



CLOSED LOOP SUPPLY CHAINS AND CIRCULAR ECONOMY – THE POSSIBILITIES OF INTERPLAY

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ABSTRACT. Background: The concepts of closed loop supply chain and circular economy are both based on the introduction of circular flow of material goods. Both concepts are becoming increasingly important not only due to the significance of reducing negative environmental impacts, but also due to supply chain disruptions caused by the COVID pandemic and the Russian invasion of Ukraine. The aim of this article is to determine the role of closed loop supply chains in circular economy and to determine the possibilities of interplay regarding practical application of these concepts.

Methods: The research method used in this paper is the review of the existing literature. The reviewed literature is related to the areas of closed loop supply chains and circular economy. The study focuses not only on the possibilities of interplay between these two concepts, but also similarities, differences, and related operational concepts, such as slowing or intensifying loops of flows of material goods.

Results: The results concern the possibilities of interplay between closed loop supply chains and circular economy and possibilities related with building the closed loop supply chains in circular economy. One of such possibilities is building circular networks consisting of closed loop supply chains. It might include collaboration related to reducing the use, reusing, and recycling of material resources.

Conclusions: The main possibility of interplay between closed loop supply chains and circular economy is collaboration between actors of different supply chains aiming at building circular networks. The main research implication is providing a basis for further research related with building closed loop supply chains and circular networks in circular economy.

Keywords: circular economy; circular supply chains; circularity; closed-loop supply chains

INTRODUCTION

This article aims to determine the role of closed loop supply chains in circular economy. Both closed loop supply chains (or circular supply chains) and circular economy share the common purpose of reducing the use of resources by introducing their circular flow. The result of achieving this goal might be reducing the negative environmental impact. However, there are no comprehensive studies regarding the interplay between closed loop supply chains and circular economy.

Building closed loop supply chains is becoming increasingly significant in modern business due to the COVID pandemic and Russian invasion of Ukraine. Both might result

in long-term supply chain disruptions. Hence, development of closed loop supply chains might reduce the use of raw materials, limit the dependence on international transport and mitigate the risk of such disruptions.

Closed loop supply chains

Both traditional (linear) supply chains consists of companies collecting natural resources, companies processing natural resources into semi-finished products, components and auxiliary materials, manufacturers of finished products and distribution companies (Witkowski, 2010).

However, the flow of finished goods in a closed-loop supply chain does not end after the usage stage. In a closed-loop supply chain used

finished goods are transferred back to their manufacturer (or a different company) to recover them. It is called material recovery or end-of-life treatment (Moosmayer *et al.*, 2020, p. 174). If all products, components, semi-products and raw materials can be recovered, there is no need to landfill them.

There are several definitions of closed loop supply chain. According to Guide and Van Wassenhove (2009), closed loop supply chain is “The design and management of a system to maximize value creation over the entire lifecycle of a product with dynamic recovery of value from different types and volumes of returns over time”. Liu *et al.* (2012) define a circular supply chain as a supply chain “where care is taken of items once they are no longer desired or can no longer be used”.

It should be noted, that according to the Guide and Van Wassenhove closed loop supply chain is design and management of a specific system, while according to Liu *et al.*, it is a type of supply chain. On the other hand, Jain *et al.* (2018) distinguish two perspectives of closed loop supply chain: material perspective and production system perspective.

Taking into account the material perspective, a closed loop supply chain is “a supply chain in which materials are reused and recycled over and over again at the end of their

useful life and there are minimal material wastes throughout the supply chain”.

According to the production system perspective, a closed loop supply chain is a production system that “must generate no solid, liquid and gaseous wastes, minimize use of toxic and hazardous chemicals, and run only on renewable energy”. It should be noted, that in some circumstances these two perspectives exclude each other. Reusing and recycling to some extent might generate waste and do not require using renewable energy. On the other hand, generating waste must not be related with emitting it, e.g. if the waste is recycled or converted to energy in-house.

