RISK GOVERNACE FOR PROTECTING CRITICAL INFRASTRUCTURE SUPPLY CHAINS: TOWARDS A CONCEPTUAL MULTI-LEVEL FRAMEWORK

Victoria Ahlqvist
Department of Industrial Management and Logistics, Lund University Faculty of Engineering, 221 00 Lund Sweden, E-mail: victoria.alqvist@tlog.lth.se

Andreas Norrman
Department of Industrial Management and Logistics, Lund University Faculty of Engineering, 221 00 Lund Sweden, E-mail: andreas.norrman@tlog.lth.se

Marianne Jahre
Department of Industrial Management and Logistics, Lund University Faculty of Engineering, 221 00 Lund Sweden and Department of Accounting, Auditing and Business Analytics, BI Norwegian Business School,
0484 Oslo, Norway, E-mail: marianne.jahre@bi.no

ABSTRACT

A core issue in supply chain management is how independent decision makers in many tiers could work together, and how this joint work could be governed. However, in supply chain risk management (SCRM), focus has mostly been on how "focal private companies" apply SCRM processes to identify, analyse and mitigate risk related to upstream and downstream flows in their supply network. The purpose of this study is to develop the term *supply chain risk governance* with a corresponding conceptual framework that captures all types of supply chains and involved actors. Based on a cross-disciplinary literature study, we dissect, compare and combine *risk governance* with inter-organisational aspects of *SCRM*. Focus is on the context of societal critical infrastructures and its governance to increase resilience.

Key word: Risk governance, Supply chain risk management, Governance mechanisms

1. INTRODUCTION

In case of a major incident occurring in today's interconnected supply chains, many organisations will be impacted by, and/or involved in handling the risk. One research domain dealing with this phenomenon is supply chain management (SCM) where research in supply chain risk management (SCRM) has grown as a response to firms' increasing need of joint strategies to manage risks. *SCRM* has many definitions focusing on the use of risk management processes in an inter-organisational context, one of the earlier being *"Supply chain risk management is to [collaborate] with partners in a supply chain apply risk management process tools to deal with risks and uncertainties caused by, or impacting on, logistics related activities or resources*" (Norrman & Jansson, 2004). Friday et *al.* (2018) argue that even though *SCRM*- definitions contain elements of collaboration, there are limitations to the extent of collaboration offered by classic risk strategies. For example, traditional mitigation techniques have received critique for being implemented at a focal firm level (Friday et *al.*, 2018). Bak (2018) brings up the importance of understanding supply chain relationships for mitigating supply chain risks in the long run, and

suggests that future research should identify how supply chain members interact and collaborate, and the resources required.

While *SCRM* research focus on private companies and their risks, other research domains (such as e.g. risk management & societal safety (RMSS) and humanitarian logistics (HL) are more concerned with societal risks and how public, or humanitarian, organisations deal with emergencies. This commonly relates to critical infrastructures, i.e. assets or systems vital for society's critical functions, such as electricity, health, transportation, and food, as their disruption or destruction have a significant societal impact. Over time, critical infrastructures have developed from local into complex interconnected, international and integrated systems involving both public and private actors. The risks to which they are exposed often classify as highly complex (Bekkers & Thaens, 2005; Klinke & Renn, 2012). A breakdown in one system might cause ripple effects and spill-overs to others, resulting in catastrophic situations (Bekkers & Thaens, 2005; Ouyang, 2014; Rinaldi, 2001). Due to the complex relations these risks can seldom be managed by one single actor, but requires collaboration (IRGC, 2008). What before was viewed as an intra-organisational task is now characterised as joint tasks in large supply networks of public and private stakeholders often with competing interests and views on risk. It is therefore important to understand the relationships between such actors. Traditional governmental top-down decisions thus do no longer suffice. In response, the concept of *risk governance* (Arvidsson & Cedergren, 2017; Debreuil, 2001; Gheorghe et al., 2007; Renn, 2008; Sajeva & Masera, 2006) has emerged in the RMSS domain RMSS with multiple stakeholder are involved and cascading effects.

