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# **ReTraCE Project**

**Realising the Transition towards the Circular Economy**

## **D1.4**

Risk and collaboration management for circular supply  
chains

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**Authors:** Felipe Alexandre de Lima, Jayani Ishara Sudusinghe, Stefan Seuring.

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## List of acronyms

CE – Circular economy

CSCs – Circular supply chains

EoL – End-of-life

SCM – Supply chain management

SCRM – Supply chain risk management

## 1. Report's general purpose and objectives

The circular economy (CE) has gained growing attention from businesses, policymakers and academics due to its focus on zero waste and pollution reduction throughout material life cycles (Nobre & Tavares, 2021). Essentially, the CE represents a paradigm shift in the extract-make-use-dispose model in response to pressing global sustainability challenges, including climate change, environmental deterioration and biodiversity loss.

The CE increasingly has been recognised as having great potential to help companies achieve breakthroughs in sustainability performance (Farooque et al., 2019). Companies that reconfigure their operations and supply chains for the CE may obtain environmental, economic and social benefits (MahmoumGonbadi et al., 2021). Accordingly, the successful implementation of circular supply chains (CSCs) can lead to material and energy efficiency, waste minimisation, value creation and job opportunities (Calzolari et al., 2022). In this regard, implementation of CE practices enables products to re-enter the supply chain at the end of their life cycles as a production input through recovery activities such as reuse, remanufacturing and recycling (Nasir et al., 2017). It also helps society reach increased sustainability at low or no material, energy and environmental costs (Ghisellini et al., 2016).

However, implementing CE practices within companies requires a systemic redesign of related business models and supply chain configurations, along with significant financial investments (MahmoumGonbadi et al., 2021). Consequently, this process encompasses risks ranging from economic, political and cultural constraints, to operational and technological complexities associated with CSCs (Bressanelli et al., 2018; Genovese et al., 2017). The emergence of CSCs increases complexity in operational decisions, allowing scholars to delve into the risks that managers face in the CE. For example, CSCs are likely to suffer disruptions due to the supply risks associated with critical materials and uncertain demand for and return of end-of-life (EoL) products. Although managers can search for less-critical alternatives to continue producing, an alternative in line with circular and closed-loop thinking relates to the development of products that can reduce environmental impacts across their life cycles and are of good quality, repairable and recyclable (Peck et al., 2015). Nevertheless, this process still depends on establishing reverse networks for EoL products, materials and components that face risks regarding quality, availability and timing of returns (Werning & Spinler, 2020). As a result, executives need to deploy coordinated and collaborative efforts to manage the inherent risks from CSC implementation. Collaboration between organisations is essential in managing CSCs (De Angelis et al., 2018).

While the interplay between risks and collaboration practices has elicited a lively debate in supply chain management (SCM) (Kache & Seuring, 2014), surprisingly little attention has been paid to how risks can be managed through collaboration practices in the context of CSCs. Remarkably, van Langen et al. (2021) argue that collaboration's role among CE stakeholder groups represents a further driving condition that allows the CE to become a viable goal. Collaboration among different stakeholders – e.g., companies, suppliers, consumers, universities, governments and non-governmental organisations (NGOs) – plays a crucial role in overcoming barriers to CSC implementation, thereby ensuring a smooth transition to the CE (Sudusinghe & Seuring, 2022).

Therefore, this report aimed to develop a framework of risk and collaboration management for CSCs. To accomplish this aim, the report analysed the perspectives provided by a panel of leading CSC experts through a Delphi study, allowing for engagement among experts worldwide while ensuring anonymous and controlled feedback. The proposed framework provides valuable insights that can help scholars and practitioners comprehend how risks can be managed through collaboration practices within CSCs.

The remainder of this report is organised as follows. The report's background is presented in Section 2. Section 3 presents the Delphi approach followed and identifies risks and collaboration practices within CSCs. Section 4 proposes a framework combining risk and collaboration management for CSCs. Section 5 concludes the report by discussing its key contributions.

## 2. Background

In recent years, companies increasingly have adopted circular thinking, owing to supply risks associated with critical materials, environmental pollution and excessive waste generation (Taghikhah et al., 2019). According to Wieland (2021), this trend builds on the urgent need to foster a circular, post-fossil-fuel, servitised and degrowth model that plays an essential role in convincing companies to keep existing resources in the loop, and to design, produce and commercialise regenerative products, allowing them to slow down their innovation processes while still enabling them to be profitable via the services sold.

To maximise circularity throughout production and consumption systems, companies can *slow*, *close* or *narrow* resource loops (Bocken et al., 2016):

- To slow resource loops, companies can design durable products and offer product-life extensions through repair and remanufacturing. As products' life cycles are extended, companies help slow the flow of resources. More and more companies are adopting designs for durability in myriad sectors, from engineering and construction to industrial manufacturing, fashion and textiles, and packaging (Ellen MacArthur Foundation, 2020a).
- To close resource loops, companies can reintroduce products and materials into the supply chain for value recovery (e.g., recycling). To establish effective waste management and recycling infrastructures, multiple organisations' involvement is necessary to provide proper controls from political, operational, financial, technological and social perspectives (Tansel, 2020). In this regard, policymakers play an essential role in investing in collecting, sorting and recycling infrastructures to foster economic value retention and reduce companies' disposal costs (Ellen MacArthur Foundation, 2020b).
- To narrow resource loops, companies can use fewer resources per product. Specifically, they need to prioritise the use of regenerative resources (e.g., biodegradable materials), reduce resource use in product design and packaging, and avoid hazardous materials (Circle Economy, 2021). Companies also can shift their business models' focus from physical items to services to increase dematerialisation. This shift requires changes across production, planning and control within organisations, as well as new capabilities, work procedures and technologies (e.g., 3D printers and additive manufacturing) (Jabbour et al., 2019).

