Supplementary Materials

Table S1 below presents the identified risk types following the structural flow of CLSCs – from upstream supply to internal operations, downstream recovery, and cross-cutting systemic risks. In this taxonomy, a clear conceptual distinction is drawn between the terms “risk” and “disruption” to enhance clarity and reproducibility. Here, “risk” refers to ex-ante vulnerabilities – latent conditions, uncertainties, or potential imbalances that increase the likelihood or severity of adverse events. Meanwhile, “disruption” denotes ex-post realised events or impacts that disturb the normal functioning of RL and CLSC networks.

To minimise conceptual overlap, instances where both terms co-exist within the same process domain (e.g., supply risk and supply disruption) are organised hierarchically. Given that the reviewed studies modelled disruptions in a simulated sense – to test network responses and mitigation strategies – these disruptions are treated as derived extensions of their corresponding risks rather than as empirically observed events. They are therefore nested within their parent risk categories to capture how potential vulnerabilities can escalate into realised system shocks, while maintaining conceptual coherence across domains. However, during risk evaluation, as reflected in the P-I-M matrix (Section 4.1.2), disruptions are analysed separately to acknowledge that even simulated disruptions generally exhibit lower probability, higher impact, and lower manageability than their underlying risk states.

The coding process involved systematically reviewing the Methodology section of each paper to extract the terminologies used to describe the examined risk types, along with any accompanying definitions. Although terminological variations were observed across studies, risk types were grouped into unified categories based on definitional similarities, as summarised in Table S1. For instance, studies referring to supplier delay or material quality uncertainty were collectively coded under “supply risk”, whereas those modelling supply interruptions or shortages under disruption scenarios were classified as “supply disruption”. In cases where a single study addressed multiple risk dimensions – for example, “facility disruption” and “demand risk” within the same model – the article was coded under both categories. Meanwhile, the category “risk in general” consolidates studies that discuss SC risk conceptually without specifying the risk type or the process stage affected. These were retained to reflect theoretical breadth but were excluded from the P-I-M grouping.

Table S1. Classification of risk types

Risk type	Description
Supply risk	• The risk of returnable transport item (such as containers, pallets or crates) stockouts at the supplier and the deterioration rate of finished products during potential delivery delays (Kim, Glock and Kwon, 2014). • The risk related to suppliers of the recycle channel (He, 2015) or the remanufacturing process (Shakourloo, Kazemi and Javad, 2016). • The uncertainty in the quality and quantity of recycled products (He, 2017), remanufactured products (Abbey et al., 2017) or returned defective products (Chen, Lin and Sheu, 2018). • The uncertainty associated with suppliers like supply shortage, delay in supply, defective materials or products received from suppliers/ distributors or liquidity risk of suppliers (Prakash, Soni and Rathore, 2017a, 2017b; Ayoughi et al., 2020; Prakash et al., 2020; Ebrahimi and Bagheri, 2022; Russo, Masorgo and Gligor, 2022; Hussaini, Nemati and Paydar, 2023; Zerbino et al., 2023; Varshney, Gupta and Ahmed, 2024). • Short-term interruption of the material flow (Duan, Ma and Xu, 2021).
Supply disruption	• Disruptions in the timing, quantity and quality of the collected EOL products (Xanthopoulos, Vlachos and Iakovou, 2011) or in the supply quantity of used products (Qiaolun and Tiegang, 2013; Huang and Wang, 2018). • Disruptions affecting many stages in the supply-side (Xu *et al.*, 2016; Jalali *et al.*, 2017; Rezaei *et al.*, 2020; Gaur, Amini and Rao, 2020; Ruiz-Torres *et al.*, 2022; Salami *et al.*, 2022; Mishra and Singh, 2022; Al-Ashhab, 2023; Bhattacharyya *et al.*, 2023; Nagasawa *et al.*, 2023; Rajabzadeh, Khamseh and Ameli, 2023; Yu, Yang and Zhen, 2023; Mohammadi and Nikzad, 2023; Rajabzadeh, Rabiee and Sarkis, 2024; Dou *et al.*, 2024; Gholipour *et al.*, 2024; Guo, Chen and Tang, 2024; Hejazi *et al.*, 2024). • Undesired return flows of materials occur due to disruptive events in the supply chain (Ivanov *et al.*, 2017). • Disruptions in the operation of primary suppliers (Guo, He and Gen, 2019; Tong, Yang and Xu, 2020; Zare Mehrjerdi and Shafiee, 2020; Ghomi-Avili *et al.*, 2021; Mehrjerdi and Shafiee, 2021; Akbari-Kasgari *et al.*, 2022). • The remanufacturer's inability to remanufacture all returned eligible obsolete products (Bakhshi and Heydari, 2021). • Supply shortages in the recycling process, which resulted from the lower capacities of disrupted facilities (Cheramin *et al.*, 2021). Disaster effects hitting the manufacturer (Katsoras and Georgiadis, 2022a).
Facility disruption	• Random facility disruptions (Hatefi *et al.*, 2015b, 2016; Torabi *et al.*, 2016; Ghadge *et al.*, 2016; Jabbarzadeh, Haughton and Khosrojerdi, 2018; Hamidieh, Arshadikhamseh and Fazli-Khalaf, 2018; Zare Mehrjerdi and Lotfi, 2019; Babaeinesami, Tohidi and Seyedaliakbar, 2021; Lotfi, Mehrjerdi, *et al.*, 2021; Shabbir *et al.*, 2021; Govindan and Gholizadeh, 2021; Zhang, Diabat and Zhang, 2021; Fazli-Khalaf *et al.*, 2021; Vali-Siar, Roghanian and Jabbarzadeh, 2022; Chen, Kaveh and Peivandizadeh, 2022; Arabi and Gholamian, 2023; Mansouri and Sahraeian, 2023; Maya Rodríguez, Morillo-Torres and Willmer Escobar, 2023; Saffari, Abbasi and Gheidar-Kheljani, 2023; Taherifar *et al.*, 2023; Zadeh *et al.*, 2023; Zhu *et al.*, 2023; Alizadeh *et al.*, 2024; Hejazi *et al.*, 2024; Silva *et al.*, 2024; Sun *et al.*, 2024; Torshizi, Bozorgi-Amiri and Sabouhi, 2024; Yu and Sun, 2024; Zhao *et al.*, 2024; Dehghani Sadrabadi *et al.*, 2024; Gholipour *et al.*, 2024).