From a research point of view a dilemma is that domains like SCM and RMSS have studied inter-organisational risk management separately, using different terms like (collaborative) *SCRM* and (societal) *risk governance.* Even if both domains developed from systems theory and attempt to describe, understand and handle systemic risk in inter- organisational contexts with multiple decisions makers and potential cascading effects. To distinguish the inter-organisational dimension of SCRM from standard risk management, we suggest the term *supply chain risk governance*.

The purpose of this study is to develop the term *supply chain risk governance* with a corresponding conceptual framework that captures all types of supply chains and involved actors. We do this by dissecting, comparing and combining *risk governance* with the inter- organisational aspects of *SCRM*. Our key contribution is the multi-level analytical framework incorporating different mechanisms for inter-organisational governance related to supply chain risk management. By adding explicit risk governance mechanisms, this contributes to previously multi-level frameworks as the one suggested by Peck (2005). Combining the domains SCM and RMSS, we offer cross-disciplinary approach.

2. METHODOLOGY

2.1 Research process

This paper utilises the literature review as a scoping study in line with suggestions by Arksey and O'Malley (2005) and Davis et al. (2009). Often performed in an iterative way, it contains the following steps: 1. identifying the research question; 2. identifying relevant studies;
1. Study selection; 4. Charting the data; 5. Collating, summarising and reporting the results. To enable a structured analysis, the literature review was combined with content analysis following Seuring and Gold's (2012) four-step model: 1. Determining the material to analyse and the unit of analysis, i.e. scoping the study; 2. Assessing formal characteristics; 3. Selecting categories for analysis; 4. Analysing the material.

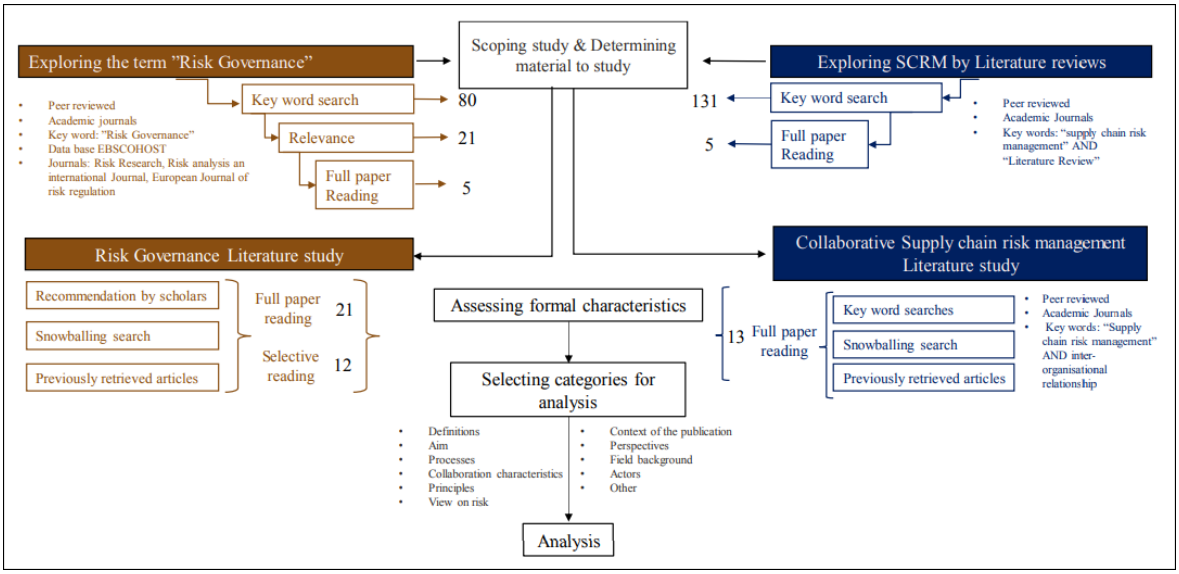

Figure 1. Outline of the research process

With a background in the SCM domain, we decided to focus on exploring literature published in the RMSS domain and complement with findings from SCM, *see table 1* for a complete list.