While adopting the strategies above can ensure competitive advantages, companies need to assess their capabilities and employ SCM to transition successfully to the CE (Bressanelli et al., 2022). Thus, implementing CE practices within companies and supply chains is a complex process that increases the likelihood of risks. Essentially, risk refers to 'the threat that something might happen to disrupt normal activities or stop things (from) happening as planned' (Waters, 2011, p. 1). Dulia et al. (2021) argued that a risk-based CSC becomes unstable and begets quality and performance issues, thereby negatively affecting the environment. De Lima et al.'s (2021) review of CSC literature found several organisational risks, such as complex product characteristics, technical bottlenecks, managers' resistance to implementing the CE within their companies and conflicting decision-making goals within organisations. Regarding supply chain risks, they identified supplier performance issues, consumers' poor opinions about CE products and services, and dispersed locations for supply chain facilities. As for external factors, they pointed out legal barriers and a lack of directives, metrics and



regulatory frameworks. To manage these risks and ensure CSCs' stability, collaboration among different stakeholders within CSCs becomes crucial (De Lima et al., 2021).

Collaboration is at the heart of supply chain risk management (SCRM), which is defined as: 'the management of supply chain risks through coordination or collaboration among the supply chain partners to ensure profitability and continuity' (Tang, 2006, p. 453). According to De Angelis et al. (2018), CSCs enable supply chain collaboration with partners within and beyond their immediate industrial boundaries, including suppliers, product designers and regulators. 'Thus, with partners' common goal of achieving greater success in supply chain operations, different collaboration practices play vital roles, particularly in managing risks within CSCs (Sudusinghe & Seuring, 2022).

Many extant SCM studies have pointed out the importance of employing collaboration to manage risks in supply chains. For instance, Chen et al. (2013) found that supply chain collaboration decreases supply chain risks due to the crucial role of sharing strategic information across the supply chain, increasing visibility and reducing risks. A review by Duong and Chong (2020) identified collaboration's usefulness in response and recovery from disruptions in commercial and humanitarian supply chains. For example, collaboration creates better capabilities, resources, finance options and service improvements to respond and recover after a disruption (Duong & Chong, 2020). Li et al. (2015) argued that managers need to employ an SCM perspective when managing risks, as well as focus on collaborating with partners to work jointly to mitigate risks. Accordingly, risk-related information- and risk-sharing mechanisms are crucial in SCRM. While the former supports SCRM information systems, the latter establishes formal arrangements (e.g., contracts) for ensuring supply chain partners' shared obligations and responsibilities towards SCRM (Li et al., 2015).

As an ambitious CE seeks to replace linear economic systems with a more sustainable business model, emphasis should be placed on collaborative efforts instead of competition (Oliveira et al., 2021), creating external uncertainties (Simangunsong et al., 2012). In this context, supply chain actors collaborate, using a cooperative approach to reduce risks, sustain costs and investments, and share information and knowledge (Calzolari et al., 2021). Thus, analysing the interplay between risk and collaboration management within CSCs remains a critical literature gap to be addressed. As noted earlier, implementing CE practices within organisations and supply chains increases the likelihood of risks, thereby requiring proper coordinated and collaborative efforts. Figure 1 summarises the arguments above into a conceptual framework.

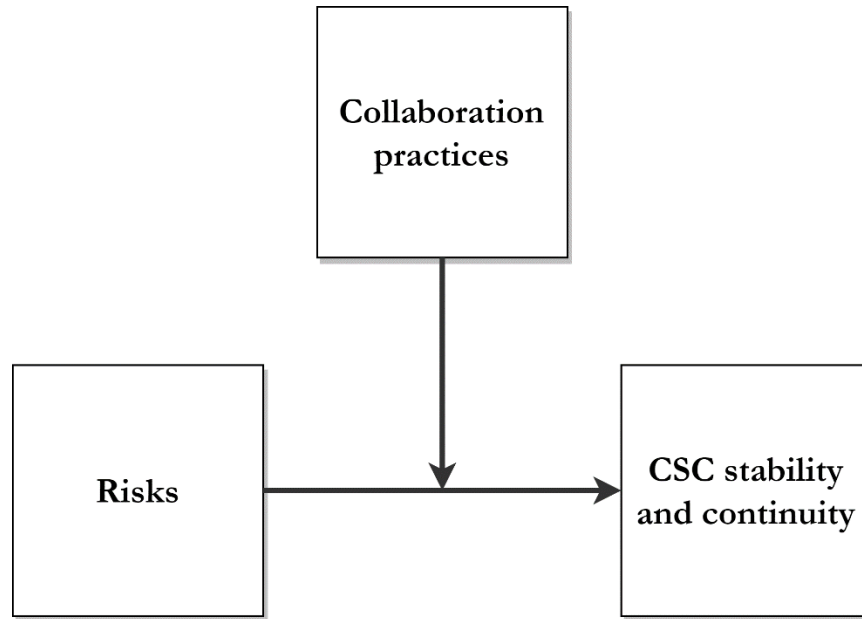


Figure 1. Conceptual framework on risk and collaboration management for CSCs.

The conceptual framework (Figure 1) indicates that risks can hinder CSC stability and continuity, and that collaboration practices play an essential role in managing risks. For example, Sarkis (2020) argued that reuse and recycling – core CE practices – imply that a product has been used previously and with post-COVID-19, consumers may perceive reused or recycled products as contaminated and unsafe. If this consumer behaviour persists, it is likely to cause disruptions within CSCs. Therefore, collaborative communication with consumers is essential in managing this risk by raising awareness, in which managers emphasise CE-oriented products' quality aspects. To provide additional examples, the conceptual framework (Figure 1) will include insights from the expert panellists on the interlinkage between risks and collaboration practices within CSCs.