Taking into account the above considerations, the definition of a closed loop supply chain can be following: a supply chain in which material goods are reused or recovered, there is no emission of solid, liquid or gaseous waste, use of toxic and hazardous materials is minimal and only renewable energy is used.

There are several material recovery activities to be distinguished, depending on the type of finished goods. Accordingly, used finished goods might be re-used, refurbished, remanufactured or recycled (Tundys, 2018). The closed loop supply chain scheme is presented in Fig. 1.

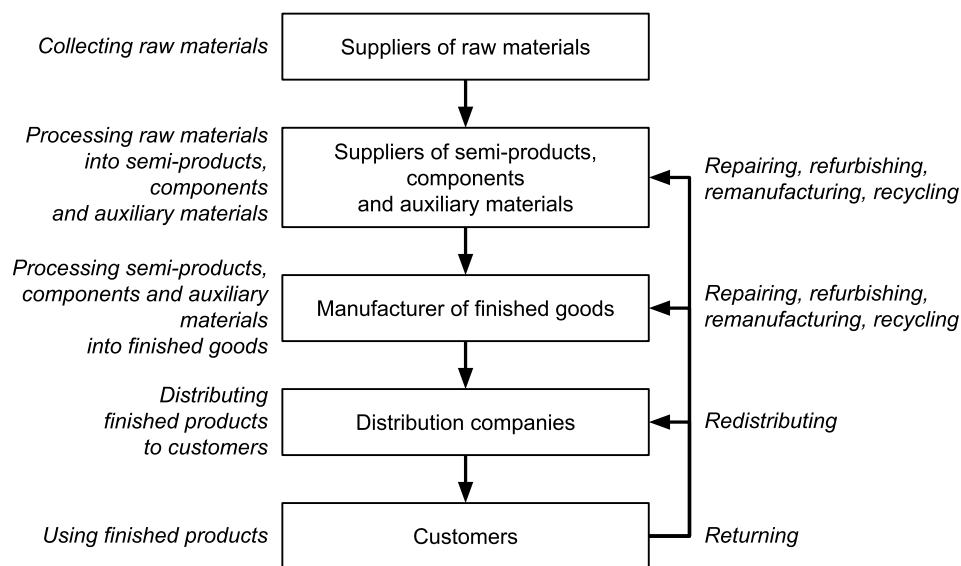


Fig. 1 Closed loop supply chain scheme

Source: own elaboration based on (De Giovanni and Zaccour, 2014; González-Sánchez *et al.*, 2020; Liu *et al.*, 2012).

Geyer and Jackson (2004) described three kinds of reprocessing activities, depending on the type of finished good: product reprocessing (e.g. IT devices, photocopy equipment), component reprocessing (e.g. electronic devices, automotive parts) and materials reprocessing (e.g. paper, glass, aluminium cans). Some of them might involve suppliers of manufacturers of finished goods.

Circular economy

As in the case of traditional supply chain, the flow of material resources in global economy is linear: raw materials are being processed into products that are distributed to end users and then consumed, therefore becoming a waste. Korhonen et al. (2018) describe economy as a growing subsystem of a shrinking parent system (environment). As long as economy is developing in unsustainable way, while natural resources are being depleted, the whole system is approaching a head collision. According to many

national and international organizations, such as UNEP (2021) OECD (2021) European Commission (2020), one of possible solution to global environmental problems is introducing circular economy.

Kirchherr et al. (2017) analysed 114 definitions of circular economy and presented their own: “an economic system that replaces the ‘end-of-life’ concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes”

On the other hand, Korhonen et al. (2018) proposed a following definition of circular economy: “an economy constructed from societal production-consumption systems that maximizes the service produced from the linear nature-society-nature material and energy throughput flow. This is done by using cyclical materials flows, renewable energy sources and cascading-type energy flows”. Visualisation of circular economy is presented in Fig. 2.

