H2020 MSCA-ITN-2018

ReTraCE Project

Realising the **Tra**nsition towards the **C**ircular **E**conomy

D1.3

Circular supply chains and related collaboration practices

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Project Information

Acronym: ReTraCE

Title: Realising the Transition towards the Circular Economy: Models, Methods and Applications

Coordinator: The University of Sheffield

Grant Number: 814247

Programme: H2020-MSCA-ITN-2018

Start: 1st November 2018

Duration: 48 months

Website: www.retrace-itn.eu

Consortium:

The University of Sheffield (USFD)
Università degli Studi di Napoli Parthenope
University of Kassel (UniKassel)
South East European Research Centre (SEERC)
Academy of Business in Society (ABIS)
Högskolan Dalarna (HDA)
University of Kent (UniKent)
Tata Steel UK Limited (Tata)
Olympia Electronics SA (OE)
Erasmus University Rotterdam (EUR)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Deliverable

Number: D1.3

Title: Circular supply chains and related collaboration practices

Lead beneficiary: UniKassel

Work package: WP1

Dissemination level: Public

Nature: Report (RE)

Due date: 30th April 2021

Submission date: 30th April 2021

Contributors: Sudusinghe, J.I., Alexandre de Lima, F., Seuring, S., Lowe, B., Bimpizas, A., Calzolari, T., MahmoumGonbadi, A., Genovese, A.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Table of Contents

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

List of acronyms

AM – Additive manufacturing

CBM – Circular business model

CE – Circular economy

CLSC – Closed-loop supply chain

CSC – Circular supply chain

EMS – Environmental management system

EoL – End of Life

EU – European Union

OEM – Original equipment manufacturer

OLSC – Open-loop supply chain

OM – Operations management

NGO – Non-governmental organization

R&D – Research and development

RL – Reverse logistics

RSC – Reverse supply chain

SC – Supply chain

SCM – Supply chain management

SLR – Systematic literature review

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

1. General purpose and objectives of the report

The transition from the traditional take-make-dispose economy to the circular economy (CE) is in its early stages. The CE offers an alternative approach to the linear production and consumption model with a regenerating model wherein waste is transformed into resources (Garcia-Muiña et al., 2018). Hence, the CE offers solutions for eliminating waste/pollution and keeping products and materials in use (Ellen McArthur Foundation, 2021).

The goal of CE implementation is to offer economic advantages to companies while benefitting society and the environment (Geissdoerfer et al., 2017). For instance, environmental outcomes include further reducing waste and emissions while improving community engagement through the creation of jobs (Korhonen et al., 2018a). As a result, in view of the sustainable impact caused by the CE, many different governments and organisations are advocating for a paradigm shift towards the CE across the globe.

Supply chains (SCs) play a notable role in implementing the CE by adopting circular production models (Batista et al., 2018b). Intra- and inter-organisational relationships are crucial for this adoption, especially in regards to the decision-making process (Jabbour et al., 2019), because well-maintained relationships assist in addressing management limitations relating to physical and energy flows in SCs (Korhonen et al., 2018b). However, relatively little is understood about how circular supply chains (CSCs) support the implementation of CE strategies (Batista et al., 2018a) and how operations management (OM) decision-making approaches must change with the adoption of new business models (Jabbour et al., 2019). This report extends this discussion on OM decision making regarding intra- and inter-organisational relationships in CSCs.

The collaborative involvement of different stakeholders, including practitioners, academics and policymakers, facilitates the transition of SCs towards the CE due to these stakeholders' unique expertise and capabilities. As a result, this report reflects on the initial steps of this attempt from a combined theoretical and practical viewpoint to foster collaboration within CSCs. The purpose of this report is to comprehensively explore the role of SC collaboration in the CE context. The content of this report is mainly comprised of the findings of 58 peer-reviewed research articles. These articles were systematically reviewed against the constructs identified by Chen et al. (2017) and Ni and Sun (2019) to understand different SC collaboration practices that will ensure the smooth transition towards the CE. In order to shift from linear SCs to CSCs, significant changes are necessary to reduce the environmental impact associated with the lifespan of products. This transition can be achieved via collaboration among partners, including suppliers, product designers and regulators, to enable concepts such as prolonging product durability, repairing, remanufacturing and recycling (De Angelis et al., 2018). Hence, the 10 CE implementation strategies proposed by Reike et al. (2018) are used to understand how SC collaboration is linked with CE. Appendix A provides an overview of this systematic approach and the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

applied analytical techniques. Additionally, different industry examples from the real world provide practitioners' viewpoints on how SC collaboration is associated with the CE.

The remainder of this report is structured as follows. Section 2 provides an overview of the CE and CSCs, while Section 3 introduces collaboration in CSCs and details the findings of the systematic literature review (SLR). Section 4 is dedicated to understanding how SC collaboration is associated with CE implementation, which is followed by concluding remarks in Section 5.

2. Background of the report

This section introduces the key concepts of this report, such as the CE and CSCs, and presents the scholarly discussion on these themes as derived from the SLR findings.

2.1. Introduction to the CE

The concept of the CE has its roots in a collection of different scientific fields, including industrial ecology, industrial symbiosis, cleaner production and ecological economics (Ghisellini et al., 2016; Korhonen et al., 2018a). While CE implementation has only recently received increased interest in the European Union (EU), other governments – such as those in China and Japan – as well as numerous business organisations and non-governmental organisations (NGOs) have been at the forefront of its implementation. The EU expects to include more robust standards and norms in production along with providing tax relief for circular products, expanding circular procurement and supporting eco-industrial parks and awareness campaigns (Hartley et al., 2020). These planned actions hint at the need for an academic approach to CE to support the societal changes required for this global transition (Merli et al., 2018). Specifically, in order to create a paradigm shift towards a sustainable CE, the knowledge coming from engineering and natural science-oriented fields should be integrated with management or social science fields (Korhonen et al., 2018b). The recent scholarly discussion on the CE has mainly addressed waste management strategies and sustainability while proposing CE implementation to bolster environmental and economic outcomes (Merli et al., 2018).

As the CE concept traces back to multidisciplinary fields and conceptual foundations, there is a lack of consensus on a specific definition of the CE (Kirchherr et al., 2017). Nevertheless, Geissdoerfer et al. (2017) claimed that the most renowned definition of a CE was provided by the Ellen MacArthur Foundation (2013), which states that 'a circular economy is an industrial system that is restorative or regenerative by intention and design' (p. 7). In this regard, Geissdoerfer et al. (2017) pointed out that the purpose of the CE lies in better use of resources and ideally eliminating all resource inputs and leakages out of the system. Bocken et al. (2016) proposed three types of resource loops – slowing, closing and narrowing – applied in the transition towards the CE. Under slowing resource loops, the focus is on prolonged use and reuse of products, while closing loops focused on reusing materials by recycling. The narrowing loop approach aims to reduce the use of resources

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

and differs from the other two approaches in that it does not affect the speed of resource flows nor involve any service loops (such as repairing).

As one of the leading think tanks driving the implementation of the CE globally, the Ellen McArthur Foundation (2015) presented four main building blocks of the CE: (1) circular product design and production, (2) new business models, (3) reverse cycles and (4) enablers and favourable system conditions.

(1) Circular product design and production

With a circular product design, the 'interchangeability, upgradability, modularity, energy-efficiency or maintainability of products and product components' (Henry et al., 2020, p. 5) are increased. As a result, resource flows are slowed down, and product life cycles are extended (Bocken et al., 2016). Since the designing of a product is initiated at the very early stages, companies' commitment to designing and developing these products is crucial (Howard et al., 2019). Designers with unique and advanced skills are needed to adopt a holistic approach to understanding social, economic and environmental needs (Farooque et al., 2019).

(2) New business models

Business models play a major role in the transition from the linear economy to the CE (Henry et al., 2020). Hence, the concept of circular business models (CBMs) is becoming more attractive due to their driving effect towards sustainable production and consumption (Hofmann, 2019). Moreover, CBMs tend to shift companies from ownership-based models to service-based models focusing on the consumer as the user, hiring, leasing and product-service systems (Howard et al., 2019). CBMs have a positive effect on economic growth when natural resources are finite, and thus they are encouraged by academia and practitioners and endorsed by policymakers and business consultancies (Hofmann, 2019).

(3) Reverse cycle

Reverse cycles allow for the recovery of end-of-life (EoL), after-use and intermediate by-products from original equipment manufacturers (OEMs), suppliers, customers and third parties, making this a prominent method for implementing CE practices at the inter-organisational level (Mokhtar et al., 2019). It is important to note that establishing cost-efficient and high-quality collection points and treatment centres for effective segmentation of EoL products is imperative to address the uncertainties relating to resource flows in reverse cycles (Howard et al., 2019). Doing so improves the financial benefits brought to the company through resale and reuse of recovered products (Larsen et al., 2018).

(4) Enablers and favourable system conditions

The Ellen McArthur Foundation (2015) highlighted the importance of different enablers, such as education, to improve the skills needed for circular innovations, financial investment in research and development (R&D) and collaborative platforms to empower joint product development for the transition to circularity. In particular, the foundation has emphasised the government's role in creating a stable regulatory environment to

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

support this transition. For instance, the European Commission – understanding the importance of certain products and processes – has already launched a product policy framework with its CE Action Plan. This guideline empowers consumers and directs producers in seven key product value chains: electronics, information and communication technology; batteries and vehicles; packaging; plastics; textiles; construction and buildings; and food (European Commission, 2020).

2.2. CE implementation strategies

From the discussion of CE implementation above, it is evident that the underlying strategies of the CE mainly point towards the three R imperatives: reduce, reuse and recycle. These have been extended to more value-retention options in view of different strategies that could be incorporated to retain a product's value throughout its life cycle. The work of Reike et al. (2018) demonstrates an extension of these R imperatives with 10 value-retention options focused on conserving resources and ensuring the existence of EoL products. These 10 Rs (Table 1) comprehensively address plausible strategies driving operations in the CE context. Hence, the CE perspective of this report is explored through the lens of these 10 Rs (CE implementation strategies), which are further categorised into short-, medium- and long-term loops.

