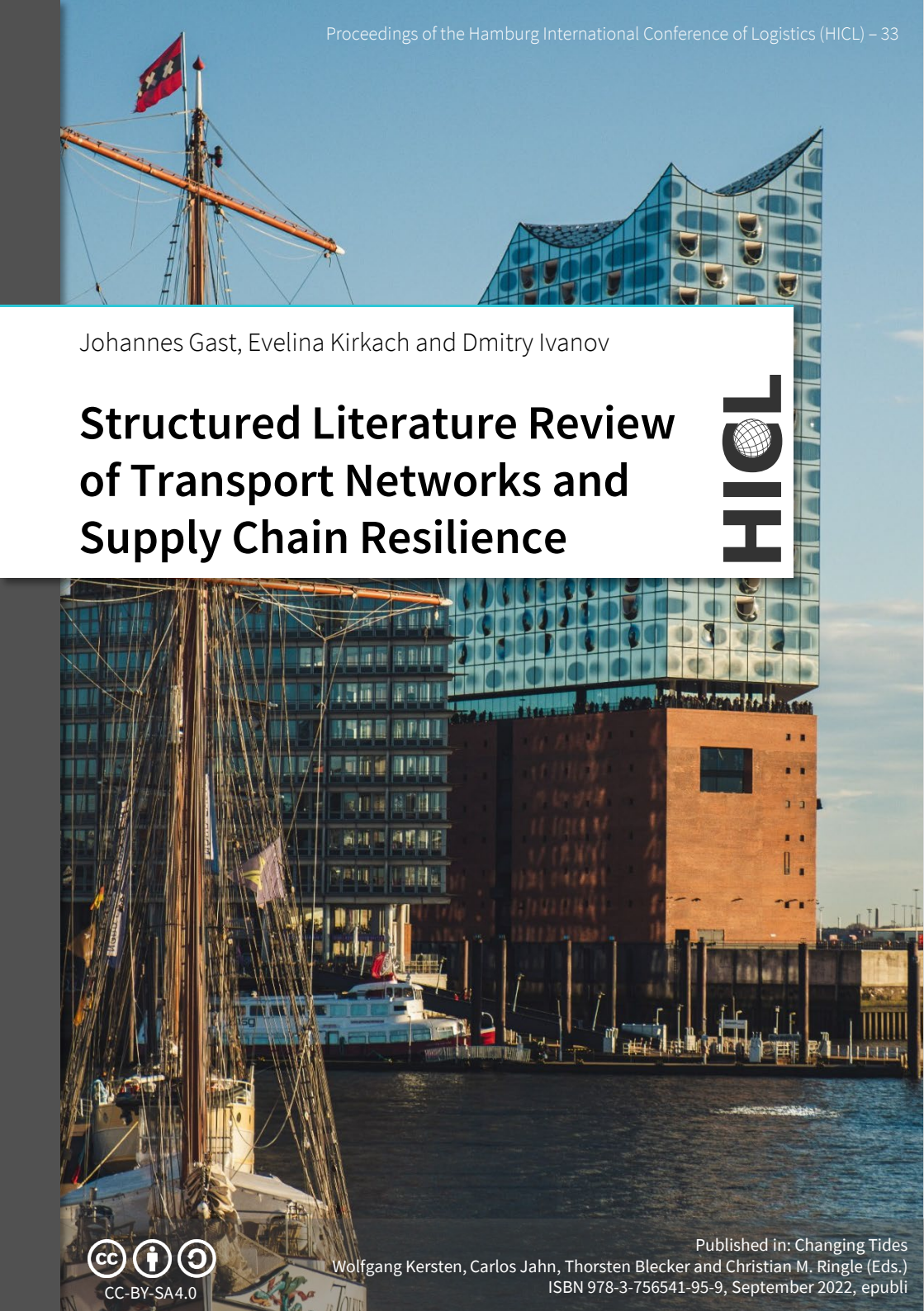

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Structured Literature Review of Transport Networks and Supply Chain Resilience

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Structured Literature Review of Transport Networks and Supply Chain Resilience

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Purpose: *The literature on Supply Chain Resilience faces a steep and significant interest in recent years owing to the pandemic and disruptions in global trade. As the literature amplifies due, this paper aims to provide transparency about the intersection of Supply Chain Resilience and transport networks. Existing literature reviews do not consider this aspect.*

Methodology: *This paper conducts a Systematic Literature Review using the keywords "Supply Chain Resilience" combined with "Transport/Infrastructure networks" to identify the relationship between transport networks and Supply Chain Resilience. The method, as a result, identifies about 251 articles from 2004 to 2022, of which 36 relevant papers are included.*