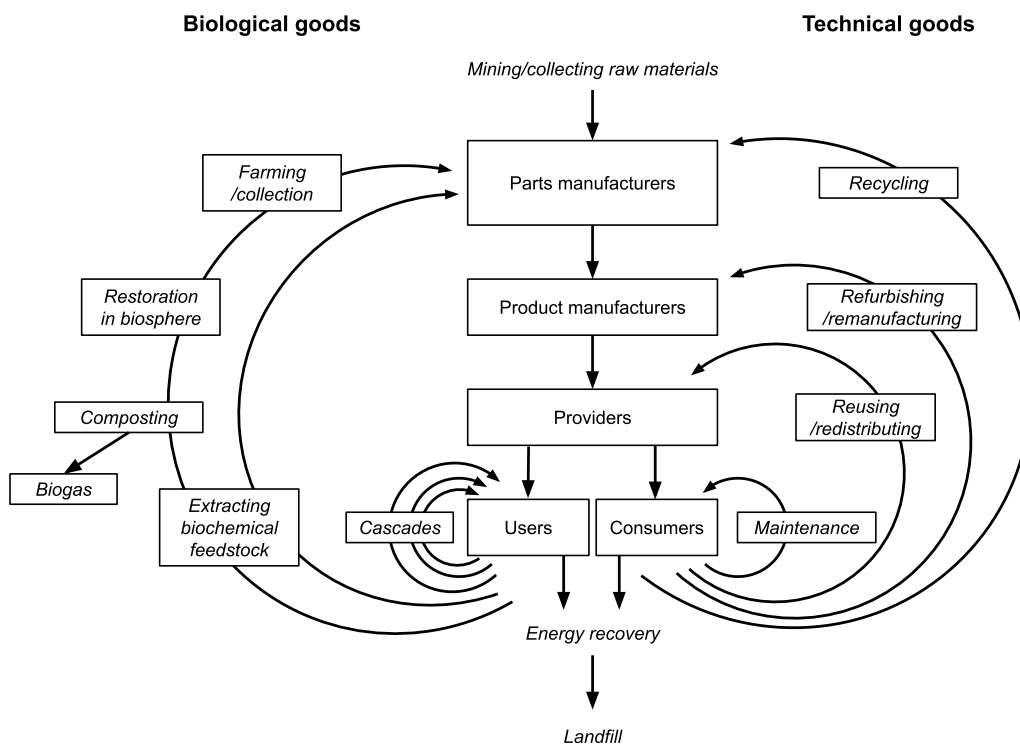


Fig. 2 Circular economy scheme
Source: own elaboration based on (Ellen MacArthur Foundation, 2014).

Similarities, differences and possibilities of interplay between closed loop supply chains and circular economy will be discussed later in this article.

RESEARCH METHODOLOGY

The study consisted of the following stages.

First, the initial literature review was conducted. It was aimed to establish the current state of literature related to areas of closed loop supply chains and circular economy. It included peer-reviewed articles, conference papers and book chapters. Second, the keywords for the main literature review were selected taking into account the results of the initial literature review. Next, the criteria for the literature selection were chosen. Then the main literature review was conducted. In the end, the results were discussed.

The results of the initial literature review are presented in the earlier chapters of this paper. To conduct the main literature review, SCOPUS was chosen as a research database. Based on the results of the initial literature review, the literature selection criteria were chosen.

Since the aim of this article is related to the closed loop supply chains and circular economy, these terms were taken into account. Other included term is circular supply chain.

After completing the list of keywords, the literature review selection criteria were chosen. This choice was based on works of other scholars related to the focal areas, especially Batista et al. (2018, p. 443). The list of criteria is given below:

1. The title, abstract or keywords of the publication contain “closed loop supply chain” or “circular supply chain” and contains “circular economy”.
2. The subject area is Business, Management and Accounting.
3. The language of the publication is English or Polish.
4. Document types taken into account are articles, reviews, books, book chapters and conference papers. Editorials and notes are excluded from the consideration.
5. Only sources in the final publication stage are taken into account. Articles in the press are excluded.
6. The publication is directly related to the area of sharing economy and/or circular supply chains.