Table 1. CE Implementation Strategies, adapted from Reike et al. (2018)

R Imperative	Description
Short-term loops – Products remain closer to the user	
R0: Refuse	Consumers buying/using less products and rejecting packaging waste; producers refusing to use hazardous material and designing products to avoid waste
R1: Reduce	Consumers using products for a longer time; producers using less material in production (dematerialisation)
R2: Resell/Reuse	Consumers buying second-hand/hardly used products; producers directly reusing unsold returns
R3: Repair	Customer or a repair company extending the life of a product by replacing defective parts
Medium-term loops – Products are upgraded with the involvement of the producers	
R4: Refurbish	Overall upgrade of the product by repairing or replacing certain components of the product
R5: Remanufacture	Product returned to original state after disassembling, cleaning and checking to see where replacement and repair are necessary
R6: Repurpose	Material from abandoned products used for completely different functions (e.g., creating jewellery from the gold retrieved from discarded electronic circuits)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

R Imperative	Description
Long-term loops – Products that lose their original function	
R7: Recycling	Processing of post-consumer products and post-producer waste using expensive technological equipment to capture (nearly) pure materials
R8: Recover Energy	Capturing energy from waste, mainly by incineration
R9: Re-mine	Remining landfills (urban mining), commonly found in developing countries

Organisations need to collaborate with others within and outside CSCs to maximise the utility of products and materials (Farooque et al., 2019) through these Rs. For instance, Red Paddle Co, which manufactures inflatable paddle boards, focuses on the repairability of newly launched products and includes a repair kit with board packages to indicate to the consumer the strategic direction of the company (Woolven, 2020a). Happy Baton, based in Hong Kong, is a company enhancing the reuse of toys. The company collects toys that are no longer needed or wanted from consumers and reuses the returned toys through their online platform. This online platform allows consumers to curate a box of toys and get it delivered. The users can renew the set of toys monthly by swapping their old toy box for a new one (Robertson-Fall, 2020).

How these 10 Rs are being discussed in the supply chain management (SCM) literature is depicted through the frequency of occurrences of terms, illustrated in Figure 1. These frequencies indicate the level of popularity in the analysed body of knowledge. The adopted methodology for this analysis is further discussed in Appendix A.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

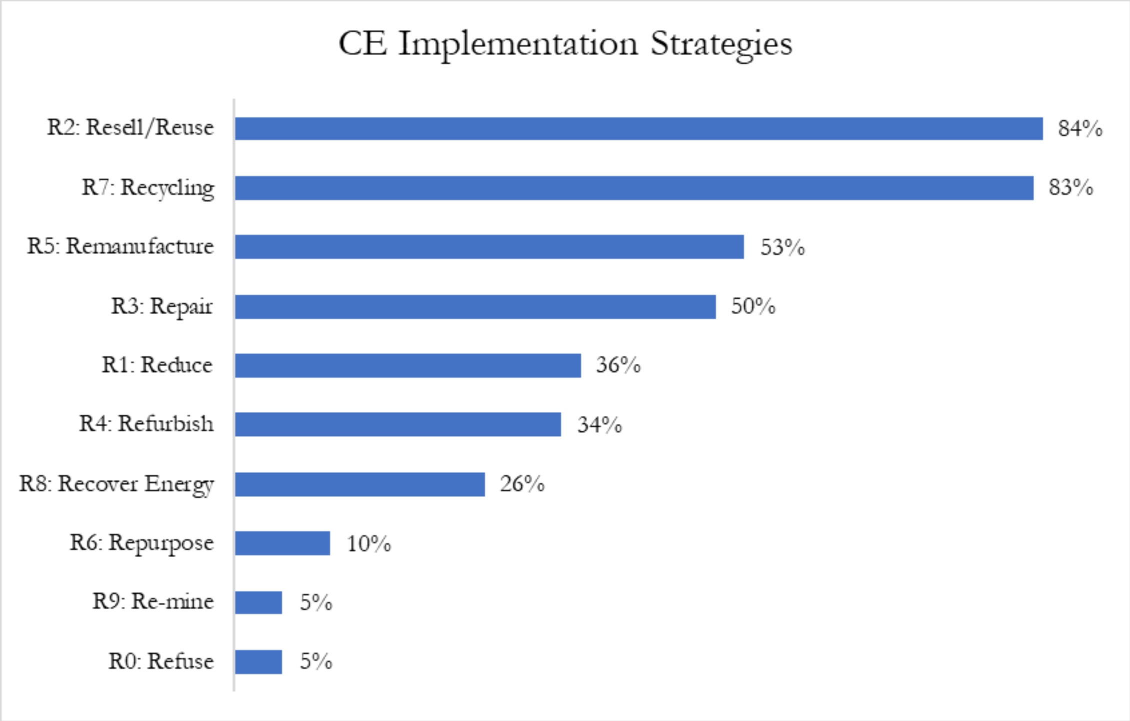

Figure 1. Frequencies of CE Implementation Strategies (N=58 articles)

The most frequently discussed CE strategies were R2: Resell/Reuse and R7: Recycling, which fall under short- and long-term loops, respectively. The least discussed CE strategies were R0: Refuse and R9: Re-mine. This finding is further aligned with the arguments by Reike et al. (2018) and Li et al. (2017), who pointed out that R2: Resell/Reuse has been discussed in the literature more often than R0: Refuse, while R9: Re-mine is an emerging research focus in the CE context. Overall, the findings of Figure 1 reflect that CE implementation at the SC level occurs in different circularity stages. However, whether these popular Rs genuinely contribute to the transition towards the CE with improved sustainability performance is an ongoing debate (Garcia-Muiña et al., 2018).

These different CE implementation strategies are employed in distinct levels, such as the micro, meso and macro levels (Ghisellini et al., 2016; Su et al., 2013). The micro level focuses on the view of a single organisation (intra-organisational), while the meso and macro levels focus on the eco-industrial park perspective (inter-organisational level within geographic proximity) and provincial level with more complex networks, respectively (Su et al., 2013). Merli et al. (2018) introduced a new level – the supply chain level – by considering the necessity of studying circular exchanges in SCs. Since the focus of this report is on the circularity of SCs, the next section scrutinises the role of SCs and why such a distinctive level is crucial in CE implementation.

2.3. Supply chain archetypes in the CE

SCs in the CE context can be categorised as open loops, closed loops and multiple cascades depending on the flow of products, components and materials (Howard et al., 2019). However, the discussion on conceptualising

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

CSCs is an ongoing debate in the scholarly literature. These different SC archetypes are challenging to comprehend due to the complexity of the different parties involved and their geographically dispersed nature. Hence, the Ellen McArthur Foundation (2014) elaborated these archetypes based on geography, as shown in Table 2.

Table 2. SC Archetypes in the CE, adapted from the Ellen McArthur Foundation (2014, p.39)

SC Archetypes in the CE	Description
Global closed loops	EoL products/components are returned to their country of origin to use their recycled materials in the production of the same or similar products/components.
Regional closed loop	EoL products/components are mainly collected in the region of usage, reengineered/remanufactured regionally and sold into local markets.
Partially open local/regional loop	EoL products/components are returned to manufacturing facilities in the same regions, and their recycled materials are used in the production of the same or similar products/components.
Open cascade	EoL products/components are collected and sold to secondary markets, where material/EoL product flows are not regulated.

A global closed-loop SC is the only one of the four SC archetypes with global reach, and its main focus is on recycling the returned EoL products and components. For instance, H&M closed the loop for fibres by crushing the used jeans collected from their global customer base and transforming them into threads to use in new jeans. A similar approach is followed at the local level by South African Breweries with a returnable bottle system, which exemplifies the regional closed-loop in SCs (Ellen McArthur Foundation, 2014). Another archetype is the partially open local/regional loops, in which EoL products and components are returned to the manufacturing facilities for use in the same or similar products. For example, the car manufacturer Renault remanufactures parts for their gearboxes and engines in regional remanufacturing plants and integrates them back into refurbished gearboxes and engines (Ellen McArthur Foundation, 2014). Lastly, the open cascade connects these different SCs. For instance, Switzerland-based I:CO is working with the garment sector to collect used garments and send them to people in need in Sub-Saharan Africa (Ellen McArthur Foundation, 2014).

3. Collaboration in CSCs

Considering the different archetypes presented, it is clear that the role of reverse supply chains (RSCs) is eminent. Hence, SCs in the CE context are trending as an integration of forward and reverse SCs. RSCs facilitate the amalgamation of recovered products and parts back into the forward SCs (Schenkel et al., 2015). Hence, good relationships need to be managed among the actors in forward and reverse SCs.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

3.1. The importance of collaboration in CSCs

SC collaboration is defined as two or more independent SC members working together to achieve greater success than acting alone. This can be done through information sharing, joint decision making and benefit sharing, and it can result in higher profitability and greater competitive advantage (Simatupang & Sridharan, 2002). Even though the focus of SC collaboration was initially limited to financial outcomes, scholarly discussions are extending towards ensuring environmental and social outcomes as well (Chen et al., 2017). Exploring the role of SC collaboration in the CE context, Jäger (2020) identified the following four advantages:

1. The transition of an industry towards the CE can be smoothed by addressing systematic changes as key stakeholders align their efforts through SC collaboration.
2. Competitive advantage can be increased at a business level with critical resources spanning the business boundaries.
3. The costs – especially relating to production and R&D – can be lowered through SC collaboration in the CE context.
4. CBMs can be efficiently executed by gathering and sharing knowledge.