	• Partial or complete disruptions in specific parts of the supply chain, namely: distribution centres (Asl-Najafi *et al.*, 2015; Fazli-Khalaf, Mirzazadeh and Pishvaee, 2017; Hamidieh and Fazli-Khalaf, 2017; Fazli-Khalaf, Chaharsooghi and Pishvaee, 2019; Ghomi-Avili *et al.*, 2021); production centres (Fazli-Khalaf and Hamidieh, 2017; Ghomi-Avili, Khosrojerdi and Tavakkoli-Moghaddam, 2019; Mishra and Singh, 2020); the supply side (Ghomi-Avili *et al.*, 2018); the power system network (Yavari and Zaker, 2019, 2020); hybrid production-recovery or hybrid distribution-collection facilities (Hatefi and Jolai, 2014, 2015; Hatefi *et al.*, 2015a; Ziari and Sajadieh, 2022); hybrid production-reproduction centres (Aghamohamadi-Bosjina, Rabbania and Manavizadehb, 2022). • Disrupted machines in the production facility due to inadequate maintenance (Khan *et al.*, 2020; Silva *et al.*, 2024).
Production disruption	• Natural or man-made disasters causing the production capacity to decrease sharply (Ge, Zhang and Yuan, 2022; Katsoras and Georgiadis, 2022b; Hasan *et al.*, 2023).
Operational risk	• Risks induced by uncertainties in the disassembly operational process and their economic consequences (Godichaud *et al.*, 2012). • Uncertainties in the maturity level of technological upgrades in the remanufacturing process (Pialot, Millet and Tchertchian, 2012). • Epistemic uncertainties embedded in the disassembly operational process (Nakashima and Gupta, 2012) or in the SC models (Hatefi and Jolai, 2014; Hatefi *et al.*, 2015a; Torabi *et al.*, 2016; Amalnick and Saffar, 2017; Farrokh *et al.*, 2018; Jabbarzadeh, Haughton and Khosrojerdi, 2018; Jiao *et al.*, 2018; Ghomi-Avili, Khosrojerdi and Tavakkoli-Moghaddam, 2019; Mishra and Singh, 2020; Tehrani and Gupta, 2021; Vali-Siar and Roghanian, 2022; Vali-Siar, Roghanian and Jabbarzadeh, 2022; Saffari, Abbasi and Gheidar-Kheljani, 2023; Dehghani Sadrabadi *et al.*, 2024; Torshizi, Bozorgi-Amiri and Sabouhi, 2024; Khot and Thiagarajan, 2024). • Minor changes in resource allocation, currency exchange, equipment quality, facility maintenance and workforce performance that should be considered in the third-party reverse logistics provider selection (Mavi, Goh and Zarbakhshnia, 2017; Zarbakhshnia, Soleimani and Ghaderi, 2018; Yang *et al.*, 2022). • Minor changes in purchasing costs, interest or currency rate and safety regulations ruled by governmental agencies that could badly influence the businesses (Ghomi-Avili *et al.*, 2018). • Any shortage that may occur during the transmission of produced goods in the network (Momenitabar *et al.*, 2022).
Demand risk	• The risk caused by not being able to fully satisfy demand or by uncertain demand for recycled materials or used products (De Rosa *et al.*, 2013; Mutha, Bansal and Guide, 2016; Gentile, Pinto and Stecca, 2022; Abad, Barzinpour and Pishvaee, 2023; Hussaini, Nemati and Paydar, 2023). • The uncertainty in demand affecting the manufacturer who is also the remanufacturer (He, 2015).
Demand disruption	• Unexpected increase in demand during disruption (Xu *et al.*, 2016; Huang and Wang, 2018; Zare Mehrjerdi and Lotfi, 2019; Mishra and Singh, 2020; Mehrjerdi and Shafiee, 2021; de Arquer, Ponte and Pino, 2021; Lotfi, Mehrjerdi, *et al.*, 2021; Mishra and Singh, 2022; Bhattacharyya *et al.*, 2023; Corsini, 2023; Wu *et al.*, 2023; Lotfi *et al.*, 2024). • Demand from the online channel of the reverse SC is disrupted (Hosseini-Motlagh *et al.*, 2019). • A sudden change in consumer demand for certain products in the event of emergencies such as COVID-19 (Cao *et al.*, 2020; Lotfi, Sheikhi, *et al.*, 2021; Lotfi *et al.*, 2022; Ma, 2022). • Disruption due to the unwillingness of the consumer to adopt green products (Dev *et al.*, 2021). • A surge in demand due to COVID-19 affecting Neodymium-iron-boron magnets recycling network (Cheramin *et al.*, 2021).

