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The role of circular supply chains in sharing economy: literature review and conceptual framework

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Abstract: *Purpose*: The aim of this paper is to determine the role of circular supply chains in sharing economy and to prepare a conceptual framework to build a circular supply chain in sharing economy. *Design/methodology/approach*: The research method used in this paper is a review of the existing literature. The reviewed literature is related to the areas of circular supply chain and sharing economy. The main concept introduced in this paper is the circular supply chain in the sharing economy. *Findings*: The results concern the interplay between circular supply chains and the sharing economy and possibilities related to building the circular supply chain in the sharing economy. *Research limitations/implications*: The main implication of research is providing a basis for further research related to concepts such concepts as product-service systems and the smart circular economy. Such a study could provide further information on possibilities related with building of circular supply chain in sharing economy.

Keywords: access-based distribution; access-based economy; circular economy; circular supply chains; circularity; closed-loop supply chain; collaborative economy; sharing economy; product-service systems; conceptual framework.

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Biographical notes: Piotr C. Sosnowski, PhD is an Assistant Professor at the Department of Logistics, Faculty of Management, University of Lodz. Previously, he was a logistics and purchasing manager for a distribution company in the HVAC sector. His current research work includes closed loop supply chains, environmental supplier evaluation and green concepts in the supply chain. He is the author of scientific publications in the fields of supply chain management, purchasing management, supplier relationship building and environmental management in the supply chain.

1 Introduction

Global digitalisation enabled quicker matchmaking of demand and supply than ever before. It was not until the twenty-first century that both companies and consumers were

able to gather and assess the data related to their business and purchasing decisions. Furthermore, globalisation created new business possibilities and opportunities for development. Unfortunately, it was not much earlier than in the second half of the twentieth century when it became clear that rapid development might cause a threat for future generations because of depletion of natural resources and environmental pollution.

There are concepts aimed at, among others, reducing different kinds of environmental impact, e.g., sharing economy, circular economy, sustainability, and circular supply chains.

This paper aims to determine the role of circular supply chains in the sharing economy and to prepare a conceptual framework for building a circular supply chain in the sharing economy. The adopted research approach considers these two concepts from a business perspective, rather than a corporate social responsibility or sustainability perspective.

What both the sharing economy and the circular supply chains have in common is reducing the use of resources, in the first case, through sharing them and in the second case – through reusing them. Furthermore, these two concepts focus on using and managing the flow of material goods, rather than changing ownership.

Despite that, there are no comprehensive studies on the interplay between sharing economy and circular supply chains. However, some scholars emphasise the connection between these two concepts. Batista et al. (2018a) consider the value of use, rather than product ownership, and approach to building collaborative consumption models as key aspects of productive systems in circular supply chains. On the other hand, other scholars, e.g., de Angelis (2018, p.55), Agrawal et al. (2019, p.2) and Ertz et al. (2019, p.870) consider both circular supply chain and sharing economy as frameworks for circular business models. In addition, some scholars, e.g., Pedersen et al. (Pedersen et al., 2019, p.316), describe concepts like ‘circular economy’ or the ‘circular business model’ in the context of supply chains. Other approaches and points of view will be explored further in this paper.

2 Sharing economy

Other names for this concept include ‘access economy’, ‘platform economy’, ‘gig economy’, ‘access economy’, ‘access-based consumption’, ‘collaborative consumption’ and ‘collaborative economy’ (Bontoux et al., 2016, p.1; Denning, 2014, p.14; Echikson, 2020, p.1; Heinrichs, 2013, p.229; Richardson, 2015, p.126; Al Salman and Claassen, 2018, p.566).

There are various definitions of the sharing economy. Dervojeda et al. (European Commission, 2013, p.3) characterise it as an “accessibility-based business model for peer-to-peer markets”. The main feature of this model is facilitating access for consumers to consumer-owned property, skills, or competencies. It should be noted that this definition limits sharing economy to the consumer-to-consumer (peer-to-peer or P2P) market.

A different description of this context is provided by Muñoz and Cohen (2017, p.21): “a socioeconomic system enabling an intermediate set of exchanges of goods and services between individuals and organisations that aim to increase efficiency and optimise the underutilised resources in society”. In this case, the sharing economy is related to business-to-business (B2B), business-to-consumer (B2C), consumer-to-

consumer (C2C) (Puschmann and Alt, 2016), and even consumer-to-business (C2B) (Sobiecki, 2016, p.29) markets. Since the aim of this paper is related to closed-loop supply chains, which are not limited to peer-to-peer markets, the author proposes the following definition: sharing economy is an accessibility-based business model enabling the exchange of goods and services between individuals and organisations to increase the use of underutilised resources.

Felländer et al. (2015, p.13) relate the sharing economy with activities including "renting, bartering, loaning, gifting and swapping of assets that are typically underutilised, either because they are lying unused or because they have not yet been monetised". Despite these activities, the sharing economy is based on facilitating access to goods or services, rather than ownership or flow of resources (Eckhardt et al., 2019, p.7; Frenken and Schor, 2017, p.5; Martin, 2016, p.155; Pietrewicz and Sobiecki, 2016, p.13). Hence, contrary to the previous definition, the parties providing such assets might be either businesses or consumers. It is important due to the fact that 'selling the use, not the product' is the idea present both the B2C and B2B markets (Matzler et al., 2015, p.72). However, it is based on the assumption that buyers are interested in accessing the goods, not ownership (Cheng, 2016).

In this context, 'sharing' means 'selling availability'. It concerns not only material goods, but also services, information, knowledge, competencies, and time. Kassan and Orsi (2012, p.3) listed, among others, the following practices as examples of sharing economy initiatives: cohousing, tool lending, coworking, and collaborative consumption. What all of the examples given by these scholars have in common is facilitating access to resources (material goods, money, time) by their owners to nonowners either for-profit or non-profit.

Why would anyone sell the availability of their resources? Pouri (2021, p.2) observed that it might be economically beneficial due to their possible abundance. It includes not only durable goods, due to their free or idle capacity (e.g., free seats in a car), but also consumable goods (due to their abundance, e.g., to avoid generating waste), time (it cannot be stored), information (e.g., software), and competences (both information and competences might lose their value over time).

2.1 Practical application of sharing economy

Numerous companies have developed online platforms using the sharing economy model to meet the needs of their users (Constantiou et al., 2017, p.231; SCHOR, 2016, p.9; Zhu et al., 2017, p.2219). A list of such companies is presented in Table 1. They operate mainly on the B2C and C2C markets (Schor and Fitzmaurice, 2015, p.23). However, some of the listed companies also operate in the B2B and C2B markets.

In some cases, these companies might also cooperate with businesses (e.g., Booking). Furthermore, some of them rely on consumers who provided funds to other consumers (Fixura) or even companies (FundedByMe, ToBorrow). Hence, this kind of activity might be considered crowdfunding. Moreover, since the companies described above rely on specific actions of their users (TaskRabbit), their activities might be considered as examples of crowd-sourcing.

Other businesses target consumers but do not exclude companies as recipients in any way (e.g., Lyft and Oferia). Consequently, the sharing economy might be considered flexible in terms of the markets served.