Understanding the crucial nature of SC collaboration in the CE context, De Angelis et al. (2018) argued that existing relationships in SCs need to be redefined or transformed to achieve the unique characteristics expected of CSCs, especially as they move from product ownership to service-based strategies. Importantly, Miemczyk et al. (2016) argued that companies need to maintain relationships with different external parties beyond their system boundaries. Therefore, the next section of this report focuses on understanding different collaboration practices to ensure the transformation of SCs towards circularity.

3.2. Different types of SC collaboration practices in the CE context

Companies tend to engage in different collaboration practices to ensure improved performance of both the company and SC. For this report, the frameworks developed by Chen et al. (2017) and Ni and Sun (2019) were utilised to comprehensively study SC collaboration practices. SC collaboration practices can be categorised into three main aspects, as depicted in Figure 2. Different collaboration practices under these three aspects are listed in Tables 3, 4 and 5. Appendix A elaborates on the methodology used to study frequencies under each collaboration practice.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

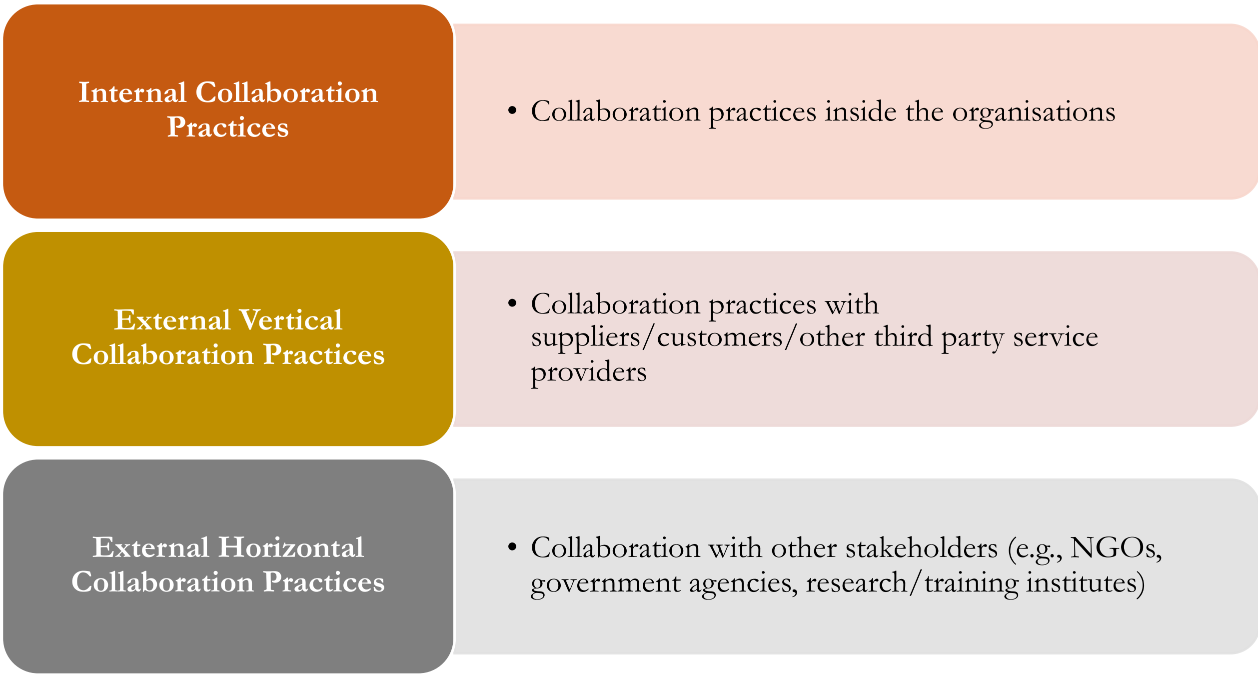

Figure 2. Three Aspects of SC Collaboration Practices, adapted from Chen et al. (2017)

3.2.1. Internal collaboration practices

Table 3 presents the leading internal collaboration practices, and Figure 3 illustrates how frequently these practices are discussed in the CE based SCM literature.

Table 3. Internal Collaboration Practices, adapted from Chen et al. (2017)

Internal Collaboration Practices	Description
Implementing cross-functional coordination	Different members from different functions/departments working together to achieve sustainability
Internal process integration	Ensuring that the internal processes are connected and simplified
Adopting an environmental management system (EMS)	A formal system integrating procedures and processes relating to training, monitoring and summarising of environmental performance information, which is reported to firms' internal and external stakeholders

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

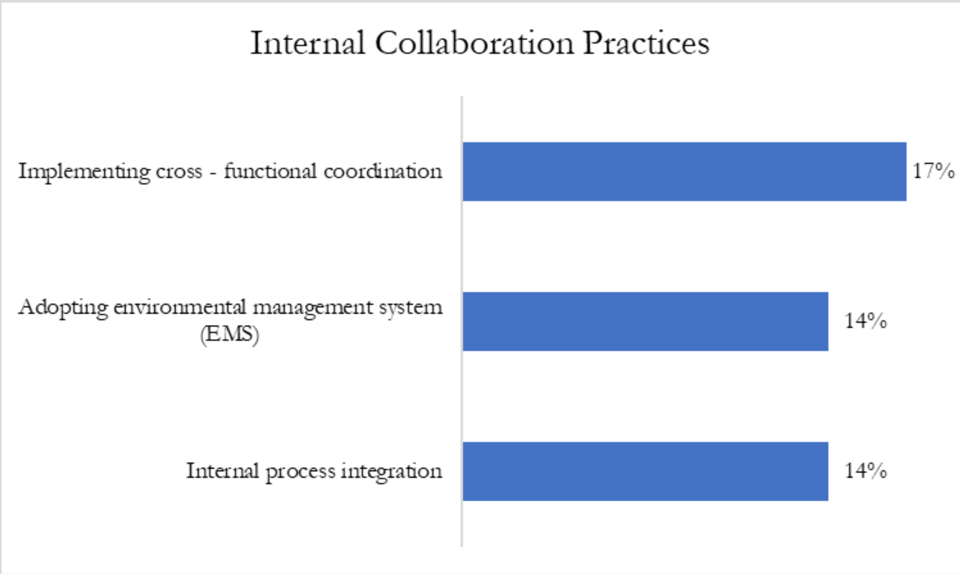

Figure 3. Frequency of Internal Collaboration Practices (N=58 articles)

As depicted in Figure 3, the overall discussion on internal collaboration practices is limited. The most frequently discussed internal collaboration practice is implementing cross-functional coordination, and the most common approach to ensure this practice is cross-functional training (Kurilova-Palisaitiene et al., 2018). Cross-functional coordination can be implemented easily in organisations through cross-training employees, as these capacity-building activities help people to lift each other up and to share knowledge and best practices (Ünal et al., 2019). Therefore, this has been highlighted as a good internal practice relating to circularity in operations.

Adopting an EMS is identified as another good collaboration practice to integrate the CE into a company's operations (Marrucci et al., 2019). With this practice, the internal commitment to resolve environmental issues can be viewed and assessed across a company's operations (Botezat et al., 2018). More importantly, EMS can work as a common platform to share the company's environmental performance with its stakeholders, such as customers, regulators and the public (Shih et al., 2018). However, the attention given to EMS in circular operations is limited, as shown in Figure 3.

Internal process integration is vital to achieving substantial reductions in industrial energy, water and utility use in the CE context (Walmsley et al., 2019). Cross-disciplinary knowledge transfers can be facilitated with process integration to enhance collective progress towards sustainable development (Walmsley et al., 2019). However, the discussion on process integration from a collaborative approach is still lacking in the SCM discourse.

3.2.2. External vertical collaboration practices

Table 4 presents the external vertical collaboration practices in detail.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Table 4. External Vertical Collaboration Practices, adapted from Chen et al. (2017) and Ni and Sun (2019)

External Vertical Collaboration Practices	Description
Penalties and incentives for sustainability-related actions	Implementing penalties (e.g., reduction in business opportunities) and incentives (e.g., priority in future business opportunities) to promote SC actors' sustainability-oriented behaviours
Sharing information with key suppliers/customers	Sharing information such as sales forecasts, production plans, order tracking, delivery status and stock level with suppliers and customers
Product design/modifications	Collaboration with suppliers and customers to design/modify products
Risk sharing	Collaboration with suppliers and customers to manage risks of a single partner in the SC
Sharing responsibility for product recovery	Suppliers and customers share responsibility for recovering used/EoL products
Long-term agreement	Arranging contracts and warranties with suppliers and customers to ensure the CE-related practices are implemented
Inter-organisational trust	The role of trust placed in an SC partner by the other partners in the SC
Communication with key suppliers/customers	Open communication with suppliers and customers to enhance SCs' sustainability performance
Technological integration	Integrating and aligning suppliers' and customers' technological systems to improve the sustainability performance of SCs
Process design/modification	Collaboration with suppliers and customers to design/modify processes
Supplier monitoring	Closely monitoring suppliers through activities such as third-party certifications, social impact assessments and supplier audits
Green purchasing	Integrating environmental aspects into purchasing policies and other programmes in the SCs
Logistical integration	Integrating and aligning suppliers' and customers' logistical systems/operations to improve the sustainability performance of SCs
Infrastructure integration	Integrating suppliers' and customers' SC infrastructure to improve the sustainability performance of SCs
Product development	Collaboration with suppliers and customers to develop products
Revenue sharing	Suppliers and customers sharing the revenues and benefits earned through collaborative approaches ensuring sustainability performance of SCs

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

External Vertical Collaboration Practices	Description
Quality improvement	Collaboration with suppliers and customers to improve quality
Supplier development	Suppliers supported by focal firms to improve their capabilities
Cost control	Collaboration with suppliers and customers to manage SC costs
Kanban	Implementing a kanban ordering system to tackle remanufacturing challenges that result in longer lead times
Continuous replenishment	Collaboration with suppliers and customers to ensure continuous availability of products
Vendor-managed inventory	Focal firms manage the availability of products through continuous monitoring
Just in time	Suppliers deliver products/materials when necessary without storing inventory

Figure 4 depicts the frequencies at which the external vertical collaboration practices were found in the literature.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Figure 4. Frequency of External Vertical Collaboration Practices (N=58 articles)

The green bars represent the five most frequently discussed vertical collaboration practices, which are further elaborated below.