The second criterion results from the research approach adopted, which is consideration of the focal concepts from a business perspective. There was no limit to the date of publication. The literature review was conducted in February of 2022. All found publications were in English. The chart describing the number of found publications per year is presented in Fig. 3.

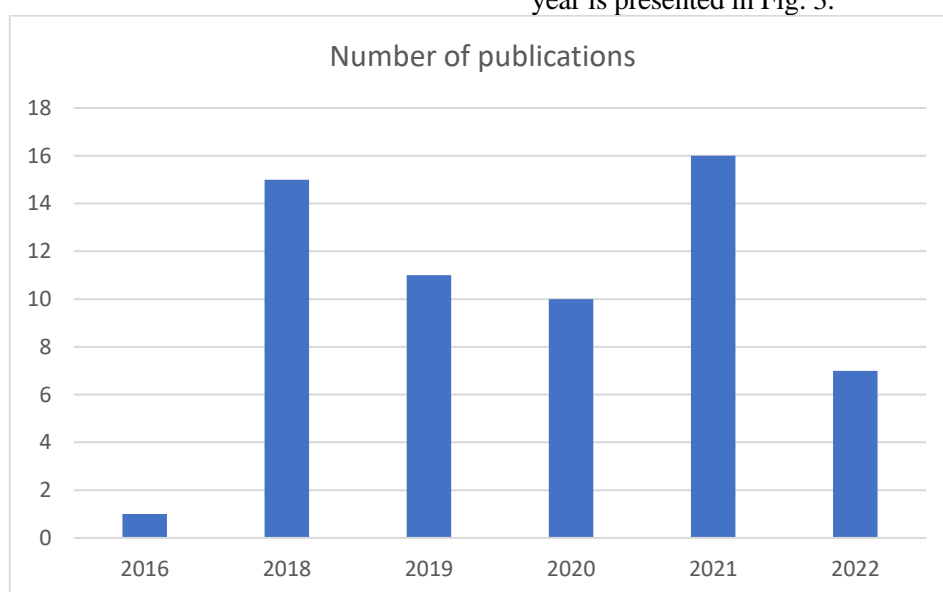


Fig. 3 Number of publications per year

It can be observed, that the number of publications related to the areas of closed loop supply chains and circular economy fluctuates slightly in recent years. However, there is only one publication on this topic older than 2018. It may indicate the growing importance of these topics for modern researchers.

The relevance of reviewed papers varies and they include such topics as collaboration between closed loop supply chains and building circular networks. The most important findings are described and discussed in the next section.

FINDINGS AND DISCUSSION

There are papers focusing on closed loops supply chains with reference to the circular economy (Mangla *et al.*, 2018; Sandvik and Stubbs, 2019). Some scholars describe building closed loop supply chains as a way to introduce circular economy (Kalverkamp and Young, 2019; Koszewska and Bielecki, 2020). However, there is a scarce of sources investigating directly the interplay between closed loop supply chains and circular economy.

Similar to the closed loop supply chain, the key activities related with circular economy are

reducing the use, reusing and recycling of material resources (Kirchherr *et al.*, 2017).

As it is shown in Fig. 2, circular economy might be visualized in a relatively similar way as a closed loop supply chain (see: Ellen MacArthur Foundation, 2014). However, the circular economy is an economic system that includes all of its participants (e.g. farmers, product manufacturers, service providers, consumers, etc.). On the other hand, a closed loop supply chain is a group of companies and consumers, related with producing, distributing and using specific product or products (Weele, van, 2014).