Findings: *Excluded overview papers address Supply Chain Resilience and transport independently. As a result of the full-text screening, a shift to quantitative methods can be observed. Network theory and mathematical programming models stick out. However, a list of specific research gaps for future research proposed in the literature remains. In particular, a dedicated transport network like highways is seldomly considered.*

Originality: *This research improves the understanding of the relationship between Supply Chain Resilience and transport networks with the interrelation of transport and supply chain disruptions.*

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1 Introduction

Supply Chain Resilience (SCRe) has gotten soaring attention recently. The Covid19-pandemic has disrupted Supply Chains (SCs) and compelled them to adapt to ongoing threats, e.g., stockouts and lockdowns (Sodhi, Tang and Willenson, 2021). An out-of-sync global trade with container vessels queueing at ports for dozens of days further exacerbates the situation (e.g., see Xiao and Bai, 2022). Meanwhile, sea freight rates surge to historic levels, questioning the economic viability of certain transport. Failure of logistics infrastructure like canals contributes its share: reshoring and nearshoring become a consideration of "changing network design and resulting in overall less transport" that can be disrupted (van Hoek and Dobrzykowski, 2021). SCs must adapt to this *new, never normal*.

The literature on SCRe attempts to gauge the *new, never normal* by describing and deriving models to assess its effects. The literature review by Farooq et al. (2021) and further findings of supply chain disruptions during the Covid19-pandemic (see Hobbs, 2020; Xu et al., 2020; Fu et al., 2022) suggest that understanding the interrelationship between SCRe and transport networks provides benefits. Moreover, Kiani Mavi et al. (2022) identify resilience management as one of five emerging topics in transport logistics. Still, main literature reviews on SCRe don’t consider networks of transport or infrastructure distinctively (see, e.g., Hosseini, Ivanov and Dolgui, 2019) but as different aspects of Supply Chain Management (SCM). Henceforth, aspects of transportation in the scope of SCRe occur without explicit reference to the existing literature on either transportation science (see, e.g., Wan et al., 2018) or transport logistics (Kiani Mavi et al., 2022).

The role of transport is acknowledged in the SC Risks Management literature and has been worked on ever since (among others, see Ho et al., 2015; Bak, 2018; Bier, Lange and Glock, 2020). The literature suggests that transportation and infrastructure could significantly impact the vulnerability of SCs (Pettit, Croxton and Fiksel, 2019; Bak, 2018). However, the literature remains vague about the effect of a disrupted transport network on capacities of SCRe and which paths exist to recover SC operations if affected, as previous literature reviews don't consider both.

The main objective of the research paper is to reveal and categorise the link between the relationship of a transportation network and SCRe to give researchers an overview of the intersection between the fields. A Systematic Literature Review (SLR) identifies relevant research that considers the role of transportation and infrastructure networks in SCRe considerations (and potentially vice versa). The objective is met by answering the following aspects via the SLR:

1. What is the relationship between SCRe due to transportation and infrastructure network disruptions? How are SC disruptions and transport disruptions linked?
2. What are managerial implications and available risk mitigation decisions considering the role of transportation and SCRe?
3. What potential has future research based on the literature gaps?

Figure 1 outlines the objective of the SLR and the potential contribution: understanding the relationship between transportation and SCRe. Whereas a solid body of literature exists for the black arrows, the green arrows highlight the aim of the first and second research aspects of the SLR. The main objective, the red arrow, elaborates the link between the transportation network layer and SCRe – be it via the route of supply chain disruption or transportation disruption.

The research objective is achieved by, firstly, outlining recent literature about SCRe and literature on transport networks with their terminology to establish common ground and demarcate this research from other research disciplines. Secondly, this paper performs a SLR of the intersection between SCRe, transport, and infrastructure networks. Relevant papers are screened to derive common findings. Managerial implications on the role of transport networks in SCRe are also outlined. Thirdly, this paper discusses the results. Eventually, this paper concludes with the revealed SLR-based understanding of the relationship between transportation networks and SCRe.

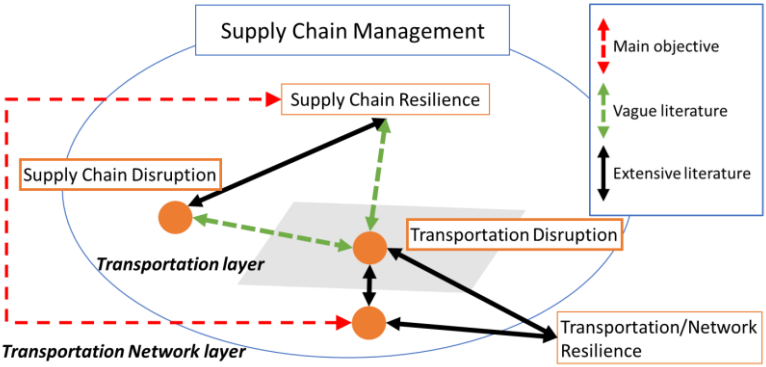

Figure 1: Schema of the objective of the Systematic Literature Review

2 Terminology and differentiating remarks

Due to the interdisciplinarity and vastness of SCM, this section carves out the necessary definitions for the research scope while also displaying ideas around resilience in transportation science, infrastructure networks (civil engineering), and network theory as opposed to SCRe.