(1) Penalties and incentives for sustainability-related actions are among the most commonly discussed collaboration practices. Financial or alternative incentives motivate the process of product returns (Mishra et al., 2018) while improving the quality of the collected waste (Zacho et al., 2018). For instance, Caterpillar includes a core deposit in their pricing scheme to encourage the consumer to return the product for an economic incentive. As a result, Caterpillar has been successful in keeping the embodied energy and materials within the Caterpillar network (Ellen McArthur Foundation, 2017a). Companies also use penalties to control the supply chains' environmental performance (Sellitto & Murakami, 2018). For instance, a focal company can cause reputational damage by blacklisting a supplier for misconduct or non-compliance. However, the decision making relating to this practice is crucial when managing relationships in the SC (Jabbour et al., 2019).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

(2) Sharing information with key suppliers/customers is another one of the most commonly discussed SC collaboration practices. A good example relating to sharing information in the CE context is illustrated by e-Choupal, an online platform empowering farmers in India. This platform shares crucial information, such as demand data, pricing information and weather forecasts, with farmers (Ellen McArthur Foundation, 2017b). As a result, farmers can make better decisions and improve their economic and competitive capacity. For instance, they can address the mismatch of supply and demand and reduce their production waste.

(3) Product design/modification is recognised as a basis for adopting a holistic approach to address different aspects of sustainability in CSCs (Farooque et al., 2019). For instance, producers are moving towards new digital technologies, such as additive manufacturing (AM) in the CE, leading to advanced product designs (Rosa et al., 2020). In such cases, engaging new SC partners, such as the AM system vendors, to integrate manufacturing techniques in the product design process is essential (Mellor et al., 2014).

(4) Risk sharing is also a frequently discussed collaboration practice and a common strategy for adopting the CE (Farooque et al., 2019). Contracts are formal governance instruments used to share risks (Cardoso de Oliveira et al., 2019). However, drawing up such contracts can become difficult in the CE context due to the high uncertainty of reverse flows (Larsen et al., 2018).

(5) Sharing responsibility for product recovery ensures that products are returned to the SC (Mishra et al., 2018). With this practice especially, the producers' extended responsibility can also be shared. For instance, the retailer can collect the products directly from the end consumer rather than the manufacturer while making it easier for the end consumer to hand over the EoL product. H&M conducts such a global initiative by collaborating with their retail outlets to collect worn garments from their end consumers (H&M Group, 2019).

The other observed SC collaboration practices are shown in the blue coloured bars in Figure 4, and how they have been applied to ensure the circularity of SCs is discussed further below.

Long-term agreement is one such practice that assists in formalising collaborations between organisations while specifying the obligations and expectations of each party (Howard et al., 2019). Kalverkamp (2018) discussed different types of remanufacturing contracts: ownership-based, service, direct order, deposit-based, credit-based, buy-back and voluntary-based contracts. Warranties are another approach to improving remanufacturing strategies (Jensen et al., 2019). Given that most negotiations among focal firms and their partners are established through formal contracts, long-term agreements play an important role in the CE transition (Cardoso de Oliveira et al., 2019). Pay-per-use contracts play a salient role in developing relationships between businesses and consumers, especially with new CBMs. For instance, Michelin leases tyres under a pay-per-kilometre contract. As a result, they provide tyre management services such as upgrades, maintenance and replacement to large truck fleets worldwide (Ellen McArthur Foundation, 2013).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Inter-organisational trust is a crucial collaborative practice to ensure confidence that the parties involved will keep their verbal and contractual promises. This practice is essential for a closed-loop system regardless of how compatible the different operations and systems are (Rajala et al., 2018). For instance, a construction company created a collaboration tool to engage various parties in a construction project through a software called Building Integrate Modeling. This software reveals the availability and flow of all the materials for all the members engaged. Trust is integral when developing a platform where an immense amount of information is shared (Leising et al., 2018). Trust can be developed based on pre-existing links, and it can be further developed through social networking. In the CE context, industrial symbiosis is an example of how trust among different partners in SCs can be improved through social networking (Herczeg et al., 2018).

Communication with key suppliers/customers is also an effective practice in the CE context to align SC actors towards a common goal (Ünal et al., 2019). Information technology-based solutions play a major role in this practice (Kalverkamp, 2018). For instance, communication techniques such as cognitive radio and peer-to-peer communication are currently being used to advance CE implementation while ensuring secure, reliable and sustainable communication channels (Demestichas & Daskalakis, 2020). Furthermore, uncertainty regarding other parties' behaviours can be reduced with close communication (Mokhtar et al., 2019).

Technological integration can improve the operational efficiency in reverse logistics by improving product tracking and return material authorisation (Yang et al., 2019). Industry 4.0, with its intelligent technologies (such as 3D printing and the Internet of Things), is the core driving force for this integration in the CE context (Niu et al., 2019). For instance, Maersk, the Danish integrated shipping company, plans to recycle their full vessels via a Cradle to Cradle Passport as they integrate their suppliers with another shipbuilding company named DSME, and they will share information on the material composition of the products (Sterling, 2020). This technological integration will improve the circularity of resource flows in the shipbuilding industry. Opendesk Furniture is a furniture retailer that has set an example by selling furniture designs instead of actual furniture. The company collaborates with global independent designers to make furniture designs available in shareable and downloadable files. Through this online platform, they connect customers to local professional furniture makers, resulting in reduced shipping, short last-mile deliveries and less packaging (Woolven, 2020b).

Collaboration on process design/modification is crucial given the operational changes required to transition towards a CE. Hence, companies collaborate to get the essential support and skills of all partners (Herczeg et al., 2018; Ünal et al., 2019). In the construction industry especially, when developing circular buildings, a new process design is required to integrate different disciplines in the SC early on. For instance, when renewable energy is used as a substitute, the building process needs to be changed by collaborating with different parties involved in the construction SC (Leising et al., 2018).

Supplier monitoring is another collaboration practice falling under supplier relationship management in the CE context (Zeng et al., 2017). For instance, companies such as Bluesign assist focal firms with auditing their

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

suppliers and reducing their environmental footprint. They track all the raw materials used in production and audit the processes to categorise raw materials into three categories: blue (safe to use), grey (requires special care) and black (prohibited). They further monitor suppliers to ensure that they do not use materials in the black category while paying special attention to those in the grey category. Additionally, they assist suppliers with moving from the grey to blue category (PwC, 2018).

Green purchasing, when linked with the CE, creates major changes to ensure sustainable performance (Dubey et al., 2019) by reducing waste and improving efficiency (Cardoso de Oliveira et al., 2019). For instance, buy-back relations falling under green purchasing is important in the CE context (Kalverkamp, 2018). Biopak is one such company that purchases responsible raw materials for the production of their compostable foodservice packaging (Ellen McArthur Foundation, 2018a).

With logistical integration, resource loops are slowed by managing take-back logistics systems (Farooque et al., 2019). For logistical integration, an information system is required to collect, store and analyse the operational data. In industrial symbiosis especially, such a system can be handy to overcome operational challenges related to logistics (Herczeg et al., 2018).

Infrastructure integration empowers companies to reach new heights in operations by providing access to new infrastructures such as machines and R&D facilities. Especially in eco-industrial parks, resources such as infrastructure are shared among the companies and their surrounding communities to achieve sustainable development along the path towards realising the CE (Zeng et al., 2017). Such an instance is depicted by an architecture company that collaborates with different organisations to reuse existing buildings rather than demolishing them to build new ones while saving energy and resources (Ünal et al., 2019).

Companies can collaborate through joint product development to achieve cross-value chain collaboration (Howard et al., 2019). As companies move towards 3D printing, they collaborate with different suppliers to develop the product to match the new technology. For instance, KLM, Royal Dutch airline, has started 3D printing repair tools for its fleet using empty PET bottles, and they work closely with the Morssinkhof Rymoplast, recycling company to receive high-quality plastic pallets for use in 3D printers (Royal Dutch Airlines, 2019).

Collaboration for quality improvement is critical in the CE context given the many uncertainties faced in CSCs due to quality issues (Zacho et al., 2018). For instance, Renault has collaborated with many stakeholders such as INDRA and Synova to develop short-loop initiatives, and polypropylene is one of many materials in this initiative. Collaboration for quality improvement is crucial to this attempt at compounding plastic pellets extrusion (Ellen McArthur Foundation, 2018b).

Supplier development is vital to support SC partners to develop the awareness and skills needed for a CBM (Ünal et al., 2019). For instance, Red Paddle Co works closely with their suppliers to educate them regarding

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

the focus of the CE and how their behaviour affects the business. However, they have found this collaboration with second-tier suppliers to be quite difficult, as the latter party neither understands the purpose of the focal company nor how it will profit immediately. As a result, they have faced some issues in ensuring the sustainability of raw materials (Woolven, 2020a).

The least discussed SC collaboration practices in the CE context are cost control, kanban, continuous replenishment, just in time and vendor managed inventory. Interestingly, these are the commonly identified collaboration practices in the traditional SCM literature (e.g., Manthou et al., 2004; Ramanathan and Gunasekaran, 2014; Sari, 2008). Therefore, the integration of collaboration practices into the operational aspect of CSCs is an area that requires further attention in the future.

3.2.3. External horizontal collaboration practices

Collaboration practices with other stakeholders of the SC are elaborated in Table 5, while their frequencies are presented in Figure 5.