### 3. Risks and collaboration practices in CSCs

To understand the interplay between risks and collaboration practices within CSCs, a Delphi study was conducted, with the experts' participation. This section elaborates on the Delphi method and this report's findings.

#### 3.1. Delphi approach

Delphi is a method for structuring a group communication process through which expert panellists provide their opinions about a complex topic (Linstone & Turoff, 1975). It allows for anonymity, iteration, controlled feedback and statistical aggregation of group responses (Rowe & Wright, 1999)

and has been employed successfully in various fields, providing robust theoretical, managerial and/or policymaking implications (Flostrand et al., 2020).

This report adopted a Delphi study, as it enabled expert panellists to apply their knowledge, expertise and insight to risk and collaboration management within CSCs. The experts' perspectives offer guidance for many stakeholders interested in CE implementation. In this regard, business organisations, policymakers and academics may benefit from the experts' perspectives to map risks within CSCs and adopt the most appropriate collaboration practices as risk management strategies.

The Delphi study's steps are illustrated in Figure 2 and discussed below to ensure research transparency and replicability.

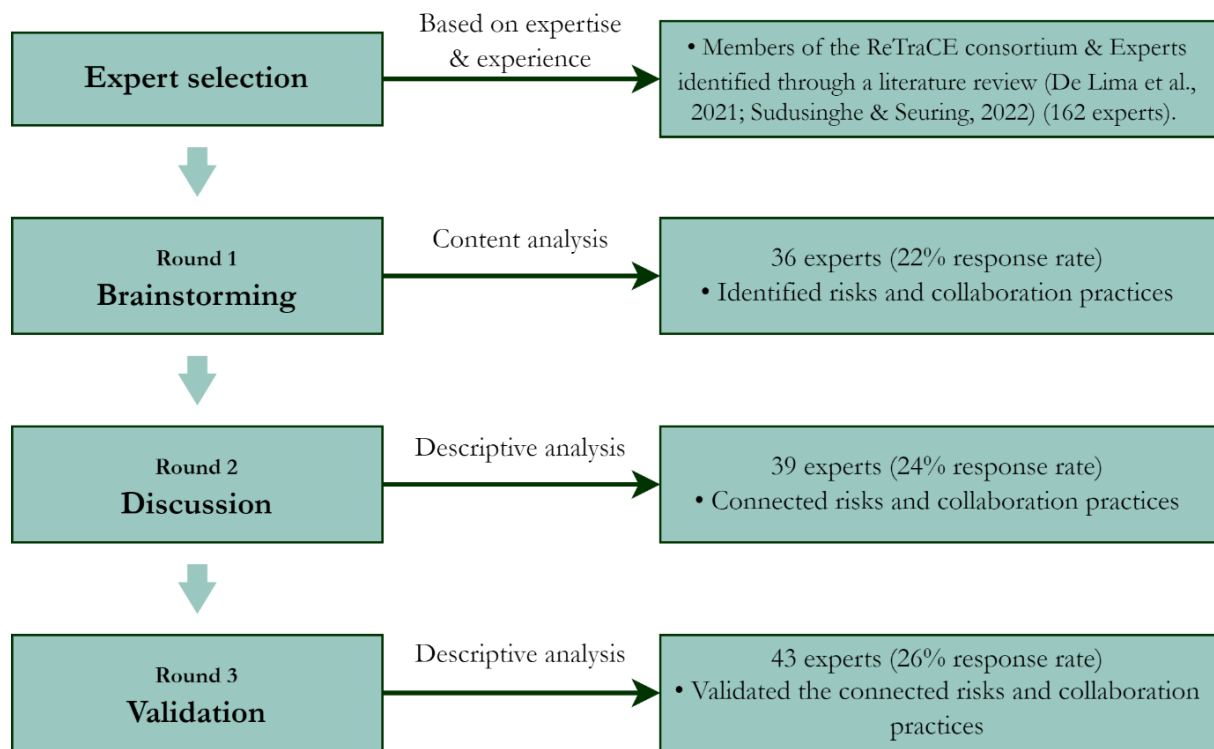


Figure 2. Steps followed in the Delphi study.

The experts were selected based on their expertise and experience in risk and collaboration management within CSCs. In this regard, this report considered members of the ReTraCE consortium (see Milestone M3) and experts who published peer-reviewed academic papers on the topic. The latter group of experts was identified through a literature review, thereby ensuring participation by experts with various institutional and geographical backgrounds (De Lima et al., 2021; Sudusinghe & Seuring, 2022).

During Round 1, 162 experts were invited, of which 36 (22%) responded to a questionnaire regarding risk and collaboration management within CSCs. Following Mayring’s (2014) recommendations, a qualitative content analysis was conducted to identify risks and collaboration practices within CSCs. Furthermore, the experts’ answers were analysed to identify connections between risks and collaboration practices within CSCs.

The identified risks, collaboration practices and related connections were discussed and validated during Rounds 2 (39 experts, 24% response rate) and 3 (43 experts, 26% response rate). In this regard, construct validity was ensured by asking the experts to discuss and validate the researchers’ interpretation and categorisation of the theoretical constructs (Okoli & Pawlowski, 2004). Descriptive analysis was employed to examine frequencies regarding the theoretical constructs of risk and collaboration management within CSCs.

The Delphi study’s results also were presented at international scientific events and the ReTraCE Project Meeting with Industry and Job Forum (Brussels, Belgium; early December 2021). Consequently, the results were discussed and validated further.

The analysis suggested that the experts grouped the main risks into three categories within CSCs: organisational; supply chain; and external. They also highlighted suitable collaboration practices to manage these risks. These findings are examined in the following sub-sections.