Collection risk	• The probability of not collecting the used products up to a certain level or target defined by the environmental laws (Subulan *et al.*, 2015). • The uncertainty in the amount of used engine oil collected from vendors (Paydar, Babaveisi and Safaei, 2017).
Collection disruption	• Both collection channels of the remanufacturer are subject to disruption (Xanthopoulos, Vlachos and Iakovou, 2011). • Extreme events causing the temporary unavailability of a warehouse for collecting used batteries (Gianesello, Ivanov and Battini, 2017) or interrupting the collection process in the pharmaceutical sector (Hosseini-Motlagh, Nami and Farshadfar, 2020). • Disruption related to collection quantities of used products (Huang *et al.*, 2022) or disruption in the collection channels of the remanufacturer (Li and Chen, 2022; Yang, Zheng and Ji, 2022; Hosseini-Motlagh *et al.*, 2023; Ebrahimi, Fathian and Hosseini-Motlagh, 2024; Lorenzo-Espejo *et al.*, 2024).
Waste management risk	• The potential impact of general solid waste, hazardous waste or explosive waste on public health and the environment while being transported and/or at site (Ahluwalia and Nema, 2006; Zhao and Ke, 2017; De Oliveira *et al.*, 2021; Hrouga, Sbihi and Chavallard, 2022; Abad, Barzinpour and Pishvaee, 2023; Liu, Tang and Zhang, 2024; Sumrit and Keeratibhubordee, 2024) • Risks associated with post-disaster debris include environmental and operational ones (Hu and Sheu, 2013). • The risk of spreading infections from medical waste (Kargar, Paydar and Safaei, 2020; Yu *et al.*, 2020; Lotfi, Kargar, *et al.*, 2021; Nosrati-Abarghooee *et al.*, 2023; Karimi *et al.*, 2024)
Logistics risk	• The risk resulted from the transportation of computer waste (Ahluwalia and Nema, 2006). • The risk related to variable lead time in the supply of items to distribution centres by plants or from distribution centres to customers (Prakash, Soni and Rathore, 2017a, 2017b; Prakash *et al.*, 2020). • The risk during the transportation of e-waste in the reverse network, which might involve collection delays, breakdown of trucks, accidents and the variation of hazardous materials (Doan *et al.*, 2018). • The risk arising from the transportation of used products or components between nodes in the network (Doan *et al.*, 2019). • Possible product damage occurring during shipping (Abushaega *et al.*, 2021). • The risk resulted from transporting hazardous materials or products (Mohabbati-Kalejahi and Vinel, 2021; Meybodi, Tayebi and Laleh, 2022).

Financial risk	• Potential shocks associated with cash flows stemming from retail reverse logistics activities (Horvath, Autry and Wilcox, 2005). • The risk reflected by the variance of the total cost (Cardoso, Barbosa-Póvoa and Relvas, 2016; Escobar, Peña and García-Cáceres, 2023; Yu, Yang and Zhen, 2023) • Downside risk (Subulan *et al.*, 2015; Fard *et al.*, 2017; Fathollahi-Fard and Hajiaghaei-Keshteli, 2018; Fathollahi-Fard, Hajiaghaei-Keshteli and Mirjalili, 2018; Hajiaghaei-Keshteli, Abdallah and Fathollahi-Fard, 2018). • The vulnerability of the independent small and medium-sized enterprises closed-loop supply chain finance (Zhang, 2016). • Potential financial loss involved in the third-party reverse logistics provider selection (Mavi, Goh and Zarbakhshnia, 2017; Zarbakhshnia, Soleimani and Ghaderi, 2018; Yang *et al.*, 2022). • Upside risk of economic cost (Liu, Ma and Liu, 2021; Xu *et al.*, 2021).
Cost disruption	• Remanufacturing cost might be disrupted since used products are collected from dispersed regions and customers (Han *et al.*, 2016, 2017; Wu *et al.*, 2018). • Production costs of new and/or remanufactured products are disrupted due to some unexpected events (Huang and Wang, 2017; Huang, Zheng and Wang, 2021; Huang *et al.*, 2022).
Natural resource scarcity	• The negative impacts of impending natural resource scarcity on CLSCs (Bell, Mollenkopf and Stolze, 2013).
Risk in general	• Risk in general (Lundin, 2012; Nakashima and Gupta, 2012; Xiao, Cai and Zhang, 2012; Mohajeri and Fallah, 2016; Senthil, Murugananthan and Ramesh, 2018; Zare Mehrjerdi and Lotfi, 2019; Fazli-Khalaf, Chaharsooghi and Pishvaee, 2019; Panjehfouladgaran and Lim, 2020; Shabbir *et al.*, 2021; Insuasty-Reina, Tascón-Rueda and Osorio-Gómez, 2022; Jayasinghe, Rameezdeen and Chileshe, 2022; Kazancoglu *et al.*, 2023; Khoei *et al.*, 2023). • Disruption in general (Fang and Xiao, 2013; Sudarto, Takahashi and Morikawa, 2017; Yousefi-Babadi *et al.*, 2017; Hamidieh *et al.*, 2017; Farrokh *et al.*, 2018; Mohammadzadeh, Sobhanallahi and Khamseh, 2020; Yavari and Zaker, 2020; Özçelik, Faruk Yılmaz and Betül Yeni, 2021; Sugimura and Murakami, 2021; Tehrani and Gupta, 2021; Yılmaz, Özçelik and Yeni, 2021; Baghizadeh, Pahl and Hu, 2021; Huang, Zheng and Wang, 2021; Insuasty-Reina, Tascón-Rueda and Osorio-Gómez, 2022; Vali-Siar and Roghanian, 2022; Nikian *et al.*, 2023; Babaei, Khedmati and Jokar, 2023; Ermes and Niemann, 2023; Afshar, Hadji Molana and Rahmani Parchicolaie, 2024; Aming'a, Marwanga and Annan, 2024; Khot and Thiagarajan, 2024; Nayeri *et al.*, 2024; Saeed *et al.*, 2024; Amoozad Mahdiraji *et al.*, 2024).