Table 1. Articles read and analysed in the study

Supply chain literature		Risk Governance literature: full paper read		Risk Governance literature: selective reading	
Bak	2018	Arvidsson & Cedergren	2017	Boholm & Corvellec	2011
Cao et *al.*	2010	Aven	2011	Escuder-Bueno & Halpin	2018
Chen et *al.*	2013	Bekkers & Thaens	2005	Florin	2013
Cruz & Liu	2011	Boholm et *al.*	2012	Hanssen et *al.*	2018
Fan & Stevenson	2018	Brown & Osborne	2013	Lansink et *al.*	2018
Friday et *al.*	2018	Cedergren & Tehler	2014	Lindøe & Kringen	2015
Ho et *al.*	2015	de Vries et *al.*	2011	Lindskog & Sjödin	2016
Lavastre et *al.*	2014	Debreuil	2001	Rooderijs et *al.*	2014
Manuj & Mentzer	2008	Debreuil et *al.*	2002	Stone et *al.*	2018
Norrman & Jansson	2004	Gheorge et *al.*	2007	van Asselt et *al.*	2015
Ojala & Hallikas	2005	Klinke & Renn	2012	van der Vegt	2018b
Wieland & Wallenberg	2013	Lindskog et *al.*	2011	Wong	2015
Zhu et *al.*	2017	Renn	2008		
		Renn et *al.*	2011		
		Rübing	2012		
		Sajeva & Masera	2006		
		Tehler	2012		
		van Asselt & Renn	2011		
		van Asselt & Van Bree	2011		
		van der Vegt	2018a		
		Wachinger et *al.*	2013		

3. LITERATURE

3.1 From Governance to Supply chain governance mechanisms

Governance refers to all processes of governing, whether conducted by a government, a market, or a network of organisations (Bevir, 2012). This leads to governance being discussed in a wide range of theoretical domains, including political science, public administration, economics and corporate strategy. Governance could be done through laws, norms, power or language of an organised society (Bevir, 2012). In business and supply chain relationships, governance could be built into relational contracts that foster long-term collaboration and innovation. Governance of inter-organisational relationships has received considerable attention from a variety of theoretical perspectives, such as new institutional economics literature (including transaction cost analysis) (Wathne & Heide, 2004), strategy, marketing and supply chain management. Corporate governance theory exerts an increasing influence upon research in a wide variety of disciplines (Keasey et al., 2005).

Governance is often distinguished from governance mechanisms. While governance is a higher-level construct describing an organisational construction or, in broader terms, institutional framework, the governance mechanisms are the underlying and concrete management and control activities. Governance mechanisms describe in detail how to motivate the partner and influence and establish the required behaviour. They are thus more "administrative tool[s]" (Martinez & Jarillo, 1989), and point to an actual operative practice between the parties.

In the context of inter-organisational relationships, two common approaches to achieve coordination are discussed: formal and/or relational governance mechanisms (Dekker, 2004; Martinez & Jarillo, 1989; Poppo & Zenger, 2002). Formal governance mechanisms are generally understood to include "depersonalised exchanges, a reliance on financial parameters, and the drafting and implementation of formal contracts" (Ferguson et al., 2005: 217). Relational governance mechanisms, on the other hand, are generally understood to include people- or social-based mechanisms that enhance open communication and the sharing of information, trust, dependence, and cooperation (Eisenhardt, 1985).

Although inter-organisational coordination between different actors in supply chains (or networks) is key in supply chain management, the SCM domain does not often use the term 'governance'. On the other hand, operative practices, mechanisms and activities to manage, control and coordinate inter-organisational relations are often discussed, using other terms than governance. Simatupang & Sridharan (2005), for example, suggested a framework of inter-organisational interface variables (or antidotes) to support SCM and coordination.

3.2 Overriding key characteristics of the governance context

The initial screening and comparison of risk governance and SCRM identified similarities and differences of the constructs' key characteristics and the governance context they address (Table 2). With its societal focus r*isk governance* include a larger number of actors such as public agencies, private companies, and others. SCRM, on the other hand, primarily focus on the risks in private companies' supply chains. We can also conclude that while risk governance takes societies' and the policy makers' perspective on how to handle risk, SCRM risk mitigation strategies and processes are formed with a focal private firm's perspective in mind.