Table 5. External Horizontal Collaboration Practices, adapted from Chen et al. (2017)

External Horizontal Collaboration Practices	Description
Collaboration with government	To promote practices relating to the CE (e.g., improving product take-back efforts by introducing incentive schemes) and support a top-down approach to achieving sustainability performance in SCs
Collaboration with other organisations	Such as industry associations and academic/research institutions to get support for CE implementation
Collaboration with entrepreneurs/ innovators	To implement the CE through different CBMs and via R&D processes and innovation
NGOs sharing knowledge and experiences	NGOs share knowledge and experiences with different SC partners to implement the CE
Collaboration with competitors	Through practices such as collaborative capacity sharing and joint production
NGOs acting as a bridge for funding	NGOs financially supporting CE implementation (e.g., helping to connect buying firms with poor suppliers or with financial institutes such as banks)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

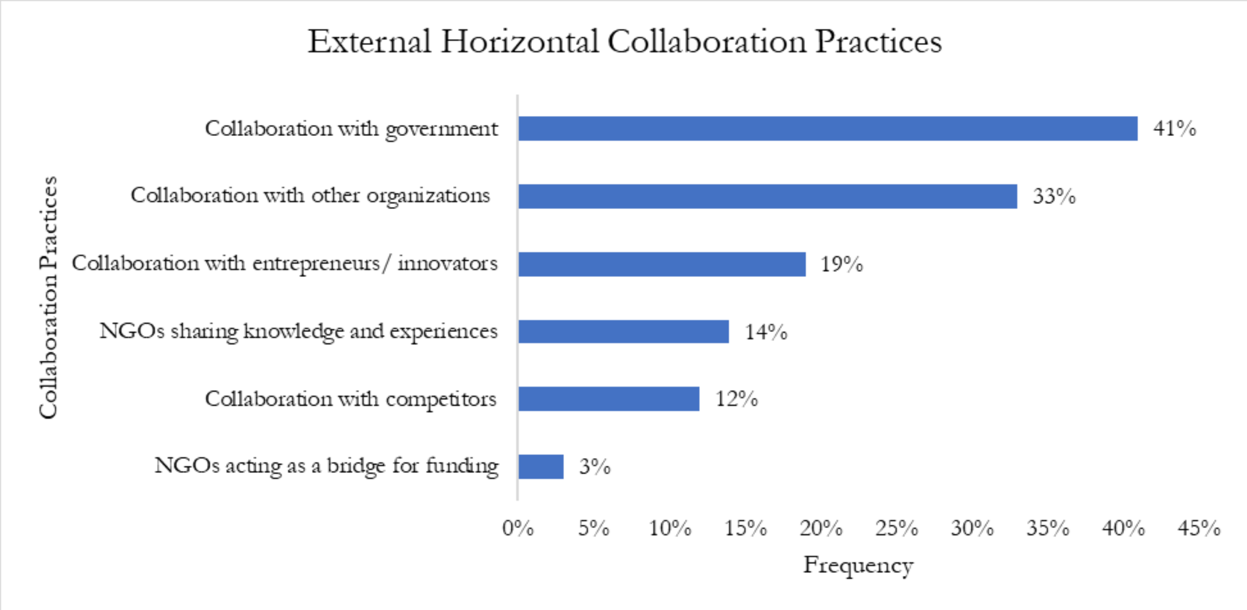

Figure 5. Frequency of External Horizontal Collaboration Practices (N=58 articles)

The most popular practice in this category is collaboration with the government. One of the main reasons for this practice may be the fact that most waste is collected by public authorities (Zacho et al., 2018). Hence, companies have to collaborate with the government sector for the material/product recovery process. For instance, First Solar, an American solar panel manufacturer, initiated discussions with EU officials regarding take-back schemes for solar panels. This discussion on behalf of other industry actors urged amendments to the WEEE directive adopted in 2012 to promote the CE globally (Veleva & Bodkin, 2018).

The other most frequently discussed external horizontal collaboration practice is collaboration with other organisations, such as industry associations and academic institutions. For instance, BioPak, a compostable packaging manufacturer, has collaborated with the Australian Organic Recycling Association and waste management industries to improve access to composting infrastructure (Ellen McArthur Foundation, 2018b). This example illustrates how collaboration can scale operations to the next level beyond the SC boundaries.

In comparison with other practices, collaboration with entrepreneurs/innovators has received less attention. With the increasing number of technologies developed by entrepreneurs (Scheepens et al., 2016), the tendency of this collaboration practice is increasing in the CE context. Companies also partner with social enterprises in the CE context to achieve social benefits (Jensen et al., 2019).

NGOs sharing knowledge and experience is another collaboration practice resulting from NGOs' greater engagement in the promotion of a CE. The Ellen McArthur Foundation is the leading NGO in terms of sharing their knowledge and experience. Another good example is provided by Lego Replay, a new initiative currently piloted in the US that encourages customers to return their used Lego bricks, which are donated to a children's charity. Lego has collaborated with three other NGOs, including Give Back Box to sort, inspect and clean the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

bricks and Teach For America to distribute these bricks among classrooms across the country. The third NGO, the Boys & Girls Clubs of Boston, uses these LEGO bricks in their after-school programmes (LEGO Group, 2019). This example clearly shows how these different NGOs share their knowledge and experience to extend the life cycle of toys.

Collaboration with competitors and NGOs acting as a bridge for funding are the two external vertical collaboration practices that have been given the least attention. Hence, these are two practices that require future research and practitioners' attention.

4. A framework for understanding the role of SC collaboration in the CE context

A contingency analysis was conducted to further understand how the literature connects CE strategies with collaboration practices (the methodology followed for the contingency analysis can be found in Appendix A), and the findings are as follows (see Figure 6).

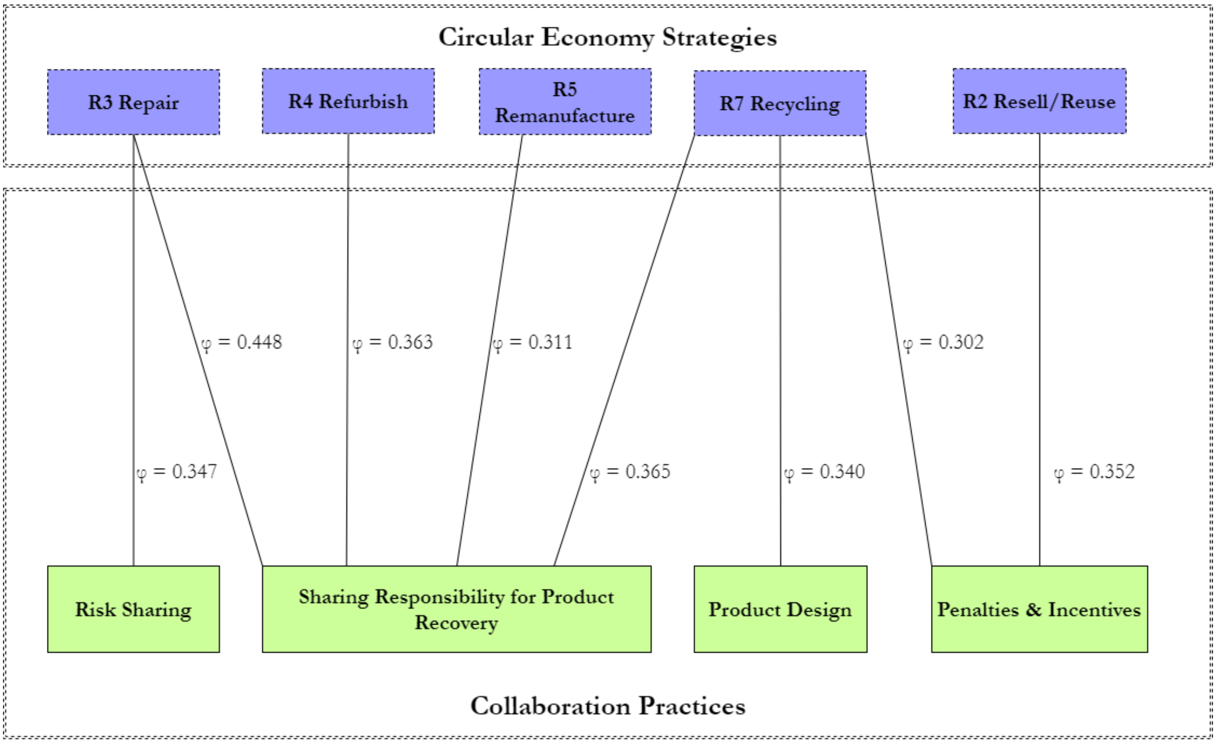

Figure 6. Contingencies Between CE Strategies and SC Collaboration Practices

The most popular collaboration practice to meet with the CE strategies is sharing responsibility for product recovery, with the highest number of positive connections. This practice connects with R3: Repair, R4: Refurbish, R5: Remanufacture, and R7: Recycling, which require the collection of EoL products. For instance, recycling hazardous and critical materials has improved with the introduction of product take-back schemes (Farooque et al., 2019). Further, this shared responsibility for encouraging product returns has motivated the

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

efforts towards repairing, refurbishing and remanufacturing products (Jensen et al., 2019; Zacho et al., 2018). A good example is the Carlsberg Circular Community, where suppliers and local partners such as retailers gathered to optimise packaging reuse and recycling. One approach they followed is creating a waste collection infrastructure to assist partners to return glass bottles for refill at the brewery. Another approach was organising regular campaigns at large music festivals to change consumers' attitude towards recycling (Nielsen, 2014).

Penalties and incentives for sustainability-related actions, which had the second-highest number of positive connections, are connected to R2: Resell/Reuse and R7: Recycling. The quality of the returned products can be further improved by enacting penalties and incentives while encouraging reuse (Zacho et al., 2018). It has also been found that recycling efficiency can be further enhanced via incentives (Chen, 2018). This latter connection with R7: Recycling is especially evident in battery recycling, as the regulatory incentives for battery recycling have resulted in companies searching for suitable recycling technologies abroad (Levänen et al., 2018).