Table S2 summarises the mitigation strategies identified in the reviewed literature, grouped into proactive, concurrent, and reactive phases following the SCRES framework. Each strategy phase is further divided into 11 key elements representing distinct mechanisms through which RL and CLSC systems strengthen their resilience against risks and disruptions.

Table S2. Classification of mitigation strategies

Mitigation strategy	Mitigation element	Reference
Proactive strategy	Robustness	(Ahluwalia and Nema, 2006; Xanthopoulos, Vlachos and Iakovou, 2011; Lundin, 2012; De Rosa *et al.*, 2013; Fang and Xiao, 2013; Hu and Sheu, 2013; Hatefi and Jolai, 2014, 2015; Asl-Najafi *et al.*, 2015; Subulan *et al.*, 2015; Hatefi *et al.*, 2015b, 2015a, 2016; Mutha, Bansal and Guide, 2016; Torabi *et al.*, 2016; Cardoso, Barbosa-Póvoa and Relvas, 2016; Ghadge *et al.*, 2016; Mohajeri and Fallah, 2016; Paydar, Babaveisi and Safaei, 2017; Prakash, Soni and Rathore, 2017b, 2017a; Sudarto, Takahashi and Morikawa, 2017; Yousefi-Babadi *et al.*, 2017; Zhao and Ke, 2017; Fard *et al.*, 2017; Fazli-Khalaf and Hamidieh, 2017; Fazli-Khalaf, Mirzazadeh and Pishvaee, 2017; Hamidieh and Fazli-Khalaf, 2017; Hamidieh *et al.*, 2017; Han *et al.*, 2017; Huang and Wang, 2017; Ivanov *et al.*, 2017; Jalali *et al.*, 2017; Amalnick and Saffar, 2017; Zhao *et al.*, 2024; Doan *et al.*, 2018, 2019; Farrokh *et al.*, 2018; Fathollahi-Fard and Hajiaghaei-Keshteli, 2018; Fathollahi-Fard, Hajiaghaei-Keshteli and Mirjalili, 2018; Ghomi-Avili *et al.*, 2018, 2021; Hajiaghaei-Keshteli, Abdallah and Fathollahi-Fard, 2018; Hamidieh, Arshadikhamseh and Fazli-Khalaf, 2018; Jabbarzadeh, Haughton and Khosrojerdi, 2018; Jiao *et al.*, 2018; Yavari and Zaker, 2019, 2020; Zare Mehrjerdi and Lotfi, 2019; Fazli-Khalaf, Chaharsooghi and Pishvaee, 2019; Ghomi-Avili, Khosrojerdi and Tavakkoli-Moghaddam, 2019; Guo, He and Gen, 2019; Prakash *et al.*, 2020; Rezaei *et al.*, 2020; Ayoughi *et al.*, 2020; Tong, Yang and Xu, 2020; Yu *et al.*, 2020; Zare Mehrjerdi and Shafiee, 2020; Gaur, Amini and Rao, 2020; Hosseini-Motlagh, Nami and Farshadfar, 2020; Kargar, Paydar and Safaei, 2020; Khan *et al.*, 2020; Mishra and Singh, 2020, 2022; Mohammadzadeh, Sobhanallahi and Khamseh, 2020; Abushaega *et al.*, 2021; Özçelik, Faruk Yılmaz and Betül Yeni, 2021; Shabbir *et al.*, 2021; Sugimura and Murakami, 2021; Tehrani and Gupta, 2021; Xu *et al.*, 2021; Yılmaz, Özçelik and Yeni, 2021; Babaeinesami, Tohidi and Seyedaliakbar, 2021; Zhang, Diabat and Zhang, 2021; Baghizadeh, Pahl and Hu, 2021; Cheramin *et al.*, 2021; Deng *et al.*, 2021; Fazli-Khalaf *et al.*, 2021; Govindan and Gholizadeh, 2021; Liu, Ma and Liu, 2021; Lotfi, Kargar, *et al.*, 2021; Lotfi, Mehrjerdi, *et al.*, 2021; Lotfi, Sheikhi, *et al.*, 2021; Mehrjerdi and Shafiee, 2021; Mohabbati-Kalejahi and Vinel, 2021; Momenitabar *et al.*, 2022; Salami *et al.*, 2022; Vali-Siar and Roghanian, 2022; Vali-Siar, Roghanian and Jabbarzadeh, 2022; Ziari and Sajadieh, 2022; Chen, Kaveh and Peivandizadeh, 2022; Ebrahimi and Bagheri, 2022; Aghamohamadi-Bosjina, Rabbania and Manavizadehb, 2022; Ge, Zhang and Yuan, 2022; Gentile, Pinto and Stecca, 2022; Akbari-Kasgari *et al.*, 2022; Li and Chen, 2022; Lotfi *et al.*, 2022, 2024; Meybodi, Tayebi and Laleh, 2022; Abad, Barzinpour and Pishvaee, 2023; Arabi and Gholamian, 2023; Nagasawa *et al.*, 2023; Nikian *et al.*, 2023; Nosrati-Abarghooee *et al.*, 2023; Saffari, Abbasi and Gheidar-Kheljani, 2023; Taherifar *et al.*, 2023; Babaei, Khedmati and Jokar, 2023; Yu, Yang and Zhen, 2023; Zadeh *et al.*, 2023; Zhu *et al.*, 2023; Escobar, Peña and García-Cáceres, 2023; Hasan *et al.*, 2023; Al-Ashhab, 2023; Hussaini, Nemati and Paydar, 2023; Khoei *et al.*, 2023; Mansouri and Sahraeian, 2023; Maya Rodríguez, Morillo-Torres and Willmer Escobar, 2023; Mohammadi and Nikzad, 2023; Saeed *et al.*, 2024; Silva *et al.*, 2024; Sun *et al.*, 2024; Torshizi, Bozorgi-Amiri and Sabouhi, 2024; Varshney, Gupta and Ahmed, 2024; Yu and Sun, 2024; Afshar, Hadji Molana and Rahmani Parchicolaie, 2024; Dehghani Sadrabadi *et al.*, 2024; Dou *et al.*, 2024;