### 3.2. Risks in CSCs

The risks that the experts identified are provided in Table 1, then discussed in detail below according to their level of occurrence, i.e., organisational, supply chain or external (De Lima et al., 2021; Simangunsong et al., 2012).

Table 1. Risks within CSCs.

<b>Organisational risks – O</b>
O1/Financial risk
O2/Lack of knowledge and expertise
O3/Operational and technological risks
O4/Top management’s resistance to change
O5/Risk-taking vs. risk-averse behaviour
O6/Intellectual property and sensitive information concerns
O7/Intricate product characteristics
O8/Product obsolescence
O9/Conflicting goals and decisions
<b>Supply chain risks – S</b>
S1/Uncertain quality, availability and delivery of secondary resources

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S2/Lack of supplier integration and information sharing  
 S3/Uncertain demand for CE products and services  
 S4/High variability in the quality, volume and delivery of customer returns in take-back systems

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**External risks – E**

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E1/Globalisation trends  
 E2/Market competition with linear-oriented companies and supply chains  
 E3/Lack of adequate regulatory frameworks and indicators  
 E4/Lack of government taxes, benefits and incentives  
 E5/Unstable prices of virgin and secondary resources

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### 3.2.1. Organisational risks

O1/Financial risk: According to the experts, companies require financial investments to implement CE practices. If they cannot cope with CSC implementation and management costs, they are likely to face financial risks. Thus, companies might need incentives to remain competitive in the CE (MahmoumGonbadi et al., 2021).

O2/Lack of knowledge and expertise: The experts highlighted that companies might lack a skilled workforce and familiarity with core concepts and strategies when implementing CE practices. Consequently, building strategic and technical capabilities is of pivotal importance if companies want to thrive in the CE (Govindan & Hasanagic, 2018).

O3/Operational and technological risks: The experts pointed out that manufacturing risks, quality risks, inadequate technical structures and uncertain technological roadmaps negatively affect companies' continuity and stability within CSCs. Manufacturing risks increase the likelihood of disruptions in recovery processes and negatively affect product and service quality. For example, an uncertain technological roadmap might hinder the development of companies' technical capacity and ability to improve recovery processes based on efficient digital tools (Jabbour et al., 2018).

O4/Top management's resistance to change: The experts argued that a linear mindset hinders the transition to the CE. If top executives are 'locked' into the business-as-usual model, they are likely to delay their companies' entry into the CE. This behaviour is known as organisational resistance, which is influenced primarily by fears of financial risks or environmental factors, e.g., cultural and market structures (Werning & Spinler, 2020).

O5/Risk-taking vs. risk-averse behaviour: Certain behavioural issues within the company can cause delays and disruptions. According to the experts, risk-taking behaviour refers to the decision-maker's inability to assess the risks and opportunities associated with CE practices effectively. However, the

risk-averse decision-maker chooses to safeguard financial resources over implementation of CE practices (De Lima et al., 2021).

O6/Intellectual property and sensitive information concerns: Managers may be unwilling to open up, possibly for fear of sharing proprietary information. The experts highlighted that such a risk is likely to affect information flows within CSCs (Hartwell & Marco, 2016).

O7/Intricate product characteristics: According to the experts, in the CE context, complex product characteristics (design, life cycle and packaging) lead to performance issues, delays and disruptions. Specifically, they impede the proper disassembly of products during recovery processes, including repairing, remanufacturing and recycling (De Lima et al., 2021).

O8/Product obsolescence: The experts pointed out that companies face increased uncertainty regarding whether they should extend or end products' lifespans, which can increase the risk of products' obsolescence if they are viewed as no longer useful. Consequently, this risk increases stocks and related costs (Jabbour et al., 2019).

O9/Conflicting goals and decisions: The experts affirmed that misalignment of goals and strategic priorities, conflicting environmental and economic goals, and individualistic behaviours lead to delays and disruptions. These issues negatively affect companies' ability to prosper in the CE (Akinade & Oyedele, 2019).

### **3.2.2. Supply chain risks**

S1/Uncertain quality, availability and delivery of secondary resources: The experts noted that secondary resources (e.g., recycled materials, components and products) pose uncertainties regarding quality, availability and delivery. Consequently, these uncertainties cause delays and disruptions within CSCs (Islam & Huda, 2018).

S2/Lack of supplier integration and information sharing: Poor communication and uncertain information sharing hamper effective integration of suppliers into circular processes and activities. This risk negatively impacts information flows within CSCs (Bressanelli et al., 2018).

S3/Uncertain demand for CE products and services: Companies face uncertain demand for CE products and services. In this regard, the experts stressed consumers' poor opinions about the quality and performance of recovered products. This issue can impact CSCs' financial performance and continuity (Sarkis, 2020).

S4/High variability in the quality, volume and delivery of customer returns in take-back systems: The experts affirmed that take-back systems pose uncertainties regarding the quality, volume and delivery of customer returns. As a result, CSCs face high variability in returns, stocks and lead times (De Lima et al., 2021).

### **3.2.3. External risks**

E1/Globalisation trends: These trends favour establishment of linear, geographically dispersed and fragmented supply chains; thus, supply chains' infrastructure in the CE requires closer proximity and coordinated recovery processes to reduce environmental impacts (Genovese et al., 2017).

E2/Market competition with linear-oriented companies and supply chains: Increased competition can occur with companies and supply chains that do not comply with or foster CE practices. This risk occurs because of weak government support for responsible environmental practices and low stakeholder awareness of CE benefits (van Langen et al., 2021).

E3/Lack of adequate regulatory frameworks and indicators: According to the experts, companies face uncertainty regarding which regulatory frameworks and CE indicators should be followed or employed accordingly. Consequently, this uncertainty makes implementation and management of CSCs complex and risky (De Lima et al., 2021).