Table 1 Overview of companies using sharing economy online platforms

Company	*Location*	*Main activities*	*Markets*
Airbnb	USA	Rental of residential spaces (mainly apartments and rooms)	C2C
Booking	Netherlands	Rental of residential spaces (apartments, rooms, hotel rooms)	B2B; B2C; C2C
DeskNearMe	USA	Renting workspace	C2C; B2B; B2C; C2B
FundedByMe*	Sweden	Lending money	C2C; B2B; B2C; C2B
Fixura	Finland	Lending material goods or money	C2C
LendingClub*	USA	Lending money	C2C
Lyft	USA	Ride-sharing, bicycle-sharing, food delivery	C2C
Oferia	Poland	Outsourcing and insourcing home and business tasks	B2C; C2C
Peerby	Netherlands	Lending material goods	C2C
Shareyourmeal (thuisgekookt.nl)	Netherlands	Selling homemade meals	C2C
TaskRabbit	USA	Outsourcing and insourcing home and business tasks	B2C; C2C
ToBorrow*	Sweden	Lending money	C2C; B2B; B2C; C2B
Uber	USA	Ride-sharing, food delivery, package delivery	C2C; C2B

*Crowdfunding

Source: Own elaboration

Assets taking part in activities presented above can be divided into tangible and intangible and tangible can be divided into services and financial assets (Felländer et al., 2015, p.14). An overview of this classification with examples is shown in Table 2.

Table 2 Overview of assets related to the sharing economy

Type of asset	*Examples of asset*	*Example of a company*
Tangible	Transportation, property, food	Airbnb, Uber
Financial	Crowdfunding, P2P lending	LendingClub, ToBorrow
Services	Professional, personal	TaskRabbit, Oferia

Source: Own elaboration based on Felländer et al. (2015, p.14)

Taking into account the above, the sharing economy relies on the matchmaking of supply and demand between companies and consumers regarding access to goods or services without transfer of ownership.

It is driven, among others, relatively lower transaction costs due to the digitalisation and use of online platforms (Felländer et al., 2015, p.18; Muñoz and Cohen, 2017, p.26). Its enablers are the possibility of creating an online platform that is focused on a specific type of sharing, lending, and renting (European Commission, 2013; Puschmann and Alt, 2016; Zhu et al., 2017) and availability of assets that are underused (Felländer et al., 2015, p.13; Muñoz and Cohen, 2017, p.26) or even unnecessary (swapping) (Daunorienė et al., 2015, p.840).

However, the success of such a business model might depend on the normalisation of this kind of activity due to lack of or insufficient legal regulation related to the sharing economy (Echikson, 2020, p.12; Eckhardt et al., 2019, p.11; Hossain, 2020, p.8) and the ability of the company to adjust to such regulations (Klemt, 2016, p.132). In addition, there might be a relationship between the ideas of sharing economy and corporate social responsibility (Hu et al., 2019, p.180; Rudnicka, 2018a, p.146) and between sharing economy and sustainable development (Pietrewicz and Sobiecki, 2016, p.22).

2.2 Key aspects of applying the sharing economy in practice

There is a classification of types of sharing economy based on their main premises: access economy, platform economy and community-based economy (Acquier et al., 2017, p.4; Richardson, 2015, p.126).

Access economy also called 'access-based economy' (Jaremen et al., 2019, p.3) is related to facilitating access to underutilised assets, both for-profit and non-profit.

The platform economy relies on using online platforms to share assets both by companies and consumers (Acquier et al., 2017, p.1).

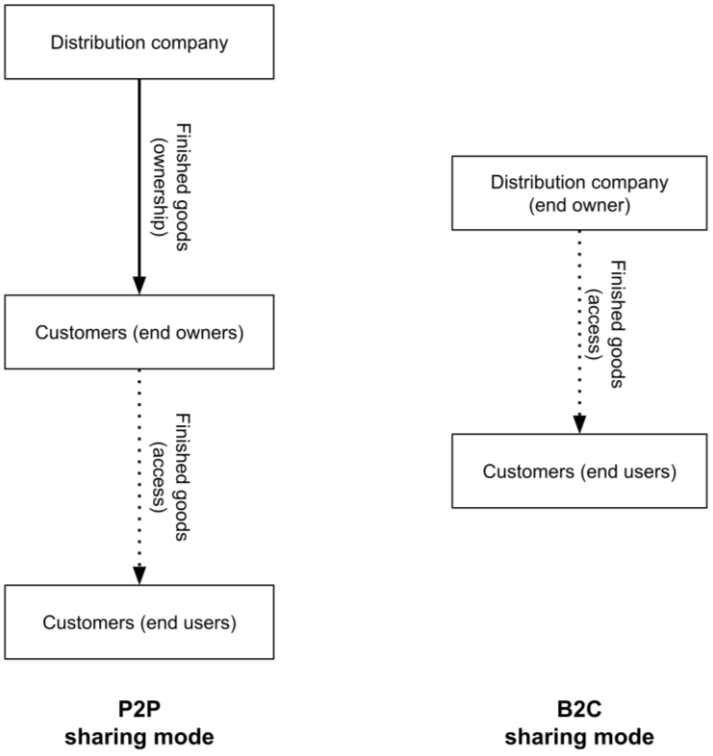
The community-based economy also called the 'moral economy' and 'social sharing' (Dredge and Gyimóthy, 2015, p.290), aims at coordinating various forms of interaction related to the exchange of assets in the community.

According to Acquier et al. (Acquier et al., 2017, p.8), the system that combines these three types can be described as 'the ideal sharing economy'.

All these kinds of sharing economies focus on providing access to material goods without change of ownership, either for profit or non-profit. Furthermore, there are numerous examples of using online platforms to facilitate matchmaking between supply and demand by both companies and non-profit initiatives.

One of the key aspects of applying the sharing economy in business is determining who is the end owner and who is the end-user. Taking into account B2B market, the answer might be the following: the end owner is a company that might also be the end-user, that facilitates access to its resource to other companies (other end users). However, in the B2C market, there are at least two possibilities of sharing economy business modes. In the first case, the end owner is a distribution company that provides access to the product to the customers (end users). It might be called P2P sharing. In the second case, the end owner is a customer that enables access to the owned product to other customers (end users) (Li et al., 2020, p.4). It might be called B2C sharing. Both modes of business in the sharing economy are depicted in Figure 1.

Figure 1 Sharing economy business modes



Source: Own elaboration based on Li et al. (2020, p.4)

The functioning of either sharing economy business modes might be determined by the policy of the manufacturer or the policy of the distribution company. The ultimate decision whether to sell the product or to provide access to it depends on the manufacturer, the distribution company, and the arrangements between them.

3 Circular supply chains

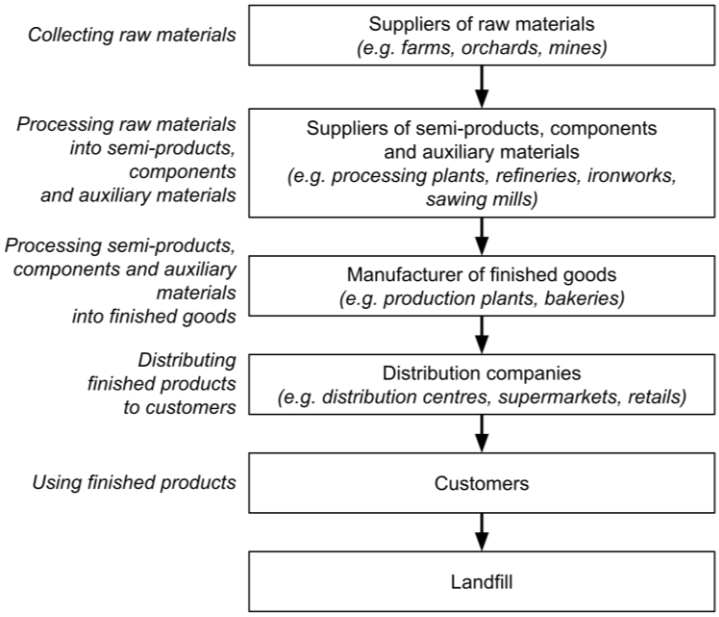
Numerous scholars have studied circular supply chains and their relationships with other concepts related to limiting negative environmental impacts in recent years (Alvarez-Risco et al., 2021a; Hussain and Malik, 2020; Mangla et al., 2018; Meherishi et al., 2019).