The correspondence between R3: Repair and risk sharing is also straightforward, as repairing can extend a product's life while minimising the quality risks related to deteriorating product attributes (Kurilova-Palisaitiene et al., 2018). For instance, Philips is moving away from the traditional product selling business model to the product as a service model. Hence, they provide light as a service by selling solutions to their customers. As a result, they provide services such as repairing light fittings at hospitals and care providers' premises while sharing the risks related to closing product loops (World Business Council for Sustainable Development, 2017).

The positive connection between R7: Recycling and product design is also very evident in practice given that products need to be designed to be recycled at their EoL. Hence, different parties involved in the SC need to work together to ensure this connection. For instance, Coca Cola Enterprises is working with ECO Plastic in Great Britain and APPE in France to improve the recyclability of its packaging. Hence, they are focused on designing plastic bottles and cans in a fully recyclable manner (Ellen McArthur Foundation, 2020).

These contingencies only point out the strongest connections among CE strategies and collaboration practices as discussed in the SCM discourse with a focus on the CE context. This discussion depicts that there are only a few well-known collaboration practices being implemented in the transition towards CSCs. For instance, the connection of CE strategies with internal collaboration practices and external horizontal collaboration practices is missing. Hence, further exploration is encouraged to understand how other collaboration practices are linked to CE strategies in different industry contexts.

5. Conclusion

The transition towards the CE requires many changes both in practice and theory. Hence, from an SC perspective, new themes and practices will emerge. As a result, the role of SC collaboration is a developing

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

topic receiving much attention. Thus, this report aims to explore new dimensions of SC collaboration and understand how they enhance the implementation of CE strategies.

5.1. Managerial implications

This report depicts how managers can integrate SC collaboration into circular operations both internally and externally. When introducing new circular practices internally, SC collaboration practices such as cross-functional coordination (where employees from various divisions work together) can be useful as employees share their experiences and knowledge relating to these new practices and ultimately make the CE a part of the company culture. Hence, it is noteworthy for managers to acquire comprehensive knowledge on collaboration practices to improve employee engagement and streamline internal operations more successfully. When operationalising circularity with external parties in the SCs, managers need to understand when and where to engage suppliers and customers in their operations. For instance, when a new product is designed, managers should be aware of the external parties involved and invite them to participate in joint decision making, as such actions are only done at the very initial stage of the operations.

When exploring the different SC collaboration practices in the CE context, it is crucial for managers to understand that new practices such as sharing responsibility for product recovery have gained attention. This is especially the case with the introduction of extended producer responsibility. For instance, manufacturers tend to collaborate with different parties to share the responsibility for product recovery, as they cannot solely ensure the circularity of their operations.

The frequency analysis and framework development in this report identified SC collaboration practices that are crucial for CE implementation. The frequency analysis revealed that SC collaboration practices such as penalties and incentives for sustainability-related actions, product design/modification, sharing responsibility for product recovery and risk sharing are mostly discussed in the SCM discourse under the umbrella of CE implementation. They can be linked to CE implementation strategies such as repairing, refurbishing, remanufacturing and recycling to pave the way for achieving circularity in operations. Hence, practitioners in the initial steps of transitioning their operations towards the CE can give special attention to these collaboration practices as a first step.

There is ample opportunity to explore how different collaboration practices affect CE implementation strategies. Certain connections between SC collaboration practices and CE implementation strategies are not discussed in this report due to the little attention given to these in the literature. For example, the CE implementation strategy of remining plays a prominent role in the product recovery process, especially with the involvement of the informal sector (Jabbour et al., 2019). However, it was not considered in the contingency analysis given the lack of studies on it in the literature. Hence, how these different CE implementation strategies can be achieved through SC collaboration is an interesting research avenue for future discussion. This

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

discussion can also be an eye opener for practitioners given that a majority of companies are in the CE transitioning phase.

As CSCs bring a dual role to the actors in the supply chain, the customer in the forward SC can act as a supplier in the RSC. For instance, the retailing shop in the forward SC can be a collection point in the RSC and act as a supplier providing EoL or returned products back to the OEM. When implementing penalties and incentive schemes to collect returned products, the engagement of this actor in decision making can be more crucial than it was earlier. Hence, managers also need to keep this dual role concept in mind when collaborating with external parties in CSCs.

Regarding the involvement of different parties in CSCs, it is evident that strategic decision making should move beyond the engagement of partners in traditional SCs. Third parties such as research institutes, industry associations and NGOs play an influential role in enhancing the sustainability performance of SCs in the CE context. For instance, manufacturing companies partner with external organisations such as NGOs to ensure the continuous supply of EoL products to meet their closed-loop manufacturing goals (Veleva & Bodkin, 2018). Hence, practitioners also need to keep an open mind and embrace these new partners in the company culture to achieve a smooth transition towards the CE. Companies also need to accept government influence for the implementation of the CE through newly established policies and regulations.

With this mediation of third parties, the traditional dyadic relationships have become more complex. For instance, the supplier–buyer relationship can be mediated with a third-party organisation/entity, such as an NGO or local authority, to empower the collaboration for improved sustainability performance. Hence, when dealing with such complex situations, managers and practitioners should adopt a network approach that considers all parties involved.

5.2. Future directions

The content of this report reflects the discussion on SC collaboration from a theoretical perspective while sharing examples and their practical implications. To further understand real-world applications and practitioners' viewpoints, we plan to conduct additional studies from a more empirical perspective.

The next step of this effort is to understand how these collaboration practices are being used in different industries through a Delphi study and case study. These two studies are currently in the work-in-progress stage. The Delphi study is presently being conducted with a selected set of experts identified from the ReTraCE project (under Milestone 1: Establishment of an expert group for investigating risk and relationship management practices in CSCs). Additional experts will also be engaged in this study based on their involvement in CE-related activities. The interviews for the case study are also currently being conducted with different industry partners from ReTraCE. Once the data have been collected and analysed, the new perspectives on SC collaboration from both academia and industry will be presented in Deliverable 1.4. (due in February of 2022).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Prior to that, the findings will be presented in numerous conferences and ReTraCE Network Schools to gain feedback from experts and develop a fruitful scholarly and managerial discussion.

Appendix A - The SLR process

An SLR was conducted using a rule-governed procedure to enhance the replicability of the research and the traceability of the arguments, which resulted in the high reliability and validity of the findings (Seuring & Gold, 2012). Further, this method provides a reliable basis for practitioners in the decision-making process (Tranfield et al., 2003). In this report, the guidelines provided by Seuring and Gold (2012) were used to conduct the SLR, which was comprised of material collection, descriptive analysis, identifying analytic categories, material evaluation and research quality. The steps followed are depicted in Figure A1.

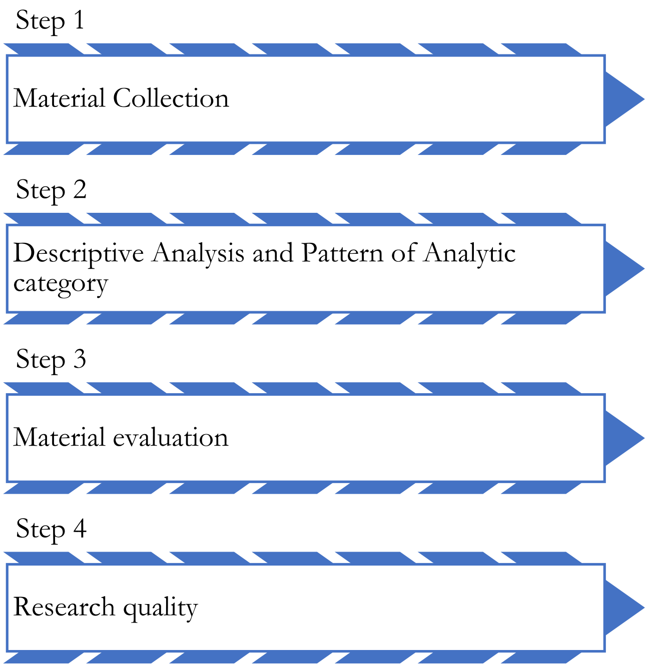

Figure A1. Rule-Governed Procedure Followed in the SLR, adapted from Seuring and Gold (2012)

Step 1 – Material collection

In this study, both the Scopus and Web of Science databases were used to retrieve research papers using keywords from SC collaboration and CE perspectives. When selecting the keywords relating to collaboration, we followed the search strings suggested by Chen et al. (2017) and Wankmüller and Reiner (2019), with a focus was on relationship management in SCs. As a result, we used keywords such as 'collaboration', 'cooperation', 'coordination', 'integration', 'relationship', 'partnership' and 'alliance'. For capturing the CE perspective, we used keywords mentioned by Reike et al. (2018), such as 'circular economy', 'circular supply chain*', 'supply chain*', 'reverse supply chain*', 'closed-loop supply chain*' and 'industrial symbiosis' along with the 10 Rs (e.g., 'reduc*', 'reus*', 'recycl*' and 'recover*'). The search strings were developed by combining these keywords appropriately.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Research papers written in the English language in peer-reviewed journals published from 2014 to January 2020 were retrieved for the final sample. The selection was further limited to management papers focusing on SCs and operations in the CE context. Finally, 58 research articles were identified for the analysis.

Step 2 - Descriptive analysis and determination of analytic categories

In order to explore the themes of the study, constructs relating to collaboration in the studies by Chen et al. (2017) and Ni and Sun (2019) and to CE perspectives in the work of Reike et al. (2018) were identified.

Step 3 - Material evaluation

As part of this step, the content analysis was operationalised by coding the identified constructs in the frameworks against the retrieved literature following the deductive approach. These individual constructs were deeply discussed in Sections 2.2 and 3.2 to understand the discussions and debates in the discourse and practice.