2.1 Terminology

Starting with “building the resilient supply chain” (Christopher and Peck, 2004), the field of SCRe has ever extended since. In short, SCRe is viewed from different perspectives, e.g., the SC capability to recover from a disruption to a desired state. Please refer to Hosseini, Ivanov and Dolgui (2019) for an extensive list of SCRe definitions. Section 4.1 describes the definitions of SCRe found in the body of literature via the SLR.

Transport plays an essential role in SC Risk Management (see Bak, 2018), where disrupted transports impact operations and threaten performance. SC Risk Management methods often are qualitative or static and neglect the recovery aspect (Bak, 2018); here, SCRe enters the limelight. However, SCRe literature lacks the consideration of transport and infrastructure networks, as described before. Contrary, "SC Design decisions consider the environment and access logistics infrastructure in the network planning stage while also emphasising disruption risks"; the optimisation of network configuration shares methods to transport network resilience (see Esmizadeh and Mellat Parast, 2021). Transport networks are highly relevant in humanitarian relief logistics, which considers SCRe aspects (Thompson and Anderson, 2021). Thus, there could be an exciting field of study to transfer methods to SCRe and transportation networks of general SCs.

2.2 Differentiation between Network Resilience and Supply Chain Resilience and Transportation Networks

SCs rely on transport infrastructure (transhipment nodes like ports and intermodal hubs), and multiple stakeholders interact with it. Network resilience is well explored and finds application in transportation science, among others, in terms of transportation

resilience. Albeit, network and transportation resilience do not consider SCM dimensions like stakeholder interaction and communication between SC agents (see Chen, Lam and Liu, 2018; Wan et al., 2018).

"Research analysing the relationship between transportation performance and their respective infrastructure networks is common, but the aspect of resilience is just emerging from a SCM perspective" (Kiani Mavi et al., 2022). Yet, combining SCRe and transportation provides benefits. For example, "effective transportation planning can reduce costs and shortages in medicine and vaccine procurement and distribution" (Farooq et al., 2021).

In addition, network resilience theory offers various methods to explore the resilience of networks (Smith et al., 2011), albeit the theory omits the linkage to SC agents or dedicated features of SCM (see Sharkey et al., 2021). Hence, this paper takes a SCRe perspective to incorporate SCM practices regarding transportation networks.

3 Method

This section describes the SLR approach to meet the research goal of deepening the understanding between SCRe and transportation. Multiple authors (i.e., Durach, Kembro and Wieland, 2017; Farooq et al., 2021) inspire this methodological approach.

3.1 SLR Methodology

A baseline sample of relevant papers is retrieved from a first scan of the literature revealing a connection between infrastructure and transport and from the authors' previous works. The SLR uses the Kühne Logistics University's main library database tool to search. The database includes publications from several databases like Scopus, Web of Science, and Wiley, and logistics journals. The earliest year of publication was set in 2004, when the discipline of SCRe got kicked off by Christopher and Peck (2004).

As directing features, the search strings in titles, abstracts, keywords, and texts are ("Supply Chain Resilience" AND "transport* network*") and ("Supply Chain Resilience" AND "transport infrastructure"). "Transport* network*" is inclusive to the similar used term "transportation" while including "infrastructure" captures other papers dealing with, e.g., road and rail networks and transport that do not use "Transport* network*". Both search strings have an overlap of 25 abstracts. See Figure 2 below.

The papers are included based on their presented topics in their abstracts: they must address SCRe by dealing with a – preferably transportation-heavy - Supply Chain Network (SCN) rather than only considering transportation network or transport infrastructure. Hence, the presence of interactions between stakeholders or SC agents is an inclusion criterion.

Generally, only papers in the English language are considered. Solely peer-reviewed articles are included. Two authors conducted the review: Based on abstract screening, the papers that only consider either SCRe or transport networks are also excluded because this research is interested in the connection of both. Several papers mentioning the search terms in the full text didn't demonstrate their relationship in the abstract and were subsequently eliminated. The described steps above are summarized in Figure 2.