E4/Lack of government taxes, benefits and incentives: Companies might be unwilling to shift to the CE due to uncertainties regarding taxes, benefits and incentives (Govindan & Hasanagic, 2018).

E5/Unstable prices of virgin and secondary resources: Price differences can favour the purchase of virgin resources. The experts mentioned that companies are likely to use virgin resources if the price of secondary resources is not attractive. Policymakers need to incentivise recovery infrastructures and secondary resource supplies to make prices attractive for companies (Khandelwal & Barua, 2020).

### **3.3. Collaboration practices within CSCs**

The collaboration practices that the experts identified are illustrated in Table 2, then discussed in detail below.



Table 2. Collaboration practices within CSCs.

Collaboration practices – C
C1/Collaborative planning
C2/Incentive alignment
C3/Joint product design
C4/Sustainability-oriented supplier selection
C5/Vertical integration
C6/Joint knowledge creation
C7/Collaboration with the government

C1/Collaborative planning: Under collaborative planning, the experts pointed out the supply chain partners' collective decision making, particularly during the planning stage. Thus, this practice improves supply chain partners' engagement through improved communication and transparency. Collaborative planning is a well-established practice in the supply chain domain (Barratt & Oliveira, 2001). For instance, this collaborative approach is followed in particular during forecasting operations (Simatupang & Sridharan, 2005). With the experts' perspectives on this practice, it is evident that its value remains relevant in the CE context. Over the years, collaborative planning has been advanced with digital technologies. Thus, the use of digital platforms to bring together different supply chain actors has enhanced communication along the supply chain and empowered collaborative planning (Upadhyay et al., 2021).

C2/Incentive alignment: Compared with the other identified collaboration practices, incentive alignment is an upcoming collaboration practice within CSCs. The experts pointed out the need to share risks, costs and benefits fairly across supply chains under incentive alignment. These incentives are agreed upon when drawing up contracts among different supply chain partners (Flygansvør et al., 2018). Within CSCs, the experts pointed out the importance of incentive alignment to ensure smooth flow of return products. With fairly distributed incentives among customers and return product suppliers, product return rates can be improved (Larsen et al., 2018). Thus, with incentive alignment, the supply chain product take-back system is empowered within CSCs.

C3/Joint product design: The experts highlighted the importance of collaboration for product design within CSCs. With CE implementation in supply chains, product-life extension is one of the main goals. Thus, product design has received special attention. With the extension of product life cycles, it is crucial to understand not only how the product is designed, but also how to use raw materials optimally and improve after-sales services to extend life cycles. Therefore, different supply chain actors, including raw material suppliers and customers, are integrated into this product design process, and their suggestions and feedback are valued further to develop the product (Franco, 2019). It is even



possible to extend this collaboration beyond existing supply chain partners and embrace new expertise and develop special skills, knowledge and technology (De Angelis et al., 2018). Thus, new relationships also will be developed under joint product design.

C4/Sustainability-oriented supplier selection: Similar to the attention that supplier selection in sustainable supply chains has received, it is crucial to select suppliers with a sustainability orientation within CSCs. This is important for collaboration to ensure that suppliers' objectives do not clash with the focal firm and other supply chain partners' objectives. Thus, before connecting with a supplier and building a long-lasting relationship, a supplier with similar values and culture in terms of sustainability orientation must be selected (Zeng et al., 2017). Thus, the experts highlighted the importance of green purchasing under this collaboration practice.

C5/Vertical integration: Vertical integration is also a well-established collaboration practice in supply chains, with an emphasis on maintaining good relationships, mainly with suppliers and customers. Thus, supplier and customer integration play a major role under vertical integration (Pohlmann et al., 2020; Gupta et al., 2019). To achieve vertical integration, the experts highlighted the importance of information sharing, communication and trust.

C6/Joint knowledge creation: Considering that new approaches (e.g., reducing the use of virgin raw materials) are applied within CSCs, supply chain actors need to develop new knowledge and skills. When they cannot get this expertise externally, they tend to build this new knowledge internally. However, individual knowledge creation is difficult; thus, different supply chain actors may get together to do this (Yang et al., 2019). For instance, a company that needs such special expertise to improve its operations may engage with a research institute, university and/or other supply chain partners and work together on a project basis for joint knowledge creation.

C7/Collaboration with the government: Considering that policymakers play a crucial role in empowering CE implementation, the experts recognised collaboration with governments and their related agencies as an important practice. Collaborating with the government is important for building regulatory frameworks that support and encourage industries to implement CE (Velenturf & Jopson, 2019). For instance, certain technologies that industries require to enhance their supply chains' circularity can be blocked through government mediation. To resolve this demotivation, effective communication should occur between industries and governments and their related agencies. Thus,

collaboration with the government is crucial as a collaboration practice in the CE context (Sudusinghe & Seuring, 2021).

The next section presents the interlinkages between risk and collaboration management within CSCs, followed by a conceptualisation of the findings into a framework of risk and collaboration management for CSCs.

#### **4. A framework on collaboration practices for managing risks within CSCs**

The expert panellists recognised collaboration practices as important risk-management strategies. Thus, this section presents the experts' perspectives on the connections between risks and collaboration practices within CSCs. The connections elaborated on below are only those that received significant attention from the expert panellists (highlighted in dark green in Figures 3, 4 and 5).

##### **4.1. Collaboration practices managing organisational risks in CSCs**

To manage organisational risks, the most suitable collaboration practices that the experts highlighted are C1/Collaborative planning, C2/Incentive alignment, C5/Vertical integration and C6/Joint knowledge creation (see Figure 3). How these collaboration practices help manage organisational risks is elaborated accordingly.