Studying and building circular supply chains can be related to concepts such as green entrepreneurship (Alvarez-Risco et al., 2021b, 2021c), sustainable development (Alvarez-Risco et al., 2021c), and circular economy (Bressanelli et al., 2019).

Traditional (linear) supply chains begin with companies that obtain natural resources. These resources are processed into semifinished products, components and auxiliary materials by suppliers of the manufacturer of finished products. Next, the manufacturer of finished products processes these semifinished products, components and auxiliary materials into the finished products. After that, distribution companies distribute finished

products to end users. In the end, used finished products are disposed of (Witkowski, 2010, p.19). This supply chain is visualised in Figure 2.

Figure 2 Linear supply chain scheme



Source: Own elaboration based on Witkowski (2010, p.19)

Liu et al. (2012, p.582) 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'. A more complex two-fold definition is provided by Jain et al. (2018), who described two perspectives of the circular supply chain: material perspective and production system perspective. According to the material perspective, a circular 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'. Taking into account the production system perspective, a circular supply chain is a production system that 'must generate no solid, liquid, or gaseous wastes, minimise use of toxic and hazardous chemicals, and operate only on renewable energy'.

If we connect both material and production system perspectives, the definition of a circular supply chain is following: a supply chain in which materials are reused or recovered, there is no solid, liquid, or gaseous waste, use of toxic and hazardous materials is minimal, and only renewable energy is used.

The flow of finished goods in a circular supply chain (closed-loop supply chain, supply loop) does not end after end users use them. In a closed-loop supply chain, used finished goods are transferred back to their manufacturer (or other designated company) to recover them. It is called material recovery or end-of-life treatment (Moosmayer et al., 2020, p.174).

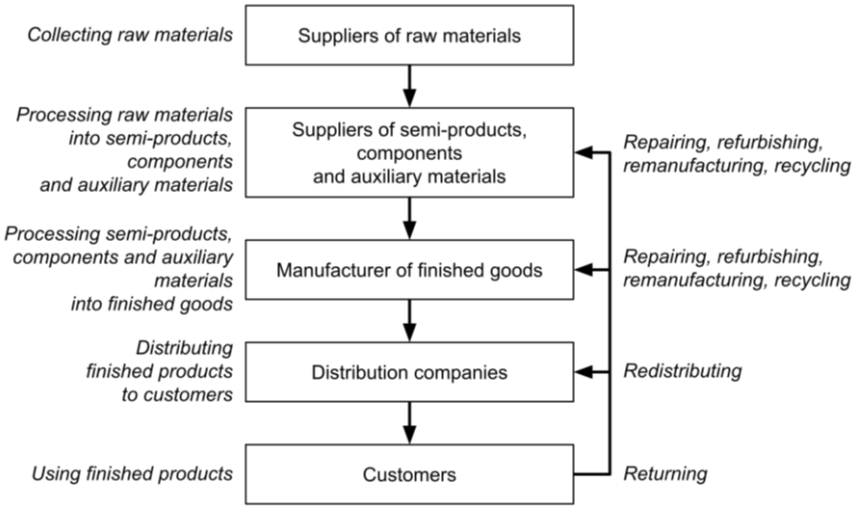
Material recovery includes various activities depending on the type of finished goods. Therefore, used finished goods might be reused, refurbished, remanufactured or recycled (Tundys, 2018, p.109). Activities such as remanufacturing or recycling could include

suppliers of finished goods manufacturers. Geyer and Jackson (2004, p.57) described three kinds of reprocessing activities, dependent 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). If all products, components, semi-products, and raw materials can be recovered, there is no need to landfill them. These recovery activities are also called end-of-life treatment processes (Moosmayer et al., 2020, p.174).

3.1 Material flow management in circular supply chains

A circular supply chain consists of a forward chain and a reverse chain. A forward chain can be described as a sequence of processes in which raw materials are processed into finished products and delivered to end-users. A reverse chain is a sequence of processes in which used finished products are reused, redistributed, repaired, refurbished, remanufactured, or recycled (De Giovanni and Zaccour, 2014, p.22; González-Sánchez et al., 2020, p.7; Liu et al., 2012, p.582). These recovery processes for material goods are also called 'restorative reverse flows' (Batista et al., 2018b, p.448). A circular supply chain and its key elements are illustrated in Figure 3.

Figure 3 Circular supply chain scheme



Source: Own elaboration based on De Giovanni and Zaccour (2014; p.22), González-Sánchez et al. (2020, p.7) and Liu et al. (2012, p.582)

It can be observed that the landfill element was eliminated. The process of successfully eliminating landfilling as an element of the supply chain in favour of material goods recovery is called 'closing the loop' (Guide and Van Wassenhove, 2009, p.15).

The 10R manufacturing concept (Bag et al., 2021, p.4) includes more restorative activities (refuse, rethink, reduce, repurpose). However, they are not crucial in the supply chain context, since they are not directly related to material flows.

Henry et al. (2020, pp.12–13) distinguished three types of key actors in the circular supply chain: upstream (suppliers), source (focal organisation) and downstream (clients).

In this context, they described different types of activities performed by these circular supply chain participants. These activities include, among others: material goods recovery activities (as described in Figure 3), sharing and trading platforms, asset tracking, and collaborative consumption.

Some scholars relate circular supply chains with sustainable supply chains (De Angelis et al., 2018, p.430) and green supply chains (Batista et al., 2018b, p.446; Liu et al., 2012, p.583). However, it should be noted that there are significant differences between these concepts.

3.2 Building circular supply chains

Shevchenko and Kronenberg (2020, p.36) listed three criteria that can be used to assess the transition from linear supply chain to the circular supply chain:

1 elimination of the use of toxic and harmful substances and materials in the product manufacturing

2 maximum possible replacement of non-renewable resources by renewable ones

3 reduction of waste to zero.

These criteria are consistent with the circular supply chain visualisation.

The crucial factor for building a circular supply chain is its economic and technical feasibility (Geyer and Jackson, 2004, p.60). From the product point of view, the economic and technical feasibility of building a circular supply chain is determined mainly in a design phase, to improve their reusability, remanufacturability, and recyclability. This kind of design is called regenerative design (Shevchenko and Kronenberg, 2020, p.33). However, from the process point of view, the main determinant of the circular supply chain is designing a reverse chain to enable the successful recovery of products, components, semi-products and raw materials (Jain et al., 2018).

However, since a circular supply chain has a different structure than a linear supply chain, it requires a different performance measurement system. To provide such a measurement system, Jain et al. (2018) developed a circular supply chain indicator framework that includes two dimensions: the supply chain phase level (upstream and the downstream) and supply chain aspect level (product/material and firm/process). They observed that to facilitate supply chain circularity, implementing a service business model instead of an ownership business model might be a success factor. Furthermore, they described a performance measurement system for circular supply chain management with indicators such as eco-design, circular supplier selection, material reduction, product sharing, and remanufacturing (Jain et al., 2018).

