrete examples of political barriers are mentioned such as the lack of conducive legal systems, policy challenges, taxes and incentives, lax existing environmental regulations, different approaches between central and local governments, lack of adequate waste infrastructure and lack of a standard system for CE performance. Finally, for Sharma et al. (2019), political barriers are observed more in developing countries, where relatively less importance is given to the food sector during planning and the government often fails to reduce food waste due to lack of resources and adequate infrastructure, avoiding the application of many already known models of circular economy in the FSCs.

3.3.2. Information Barriers

Three articles mention information barriers. Formentini et al. (2022) investigated the limited availability of data at various stages of the supply chain and the specific characteristics of the products to be analyzed are a significant barrier to the development of any CE project. Kumar Mangla et al. (2021), unlike the previous authors, are not based on the lack of information as a barrier, but on the action of hiding information among all interested parties through, that is why they propose a theory between interested parties for a traceability system in the FSCs. For Atanasovska et al. (2022), the lack of ease of measuring social impacts and obtaining information on said impacts is already a barrier to thinking about the social impacts that the implementation of CE in FSC can generate, it can be said that it is the clearest idea. found why there are not many studies on the social impacts generated by the application of CE in FSC.

3.3.3. Socioeconomic barriers

A couple of articles mention the existence of socioeconomic barriers. Chiaraluce, Bentivoglio e Finco (2021), mention the existence of socioeconomic barriers to a specific application of EC in FSC (use of nutrient waste streams from thermal and anaerobic conversion of biomass as sustainable soil amendments for use in instead of traditional fertilizers) but does not specify what they are. Luo et al. (2021), mention that given external constraints such as credit restrictions and insufficient investment in infrastructure, FLW (food loss and waste) operations are considered only one approach to increase long-term profits in an FSC, which is why they are they tend to overlook the impacts they generate in this area, therefore they should not be understood as barriers.
3.3.4. Market barriers

Market barriers are mentioned in four of the articles investigated. Kharola et al. (2022), focused only on the CE of waste generated in an FSC in India mention that little knowledge about product labeling, standards and expiration dates as well as low planning potential contribute to food waste but this, added to the fact that people do not know how to consume food in a sustainable way, already creates a barrier to not knowing where to start applying CE practices to solve or take advantage of the waste generated in the FSC. Kayiksi et al. (2021), basing their research on the Turkish market and on the application of CE principles for FLW, mention that the closed expiration date of the products that result from this application already creates a barrier for consumers to buy them and therefore not to be sold. Kumar et al. (2021), mention several examples in relation to adopting sustainable FSC, they talk about mistrust between retailers, farmers and middlemen, where low-quality products produced in an unsustainable way can be mislabeled and added to the sustainable FSC, they also mention the lack of constant connectivity between market places and production centers, the capital and operating costs of the stalls, the space and cooling systems in the markets, the lack of diversity in production local and lack of responsibility in customer service due to the presence of a greater number of organizations in a supply chain. Finally, Farooque, Zhang e Liu (2019), develop a fairly exhaustive study on the barriers to developing FSC circular in China, among them they mention that the Chinese government does not have a formal institutional channel to promote the participation of the Chinese people in environmental policies, therefore it does not there is an active participation or public awareness and participation in CE activities, this being a barrier to its development.

3.3.5. Environmental barriers

Within this category we find only one item. For Kumar et al. (2022), who carry out a sustainable performance evaluation and according to this study (after measuring some important KPIs), environmental factors receive a weight of 34% in the importance of their execution for positive effects of CE in the FSCs. In addition, it is one of the three largest categories of barriers to the implementation of CE in FSC Farooque, Zhang e Liu (2019), mention that weak environmental regulations and the weak application of existing regulations are already a barrier for opening more applications of CE in FSC.
3.3.6. Institutional barriers

In this category two articles were found. For Okorie e Russell (2022), who carry out an analysis of the risks and barriers of the application of blockchain and CE in FSC, there are very important institutional barriers such as the resistance of organizations to cultural changes, the lack of experience in this field due to part of the workers of the organizations, important changes in the organizational protocols and the lack of flexibility and standardization. On the other hand, Mehmood et al. (2021), brings a more relevant importance, for them this category represents 64% of the barriers to implement CE in the AFSC; Although that certain one specifies that they are AFSC, we cannot understand that they are all the FSC. However, like Okorie e Russell (2022), he mentions that as part of the institutional barriers is the lack of standardization of the processes, new laws with insufficient coordination and the existence of regulations that do not support the development of CE.

3.3.7. Knowledge barriers

Five of the articles found mention barriers related to knowledge. For Dossa et al. (2022), who bring a practical example of the application of CE in FSC wheat, the problems generated by lack of knowledge can generate great barriers; however, since it is an investigation that has already been carried out, they mention types of solutions to eliminate this barrier such as facilitate digital tools and work on incentives to influence the improvement of openness to knowledge. For Khan et al. (2022), who already do an in-depth investigation of the specific barriers for the application of CE in FSC, mention that the lack of knowledge is a barrier, above all that knowledge related to the consumer about the benefits of CE, as they again mention that in developing countries, losses associated with food waste are highly concentrated at the consumer level. Therefore, the role of consumers and suppliers is critical in making the transition from CE to CE, so their awareness and knowledge of material recycling is particularly crucial for the adoption of CE in FSC. Ada et al. (2021), mention another important barrier related to this category because the lack of knowledge can make it difficult to define which CE methodology is appropriate, as well as delay its application.