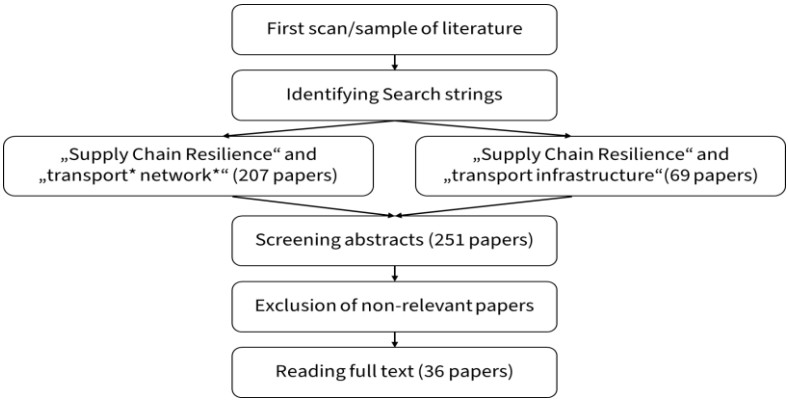

Figure 2: Step of the Systematic Literature Review

3.2 A structural and methodological analysis

Figure 3 below, created with the tool VOSviewer (2022), shows the keywords occurring with the default minimum of at least five times in the literature body of the rejected abstracts. Multiple topics around SCM are present and common methods in the field like literature reviews. The tool allows the clustering of keywords provided by the publisher/authors and colours papers regarding prominent keywords and co-occurring keywords like the colour red for general SCM topics in Figure 3. In contrast, the obtained body of literature consists of 36 relevant papers. The keyword analysis in Figure 4 remarkably shows only the keywords associated with the SLR research objective because they occur more than five times and are thus visualised: "*Transportation*", "*Supply Chain disruptions*", "SCs", "*SCRe*", and "*resilience*". As these keywords associated with the main research objective are not present in Figure 3 of the excluded papers but in Figure 4 of the included papers, this supports the validity of the abstract screening to an extent.

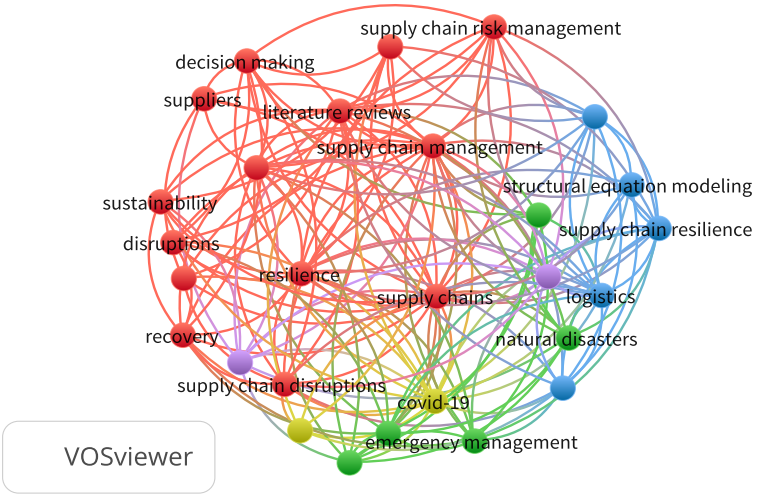

Figure 3: Co-occurrence of keywords in excluded papers

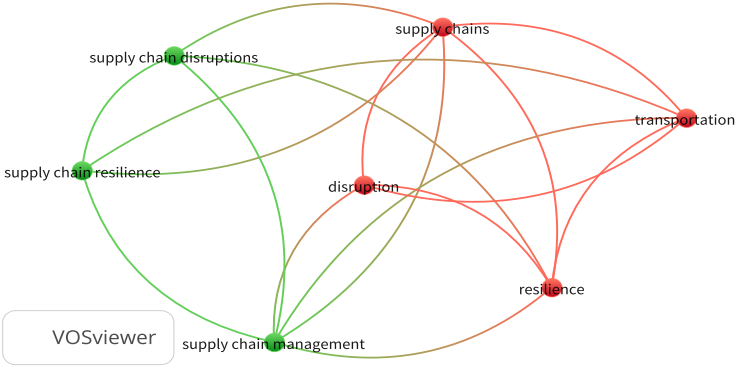

Figure 4: Co-occurrence of keywords in relevant papers

Most of the 36 papers were published just recently, as Figure 5 above shows. Note the gap between 2005–2011. Forestalling the discussion section, Peck (2005) identified the

relevancy of transportation infrastructure for stakeholders in a forward-looking survey building on studies issued by the UK government. The academic interest continued from 2011 onwards. Even though Figure 5 pictures a trend that potentially is related to the pandemic or general rising interest in SCRe, the statistical trend is not yet significant due to the low number of publications per year. The relevant papers were read thoroughgoingly to derive findings on the relationship between SCRe and transport.