Batista et al. (2018b, p.445) listed the predominant factors for building circular supply chains: supply chain structure that enables and supports reverse flow of material resources and integration of both forward and reverse supply chain to cover the entire product life cycle. This is consistent with the above considerations, especially with the economic and technical feasibility. Having these conditions met, product life cycle management from cradle to cradle (instead of from cradle to grave) might be implemented.

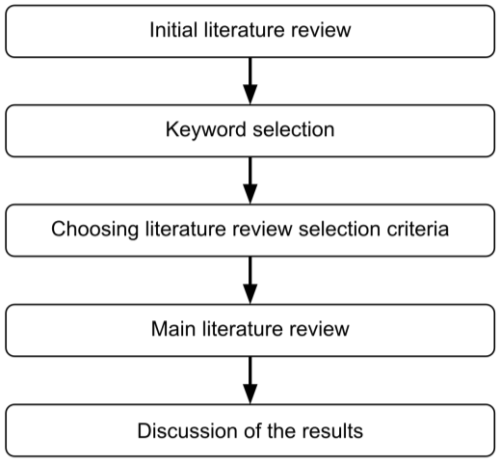
Another key factor for building a circular supply chain is supplier selection and evaluation (Mina et al., 2021, p.8; Sosnowski, 2020, p.134). Taking into account the characteristics of a circular supply chain, the main problem is determining proper criteria

related both with processes and products, e.g., environmentally friendly processes, eco-design, and recoverability of used raw materials, components, and semi-products.

4 Research methodology

The study consisted of the following stages. First, the initial literature review was performed. It aimed to determine the current state of literature related to areas of sharing economy and circular supply chains. It included peer-reviewed papers and reports prepared by e.g., Organisation for Economic Cooperation and Development, World Economic Forum, and Massachusetts Institute of Technology. Secondly, the keywords for the main review of the literature were selected based on the results of the initial literature review. The third stage was the choice of literature selection criteria. The main literature review was conducted. In the end, the results were discussed. The visualisation of the research methodology is presented in Figure 4.

Figure 4 Research methodology



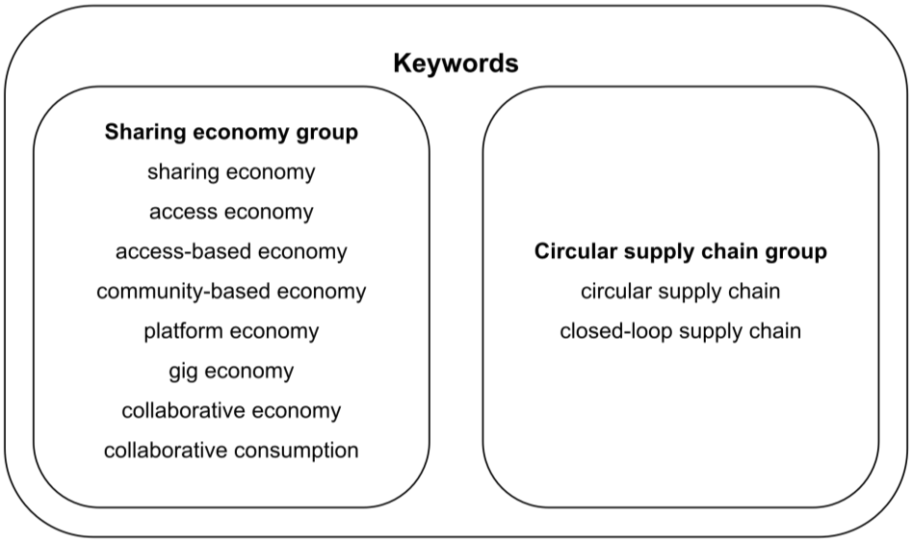
Source: Own elaboration

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 paper is related to the sharing economy and circular supply chain, they were primarily taken into account. Other included terms are the following: access economy, access-based economy, community-based economy, platform economy, gig economy, collaborative economy, collaborative consumption, and closed-loop supply chain.

These keywords were divided into two groups: sharing economy group and circular supply chain group. These groups are visualised in Figure 5.

Figure 5 Visualisation of the groups of keywords



Source: Own elaboration

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

1 The full text of the publication contains at least one keyword from both groups visualised in Figure 5.

2 The subject area is Business, Management, and Accounting.

3 The language of the publication is English.

4 Document types taken into account are papers, reviews, books, book chapters, and conference papers. Editorials are excluded from the consideration.

5 Only sources in the final publication stage are taken into account. Papers in the press are excluded.

6. The publication is directly related to the area of the sharing economy and/or circular supply chains.

The second criterion results from the adopted research approach, 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 April 2021. The final literature search query and the number of records found are presented in Table 3.

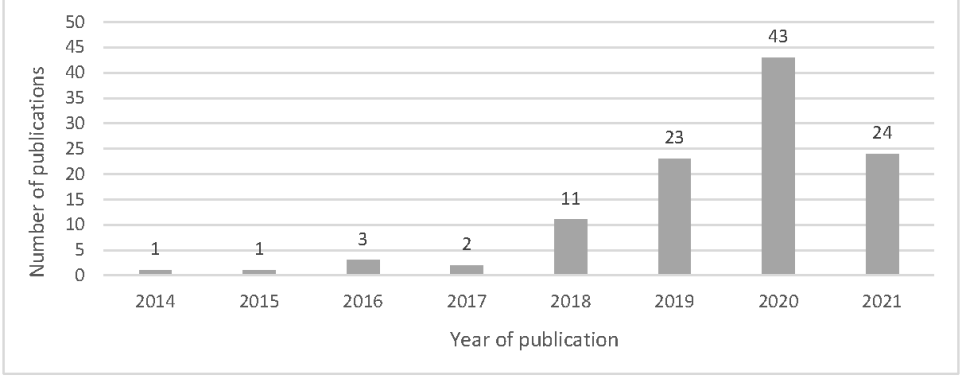
All publications found were in English. It should be noted that initially only the publication abstracts were to be searched. However, the initial attempt resulted in 0 records found. Therefore, finally, the full texts of the publications were searched. The chart describing the number of publications found per year is presented in Figure 6.

Table 3 Results of the literature search query

The literature search query	*Number of records*
ALL (‘sharing economy’ OR ‘access economy’ OR ‘gig economy’ OR ‘collaborative economy’ OR ‘collaborative consumption’ OR ‘access-based economy’ OR ‘community-based economy’ OR ‘platform economy’) AND ALL (‘circular supply chain’ OR ‘closed-loop supply chain’) AND (LIMIT-TO (SUBJAREA , ‘BUSI’)) AND (LIMIT-TO (DOCTYPE , ‘ar’) OR LIMIT-TO (DOCTYPE , ‘re’) OR LIMIT-TO (DOCTYPE , ‘ch’) OR LIMIT-TO (DOCTYPE , ‘bk’) OR LIMIT-TO (DOCTYPE , ‘cp’)) AND (LIMIT-TO (LANGUAGE , ‘English’)) AND (LIMIT-TO (PUBSTAGE , ‘final’))	108

Source: Own elaboration

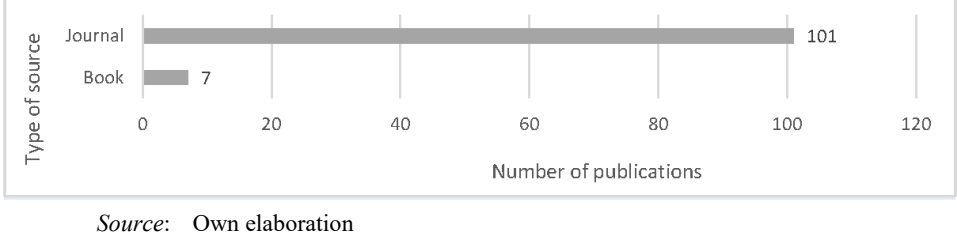
Figure 6 Number of publications found per year



Source: Own elaboration

It can be observed that the number of publications related to the areas of sharing economy and circular supply chains is increasing steadily. It may indicate the growing importance of these topics for modern researchers. The number of found publications per type of source and the number of found publications per source are given in Figures 7 and 8 respectively.