	Situation awareness	Gholipour *et al.*, 2024; Guo, Chen and Tang, 2024; Hejazi *et al.*, 2024; Alizadeh *et al.*, 2024; Karimi *et al.*, 2024; Khot and Thiagarajan, 2024; Liu, Tang and Zhang, 2024; Aming'a, Marwanga and Annan, 2024) (Horvath, Autry and Wilcox, 2005; Ahluwalia and Nema, 2006; Xanthopoulos, Vlachos and Iakovou, 2011; Godichaud *et al.*, 2012; Lundin, 2012; Nakashima and Gupta, 2012; Pialot, Millet and Tchertchian, 2012; Xiao, Cai and Zhang, 2012; De Rosa *et al.*, 2013; Fang and Xiao, 2013; Hu and Sheu, 2013; Qiaolun and Tiegang, 2013; Bell, Mollenkopf and Stolze, 2013; Kim, Glock and Kwon, 2014; He, 2015, 2017; Subulan *et al.*, 2015; Cardoso, Barbosa-Póvoa and Relvas, 2016; Han *et al.*, 2016, 2017; Mohajeri and Fallah, 2016; Shakourloo, Kazemi and Javad, 2016; Xu *et al.*, 2016, 2021; Zhang, 2016; Abbey *et al.*, 2017; Zhao and Ke, 2017; Fard *et al.*, 2017; Gianesello, Ivanov and Battini, 2017; Huang and Wang, 2017, 2018; Mavi, Goh and Zarbakhshnia, 2017; Paydar, Babaveisi and Safaei, 2017; Prakash, Soni and Rathore, 2017b, 2017a; Chen, Lin and Sheu, 2018; Fathollahi-Fard and Hajiaghaei-Keshteli, 2018; Fathollahi-Fard, Hajiaghaei-Keshteli and Mirjalili, 2018; Ghomi-Avili *et al.*, 2018; Hajiaghaei-Keshteli, Abdallah and Fathollahi-Fard, 2018; Senthil, Murugananthan and Ramesh, 2018; Wu *et al.*, 2018; Zarbakhshnia, Soleimani and Ghaderi, 2018; Doan *et al.*, 2019; Guo, He and Gen, 2019; Hosseini-Motlagh *et al.*, 2019; Zare Mehrjerdi and Lotfi, 2019; Ayoughi *et al.*, 2020; Kargar, Paydar and Safaei, 2020; Khan *et al.*, 2020; Panjehfouladgaran and Lim, 2020; Rezaei *et al.*, 2020; Tong, Yang and Xu, 2020; Cao *et al.*, 2020; Yu *et al.*, 2020; Abushaega *et al.*, 2021; de Arquer, Ponte and Pino, 2021; De Oliveira *et al.*, 2021; Dev *et al.*, 2021; Huang, Zheng and Wang, 2021; Liu, Ma and Liu, 2021; Lotfi, Mehrjerdi, *et al.*, 2021; Lotfi, Sheikhi, *et al.*, 2021; Bakhshi and Heydari, 2021; Mohabbati-Kalejahi and Vinel, 2021; Shabbir *et al.*, 2021; Yılmaz, Özçelik and Yeni, 2021; Ebrahimi and Bagheri, 2022; Gentile, Pinto and Stecca, 2022; Akbari-Kasgari *et al.*, 2022; Huang *et al.*, 2022; Insuasty-Reina, Tascón-Rueda and Osorio-Gómez, 2022; Jayasinghe, Rameezdeen and Chileshe, 2022; Li and Chen, 2022; Lotfi *et al.*, 2022; Ma, 2022; Yang *et al.*, 2022; Yang, Zheng and Ji, 2022; Zhu *et al.*, 2023; Escobar, Peña and García-Cáceres, 2023; Khot and Thiagarajan, 2024; Lorenzo-Espejo *et al.*, 2024; Nayeri *et al.*, 2024)
	Increasing visibility	(Asif *et al.*, 2012; Chen, Lin and Sheu, 2018; Rezaei *et al.*, 2020; Zare Mehrjerdi and Shafiee, 2020; Govindan and Gholizadeh, 2021; Mehrjerdi and Shafiee, 2021; Hrouga, Sbihi and Chavallard, 2022; Babaei, Khedmati and Jokar, 2023; Ebrahimi, Fathian and Hosseini-Motlagh, 2024)
	Knowledge management (pre-risk)	(Xiao, Cai and Zhang, 2012; Fang and Xiao, 2013; Qiaolun and Tiegang, 2013; Panjehfouladgaran and Lim, 2020; De Oliveira *et al.*, 2021; Insuasty-Reina, Tascón-Rueda and Osorio-Gómez, 2022; Katsoras and Georgiadis, 2022a; Corsini, 2023; Ermes and Niemann, 2023; Kazancoglu *et al.*, 2023; Aming'a, Marwanga and Annan, 2024; Sumrit and Keeratibhubordee, 2024)
	Building security	(Hosseini-Motlagh *et al.*, 2019; Ghomi-Avili *et al.*, 2021; Hrouga, Sbihi and Chavallard, 2022; Vali-Siar and Roghanian, 2022; Vali-Siar, Roghanian and Jabbarzadeh, 2022; Al-Ashhab, 2023; Kazancoglu *et al.*, 2023; Saffari, Abbasi and Gheidar-Kheljani, 2023; Dehghani Sadrabadi *et al.*, 2024; Zhao *et al.*, 2024; Sinha, 2024)
Concurrent strategy	Building redundancy	(Qiaolun and Tiegang, 2013; Fang and Xiao, 2013; Ghadge *et al.*, 2016; Gianesello, Ivanov and Battini, 2017; Jalali *et al.*, 2017; Fazli-Khalaf, Chaharsooghi and Pishvaee, 2019; Rezaei *et al.*, 2020; Yavari and Zaker, 2020; Govindan and Gholizadeh, 2021; Lotfi, Mehrjerdi, *et al.*, 2021; Shabbir *et al.*, 2021; Sugimura and Murakami, 2021; Babaeinesami, Tohidi and Seyedaliakbar, 2021; Cheramin *et al.*, 2021; Dev *et al.*, 2021; Fazli-Khalaf *et al.*, 2021; Aghamohamadi-Bosjina, Rabbania and Manavizadehb, 2022;