Korhonen *et al.* (2018) based their definition of circular economy on societal production-consumption systems. It should be noted, that societal production-consumption systems include both companies and end-consumers, therefore they can be identified with supply chain actors.

Geissdorfer *et al.* (2018) described circular business model and listed operational concepts related with closing the loop of supply chain (see:

Table 1). The same concepts are consistent with the concept of circular economy.

Table 1 Characteristics of closed loop supply chain and circular economy

Characteristics	Closed loop supply chain	Circular economy
What is it?	A type of supply chain	A type of economic system
Does it include the circularity of material goods?	Yes	Yes
Operational concepts	closing loops, slowing loops, intensifying loops, narrowing loops, dematerialising loops	closing loops, slowing loops, intensifying loops, narrowing loops, dematerialising loops
Key activities	Reducing the use, reusing and recycling of material resources	Reducing the use, reusing and recycling of material resources
Main driving force	Business, consumers	Government, business, consumers , NGOs
Participants	Supply chain actors	Economic system actors
Does introducing this concept result in introducing the remaining concept?	Yes (provided, that “economy” can be applied to a single enterprise)	Not necessarily

Similarities are bolded

However, transition to a circular business model is related with several challenges, including customer behaviour related with understanding market for recirculated products,

cost of operating circular business model compared to cost savings of product recovery (recoverable value), access to good quality returns and speed of technological progress (van Loon and Van Wassenhove, 2020).

Circular network

Introducing a circular economy concept in a supply chain does not necessarily leads to building a closed loop supply chain. Instead, it might result in adapting circular practices (e.g. recycling) in a facility of one supply chain actor (Leising *et al.*, 2018).

Nevertheless, some scholars study the interplay between closed loop supply chains and circular economy. The example of such interplay is the concept of circular supply chain management, defined by Farooque *et al.* (2019) as “Circular supply chain management is the integration of circular thinking into the management of the supply chain and its surrounding industrial and natural ecosystems. It systematically restores technical materials and regenerates biological materials toward a zero-waste vision through system-wide innovation in business models and supply chain functions from product/service design to end-of-life and waste

management, involving all stakeholders in a product/service lifecycle including parts/product manufacturers, service providers, consumers, and users”.

Therefore, circular supply chain management is an application of circular economy in supply chain management (not in a supply chain). It is significant for the focal topic, since a closed loop supply chain can be distinguished from a circular supply chain by the relationship with other supply chains. As Farooque *et al.* (2019) point out, circular supply chains collaborate with other supply chains in order to recover value from waste to achieve the goal of becoming a zero-waste supply chain.

Hence, the possibility of interplay between concepts of closed loops supply chain and circular economy is building a circular network from closed loop supply chains by collaboration between them, as shown in Fig. 4.