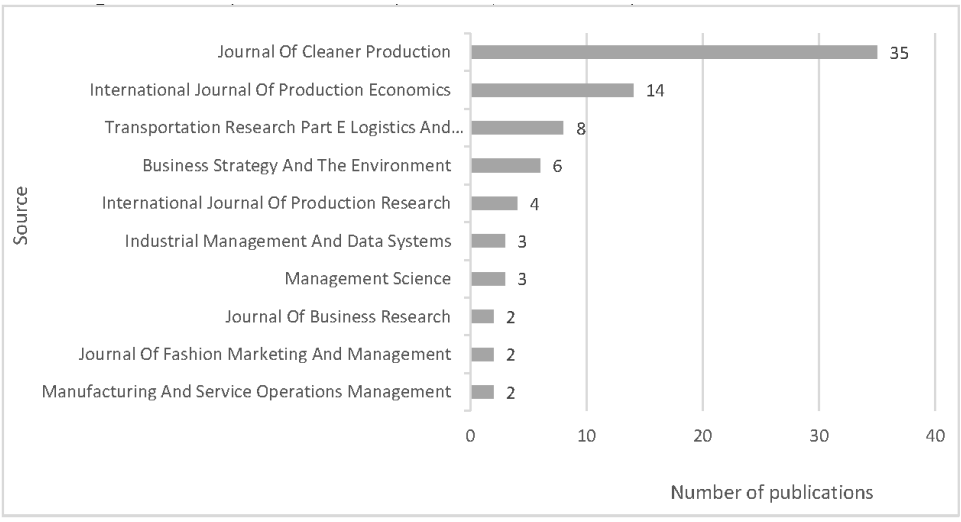
Figure 7 Number of publications found per type of source



Source: Own elaboration

The relative majority of sources are journal papers: 101 out of 108. 7 Sources are books.

Figure 8 Number of publications found per source (TOP 10 sources)



Source: Own elaboration

It should be noticed that the relative majority of found publications (57 out of 108) were issued only in 3 out of 39 sources: *Journal of Cleaner Production, International Journal of Production Economics and Transportation Research Part E Logistics And* Transportation *Review*. However, 29 sources contain only one publication (per source). It might indicate a relatively high level of specialisation of the first three journals related to sharing economy and circular supply chains.

After reviewing 108 sources, 40 of them were evaluated as key sources that could be of crucial importance for achieving the purpose of this paper (see Table 4).

It can be observed that relevance of reviewed papers varies and they include such topics as circular business models, product-service systems, and strategies for the circular supply chain. In some cases (e.g., Jayakumar et al., 2020, Ma et al., 2020) sharing economy was incorporated into the framework of the circular supply chain in the form of access-based distribution. The most important findings are described and discussed in the next section.

5 Findings and discussion

Manufacturers might benefit from sharing economy platforms. However, it depends, among others, their ability to set a consistent pricing policy over a long period (Ye et al., 2021, p.15). Additionally, the interaction between the manufacturer and the so-called secondary market platform may influence the total sale (Feng et al., 2019, p.56).

Table 4 Key sources and their relevance to the topic

Source	*Relevance to the topic*
Agrawal et al. (2019)	Definition of operational strategies for circular supply chain
Alonso-Almeida et al. (2020)	Identification of factors for promoting circular supply chains in the consumption phase
Bag et al. (2021)	Study of 10R manufacturing concept
Batista et al. (2018a)	Identification of the key aspects of productive systems in circular supply chains
Becker-Leifhold and Iran (2018)	Study of a textile circular supply chain with service-based distribution
Bocken et al. (2014)	Identification of the sustainable business models, including PSS (product-service systems) and circular supply chains; Identification of the eight archetypes of sustainable business models that describe, among others, sharing economy and circular supply chains
Chen et al. (2020)	Identification of value propositions for smart product-service systems
Ciulli et al. (2020)	Study of 'circularity hole'
Day et al. (2020)	Study of product-service systems
de Angelis (2018)	Identification of business models in the circular economy
Ertz et al. (2019)	Identification of sustainable and circular business models
Fehrer and Wieland (2021)	Study of circular business models
Feng et al. (2019)	Study of the interplay between the manufacturer and secondary market platform
Geissdoerfer et al. (2018)	Study of circular business models
Halldórsson et al. (2019)	Study of first-mile waste supply chain
Hankammer et al. (2019)	Study of end-user participation in the circular supply chain
Henry et al. (2020)	Study of circular business models and strategies
Iran et al. (2019)	Study of collaborative fashion consumption
Jain et al. (2018)	Visualisation fo a circular supply chain of service-oriented business model
Jayakumar et al. (2020)	Design of a circular production system with sharing networks
Kortmann and Piller (2016)	Identification of Open Business Models in Extended Product Life Cycles Openness
Kristoffersen et al. (2020)	Design of a framework for smart circular economy
Li et al. (2021)	Study of downstream circular supply chain strategies
Li et al. (2020)	Identification of sharing economy business modes
Ma et al. (2020)	Identification of a structure of a bicycle-sharing circular supply chain network
Mina et al. (2021)	Study of supplier selection and evaluation in circular supply chain
Mont and Heiskanen (2015)	Identification of resource optimisation strategies in a circular economy
Moosmayer et al. (2020)	Study of end-of-life product treatment processes
Pedersen et al. (2019)	Study of circular business models

Table 4 Key sources and their relevance to the topic (continued)

Source	*Relevance to the topic*
Provin et al. (2021)	Study of a circular supply chain in the textile industry
Sandin and Peters (2018)	Study of a textile circular supply chain with service-based distribution
Schallehn et al. (2019)	Study of product-service systems related to used products
Shan and Yang (2020)	Study of the responsibility flow of stakeholders in circular supply chain
Singh and Giacosa (2019)	Identification of barriers of implementation of access-based circular supply chains
Wang et al. (2020a)	Study of reverse material flow channel models
Wang et al. (2020b)	Design of a smart product-service system
Wei et al. (2020)	Preparing the conceptual framework of two-stage partner selection for servitisation
Ye et al. (2021)	Study of competition between manufacturers and sharing economy platforms
Zamani et al. (2017)	Identification of the environmental advantages and disadvantages of clothing libraries concerning conventional business models; Identification of the key controlling factors influencing the environmental impact of clothing libraries
Zheng et al. (2019)	Study of non-cooperative and cooperative circular supply chain models

Source: Own elaboration

5.1 Circular business models and sharing economy

Rudnicka (2018b, p.111) described a classification of circular business models that might serve as a frame of reference for relating circular supply chains with different types of sharing economy, according to the typology given by Richardson (2015, p.126) and Acquier et al. (2017, p.4). This classification is based on the ReSOLVE framework and the work of other scholars. Furthermore, Henry et al. (2020, p.11) developed a classification of circular business model strategies that are relatively similar to the ReSOLVE framework, described among alia by Lahane et al. (2020). However, Henry et al. pointed out the role of value recovery that might be obtained from materials that cannot be recycled, e.g., in form of energy recovery. Geissdoerfer et al. (2018) compared circular business models with traditional and sustainable business models.