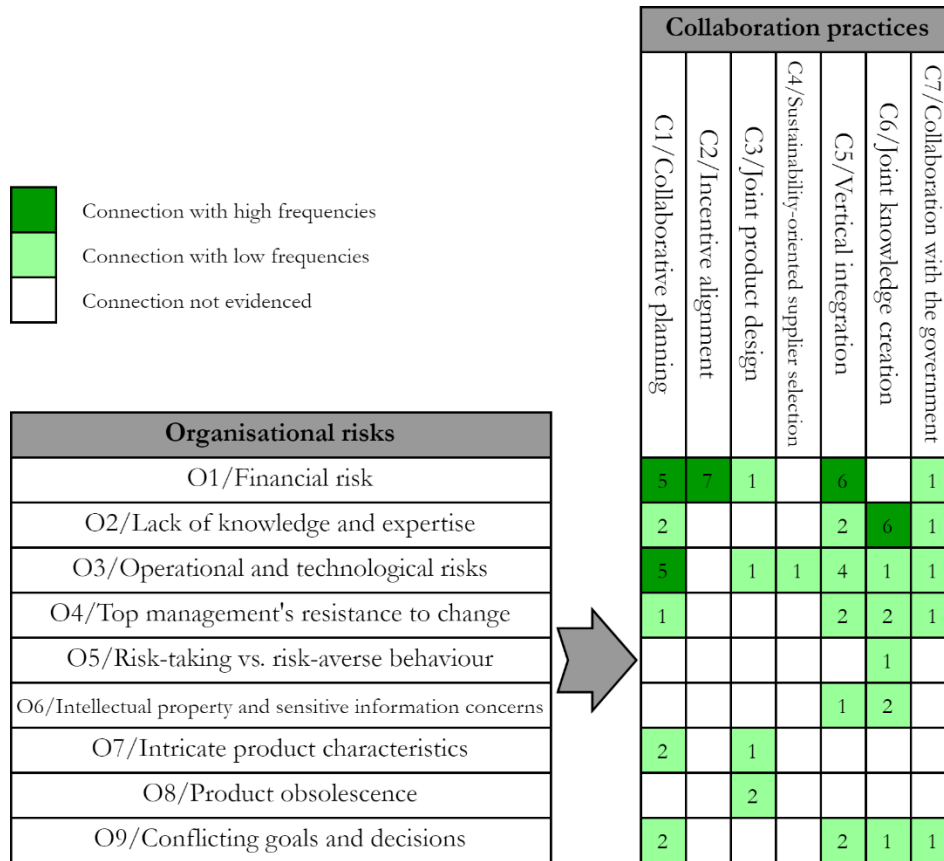


Figure 3. Collaboration practices to manage organisational risks within CSCs (frequency count of connections).

C1/Collaborative planning helps manage O1/Financial risk. When companies work with supply chain partners and collaboratively plan ahead to implement CE practices in supply chains, all involved parties can build financial budgets with more transparency. Thus, uncertain and unexpected finances can be reduced compared with working alone.

Considering that C1/Collaborative planning requires the use of digital technologies to attract various parties to a single platform, O3/Operational and technological risks can be managed. Reducing miscommunication is one approach to managing these risks, particularly by maintaining transparency among supply chain actors and improving their virtual closeness (Khan et al., 2021).

The experts pointed out that C2/Incentive alignment can be adopted to manage O1/Financial risk. Accordingly, it can be part of contract creation (Flygansv r et al., 2018) under vertical integration. Incentives can be included as a clause in the contract to reduce hidden costs, and incomes can be predicted to avoid any uncertain financial flows.

C5/Vertical integration is identified as a vital collaboration practice for managing organisational risks, particularly O1/Financial risk. In this case, the costs associated with recovery processes (e.g., repairing and remanufacturing) can be reduced by specifying customers' responsibilities through contracts.

C6/Joint knowledge creation has been suggested as the most appropriate collaboration practice for addressing O2/Lack of knowledge and expertise. Despite supply chain actors' efforts to change linear supply chains to CSCs, they may not have the knowledge and expertise required, neither individually nor collectively. Thus, they can collaborate and build the required skills and knowledge through research and development. Given the CE-related applications' novelty, this is one of the best approaches to overcome this risk of knowledge and expertise deficits.

#### 4.2. Collaboration practices for managing supply chain risks within CSCs

As indicated in Figure 4, C1/Collaborative planning, C2/Incentive alignment and C5/Vertical integration are the most appropriate collaboration practices for managing supply chain risks. How such management occurs is elaborated further below.