	Increasing flexibility Collaboration Agility	Akbari-Kasgari *et al.*, 2022; Gentile, Pinto and Stecca, 2022; Katsoras and Georgiadis, 2022b; Lotfi *et al.*, 2022, 2024; Mishra and Singh, 2022; Momenitabar *et al.*, 2022; Ruiz-Torres *et al.*, 2022; Vali-Siar and Roghanian, 2022; Vali-Siar, Roghanian and Jabbarzadeh, 2022; Hosseini-Motlagh *et al.*, 2023; Al-Ashhab, 2023; Mansouri and Sahraeian, 2023; Maya Rodríguez, Morillo-Torres and Willmer Escobar, 2023; Mohammadi and Nikzad, 2023; Nagasawa *et al.*, 2023; Arabi and Gholamian, 2023; Rajabzadeh, Khamseh and Ameli, 2023; Taherifar *et al.*, 2023; Zerbino *et al.*, 2023; Guo, Chen and Tang, 2024; Liu, Tang and Zhang, 2024; Nayeri *et al.*, 2024; Rajabzadeh, Rabiee and Sarkis, 2024; Silva *et al.*, 2024; Varshney, Gupta and Ahmed, 2024; Zhao *et al.*, 2024; Dehghani Sadrabadi *et al.*, 2024) (Ghadge *et al.*, 2016; Gianesello, Ivanov and Battini, 2017; Ghomi-Avili, Khosrojerdi and Tavakkoli-Moghaddam, 2019; Mishra and Singh, 2020, 2022; Yavari and Zaker, 2020; Zare Mehrjerdi and Shafiee, 2020; Gaur, Amini and Rao, 2020; Lotfi, Kargar, *et al.*, 2021; Lotfi, Mehrjerdi, *et al.*, 2021; Lotfi, Sheikhi, *et al.*, 2021; Mehrjerdi and Shafiee, 2021; Shabbir *et al.*, 2021; Sugimura and Murakami, 2021; Babaeinesami, Tohidi and Seyedaliakbar, 2021; Baghizadeh, Pahl and Hu, 2021; Dev *et al.*, 2021; Aghamohamadi-Bosjina, Rabbania and Manavizadehb, 2022; Katsoras and Georgiadis, 2022a; Lotfi *et al.*, 2022, 2024; Vali-Siar and Roghanian, 2022; Taherifar *et al.*, 2023; Yu, Yang and Zhen, 2023; Zhu *et al.*, 2023; Alizadeh *et al.*, 2024; Liu, Tang and Zhang, 2024; Aming'a, Marwanga and Annan, 2024; Dehghani Sadrabadi *et al.*, 2024) (Hatefi *et al.*, 2015a, 2015b, 2016; Xu *et al.*, 2016; Wu *et al.*, 2018, 2023; Hosseini-Motlagh, Nami and Farshadfar, 2020; Ghomi-Avili *et al.*, 2021; Salami *et al.*, 2022; Katsoras and Georgiadis, 2022a, 2022b; Yu, Yang and Zhen, 2023; Hosseini-Motlagh *et al.*, 2023; Saffari, Abbasi and Gheidar-Kheljani, 2023; Ebrahimi, Fathian and Hosseini-Motlagh, 2024; Yu and Sun, 2024) (Dev *et al.*, 2021; Aghamohamadi-Bosjina, Rabbania and Manavizadehb, 2022; Katsoras and Georgiadis, 2022b; Aming'a, Marwanga and Annan, 2024)
Reactive strategy	Contingency planning Knowledge management (post-risk)	(Ivanov *et al.*, 2017; Jalali *et al.*, 2017; Jabbarzadeh, Haughton and Khosrojerdi, 2018; Ghomi-Avili, Khosrojerdi and Tavakkoli-Moghaddam, 2019; Tong, Yang and Xu, 2020; Yavari and Zaker, 2020; Mishra and Singh, 2020; Cheramin *et al.*, 2021; Momenitabar *et al.*, 2022; Russo, Masorgo and Gligor, 2022; Babaei, Khedmati and Jokar, 2023; Bhattacharyya *et al.*, 2023; Mohammadi and Nikzad, 2023; Nayeri *et al.*, 2024; Silva *et al.*, 2024; Zhao *et al.*, 2024; Dehghani Sadrabadi *et al.*, 2024; Guo, Chen and Tang, 2024) (Duan, Ma and Xu, 2021; Bhattacharyya *et al.*, 2023; Amoozad Mahdiraji *et al.*, 2024)