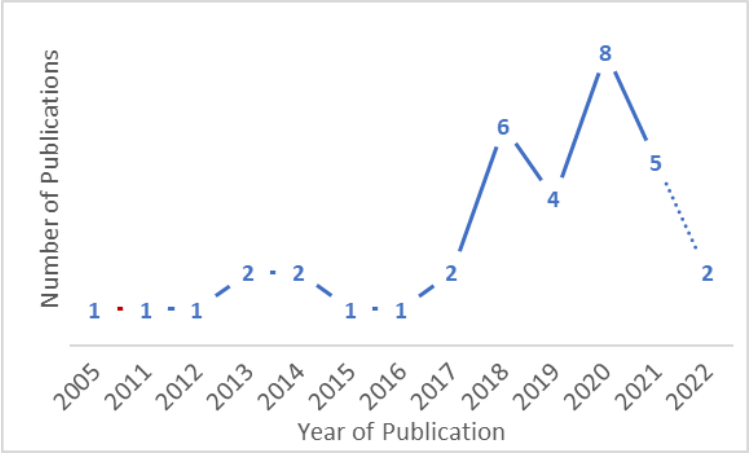

Figure 5: Year distribution of publications

Table 1 below shows the relevant papers clustered according to their methods while also listing the scope of their transport networks. Some mixed-method approaches are occasionally present, where: qualitative connections between SCRe and operational SC elements are identified through literature or workshops followed by quantitative analysis to determine the dependency metrics. Most papers did not define the transport mode of their SC. Instead, transportation is an undefined graph or flow network with links between origin and destination and nodes representing warehouses, suppliers, or production sites. Therefore, they are classified as “unspecified” in Table 1. Only around 10% of the papers did specify road, maritime or multimodal transport networks and subsequently address specific network infrastructure characteristics, for example, how a city's access to a highway impacts delivery.

Table 1: Paper overview according to methods

Method	**The transport network in the scope of the research papers**
Graph theory	*Unspecified*: Hearnshaw and Wilson (2013); Zhang, Dadkhah and Ekwall (2011). *Maritime*: Gong and Liu (2020). *General Infrastructure*: Kayikci (2021); Yi-Zhu Su and Wei-Chang Yeh (2022)
Mixed Linear Programming (or similar optimisation)	*Unspecified*: Behzadi et al. (2018); Adenso-Díaz; Mar-Ortiz and Lozano (2018); Wang, Herty and Zhao (2016); Guan et al. (2020); Zhang and Yu (2021); Zhao and You (2019); Mari, Young Hae Lee and Memon (2014). *Road*: Ishfaq (2012). *Multimode*: Ehlen et al. (2014); Mousavi Ahranjani et al. (2020); Kabadurmus and Erdogan (2020)
Simulation/ Heuristics	*Unspecified*: Paul et al. (2019); Mao et al. (2020). *Road*: Viljoen and Joubert (2018). *Maritime*: Yuan, Hsieh and Su (2020). *Multimode*: Chen, Lam and Liu (2018); Beheshtian et al. (2019)
Qualitative Research	*Unspecified*: Bhattacharya et al. (2013); Singh et al. (2019); Fu et al. (2022). *Road*: Singh-Peterson and Lawrence (2015). *Multimode*: Xu et al. (2020). *General Infrastructure including Transportation*: Peck (2005)
Mixed method	*Unspecified*: Forbes and Wilson (2018); Xia (2021); Oluwole, Odehairo and Oladokun (2021). *Road*: Costa et al. (2020); Sharma and George (2018)
Empirical studies	*Unspecified*: Tukamuhabwa, Stevenson and Busby (2017); Xing Liu et al. (2017);

4 Findings

The obtained body of literature reveals insights presented in this section. This section starts with some general observations before structurally clustering the insights regarding the main research objective, the link between SCRe and transportation networks: The first aspect, “the relationship”, is deduced in section 4.2. Based on the established relationship clusters, the second aspect, “managerial implications”, are presented in section 4.3. The third aspect, “future research avenue”, is highlighted in section 4.4.

4.1 General findings

SCRe and sustainability are conjointly present in eight papers (Beheshtian et al., 2019; Behzadi et al., 2018; Zhang and Yu, 2021; Mousavi Ahranjani et al., 2020; Kayikci, 2021; Mari, Young Hae Lee and Memon, 2014; Kabadurmus and Erdogan, 2020; Yi-Zhu Su and Wei-Chang Yeh, 2022). Though there is evidence that the pandemic incited research on SCRe (see Farooq et al., 2021), only two relevant papers dealt with the subject (Xu et al., 2020; Fu et al., 2022); that subject felt more present in the excluded abstracts.

Surprisingly, no author of the relevant papers has a (co-)authorship of any other papers, which is opposite to literature identified by major SCRe reviews like Hosseini, Ivanov and Dolgui (2019). Presumably, no overlapping authorships indicate that the research discipline is not yet established. Moreover, no case studies have been conducted in Europe or North America but mainly in the Southern Hemisphere (e.g., Tukamuhabwa, Stevenson and Busby, 2017; Costa et al., 2020; Oluwole, Odehairo and Oladokun, 2021).