The criterion for assigning a type of sharing economy to a circular business model was the direct relationship between them. For example, product life extension focuses on extending the life cycle of material goods by repairing, upgrading, or reselling. Since reselling material goods is directly related to the platform economy, it is assigned to it. Table 5 illustrates these relationships.

It can be observed that only three of ten listed circular business models are directly related to any of the types of sharing economy: ‘Share’, Product Life Extension, sharing platforms and Product as a service. However, it does not exclude any other circular business model from implementing the concept of a sharing economy. For example, a

company that operates using the 'Loop' or 'Resource recovery' model might remanufacture and/or recycle material goods for other companies.

Table 5 Relationships between circular business models and sharing economy

Business model	*Short description*	*AE**	*PE**	*CE**
'Regenerate'	Shifting to renewable energy and materials			
'Share' /Reuse /Sharing platforms /Intensifying	Increasing utilisation rate of material goods by shared use/access/ownership	X	X	X
'Optimise' /Reduce	Increasing product performance and efficiency, e.g., by preventing or minimising the use of hazardous or virgin materials			
'Loop' /Recycle /Cycling	Remanufacturing and recycling of materials, components and products			
'Virtualise'	Dematerialisation (e.g., limiting the use of paper in favour of digital media)			
'Exchange'	Replacing old materials and technology with advanced counterparts			
Circular supplies	Providing renewable input materials and energy			
Resource recovery	Recovering resources and/or energy out of disposed of products or by-products			
Product Life Extension /Slowing the loop/ Extending	Extending the life cycle of materials goods by repairing, upgrading or reselling		X	
Product as a Service /Dematerialising	Offering access to a product instead of ownership	X	X	

*AE – access economy, PE – platform economy, CE – community economy.

Source: Own elaboration based on Geissdoerfer et al. (2020, p.7), Henry et al. (2020, p.11) and Rudnicka (2018a, p.111)

Geissdoerfer et al. (2020, p.9) provided a review of circular business models. The circular business models listed by them are consistent with the classification presented in Table 5. These scholars also divided circular business models into four groups, taking into account the focus of circular strategy: cycling (reuse, recycling, remanufacturing, refurbishing), extending (extending the life cycle of materials goods by repairing, upgrading, or reselling), intensifying (increasing utilisation rate of material goods by shared use/access/ownership), and dematerialising (offering access to a product instead of ownership) (Geissdoerfer et al., 2020, p.7). The list of circular business models presented in Table 5 is also consistent with the classification developed by Fehrer and Wieland (2021, p.611).

5.2 Challenges related to circular supply chains in the sharing economy

Bressanelli et al. (2019) listed circular supply chain challenges related to the sharing economy, especially the 'product as a service' model. They described, among others, time mismatch between revenue and cost streams, market cannibalisation, and fashion

change as such challenges. Furthermore, these scholars provided a list of solutions developed based on both literature review and empirical cases (Bressanelli et al., 2019). It should be noted that 23 of 24 stated problems have their solution: 21 in literature and 22 in empirical cases.

Time mismatch between revenue and cost streams might be a financial problem, but it was already met e.g., by car leasing service providers. Therefore, a proper pricing strategy might be a solution. However, market cannibalisation is a well-known challenge related to both sharing economy (Ye et al., 2021, p.2) and circular supply chains (Shekarian, 2020, p.14). If an end user buys access to the product, he or she will not buy ownership of the product. The answer might be a complete business reorientation: manufacturers and/or distribution companies stop selling ownership of the specific product and begin to sell access to it. Therefore, these companies will also control distribution processes.

A similar problem is related to the circular supply chain. If there is a possibility of buying used material goods instead of a new one, it might affect sales of new products. In this case, the solution might be including the manufacturer in the recovery processes to channel the revenue to the manufacturers and to avoid cannibalisation.

Another challenge is fashion change. Products designed and produced to last might quickly get out of fashion than wear out. In this case, product remanufacturing or upgrading might be a default solution, but it might not always solve the problem.

The different challenge related to implementing the circular supply chain in a sharing economy is the cost of innovation. Designing and introduce a product that is fit for resource recovery could involve significant investment (Reimann et al., 2019, p.511). In this case, the proposed solutions are reducing the costs and integrating the supply chain to share the necessary investment between supply chain members (e.g., manufacturer and retailer).

Another problem in building a circular supply chain in sharing economy is 'circularity hole'. Ciulli et al. (2020, p.303) describe it as a lack of communication between supply chain members regarding supply and demand of material goods, which are redundant for one supply chain member and needed by other. In other terms, a circularity hole is a mismatch of information regarding the supply and demand of material goods in the supply chain that otherwise would circulate. One possible solution to that challenge is introducing a waste platform organisation that might function as a circularity broker by matching supply and demand (Ciulli et al., 2020, p.311).

Kassan and Orsi (2012, p.3) noticed that the sharing economy is not a top-down solution. It means that it is not imposed, so far, by legal regulations. It can be noticed that the same applies to circular supply chains. Hence, despite any possible economic, social, or environmental benefits deriving from implementing either sharing economy or circular supply chains, there are no direct legal or tax drivers directly related to its implementation. To change this situation, a change of legal regulation regarding sharing economy and circular supply chains should take place (Alonso-Almeida et al., 2020, p.2809).

Eckhardt and Bardhi (2016) observed that the phrase 'sharing economy' in a business sense refers mainly to access economy. Therefore, when circular supply chains in the sharing economy are considered, they might be addressed as access-based circular supply chains. In this perspective, producers (or distribution companies) are selling access to goods instead of selling ownership. It should be noted that it includes both access to the

tradable goods and the non-tradable goods owned by the company, e.g., production machines.

Under these circumstances, the end user is not an end owner, which is described by Singh and Giacosa (2019, p.926) as one to the main barriers of building access-based circular supply chains. Although it should be noted that access-based consumption does not require sharing of the final product between end-users. The condition for this is that the product is used by a single user (or a single household) for the entire life cycle. The opposite solution is the so-called shared utilisation service, in which end users share access to the product (Hankammer et al., 2019, p.343).

The question that also should be answered is who is responsible for collecting used products for material recovery. Wang et al. (2020a, p.5) described three reverse materials flow channel models. The first and second possibility is that either a manufacturer or a retailer is responsible for collecting used products, while according to the third possibility, both of them are responsible. However, it could depend on legal regulation of used product treatment, supply chain configuration, market specificity, technical features of the product, or contractual arrangements between manufacturer or distribution company and company that conducts material recovery (Shan and Yang, 2020, p.4).

Another issue related to the distribution part of the circular supply chain (downstream supply chain) in sharing economy is the contractual agreement between manufacturer and distribution companies regarding the sharing of costs and revenues resulting from providing access to the final product to end users and from the recovery of material goods. This problem was addressed, among others, by Li et al. (2021, p.5). They concluded that profitability of every solution to this problem also depends on supply chain configuration, market specificity, and technical features of the product (Li et al., 2021, p.13).