Since content analysis alone brings a limited value to the information on individual constructs, we studied the links between them to assist in drawing broader conclusions. Hence, in addition to the content analysis, a secondary analytical step – a contingency analysis – was employed to explore the relationships between CE strategies and SC collaboration practices. This technique helped identify relationships between constructs that appeared more frequently together in one paper than the product of their single probabilities would suggest (Gold et al., 2010). As the first step in contingency analysis, contingency tables were developed based on the already conducted content analysis. Then, statistical tests were performed to assess the statistical significance of the connections between constructs. The strengths of the different connections were evaluated based on the phi coefficient, which was calculated by performing a chi-squared test using SPSS Statistics software. A phi value (φ) greater than 0.3 was considered the threshold for a significant connection (Fleiss et al., 2003). Hence, we removed the connections with phi values that were less than or equal to 0.3 and chi-squared values greater than 0.05. Figure 6 presents these statistically significant connections.

However, the causality of these connections could not be determined based on the results of the contingency analysis (Bryman & Bell, 2011). Therefore, the associations between two constructs needed to be explained based on the literature (Gold et al., 2010). Further, to ensure the validity of the contingency analysis, we only considered the categories with a frequency of 10% or above in the material evaluation to avoid capturing marginal contingencies. The contingency findings and the discussion on these connections were presented in Section 4.

Step 4 – Research Quality

The research progress and the findings have been presented at different research conferences and ReTraCE Network Schools held in Naples (December 2019) and online (ReTraCE Industry and Policymaking Roundtable

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Event, May 2020) to receive feedback from the experts both in academia and industry. This feedback has further assisted with validating this four-step process followed in the SLR.

References

Batista, L., Bourlakis, M., Liu, Y., Smart, P., Sohal, A., 2018a. Supply chain operations for a circular economy. Prod. Plan. Control 29, 419–424. https://doi.org/10.1080/09537287.2018.1449267

Batista, L., Bourlakis, M., Smart, P., Maull, R., 2018b. In search of a circular supply chain archetype–a content-analysis-based literature review. Prod. Plan. Control 29, 438–451. https://doi.org/10.1080/09537287.2017.1343502

Bocken, N.M.P., de Pauw, I., Bakker, C., van der Grinten, B., 2016. Product design and business model strategies for a circular economy. J. Ind. Prod. Eng. 33, 308–320. https://doi.org/10.1080/21681015.2016.1172124

Botezat, E.A., Dodescu, A.O., Vaduva, S., Fotea, S.L., 2018. An exploration of circular economy practices and performance among Romanian producers. Sustainability 10, 3191. https://doi.org/10.3390/su10093191

Bryman, A., Bell, E., 2011. Business Research Methods, 3rd ed. Oxford University Press, New York.

Cardoso de Oliveira, M.C., Machado, M.C., Chiappetta Jabbour, C.J., Lopes de Sousa Jabbour, A.B., 2019. Paving the way for the circular economy and more sustainable supply chains: Shedding light on formal and informal governance instruments used to induce green networks. Manag. Environ. Qual. An Int. J. 30, 1095–1113. https://doi.org/10.1108/MEQ-01-2019-0005

Chen, C.W., 2018. Guidance on the conceptual design of sustainable product-service systems. Sustainability 10, 2452. https://doi.org/10.3390/su10072452

Chen, L., Zhao, X., Tang, O., Price, L., Zhang, S., Zhu, W., 2017. Supply chain collaboration for sustainability : A literature review and future research agenda. Int. J. Prod. Econ. 194, 73–87. https://doi.org/10.1016/j.ijpe.2017.04.005

De Angelis, R., Howard, M., Miemczyk, J., 2018. Supply chain management and the circular economy: towards the circular supply chain. Prod. Plan. Control 29, 425–437. https://doi.org/10.1080/09537287.2018.1449244

Demestichas, K., Daskalakis, E., 2020. Information and communication technology solutions for the circular economy. Sustainability 12, 1–19. https://doi.org/10.3390/su12187272

Dubey, R., Gunasekaran, A., Childe, S.J., Papadopoulos, T., Helo, P., 2019. Supplier relationship management for circular economy: Influence of external pressures and top management commitment. Manag. Decis. 57, 767–790. https://doi.org/10.1108/MD-04-2018-0396

Ellen McArthur Foundation, 2021. Universal circular economy policy goals.

Ellen McArthur Foundation, 2020. Increasing post-consumer plastic content in packaging [WWW Document]. Case Stud. URL https://www.ellenmacarthurfoundation.org/case-studies/increasing-post-consumer-plastic-content-in-packaging

Ellen McArthur Foundation, 2018a. Closing the loop on single-use food packaging [WWW Document]. Case Stud.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Ellen McArthur Foundation, 2018b. Short-loop recycling of plastics in vehicle manufacturing [WWW Document]. Case Stud.

Ellen McArthur Foundation, 2017a. Design and business model considerations for heavy machinery remanufacturing [WWW Document]. Case Stud. URL https://www.ellenmacarthurfoundation.org/case-studies/design-and-business-model-considerations-for-heavy-machinery-remanufacturing (accessed 3.7.21).

Ellen McArthur Foundation, 2017b. Improving income levels of Indian farmers through better access to information [WWW Document]. Case Stud. URL https://www.ellenmacarthurfoundation.org/case-studies/improving-income-levels-of-indian-farmers-through-better-access-to-information (accessed 3.7.21).

Ellen McArthur Foundation, 2015. Towards a circular economy: business rationale for an accelerated transition, Ellen MacArthur Foundation.

Ellen McArthur Foundation, 2014. Towards the Circular Economy - Accelerating the scale-up across global supply chains, Ellen MacArthur Foundation. https://doi.org/10.12816/0012246

Ellen McArthur Foundation, 2013. Towards the CIrcular Economy - Economic and business rationale for an accelerated transition.

European Commision, 2020. Circular Economy Action Plan.

Farooque, M., Zhang, A., Thürer, M., Qu, T., Huisingh, D., 2019. Circular supply chain management: A definition and structured literature review. J. Clean. Prod. 228, 882–900. https://doi.org/10.1016/j.jclepro.2019.04.303

Fleiss, J.L., Levin, B., Paik, M.C., 2003. Statistical methods for rates and proportions. john wiley & sons.

Garcia-Muiña, F.E., González-Sánchez, R., Ferrari, A.M., Settembre-Blundo, D., 2018. The paradigms of Industry 4.0 and circular economy as enabling drivers for the competitiveness of businesses and territories: The case of an Italian ceramic tiles manufacturing company. Soc. Sci. 7, 255. https://doi.org/10.3390/socsci7120255

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E.J., 2017. The Circular Economy – A new sustainability paradigm? J. Clean. Prod. 143, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. J. Clean. Prod. 114, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

Gold, S., Seuring, S., Beske, P., 2010. Sustainable Supply Chain Management and Inter-Organizational Resources: A Literature Review. Corp. Soc. Responsib. Environ. Manag. 17, 230–245. https://doi.org/10.1002/csr.207

H&M Group, 2019. Recycling and Upcycling [WWW Document]. H&M Gr. URL https://hmgroup.com/sustainability/circular-and-climate-positive/recycling/ (accessed 3.7.21).

Hartley, K., van Santen, R., Kirchherr, J., 2020. Policies for transitioning towards a circular economy: Expectations from the European Union (EU). Resour. Conserv. Recycl. 155, 1–10. https://doi.org/10.1016/j.resconrec.2019.104634

Henry, M., Bauwens, T., Hekkert, M., Kirchherr, J., 2020. A typology of circular start-ups: Analysis of 128

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

circular business models. J. Clean. Prod. 245, 118528. https://doi.org/10.1016/j.jclepro.2019.118528

Herczeg, G., Akkerman, R., Hauschild, M.Z., 2018. Supply chain collaboration in industrial symbiosis networks. J. Clean. Prod. 171, 1058–1067. https://doi.org/10.1016/j.jclepro.2017.10.046

Hofmann, F., 2019. Circular business models: Business approach as driver or obstructer of sustainability transitions? J. Clean. Prod. 224, 361–374. https://doi.org/10.1016/j.jclepro.2019.03.115

Howard, M., Hopkinson, P., Miemczyk, J., 2019. The regenerative supply chain: a framework for developing circular economy indicators. Int. J. Prod. Res. 57, 7300–7318. https://doi.org/10.1080/00207543.2018.1524166

Jabbour, A.B.L. de S., Luiz, J.V.R., Luiz, O.R., Jabbour, C.J.C., Ndubisi, N.O., de Oliveira, J.H.C., Junior, F.H., 2019. Circular economy business models and operations management. J. Clean. Prod. 235, 1525–1539. https://doi.org/10.1016/j.jclepro.2019.06.349

Jäger, J.K., 2020. Will you be my partner?

Jensen, J.P., Prendeville, S.M., Bocken, N.M.P., Peck, D., 2019. Creating sustainable value through remanufacturing: Three industry cases. J. Clean. Prod. 218, 304–314. https://doi.org/10.1016/j.jclepro.2019.01.301

Kalverkamp, M., 2018. Hidden potentials in open-loop supply chains for remanufacturing. Int. J. Logist. Manag. 29, 1125–1146. https://doi.org/10.1108/IJLM-10-2017-0278

Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: An analysis of 114 definitions. Resour. Conserv. Recycl. 127, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Korhonen, J., Honkasalo, A., Seppälä, J., 2018a. Circular Economy: The Concept and its Limitations. Ecol. Econ. 143, 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041

Korhonen, J., Nuur, C., Feldmann, A., Birkie, S.E., 2018b. Circular economy as an essentially contested concept. J. Clean. Prod. 175, 544–552. https://doi.org/10.1016/j.jclepro.2017.12.111

Kurilova-Palisaitiene, J., Sundin, E., Poksinska, B., 2018. Remanufacturing challenges and possible lean improvements. J. Clean. Prod. 172, 3225–3236. https://doi.org/10.1016/j.jclepro.2017.11.023

Larsen, S.B., Masi, D., Feibert, D.C., Jacobsen, P., 2018. How the reverse supply chain impacts the firm's financial performance: A manufacturer's perspective. Int. J. Phys. Distrib. Logist. Manag. 48, 284–307. https://doi.org/10.1108/IJPDLM-01-2017-0031

LEGO Group, 2019. The LEGO Group to pilot new program LEGO Replay in the United States [WWW Document]. URL https://www.lego.com/en-us/aboutus/news/2019/october/lego-replay/#:~:text=October 8%2C 2019%3A Today%2C,Boys %26 Girls Clubs of Boston (accessed 3.7.21).