Table 2. Comparison of the constructs' background and perspectives

ASPECT	RISK GOVERNANCE	SCRM/CRM
Context	Public agencies & private companies, society, global systems	Private companies, global system
Perspective	Society & Policy makers	Focal firm
Aim	Public safety, trust & compliance (finance constraint)	Financial results & customer satisfaction first, (public safety later)
Actors	Governmental agencies, Public sector, Civil society (the public),Scientists, Private sector, NGOs etc.	Supply chain actors (mainly private sector)
Relationships	More based on regulations and policies, the public's trust	More based on supply chain transactions
Focused risks	Systemic risk affecting society	Business risks
View on risk	Perception + Probability x Impact	Probability x Impact
Risk Categories	Risk sourced are analysed differently dependent on known risk uncertainty	More instrumental analysis of risk sources
Definition	Descriptive & Normative, Joint approach, Collaborative relationship	Normative, mutual commitment, strategic relationship
Process	Application of the RM-process based on pre-estimation of actors values & risk characteristics	Instrumental application of a traditional RM-process
Applied	When traditional RM loose efficiency due to interconnections	When there is a high level of interdependencies in the SC

3.3 Governance mechanisms

The study's focus was to identify formal as well as relational concrete activities and approaches that facilitate inter-organisational coordination of SCRM-processes. Both domains offer such more operational governance mechanisms, but they use different terms. By studying two different domains and constructs we have established that there are multiple variables influencing the interface between organisations (see figure 3). However, neither domain presents a homogenous picture of how to design inter-organisational risk management. Comparing the two domains, we distinguish between their perspectives on: i) who are involved in the interface, ii) what mechanisms that influence the inter-organisational coordination, iii) what overall approach that guides the collaboration, and finally iv) what are the focal processes for the governance.

While both domains deal with complex inter-organisational systems of multiple actors, the focused actors have traditionally differed (society and public vs. private companies in supply chains) but get increasingly more similar. The focused goal for governance and the risk management processes are quite similar in terms of steps and concrete activities, but differ in type and scope of risks. When it comes to interface variables and governance mechanisms, we find both similarities and differences. Many differences can be deduced back to the domains' different underlying background perspectives (Table 2). The societal perspective of risk governance highlights more the role of institutional structures and mechanisms, while SCRM relies more on formal and relational mechanisms that are collaboratively developed between business partners.