CIRCULAR NETWORK SCHEME

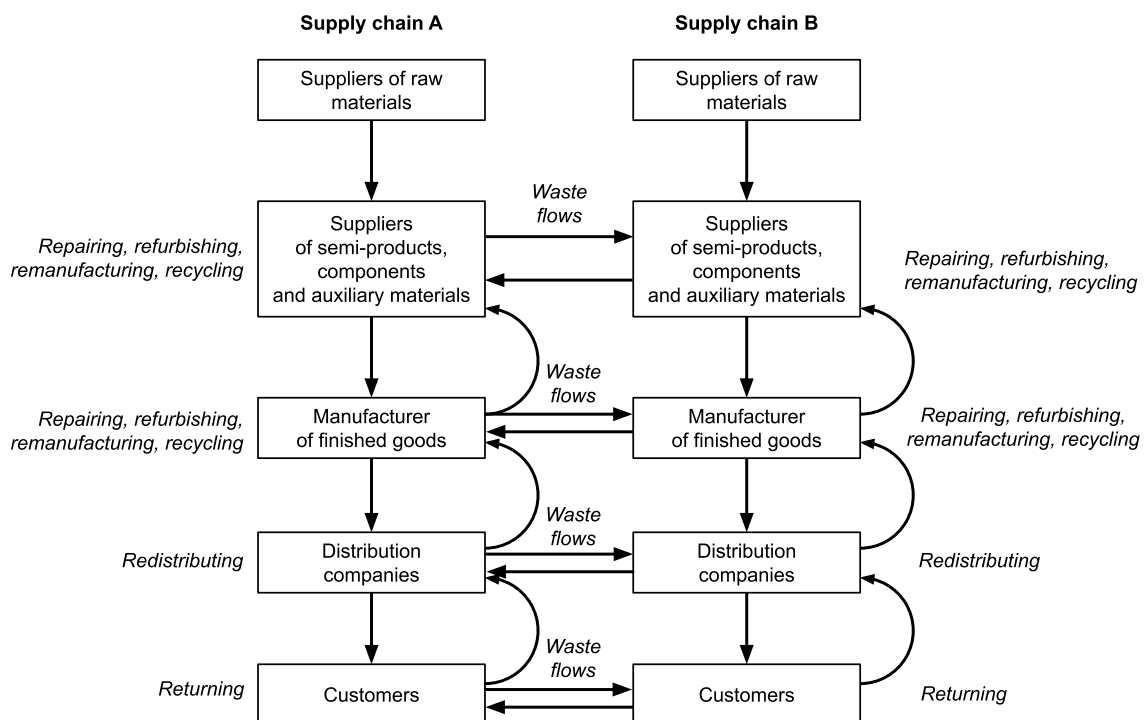


Fig. 4 Circular network scheme

Source: own elaboration based on (Farooque *et al.*, 2019; Leising *et al.*, 2018).

In such network, supply chain actors would collaborate in order to maximize the added value of waste recovery and to avoid landfilling. E.g. furniture manufacturers might collaborate with other furniture manufacturers (hence, actors from different supply chain) by selling wood waste that can be processed into furniture from recycled materials (FURN360, 2017), which might be more profitable on some markets compared to others. Similar possibility was suggested by Kalverkamp and Young (2019).

Other examples of practical application of closed loop supply chain include automotive supply chain (Kalverkamp and Young, 2019; van Loon and Van Wassenhove, 2018), textile supply chain (Sandvik and Stubbs, 2019), electric appliance supply chain (van Loon and Van Wassenhove, 2020), household appliance supply chain (van Loon and Van Wassenhove, 2020).

CONCLUSION

To summarize, the interplay between closed loop supply chain and circular economy is possible in form of collaboration between closed loop supply chains and building circular networks composed of closed loop supply chains. It might result in development of an economic system consisting of companies aiming at maximizing the resource utility and minimizing the emission of waste that cannot be recovered.

Collaboration between closed loop supply chains in order to build circular networks might include environmental cooperation and collaboration with suppliers (Sosnowski, 2019) and conducting environmental supplier evaluation (Sosnowski, 2022).

IMPLICATIONS FOR BUSINESS

The main implication related with focal topic for business is building relationships with business partners. It includes not only suppliers and clients, but also companies with similar profile to ours. Due to the global pandemic and ongoing war between Ukraine and Russia it might be beneficial to seek cooperation opportunities related with material recovery even with direct competitors.

IMPLICATIONS FOR GOVERNMENT

The main implication for government is providing opportunities for both domestic and international cooperation between companies aiming at profitable material recovery. Such opportunities might include simplifying legal regulations regarding trade and transport (including transit) of used products and materials to be recovered.

It might enable building circular networks and stimulate value recovery.

RECOMMENDATIONS FOR FUTURE RESEARCH

The main recommendation for future research is conducting a study regarding building closed loop supply chains taking into account activities related with material recovery. Results of such study might provide insights on determinants of building closed loop supply chain from business perspective. Furthermore, future research should take into account the circumstances of the COVID pandemic and possible supply chain disruption related with Russian invasion of Ukraine.

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