Leising, E., Quist, J., Bocken, N., 2018. Circular Economy in the building sector: Three cases and a collaboration tool. J. Clean. Prod. 176, 976–989. https://doi.org/10.1016/j.jclepro.2017.12.010

Levänen, J., Lyytinen, T., Gatica, S., 2018. Modelling the Interplay Between Institutions and Circular Economy Business Models: A Case Study of Battery Recycling in Finland and Chile. Ecol. Econ. 154, 373–382. https://doi.org/10.1016/j.ecolecon.2018.08.018

Li, Y., Xu, F., Zhao, X., 2017. Governance mechanisms of dual-channel reverse supply chains with informal

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

collection channel. J. Clean. Prod. 155, 125–140. https://doi.org/10.1016/j.jclepro.2016.09.084

Manthou, V., Vlachopoulou, M., Folinas, D., 2004. Virtual e-Chain (VeC) model for supply chain collaboration. Int. J. Prod. Econ. 87, 241–250. https://doi.org/10.1016/S0925-5273(03)00218-4

Marrucci, L., Daddi, T., Iraldo, F., 2019. The integration of circular economy with sustainable consumption and production tools: Systematic review and future research agenda. J. Clean. Prod. 240, 118268. https://doi.org/10.1016/j.jclepro.2019.118268

Mellor, S., Hao, L., Zhang, D., 2014. Additive manufacturing: A framework for implementation. Int. J. Prod. Econ. 149, 194–201. https://doi.org/10.1016/j.ijpe.2013.07.008

Merli, R., Preziosi, M., Acampora, A., 2018. How do scholars approach the circular economy? A systematic literature review. J. Clean. Prod. 178, 703–722. https://doi.org/10.1016/j.jclepro.2017.12.112

Miemczyk, J., Howard, M., Johnsen, T.E., 2016. Dynamic development and execution of closed-loop supply chains: a natural resource-based view. Supply Chain Manag. 21, 453–469. https://doi.org/10.1108/SCM-12-2014-0405

Mishra, J.L., Hopkinson, P.G., Tidridge, G., 2018. Value creation from circular economy-led closed loop supply chains: a case study of fast-moving consumer goods. Prod. Plan. Control 29, 509–521. https://doi.org/10.1080/09537287.2018.1449245

Mokhtar, A.R.M., Genovese, A., Brint, A., Kumar, N., 2019. Improving reverse supply chain performance: The role of supply chain leadership and governance mechanisms. J. Clean. Prod. 216, 42–55. https://doi.org/10.1016/j.jclepro.2019.01.045

Ni, W., Sun, H., 2019. The effect of sustainable supply chain management on business performance: Implications for integrating the entire supply chain in the Chinese manufacturing sector. J. Clean. Prod. 232, 1176–1186. https://doi.org/10.1016/j.jclepro.2019.05.384

Nielsen, M., 2014. Rethinking the future - circular economy [WWW Document]. Carlsb. Gr. CSR.

Niu, S., Zhuo, H., Xue, K., 2019. DfRem-Driven closed-loop supply chain decision-making: A systematic framework for modeling research. Sustainability 11, 3299. https://doi.org/10.3390/SU11123299

PwC, 2018. Closing the loop – the circular economy, what it means and what it can do for you, PriceWaterhouseCoopers Magyarország Kft.

Rajala, R., Hakanen, E., Mattila, J., Seppälä, T., Westerlund, M., 2018. How Do Intelligent Goods Shape Closed-Loop Systems? Calif. Manage. Rev. 60, 20–44. https://doi.org/10.1177/0008125618759685

Ramanathan, U., Gunasekaran, A., 2014. Supply chain collaboration : Impact of success in long-term partnerships. Int. J. Prod. Econ. 147, 252–259. https://doi.org/10.1016/j.ijpe.2012.06.002

Reike, D., Vermeulen, W.J. V, Witjes, S., 2018. New or Refurbished as CE 3 . 0 ? — Exploring Controversies in the Conceptualization of the Circular Economy through a Focus on History and Resource Value Retention Options. Resour. Conserv. Recycl. 135, 246–264. https://doi.org/10.1016/j.resconrec.2017.08.027

Robertson-Fall, T., 2020. Creating a circular economy for toys [WWW Document]. Circ. News - Ellen MacArthur Found. URL https://medium.com/circulatenews/creating-a-circular-economy-for-toys-9c11dc6a6676 (accessed 3.7.21).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Rosa, P., Sassanelli, C., Urbinati, A., Chiaroni, D., Terzi, S., 2020. Assessing relations between Circular Economy and Industry 4.0: a systematic literature review. Int. J. Prod. Res. 58, 1662–1687. https://doi.org/10.1080/00207543.2019.1680896

Royal Dutch Airlines, 2019. From drink to ink – KLM makes tools from PET bottles [WWW Document]. Annu. Reports. URL https://news.klm.com/from-drink-to-ink--klm-makes-tools-from-pet-bottles/ (accessed 3.7.21).

Sari, K., 2008. On the benefits of CPFR and VMI : A comparative simulation study. Int. J. Prod. Econ. 113, 575–586. https://doi.org/10.1016/j.ijpe.2007.10.021

Scheepens, A.E., Vogtländer, J.G., Brezet, J.C., 2016. Two LCA based methods to analyse and design complex (regional) circular economy systems. Case: Making water tourism more sustainable. J. Clean. Prod. 114, 257–268. https://doi.org/10.1016/j.jclepro.2015.05.075

Schenkel, M., Caniëls, M.C.J., Krikke, H., Van Der Laan, E., 2015. Understanding value creation in closed loop supply chains - Past findings and future directions. J. Manuf. Syst. 37, 729–745. https://doi.org/10.1016/j.jmsy.2015.04.009

Sellitto, M.A., Murakami, F.K., 2018. Industrial symbiosis: A case study involving a steelmaking, a cement manufacturing, and a zinc smelting plant. Chem. Eng. Trans. 70, 211–216. https://doi.org/10.3303/CET1870036

Seuring, S., Gold, S., 2012. Conducting content-analysis based literature reviews in supply chain management. Supply Chain Manag. An Int. J. 17, 544–555. https://doi.org/10.1108/13598541211258609

Shih, D.H., Lu, C.M., Lee, C.H., Cai, S.Y., Wu, K.J., Tseng, M.L., 2018. Eco-innovation in circular agri-business. Sustain. 10, 1140. https://doi.org/10.3390/su10041140

Simatupang, T.M., Sridharan, R., 2002. The Collaborative Supply Chain. Int. J. Logist. Manag. 13, 15–30.

Sterling, J., 2020. Cradle to Cradle Passport – towards a new industry standard in ship building, Maersk Line.

Su, B., Heshmati, A., Geng, Y., Yu, X., 2013. A review of the circular economy in China: Moving from rhetoric to implementation. J. Clean. Prod. 42, 215–227. https://doi.org/10.1016/j.jclepro.2012.11.020

Tranfield, D., Denyer, D., Smart, P., 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. Br. J. Manag. 14, 207–222. https://doi.org/10.1111/1467-8551.00375

Ünal, E., Urbinati, A., Chiaroni, D., Manzini, R., 2019. Value Creation in Circular Business Models: The case of a US small medium enterprise in the building sector. Resour. Conserv. Recycl. 146, 291–307. https://doi.org/10.1016/j.resconrec.2018.12.034

Veleva, V., Bodkin, G., 2018. Corporate-entrepreneur collaborations to advance a circular economy. J. Clean. Prod. 188, 20–37. https://doi.org/10.1016/j.jclepro.2018.03.196

Walmsley, T.G., Ong, B.H.Y., Klemeš, J.J., Tan, R.R., Varbanov, P.S., 2019. Circular Integration of processes, industries, and economies. Renew. Sustain. Energy Rev. 107, 507–515. https://doi.org/10.1016/j.rser.2019.03.039

Wankmüller, C., Reiner, G., 2019. Coordination, cooperation and collaboration in relief supply chain management, Journal of Business Economics. Springer Berlin Heidelberg. https://doi.org/10.1007/s11573-019-00945-2

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Woolven, J., 2020a. Overcoming design challenges to make your business circular [WWW Document]. Circ. News - Ellen MacArthur Found. URL https://medium.com/circulatenews/overcoming-design-challenges-to-make-your-business-circular-649bd4045a3f (accessed 3.7.21).

Woolven, J., 2020b. This article is not about plastic pollution [WWW Document]. Circ. News - Ellen MacArthur Found. URL https://medium.com/circulatenews/this-article-is-not-about-plastic-pollution-13d32236265f (accessed 3.7.21).

World Business Council for Sustainable Development, 2017. Business cases for the circular economy.

Yang, Y., Chen, L., Jia, F., Xu, Z., 2019. Complementarity of circular economy practices: an empirical analysis of Chinese manufacturers. Int. J. Prod. Res. 57, 6369–6384. https://doi.org/10.1080/00207543.2019.1566664

Zacho, K.O., Bundgaard, A.M., Mosgaard, M.A., 2018. Constraints and opportunities for integrating preparation for reuse in the Danish WEEE management system. Resour. Conserv. Recycl. 138, 13–23. https://doi.org/10.1016/j.resconrec.2018.06.006

Zeng, H., Chen, X., Xiao, X., Zhou, Z., 2017. Institutional pressures, sustainable supply chain management, and circular economy capability: Empirical evidence from Chinese eco-industrial park firms. J. Clean. Prod. 155, 54–65. https://doi.org/10.1016/j.jclepro.2016.10.093

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie European Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).