Other challenges related to building a circular supply chain in the sharing economy are the selection and evaluation of suppliers capable of producing semiproducts and components suitable for producing final products suitable for sharing and material recovery (Sosnowski, 2020, p.136; Wei et al., 2020, p.12) and integration of the circular economy into individual supply chain functions (Batista et al., 2018b; Farooque et al., 2019). Also, building relationships with such suppliers could be crucial for successful cooperation and collaboration in a circular supply chain (Sosnowski, 2019, p.334).

5.3 Building a circular supply chain in the sharing economy

In the following section, four phases of building a circular supply chain in a sharing economy are presented, based on the critical literature review. They are described in Table 6.

Jain et al. concluded that to successfully facilitate building circular supply chains, a service-based business model must be adapted. However, its adoption could depend on the characteristics of the final product (Jain et al., 2018, p.3243). It is supported by Mont and Heiskanen (2015, p.36), who identified strategies for resource optimisation in circular supply chains. Furthermore, both circular supply chains and sharing economy are compliant with sustainable business models described, among others, by Bocken et al. (2014, p.48).

Kortmann and Piller took a different approach. They described a closed-loop supply chain, incorporating value flows that are present in the sharing economy (Kortmann and Piller, 2016, p.91). In this case, the manufacturing company sells finished goods or

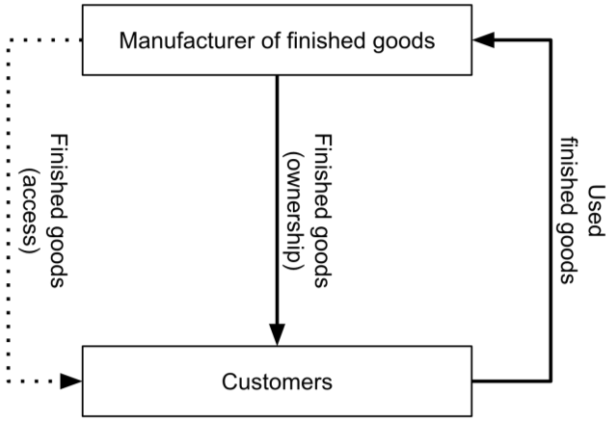
provides access to them through servitisation. When the product service life is exhausted, the manufacturing company re-acquires goods to redistribute, repair, refurbish, remanufacture or recycle them. It is shown in Figure 9.

Table 6 Phases of building circular supply chain in sharing economy

Phase	*Focus*
I	Determining the relationship between the manufacturer and end-users, e.g., the form of providing access to final products
II	Determining the structure of distribution of final products
III	Determining the organisation of recovery of used products
IV	Determining the scope and organisation of material recovery, including recovery of components, semi-products and raw materials

Source: Own elaboration

Figure 9 Building a circular supply chain in the sharing economy – phase I



Source: Own elaboration based on Kortmann and Piller (2016, p.91)

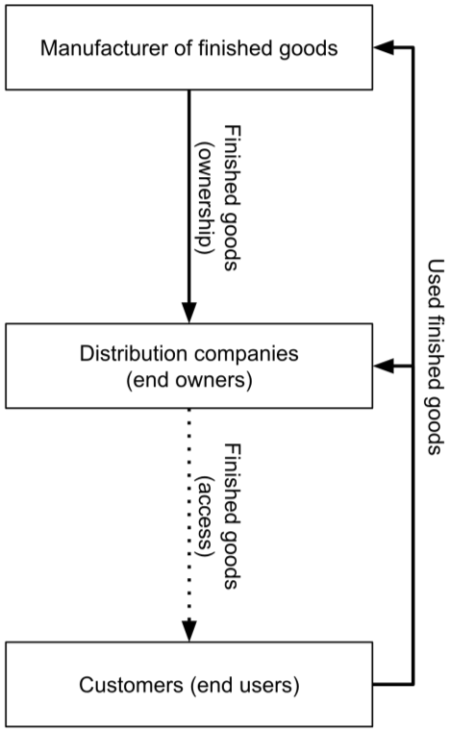
The main assumption, in this case, is that the manufacturer is solely responsible for redistribution, remanufacturing, or recycling of used finished goods.

The main limitation of building a circular supply chain in the sharing economy is the possibility of building only the supply chains of durable products. Consumable products cannot be the subject of sharing economy because they are manufactured to be consumed by consumers.

It should be noted that the role of distribution companies is omitted, but it might be important, e.g., due to the capturing a collaborative value (De Angelis et al., 2018). It depends on the relationships between the manufacturer and the distribution companies and the policy on access to finished goods. The key question is if the distribution companies can also buy from the manufacturer access to the finished goods (instead of ownership).

One of the possible answers is given by Zamani et al. (2017, p.1370). They described a clothing supply chain in which clothes are distributed to end users by clothing libraries. In this case, distribution companies are end owners of the products and they are providing access to the products to the customers (end users), as is described in Figure 10.

Figure 10 Building a circular supply chain in the sharing economy – phase II



Source: Own elaboration based on Zamani et al. (2017, p.1370)

The phrase 'distribution company' includes both wholesale distributors and retailers. The complexity of the distribution network might depend on the type of final product, market features, and the manufacturer policy.

It should be noted that those distribution companies are in this case operating as service providers and they are responsible for receiving used finished goods from end-users (Jain et al., 2018, p.3243). These finished goods are then either redistributed to the next customers or returned to the manufacturer or other company responsible for repairing, refurbishing, remanufacturing, or recycling recovered items (Hankammer et al., 2019, p.343).

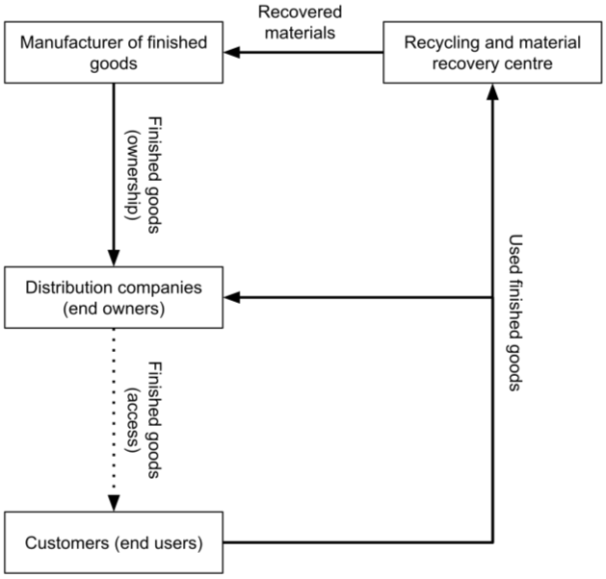
There may be a separate company responsible for recycling or other material recovery activities. Such a company could reprocess the recovered material goods into finished products or supply a manufacturer with recovered resources (Halldórsson et al., 2019, p.406; Ma et al., 2020, p.9; Zheng et al., 2019, p.231). It is visualised in Figure 11.

Redistribution activities might also be carried out by a stand-alone enterprise, e.g., in the form of product-service systems related to used products (Schallehn et al., 2019, p.931). Service-based distribution in circular supply chains is described, among others, for the textile industry (Becker-Leifhold and Iran, 2018, p.199; Iran et al., 2019, p.313; Provin et al., 2021, p.3; Sandin and Peters, 2018, p.356).