Many papers discuss transport networks implicitly as an element of SCRe or enablers of risk mitigation strategies like rerouting (see Table 2 below). However, contrary views are not present claiming transport is part of the SCRe principles (according to Christopher and Peck, 2004) or linking transportation to SCRe capabilities (according to Pettit, Croxton and Fiksel, 2019) are not present.

4.2 Relationship between transport networks and SCRe

Undoubtedly, the method used influences the findings of the relevant papers. Table 1 above already shows the high amount of used quantitative methods stemming from Operations Research. Nevertheless, there exist significantly distinctive definitions of SCRe in the papers' models that affect the parametrisation and thus potentially lead to different outcomes in the relationship between SCRe and transportation networks. Nearly all follow the principles outlined by Christopher and Peck (2004), which get extended in two distinctive ways: the cross path between SCRe as a "cost/resilience enhancement trade-off" (Tang, 2006) – respectively an efficiency/resilience tradeoff. Or "SCRe describes the recovery of SC performance to a preferably better state" (Tukamuhabwa et al., 2015).

Papers following the first way are present in the second and third clusters in Table 2; the ones following the second way are present in the first cluster in Table 2. Moreover, the following definitions exist in addition to the ones above: Some papers adopt a view from SC Risk Management rather than SCRe (Behzadi et al., 2018; Xu et al., 2020), dealing with probabilistic occurrences. Unfortunately, the definitions used are not always explicitly stated; Ehlen et al. (2014) reveal not even an implicit view on SCRe. Nevertheless, a clear definition gets fully incorporated into the papers' models by Mao et al. (2020) and Hearnshaw and Wilson (2013). Their definitions are used with a graph-based method focusing on the mathematical relationship between recovery and relevant network configurations (i.e., node criticality and the redundancy of links). An odd way is setting SCRe equal to delivery reliability by Paul et al. (2019). Finally, Guan et al. (2020) define SCRe from a disaster relief management perspective.

To sum up, available characteristics or managerial choices in transportation networks are a contributing factor to building up or enhancing SCRe. Besides, no authors undertake to add their own research findings to phrase a new definition of SCRe for a specific context. Eventually, six distinct ways to describe the relationship of aspect 1 of the main objective are presented in the following:

Structured Literature Review of Transport Networks and SC Resilience

(1) Transport networks are part of SCN and contributing factor to SCRe

Where transport is part of the SCN, the relationship between transport and SCRe is parametrised with qualitative and quantitative identified key mechanisms. SCRe can be built and enhanced with transport network considerations.

(2) Transport disruptions equal SC disruptions that are part of SCRe

Moreover, suppose transportation disruptions due to node/link failure in the SC are also analysed. In that case, the relationship between SCRe and transport gets quantifiable regarding the impact of disruptions on operations in the SC network.

(3) The resilience of transport networks affects SC performance

Considering the role of transport on SC performance under disruption scenarios allows one to calculate an optimal network design with an efficiency/resilience trade-off.

(4) Decision-makers have choices in SCRe relying on transportation networks

Considering specific choices of SCM decision-makers even enhances the optimal planned network as literature considers further dimensions like time and CO_2 emission costs. Hence, available choices in transportation networks are a contributing factor to building up or enhancing SCRe.

(5) Transport is disrupted by infrastructure failure affecting SCs

These papers look closely on the relationship between transport and the required infrastructure, which public stakeholders run. From the infrastructure perspective, implications on the resilience of potentially affected SCs are discussed.

(6) Empirical studies about SCRe identify a relationship

Empirical studies and mixed-method approaches identify a link between SCRe and transportation networks without prior assumption of such a connection. As transportation networks were not the objective, a comparison between other factors next to transportation networks affecting SCRe is presented.