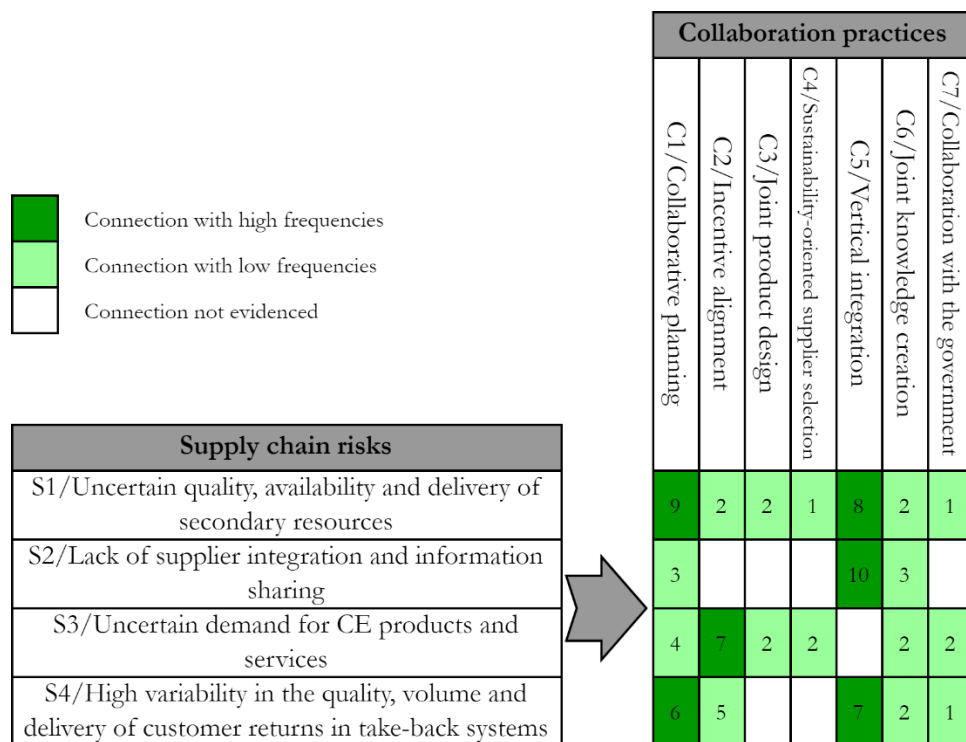


Figure 4. Collaboration practices to manage supply chain risks within CSCs (frequency count of connections).

The role of C1/Collaborative planning and C5/Vertical integration in managing S1/Uncertain quality, availability and delivery of secondary resources and S4/High variability in the quality, volume and

delivery of customer returns in take-back systems is understandable given that the main focus of both collaboration practices is to improve engagement among the different actors in the supply chain. With improved transparency and frequent communication with suppliers and customers, the quality risks regarding end-of-life products and secondary materials can be managed accordingly.

Furthermore, C5/Vertical integration is identified as a suitable collaboration practice for managing risks relating to S2/Lack of supplier integration and information sharing. This is understandable because vertical integration involves working closely with suppliers and customers.

Interestingly, C2/Incentive alignment is an essential collaboration practice that can be adopted to manage supply chain risks, particularly S3/Uncertain demand for CE products and services, and S4/High variability in the quality, volume and delivery of customer returns in take-back systems. This connection is understandable considering that incentives are identified as a feasible solution to ensure the smooth flow of return products back into the system (Mishra et al., 2018). As a result, return products' variability can be managed through forecasting approaches.

#### **4.3. Collaboration practices for managing external risks within CSCs**

Figure 5 demonstrates that C7/Collaboration with the government is the most appropriate practice for managing external risks.

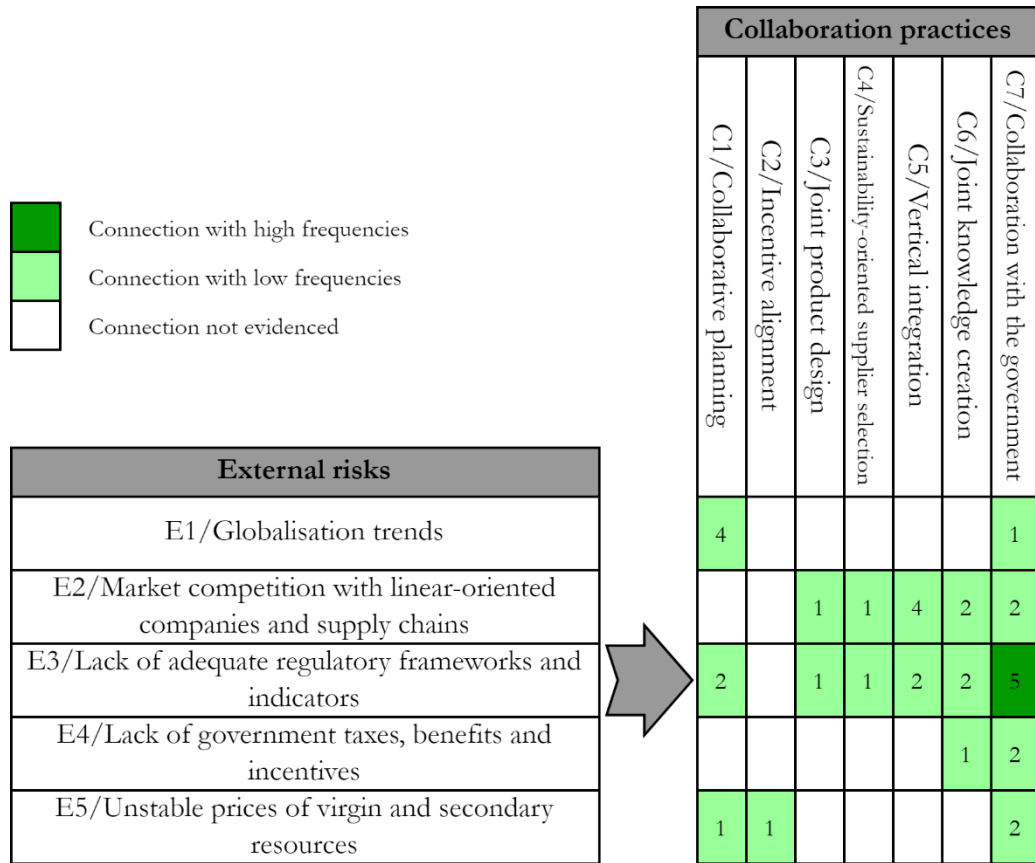


Figure 5. Collaboration practices to manage external risks within CSCs (frequency count of connections).

According to the experts, C7/Collaboration with the government can address E3/Lack of adequate regulatory frameworks and indicators. This connection is reasonable because industries should work together with governmental agencies to ensure that realistic frameworks and indicators are in place. Govindan and Hasanagic (2018) affirmed that the government plays a significant role in CE implementation; therefore, they must be aware of CE-related risks and barriers. The authors pointed out that government laws need to be implemented adequately because some laws make it difficult for enterprises to develop a CE in their supply chains (Govindan & Hasanagic, 2018). Castro et al. (2022) affirmed that environmental policies are how governments can encourage the transition to CE, but without adaptation to specific local contexts and collaborations between governments for joint measures, they can lead to rebound effects locally or in regions outside their borders.