Table S3 categorises the methodological approaches used to develop mitigation strategies. It distinguishes between qualitative and quantitative studies, with the latter grouped by modelling type – optimisation, game theory, simulation, hybrid, and others – and highlights the emerging use of data-driven methods for risk mitigation in RL and CLSC research.

Table S3. Classification of mitigation development approaches

Mitigation development approach			Reference
Qualitative			(Bell, Mollenkopf and Stolze, 2013; Abbey *et al.*, 2017; De Oliveira *et al.*, 2021; Hrouga, Sbihi and Chavallard, 2022; Insuasty-Reina, Tascón-Rueda and Osorio-Gómez, 2022; Jayasinghe, Rameezdeen and Chileshe, 2022; Ermes and Niemann, 2023; Zerbino *et al.*, 2023; Lorenzo-Espejo *et al.*, 2024)
Quantitative	Model-based	Optimisation	(Horvath, Autry and Wilcox, 2005; Ahluwalia and Nema, 2006; Xanthopoulos, Vlachos and Iakovou, 2011; Lundin, 2012; Xiao, Cai and Zhang, 2012; De Rosa *et al.*, 2013; Fang and Xiao, 2013; Hu and Sheu, 2013; Hatefi and Jolai, 2014, 2015; Kim, Glock and Kwon, 2014; Hatefi *et al.*, 2015a, 2015b, 2016; Asl-Najafi *et al.*, 2015; Subulan *et al.*, 2015; Cardoso, Barbosa-Póvoa and Relvas, 2016; Ghadge *et al.*, 2016; Mohajeri and Fallah, 2016; Mutha, Bansal and Guide, 2016; Shakourloo, Kazemi and Javad, 2016; Torabi *et al.*, 2016; Yousefi-Babadi *et al.*, 2017; Zhao and Ke, 2017; Fard *et al.*, 2017; Fazli-Khalaf and Hamidieh, 2017; Fazli-Khalaf, Mirzazadeh and Pishvaee, 2017; Amalnick and Saffar, 2017; Hamidieh and Fazli-Khalaf, 2017; Hamidieh *et al.*, 2017; Ivanov *et al.*, 2017; Jalali *et al.*, 2017; Paydar, Babaveisi and Safaei, 2017; Prakash, Soni and Rathore, 2017b, 2017a; Doan *et al.*, 2018, 2019; Farrokh *et al.*, 2018; Fathollahi-Fard and Hajiaghaei-Keshteli, 2018; Fathollahi-Fard, Hajiaghaei-Keshteli and Mirjalili, 2018; Ghomi-Avili *et al.*, 2018, 2021; Hajiaghaei-Keshteli, Abdallah and Fathollahi-Fard, 2018; Hamidieh, Arshadikhamseh and Fazli-Khalaf, 2018; Jabbarzadeh, Haughton and Khosrojerdi, 2018; Jiao *et al.*, 2018; Zare Mehrjerdi and Lotfi, 2019; Fazli-Khalaf, Chaharsooghi and Pishvaee, 2019; Ghomi-Avili, Khosrojerdi and Tavakkoli-Moghaddam, 2019; Guo, He and Gen, 2019; Yavari and Zaker, 2019, 2020; Yu *et al.*, 2020; Zare Mehrjerdi and Shafiee, 2020; Gaur, Amini and Rao, 2020; Kargar, Paydar and Safaei, 2020; Khan *et al.*, 2020; Ayoughi *et al.*, 2020; Mishra and Singh, 2020; Mohammadzadeh, Sobhanallahi and Khamseh, 2020; Prakash *et al.*, 2020; Rezaei *et al.*, 2020; Tong, Yang and Xu, 2020; Abushaega *et al.*, 2021; Zhang, Diabat and Zhang, 2021; Cheramin *et al.*, 2021; Deng *et al.*, 2021; Fazli-Khalaf *et al.*, 2021; Govindan and Gholizadeh, 2021; Liu, Ma and Liu, 2021; Lotfi, Kargar, *et al.*, 2021; Lotfi, Mehrjerdi, *et al.*, 2021; Lotfi, Sheikhi, *et al.*, 2021; Mehrjerdi and Shafiee, 2021; Mohabbati-Kalejahi and Vinel, 2021; Babaeinesami, Tohidi and Seyedaliakbar, 2021; Özçelik, Faruk Yılmaz and Betül Yeni, 2021; Shabbir *et al.*, 2021; Sugimura and Murakami, 2021; Tehrani and Gupta, 2021; Baghizadeh, Pahl and Hu, 2021; Xu *et al.*, 2021; Yılmaz, Özçelik and Yeni, 2021; Aghamohamadi-Bosjina, Rabbania and Manavizadehb, 2022; Ziari and Sajadieh, 2022; Gentile, Pinto and Stecca, 2022; Akbari-Kasgari *et al.*, 2022; Lotfi *et al.*, 2022; Meybodi, Tayebi and Laleh, 2022; Momenitabar *et al.*, 2022; Vali-Siar and Roghanian, 2022) (Ge, Zhang and Yuan, 2022; Li and Chen, 2022; Mishra and Singh, 2022; Salami *et al.*, 2022; Vali-Siar, Roghanian and Jabbarzadeh, 2022; Chen, Kaveh and Peivandizadeh, 2022; Abad, Barzinpour and Pishvaee, 2023; Hasan *et al.*, 2023; Hussaini, Nemati and Paydar, 2023; Khoei *et al.*, 2023; Al-Ashhab, 2023; Mansouri and Sahraeian, 2023; Maya Rodríguez, Morillo-Torres and Willmer Escobar, 2023; Mohammadi and Nikzad, 2023; Nagasawa *et al.*, 2023; Nikian *et al.*, 2023; Nosrati-Abarghooee *et al.*, 2023; Saffari, Abbasi and Gheidar-Kheljani, 2023; Taherifar *et al.*, 2023; Zadeh *et al.*, 2023; Arabi and Gholamian, 2023; Zhu *et al.*, 2023; Babaei, Khedmati and Jokar, 2023; Escobar, Peña and García-Cáceres, 2023; Afshar, Hadji Molana and Rahmani Parchicolaie, 2024; Gholipour *et al.*, 2024; Guo, Chen and Tang, 2024; Hejazi *et al.*, 2024; Karimi *et al.*, 2024; Khot and Thiagarajan, 2024; Liu, Tang and Zhang, 2024; Lotfi *et al.*, 2024; Saeed *et al.*, 2024; Alizadeh *et al.*, 2024; Silva *et al.*, 2024; Sun *et al.*, 2024; Torshizi, Bozorgi-Amiri and Sabouhi, 2024; Varshney, Gupta and Ahmed, 2024; Yu and Sun, 2024; Zhao *et al.*, 2024; Dehghani Sadrabadi *et al.*, 2024; Dou *et al.*, 2024).