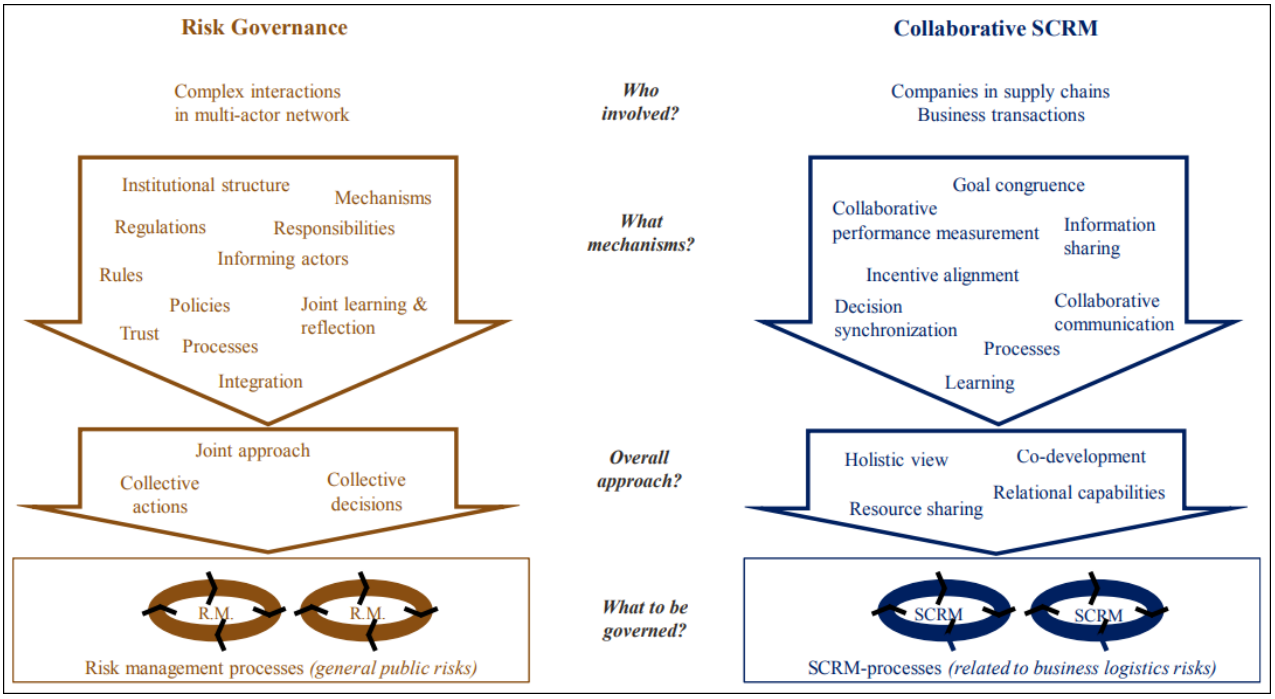

Figure 3. Comparison of the governance mechanisms/ interface variables

4. TOWARDS A CONCEPTUAL FRAMEWORK

In the following we develop a conceptual framework for *supply chain risk governance*

based on the comparison of *risk governance* and (collaborative) *SCRM*. Our multi- level framework (Figure 4) has three layers and combines the structures from Peck (2005) and Simatupang and Sridharan (2005). For simplification purposes, we combine Peck's (2005) three levels in our bottom level, which illustrates the supply chain flows where risks must be managed to not disrupt the flows (e.g. related to critical infrastructures, emergency flows, or just private companies). Hence, actors are either public organisations or private companies - normally a combination – connected to the supply chain in different ways. These actors can be physically directly related to the critical flows, or indirectly, such as institutions that create platforms for interactions (e.g. industry and trade associations) or organisations that could intervene through policies and decisions (e.g. different authorities on sector level, or regional vs. local level).

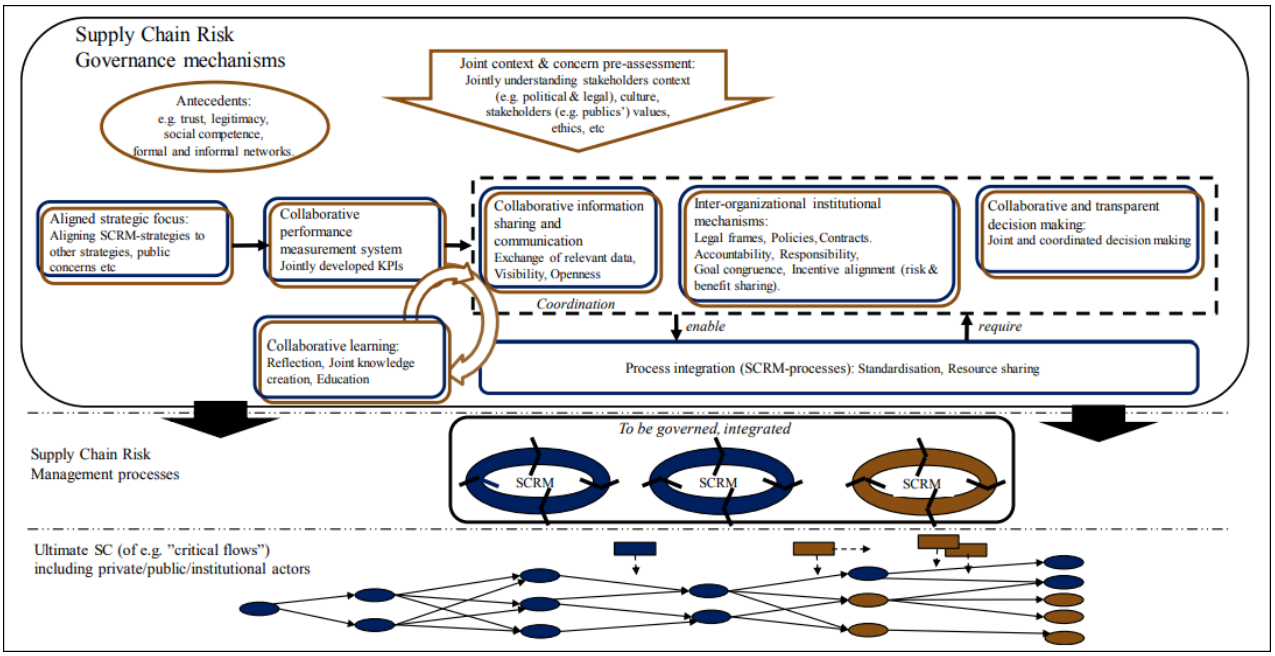

Figure 4. Conceptual multi-level framework for *Supply chain risk governance*.