Table 2: The various relationships between SCRe and transportation networks

Cluster	Authors	Implication and Findings regarding supply chain resilience
(1)	Bhattacharya et al. (2013); Singh et al. (2019); Zhang, Dadkhah and Ekwall, (2011); Xing Liu et al. (2017); Forbes and Wilson (2018); Mao et al. (2020); ZHANG and YU (2021); Xia (2021); Mousavi Ahranjani et al. (2020); Neboh and Mbhele (2021); Mari, Young Hae Lee and Memon (2014); Sharma and George (2018); Hearnshaw and Wilson (2013)	Transportation and underlying networks allow to build and enhance SCRe with managerial practices and restoration strategies. Key mechanisms are identified or derived from graph theory that can already be incorporated into the planning and design stage.
(2)	Adenso-Díaz, Mar-Ortiz and Lozano (2018); Ehlen et al. (2014); Paul et al. (2019)	By assessing transport disruptions, SCRe gets also quantified and assessed.
(3)	Beheshtian et al. (2019); Yuan, Hsieh and Su (2020); Ishfaq (2012); Lam and Liu (2018); Fu et al. (2022); Xu et al. (2020); Kayikci (2021); Zhao and You (2019)	Resilience is measured in terms of performance impact and cost trade-off. Private investments mitigate risks.
(4)	Behzadi et al. (2018); Wang, Herty and Zhao (2016); Kabadurmus and Erdogan (2020)	The focused topic is *rerouting*, leading to optimal performance but lower costs with multimode and CO2 prices.
(5)	Peck (2005), OLUWOLE, ODEDAIRO and OLADOKUN (2021); Gong and Liu (2020); Yi-Zhu Su and Wei-Chang Yeh (2022); Viljoen and Joubert (2018); Chen, Lam and Liu (2018)	Public investments in the design and state of infrastructure have to account for a trade-off between cost and resilience.

Cluster	Authors	Implication and Findings regarding supply chain resilience
(6)	Tukamuhabwa, Stevenson and Busby (2017); Singh-Peterson and Lawrence (2015); Costa et al. (2020)	Transportation is of relevance for SCRe, depending on the context.

4.3 Decision to mitigate risks and future research avenue

Papers analysing the impact of disruptions on transport networks often highlight ways to mitigate risks and thereby enhance SCRe: Costa et al. (2019) reveal that transport, in fact, is an element of resilience which leads to significant managerial implications, for example, that the use of telematic systems mitigates the impact of disrupted road transport networks, see (1) of Table 1. Reliability of supply in a SC network is relevant: Ensuring delivery reliability increases SCRe (Ehlen et al., 2014; Adenso-Díaz, Mar-Ortiz and Lozano, 2018), see (2). "Rising the awareness of SCM about the transport network" by increasing the transparency about available routes and their redundancies enhances SCRe (Xu et al., 2020), see (3). Utilising modal shifts (Wang, Herty and Zhao, 2016) and rerouting then also becomes more viable with network redundancies. Moreover, rerouting is the prominent strategy (Behzadi et al., 2018; Wang, Herty and Zhao, 2016), see (4). Private investments into the logistics infrastructure (Ishfaq, 2012) or public investments (Chen, Lam and Liu, 2018) into transport networks enhance SCRe and prevent the infrastructure from degradation, see (5). Regarding (5) and (6), there is no evidence that a good state of the infrastructure enhances resilience. However, there is evidence that badly maintained infrastructure has a negative effect on SCRe (Tukamuhabwa, Stevenson and Busby, 2017; Oluwole, Odedairo and Oladokun, 2021).

4.4 Future research avenue

Most papers provide suggestions for the extension of their developed models. For example, Yuan, Hsieh and Su (2020) suggest that external macroeconomic factors, such as the global economic outlook, facilitate resource allocation on existing and new

shipping routes. Zhang, Dadkhah and Ekwall (2011) propose to consider risk prevention and mitigation strategies targeted to infrastructure. Paul et al. (2019) suggest that researching the disruption effect on lead-time and recovery plans is a future research step. Finally, Mao et al. (2020) suggest considering varying demand during recovery.

Several researchers recommend validating their findings: For example, Costa et al. (2020) propose to validate findings by employing more quantitative studies in various industries to identify their SCs' elements of resilience and interactions among them. Kabadurmus and Erdogan (2020) suggest applying their model to a real-life case study to validate the current results and discover new relationships. Saliently, Bhattacharya et al. (2013) argue that "future research should be directed towards building an SCN with the concepts of econophysics adapted from statistical physics and quantum physics, thereby providing a resilient and more robust SCN mode". However, econophysics have not been pursued further yet. Neboh and Mbhele (2021) recommended that future researchers adopt a longitudinal approach to test the relationships between SC Design and Resilience.

5 Discussion

This paper presented a SLR to reveal the link between transportation and infrastructure networks and SCRe considerations. The main objective of the research paper is achieved in section 4.2. Most papers, except for the empirical and qualitative research, view this link primarily bottom up, meaning that transportation networks influence the outcome of SCRe. The other view that the management of SCRe can impact the configuration of transportation and infrastructure networks is not present. Likely, this requires communication and collaboration with infrastructure operators, often public stakeholders, which was not in the scope of the relevant papers.

5.1 Discussion of findings in the academic context

Six different views on the link have been identified and presented in section 4.2 since the link gets acknowledged multiple times (see Costa et al., 2020). Although the direct link between the transportation network layer and SCRe often isn't explicitly stated, the formulisation of the models of the relevant papers embeds this link implicitly by, e.g., setting up an optimisation model with a SCRe objective that also considers characteristics of the transportation networks.