3.3.8. Financial barriers

This is another of the categories with the greatest mention in the articles found. For Salim, Guarnieri e Leitão (2021), who carry out a systematic review of food waste from a CE perspective, the barriers are different for those companies that already have CE applied to their FSC and for those companies that have not yet. The latter with which you find financial barriers
before the application of EC in their FSC, especially those related to cost benefit and this is also closely related to the lack of incentives from governments to consume products based on recyclable processes, being one of them the reduction of tax rates, etc.

In the case of Mehmood et al. (2021), 48% of barriers related to the application of CE in AFSC, are within this category and this is related to the fact that AFSC have already faced various financial and economic risks due to the seasonality of the cycle of production. These risks affect the price, quality, availability and accessibility of products and services. Among these, price risks are the most unpredictable, mainly in commodity markets where supply and demand conditions are continually changing nationally and internationally. For Gkountani, Tsoufas e Rachaniotis (2021), the financial barrier is related to the high cost of investment in even already related methods. Baratsas, Pistikopoulos e Avraamidou (2021), in their design of a systems engineering framework for the optimization of food supply chains under circular economy considerations, mention that there is a great effort in governments to accelerate the transition to circular economies, for through the definition of objectives and detection of barriers, including economic ones, but it does not specify which ones it refers to.

Achillas et al. (2020), carry out an investigation of sustainable agricultural chains based on CE and mention that one of the main barriers faced by stakeholders who are willing to exploit the opportunities of the circular economy and apply a circular model in their day to day is the fact that, in most cases, it involves significant investment costs, often making them reluctant to proceed with business reengineering and achieve the transition to the new model. However, the potential is great, the business prospects are important, and also the great interest in the use of agri-food waste, despite the fact that the substantial investment cost is high.

3.3.9. Technological barriers

Five of the leaked articles mention this category of barriers, for Mehmood et al. (2021), we face problems of global environmental damage, depletion of natural resources and climate change; the agricultural sector is directly prone to these problems but the development of technology can address these problems and its availability is a relevant requirement for the implementation of CE, however; mentions that according to relevant studies, this prerequisite is not yet met and stands as one of the main barriers to implement CE initiatives. For Gkountani, Tsoufas e Rachaniotis (2021), one of the biggest barriers is the lack of technology and innovation. For them, technology has a key role in supporting the transition towards a circular economy. Innovative solutions in the fields of product development that incorporate new materials and
zero-waste techniques or predictive data analytics can enable the transition to a circular model and that the lack of these types of innovations results in large waste production and in general, an unsustainable behavior with environmental and economic impacts.

For Gedam et al. (2021), the lack of technology and innovation also represents a barrier in FSCs because the food industry generates a large amount of food waste, which leads to economic and environmental losses. Such losses can be avoided through technological and innovative interventions, i.e. biorefinery, industrial symbiosis, eco-innovation, etc. The presence of solution technology and innovation is a prerequisite for CE adoption, however; Given the lack of development of these, it generates that it becomes a barrier. For Ada et al. (2021), the low development of technologies in some countries is a barrier because technical options for recycling, for example, are limited, to integrate information and there is a lack of eco-efficiency in technological processes.

Finally, for Sharma et al. (2019), they comment that following innovative and technological practices such as environmentally friendly and innovative design processes, using new materials and techniques, helps organizations in many ways, including increasing market opportunities, quality, etc.

3.3.10. Regulatory barriers

Two articles mention barriers related to this category. For Chiaraluce, Bentivoglio e Finco (2021), there is a great discrepancy, for example in the European Union, specifically Italy, a country that occupies the first positions in Europe in terms of circular economy, because they are working on policies and regulations that are approved at a national level. national. As a consequence of the issuance of Law no. 221 of December 28, 2015, the so-called "Collegato Ambientale" and other regulatory measures, the Italian government has launched some actions aimed at promoting CE. The Strategy offers a shared vision of the environmental, economic, social and international cooperation opportunities and challenges related to the development of an Italian bioeconomy rooted in the territory. In addition, in 2018 the Italian Circular Economy Stakeholder Platform (ICESP) was created, a mirror platform of ECESP. Ada et al. (2021), give examples of types of regulatory barriers, including the lack of conducive legal systems, policy challenges, taxation and incentives, existing lax environmental regulations, differing approaches between central and local governments, the lack of adequate infrastructure for waste and the lack of a standard system for CE performance.
4. Conclusion

Based on the premise that the adoption of CE precepts in the food supply chains can contribute to its sustainability, this study aimed to identify the existing barriers to the promotion of social sustainability in the context of CE. This objective was achieved by conducting a systematic literature review.

Papers relating the topic are recent (as of 2019), evidencing an evolving literature and openness for further development. Through the review it was possible to systematize ten categories of barriers toward a transition to CE in food supply chains, among which Financial, Technological, and Market were the most mentioned in the analyzed documents.

Financial barriers permeate the high costs of products for CE and the need for better structuring of government incentives to encourage consumption of these products. The lack of technology and innovation hinder viable economic and environmental results. Added to this is the incipient knowledge and low interest of consumers in sustainable food products from a CE perspective. These and other identified barriers highlight the various challenges and complexities to be overcome in food supply chains to promote circularity.

The systematization of future applied studies related to the scope proposed in this study may reveal whether the barriers differ according to the different local contexts and regulations in which the food industry supply chains are inserted.

REFERENCES


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