The complex visualisation of the circular supply chain in sharing economy should include also suppliers of raw materials, semi-finished products, components, and auxiliary materials (Jayakumar et al., 2020, p.412). They might use the materials

recovered by recycling and material recovery centre, depending on the physical, chemical and biological characteristics of these products, as shown in Figure 12.

Figure 11 Building a circular supply chain in the sharing economy – phase III



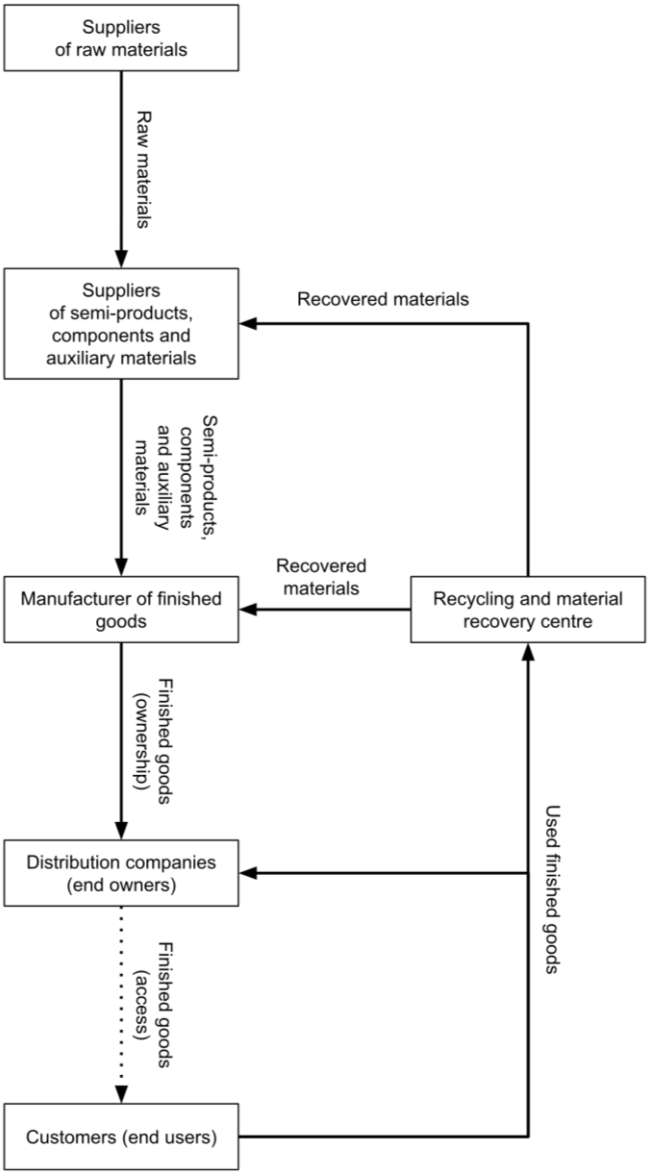
Source: Own elaboration based on Ma et al. (2020, p.8)

Building a circular supply chain following sharing economy principles might include, among others, introducing product servitisation or product-service systems (Day et al., 2020, p.1322). Furthermore, to maximise the use of products, a smart product-service system (smart PSS) might be introduced. Although a product-service system is a system providing access to the product in the form of a service (Valencia et al., 2015, p.13), the definition of a smart product-service system is relatively more complex. It combines the ideas of a smart product, e-service, and a product-service system (Valencia et al., 2015, p.16). It includes such concepts as smart repair, smart maintenance, smart recovery, smart sharing, and smart data feedback to the supply chain (Chen et al., 2020, p.4).

These concepts have in common monitoring and collecting data from smart connected products (also called SCP), including smart connected vehicles (SCV). It enables the end-owner distribution company or the manufacturer to take product-related measures in cooperation with the end users (Chen et al., 2020, p.4; Wang et al., 2020b, p.7). Since building circular supply chains in the sharing economy is limited to durable material goods, the smart product-service system might be introduced. In this case, the end owners could operate such a system.

Kristoffersen et al. (2020, p.251) developed a framework for a similar concept: the smart circular economy. This concept combines the capabilities of smart connected products with the characteristics of a circular supply chain. In this case, the goal of monitoring and collecting data from smart connected devices is also to maximise their usage, but not by sharing them, but by circulating material goods for recovery. It should be noted, however, that the ideas of smart circular economy and smart product-service systems might be compatible.

Figure 12 Building a circular supply chain in the sharing economy – phase IV



Source: Own elaboration based on Jayakumar et al. (2020, p.412)

Furthermore, the visualisation developed (Figure 12) might provide a basis for developing a circular supply chain framework for the sharing economy.

6 Conclusion

In summary, the following conclusions were formulated. The interplay between the circular supply chain and the sharing economy enables supply chain participants to

facilitate the building of a circular supply chain of products following the principles of the sharing economy. It includes, among others, the introduction of product servitisation or product-service systems.

The focus of this paper is consistent with the Sustainable Development Goals ('THE 17 GOALS | Sustainable Development', 2020), especially with Goals 9 (Build resilient infrastructure, promote inclusive and sustainable industrialisation, and foster innovation) and 12 (Ensure sustainable consumption and production patterns). Building circular supply chains in sharing economy (e.g., using access-based distribution systems) might promote sustainable industrialisation and ensure both sustainable consumption and sustainable production patterns.

It should be noted that sharing economy on B2B and B2C markets is related to providing access to the products to the consumers. Therefore, the access-based distribution model might be the most suitable distribution model for circular supply chains in the sharing economy.

In addition, the key aspects of building a circular supply chain in the sharing economy are the following:

- Facilitating access to the final product to end users by manufacturers and distribution companies. It might include implementing a product-service system.
- Matchmaking of supply and demand between companies and consumers in terms of access to goods or services without transfer of ownership. It might include the use of electronic platforms and participation of circularity brokers.
- Coordination of material recovery between end users, distribution companies, manufacturers and material recovery plants. It might include implementing the concept of a smart circular economy.

7 Implications for business

Building a circular supply chain in the sharing economy requires cooperation between companies that have different roles at different levels of the supply chain. It includes, among others, cooperation between manufacturers and distribution companies that provide access-based distribution and between material recovery facilities and all companies involved with material recovery. Therefore, the main implication related to the focal topic for business is building relationships with other supply chain participants willing to build circular supply chains in the sharing economy.

Such relationships might include coopetition between different manufacturers or between different distribution companies focused on material recovery or collecting used products.

8 Implications for government

The main implication for the government is strictly related to sharing economy. Taking into account the review of the literature, the key issue for stimulating the development of sharing economy is lowering barriers to entry to raise competition between the companies

willing to introduce access-based distribution to their clients (Echikson, 2020, p.12; Eckhardt et al., 2019, p.11; Hossain, 2020, p.8).

9 Recommendations for future research

This paper focuses on the role of circular supply chains in the sharing economy. Taking into account the conducted review of the existing literature, the first recommendation for future research is related to studying the interplay between the circular economy and the sharing economy. Linking these two concepts could provide new insights related to limiting negative environmental impacts.

Future research might also include possibilities of implementing such concepts as product-service systems and smart circular economy. Such a study could provide further information on possibilities related to building of a circular supply chain in sharing economy.

The last recommendation for future research is related to the study of drivers, enablers, and barriers of building a circular supply chain in sharing economy. This study might be divided into two parts. The goal of the first part would be determining drivers, enablers, and barriers related to providing access-based distribution to end-users. The second part would determine these factors regarding material recovery.

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