Operation Research methods (i.e., graph theory and linear optimisation) are most common to analyze transportation networks and the tradeoff between performance and resilience. This finding is in line with Ivanov and Dolgui (2021). Besides, the authors (2021) point out the problematic nature of not precisely defining a specific setting for the research objective – in their case, the pandemic. Because this way, findings would always be transferrable into the general pandemic context. Their observation finds evidence for this research as only around 10% of the relevant papers specify road, maritime or multimodal transport networks and subsequently don't address specific network infrastructure characteristics or vulnerability towards certain events. For example, inland waterway transportation networks that rely heavily on infrastructure are entirely missing and easily disrupted by extreme weather effects.

Hosseini, Ivanov and Dolgui (2019) pointed to the lack of quantitative and mathematical methods back then. This seems addressed as most relevant papers apply quantitative

and mathematical methods. The relevant papers benefit from Operation Research methods as these are capable to capture the network characteristics of … the transportation and infrastructure networks. Furthermore, (intermodal) rerouting facilitated by "redundancy within the transportation network" is a common consideration (Hosseini, Ivanov and Dolgui, 2019). In fact, there is an overlap of identified papers between the SLRs, i.e Tukamuhabwa et al. (2015) and Behzadi et al. (2018). However, this SLR missed out on Khaled et al. (2015) analysing SCRe and the criticality of railroad networks. The missing out can be explained due to the narrowly defined two keywords in this paper, which contrasts with Hosseini, Ivanov and Dolgui (2019), who use 12 keywords to get a holistic overview of SCRe, for example including "resilient supply". Transportation networks in context of SCM could benefit from precise definitions incorporating SCRe.

The influence of transportation and infrastructure networks gets more attention due to disruptions affecting SCs globally; for example, the pandemic, the blockage of the Suez Canal, and queues at the port of Los Angeles incited discussion on SCRe and require SC decision-makers to act upon. Adding characteristics of intertwined transportation networks and sustainability considerations (e.g., emission pricing) connects this paper's output to the relatively new field of SC Viability research (see Ivanov, 2020): whether SCs in their current design can operate in the future, or a reconfiguration becomes necessary — and that infrastructure investments by the public heavily influence that design. Multiple available decisions for SC decision-makers are listed in 4.3 and briefly discussed in the following.

5.2 Discussion of managerial insights

The derived managerial implications mainly have three streams of impact.

1. Most papers propose that their methods are used to prepare, assess, alleviate, and manage the consequences of transportation disruptions by intensifying SCR investments. Public stakeholders can facilitate this to at least prevent the degradation of the current state of infrastructure.

2. Papers provide decision-making tools containing strategies like rerouting considering SCRe and transportation.
3. There Is an optimum of investment, resource allocation, and risk based on quantifiable SCRe. However, the applicability of most of the proposed managerial implications is not tested in empirical studies. Thus, section 4.4. shows many instances where validating the model is presented as a future research opportunity.

Hosseini, Ivanov and Dolgui (2019) name three potential assets enhancing SCRe for decision-makers to obtain: "(i) redundancies such as risk mitigation inventories, subcontracting capacities, backup supply and transportation infrastructures, (ii) data-driven, real-time monitoring and visibility systems, and (iii) contingent recovery plans." All assets are present in the relevant. Next, the authors also point out the cost associated with these resilience assets. However, as transportation infrastructures are often run by public authorities or at least multi-user systems, costs are optimized against the requirements of multiple affected SCs. Finding the right balance between public and private investments enhancing one's SC is highlighted as an addition to the findings in section 4.2.

6 Conclusion

This paper establishes a link between transportation network and Supply Chain Resilience by conducting a Systematic Literature Review of 36 relevant academic journal papers. The review identifies six distinct categories describing various characteristics of said link with their managerial implications. In short: transport networks are an element of resilience and contribute to building resilience capabilities, whereas network disruptions affect supply chain performance and require decision-making in mitigating risks. The findings emphasise the benefit of considering networks for resilience considerations by, e.g., applying appropriate mitigation strategies for transportation as this also enhances Supply Chain Resilience.

This paper contributes to the rising field of Supply Chain Resilience literature by structuring existing research from the perspective of transportation and infrastructure

networks. Researchers can use this foundation and take into consideration the extracted directions of future research; for example, specifying the mode of a transportation network provides further insights that is not present in most of current research.

The review method is subject to the authors' bias. Still, the figures from VOSviewer indicate a sound result as "transportation" is highlighted in the relevant papers but not present in the excluded abstract. Applying such a toolkit could bear fruit for the Systematic Literature Review method in general because statistics are computed algorithmically immediately. The overall amount of contained, peer-reviewed papers is around 4,200 for "Supply Chain Resilience" and 98,000 for "Transport* network*" indicating that future SCRe research could build upon the understanding and methods used to analyse transportation networks and link these to SCM.

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