#### 4.4. Conceptualising collaboration practices as risk management strategies

Based on Figures 3, 4 and 5, a framework of risk and collaboration management for CSCs is illustrated in Figure 6.

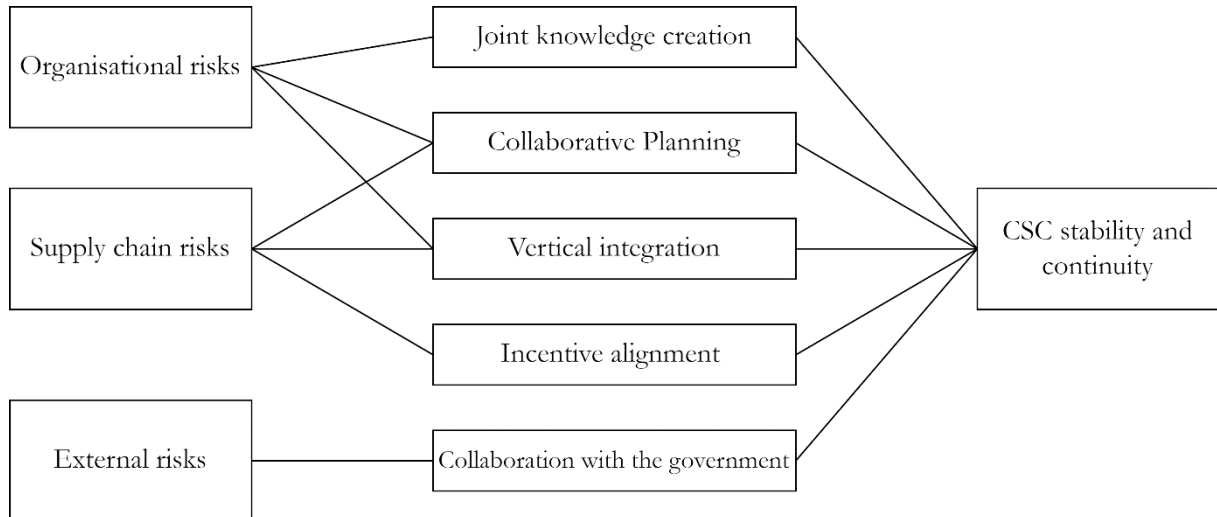


Figure 6. A framework for risk management through collaboration within CSCs.

The experts pointed out that incentive alignment, vertical integration, collaborative planning and joint knowledge creation are the most prominent collaboration practices for managing organisational and supply chain risks, as well as increasing CSCs' stability and continuity. This result indicates that collaboration is a crucial aspect of SCRM (Kache & Seuring, 2014; Tang, 2006). Sudusinghe and Seuring (2022) pointed out the importance of incentive alignment in managing risks, given the complexities of CSCs compared with traditional supply chains.

According to the experts, collaborating with the government plays a crucial role in managing external risks and fostering CSCs' stability and continuity. Companies collaborate with governments to influence responsible behaviour and CE implementation, and strong institutional support is needed to incentivise companies to transition to the CE. In this regard, proper regulatory changes and public policies play a fundamental role in financing and making CSCs economically and environmentally feasible, i.e., 'companies, financiers, accountants and regulators must collaborate with knowledge institutions and civil society to jointly overcome obstacles to the circular transition and recognise that their progress is co-dependent' (Circle Economy, 2022, p. 23). As a result, these changes can mitigate external risks for organisations transitioning to the CE.

## 5. Conclusion

### 5.1. Managerial and theoretical implications

To offer empirical evidence on the use of collaboration as a risk management strategy within CSCs, this report conducted a Delphi study with a panel of leading CSC experts. Therefore, it contributes to the existing body of knowledge and practice on CSCs in four ways:

First, the results identified several risks that can impede the successful transition towards CSCs; therefore, managers need to be aware of organisational, supply chain and external issues when implementing CE practices within their organisations, ranging from financial risks to complex take-back systems and a lack of adequate regulatory frameworks and indicators in the CE.

Second, collaboration practices are necessary to engage and empower key stakeholders within CSCs. These practices comprise collaborative planning, incentive alignment, joint product design, sustainability-oriented supplier selection, vertical integration, joint knowledge creation and collaboration with governments.

Third, this report offers a framework that connects risk and collaboration management within CSCs, thereby extending the previous deliverables D1.2 – *Circular supply chains and related risk/uncertainty management practices* and D1.3 – *Circular supply chains and related collaboration practices*. The links among different collaboration practices and organisational, supply chain and external risks within CSCs guide practitioners in managing the appropriate relationships and achieving stability and continuity. Thus, managers can invest their time and resources on essential relationships while managing potential risks faced when implementing CSCs.

Finally, this report demonstrates that collaboration with governmental agencies is essential to improving CE regulatory frameworks and financing implementation of CSCs through taxes and incentives. External risks emerging from complex or fragmented regulatory requirements create legal barriers to companies in the CE. Moreover, if companies cannot cope with the costs of implementing CE practices, they are likely to face financial risks. In light of this, policymakers play a crucial role in establishing proper regulatory mechanisms to facilitate the CE transition while creating room for innovation and responsible change.



## 5.2. Future research directions

Future empirical research through case studies is needed to examine the interplay between risks and collaboration practices in manufacturing CSCs. This Delphi study's results could be validated further through surveys in different geographical contexts in which CE is being adopted. Future researchers can analyse how risks and collaboration practices impact economic, environmental and social sustainability within CSCs. Contingency theory and stakeholder theory, among others, could be used as theoretical lenses through which to comprehend the connections between risks and collaboration practices within CSCs.

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