		Game theory	(He, 2015, 2017; Xu *et al.*, 2016; Han *et al.*, 2016, 2017; Huang and Wang, 2018, 2017; Wu *et al.*, 2018, 2023; Hosseini-Motlagh *et al.*, 2019, 2023; Hosseini-Motlagh, Nami and Farshadfar, 2020; Bakhshi and Heydari, 2021; Huang, Zheng and Wang, 2021; Huang *et al.*, 2022; Ma, 2022; Yang, Zheng and Ji, 2022; Rajabzadeh, Khamseh and Ameli, 2023; Yu, Yang and Zhen, 2023; Ebrahimi, Fathian and Hosseini-Motlagh, 2024; Rajabzadeh, Rabiee and Sarkis, 2024).
		Simulation	(Asif *et al.*, 2012; Pialot, Millet and Tchertchian, 2012; Qiaolun and Tiegang, 2013; Gianesello, Ivanov and Battini, 2017; Dev *et al.*, 2021; Duan, Ma and Xu, 2021; Katsoras and Georgiadis, 2022a, 2022b).
		Hybrid	(Zhang, 2016; Sudarto, Takahashi and Morikawa, 2017; Cao *et al.*, 2020; de Arquer, Ponte and Pino, 2021; Ebrahimi and Bagheri, 2022; Bhattacharyya *et al.*, 2023; Corsini, 2023; Sinha, 2024).
		Others	(Godichaud *et al.*, 2012; Nakashima and Gupta, 2012; Mavi, Goh and Zarbakhshnia, 2017; Senthil, Murugananthan and Ramesh, 2018; Zarbakhshnia, Soleimani and Ghaderi, 2018; Chen, Lin and Sheu, 2018; Ruiz-Torres *et al.*, 2022; Russo, Masorgo and Gligor, 2022; Yang *et al.*, 2022; Kazancoglu *et al.*, 2023; Aming'a, Marwanga and Annan, 2024; Amoozad Mahdiraji *et al.*, 2024; Sumrit and Keeratibhubordee, 2024; Nayeri *et al.*, 2024).
	Data-driven		(Panjehfouladgaran and Lim, 2020)

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