The risk management processes themselves are part of the second level, and can be used separately by the different private and public actors. The framework does not describe or develop those processes, but highlights that those are the processes that should be inter- organisationally governed. The focus of the framework is the upper level which operationalises the *supply chain risk governance* structure into different inter-organisational governance mechanisms and interface variables. Influenced by Simatupang and Sridharan's (2005) SCM- framework, we propose that the governance structure in this level improve coordination of separate processes. We found *supply chain risk governance* elements suggested in the supply chain management literature (blue frames) or *risk governance* literature (brown frames), or in both. In general we found that the *risk governance*-literature focus more on societal elements at a higher level and the *SCRM*-literature puts more focus on operational mechanisms for process integration. However, many of the governance mechanisms suggested are common although different terms are used.

To ensure a shared commitment in the supply chain it seems important to understand if and how the SCRM-processes are aligned to other important elements in the context, such as other strategies (public authorities' as well as private firms' strategic goals) and other stakeholders' values, society, political ambitions, ethical and legal issues. Following from the strategic intents,

collaborative performance measurement systems could have different purposes; to drive collaboration as well as to monitor and drive behaviour so that it aligns with the existing strategies. If strategic alignment and performance measurement systems serves as formal governance mechanisms and support involved actors to get a shared commitment, the following governance mechanisms i.e. collaborative information sharing, inter-organisational institutional mechanisms and collaborative decision making, will drive increased collaboration and coordination (Simatupang & Sridharan, 2005). Collaborative information sharing and communication are, in both domains, proposed as important relational governance mechanisms. A set of more formal governance mechanisms are clustered in the inter-organisational institutional mechanisms. This include for example legal frames and policies (more related to society) and contracts (more related to the private sector). These are tools that assist with defining accountability and responsibility, as well aligning incentives and creating goal congruence between the different actors. More relational governance mechanisms include collaborative and transparent decision making. It is here important to understand how joint and coordinated decision making can be facilitated and take place, both pro-actively and reactively related to risks, and what platforms are available for coordinated decision making.

While these three *supply chain risk governance* mechanisms should enable more integration of the previously separated SCRM-processes, it is also of interest to know how the integrated SCRM-processes could be developed and defined.

On a higher level, the risk governance-literature suggests the importance of having mechanisms for a joint pre-estimation of the context. This could in particular influence the aligned strategic focus. Many involved actors with presuming different perspectives, makes it important to jointly develop an understanding of the different stakeholder's political and legal contexts, their cultures and values, ethics etc. Finally, mechanisms for collaborative learning is important to be able to develop and improve SCRM-processes both internally and between actors. Development could be based on experiences both from pro-active and reactive SCRM- work. Learning, exemplified by mechanisms for reflection, joint knowledge creation, and education, seems more frequently discussed in articles related to the term resilience and can be found in both domains.

5. CONCLUSIONS, LIMITATIONS AND FUTURE RESEARCH

There are many supply chains in the context of multi-actor private-public partnerships, with inter-organisational challenges regarding risk management. To handle the risks created in, or disrupting, these supply chains require extensive collaboration between the actors. As these actors have different characteristics, governance mechanisms relevant for all must be in place. We have compared and combined *risk governance* in the RMSS domain with collaborative *SCRM* suggesting a multi-level framework including the supply network, the risk management processes, with special focus on the inter-organisational governance mechanisms that could drive increased collaboration in SCRM. This extends previous multi-level frameworks that do not discuss collaboration mechanisms. Furthermore, mechanisms proposed in existing supply chain frameworks (Simatupang & Sridharan, 2005), are extended by adding societal variables such as policies and legal frames, as well as learning, contextual pre-assessment and antecedents. This multi-level framework contributes with a new set of governance mechanisms. Future research should empirically test them on different types of supply chains.

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