

Interorganizational complexity and organizational accident risk: A literature review

Vibeke Milch * (Corresponding author)

Department of Psychology
Norwegian University of Science and Technology,
NO-7491 Trondheim, Norway

Telephone: +47 73 59 19 79
Mobile: +47 47 66 01 08
Email address: Vibeke.milch@svt.ntnu.no

Karin Laumann

Department of Psychology,
Norwegian University of Science and Technology,
NO-7491 Trondheim, Norway

Email address: Karin.Laumann@svt.ntnu.no

Abstract: Due to increased outsourcing in many industries, organizations are becoming larger and more interorganizationally complex and numerous operations now require cooperation among employees from different organizations. This paper presents a review of empirical literature addressing safety issues in complex interorganizational systems wherein the potential for major organizational accidents is present. Thematic analysis of the literature resulted in four main themes: economic pressures, disorganization, dilution of competence and organizational differences. The themes were viewed in light of different theoretical perspectives on organizational accident risk. The findings suggest that issues due to interorganizational complexity can hinder efficient safety management and thereby elevate the risk of organizational accidents. It is emphasized that further research is needed to better understand the implications of interorganizational complexity on safety management.

Keywords: *Interorganizational complexity, safety, organizational accident risk, literature review*

1. Introduction

The present dynamic society is characterised by rapid change, globalisation, fierce competition and the rapid advancement of technology (Rasmussen, 1997), features that require organizations to obtain flexible personnel with specialized expertise and skills in order to stay competitive. In many industries there has been a tendency towards increased outsourcing of activities and functions to subcontractor companies (Johnstone, Mayhew & Quinlan, 2005). This development has given rise to complex socio-technical systems in which multiple companies are involved and work processes require the collaboration of employees from different organizations and coordination across organizational boundaries. This phenomenon can be referred to as *interorganizational complexity* and is arguably a consequence of increased outsourcing. Interorganizational complexity represents an emergent characteristic of modern organizations that use complex, hazardous technology. As industrial

installations become larger and more interorganizationally complex, an important question is what implication such complexity has for safety.

It is largely acknowledged that increased complexity in technology, work tasks and organizational structures renders organizations more vulnerable to organizational accident risk due to increased degrees of freedom and ways in which components of complex systems may interact and produce unforeseen situations (e.g. Perrow, 1984; Rasmussen, 1997; Reason, 1997; Dekker, 2011). While outsourcing indeed may involve benefits in terms of increased flexibility, competitiveness, specialized expertise and cost effectiveness, the involvement of multiple organizations adds to the complexity in a system (Perrow, 1984) by introducing an increased number of organizational interfaces to be coordinated, employees with different backgrounds and practices, different sets of rules and operational procedures, and the need for greater communication and information sharing across organizational boundaries.

Investigations into several large scale organizational accidents have shown that issues with roles and responsibilities, communication and coordination between organizations were contributing factors leading up to accident scenarios. Examples include NASA accidents *Challenger* and *Columbia* (Garner, 2006; Vaughan, 1990) as well as the more recent *Deepwater Horizon* accident (Tinnmannsvik et al., 2011). Such findings suggest that interorganizational complexity may have implications for managing the risk of organizational accidents. Yet, in safety research, few studies have addressed the connection between safety and complexities that result from interactions among multiple organizations.

We argue that understanding the issues arising at the interfaces between organizations may provide valuable insight into better understanding organizational accident risk and how to manage it. The objective of this paper is to examine this connection by reviewing empirical literature that addresses safety in complex interorganizational systems wherein the risk of organizational accidents is present. The aim is to identify issues addressed in the literature and

consider how such issues pose challenges for both safety and risk of major accidents. As such, two research questions are posed: *What interorganizational safety challenges can be identified in the literature? Moreover, how are the interorganizational issues identified in the literature related to organizational accident risk?*

The rest of the paper is organized as follows: the second section will describe the theoretical framework on organizational accidents in complex systems used to analyse the findings from the literature analysis. The next section describes the approach for the literature review. Findings are presented in section 4, and in section 5 discussed in light of theoretical perspectives. Finally, some main points are drawn in summary and conclusion.

2. Theoretical perspectives

Since there are many approaches to safety, there are many approaches to assessing safety in a system. Accident rates, analyses of risks and hazards, investigations of past accidents and near misses, and analyses of organizational characteristics such as safety culture or safety climate all provide sources of information about different aspects of safety. In the safety literature, a distinction is commonly drawn between individual accidents and organizational accidents (Reason, 1997). While the former relate to relatively isolated failures, often due to unsafe acts committed by individuals in which there is a clear relation between cause and effect, the latter involves complex and often catastrophic events with multiple causes and system-wide implications. The causal roots of organizational accidents are thought to be far more comprehensive than those of individual accidents and involve complex interrelations among multiple contributing factors. Accordingly, it has been acknowledged that a systems perspective is essential to understanding organizational accident risk in complex systems (Dekker, 2011; Rasmussen, 1997; Reason, 2000).

There are several theoretical perspectives taking a systemic approach to organizational

accidents in complex systems. In this paper, findings are discussed from three different perspectives. Reason's (1997) ideas on latent conditions, Dekker's (2011) concept of drift into failure, and Weick and Sutcliffe's (2007) perspective on high reliability organizations. These were chosen because they represent different viewpoints on organizational accidents in complex systems and include both longstanding ideas and recent theoretical developments. Arguably, the combination of these perspectives provides the width necessary to illuminate and explore the findings in a nuanced manner. A brief description of each framework is provided in the following.

In the well-known Swiss cheese model, Reason (1997) describes how latent conditions dormant in a system may combine with active failures to ultimately breach the defences in depth. Active failures are errors with immediate, visible consequences made by people at the sharp end, while latent conditions represent invisible faults that may linger in the system for years, originating from decisions made by people higher up in the system. An organizational accident occurs if successive holes in the layers of defence align, representing a breach of existing safety barriers. In this respect, organizational accidents imply a systemic malfunction. In recent years, however, some researchers have argued that organizational accidents in complex systems can occur from unanticipated interaction among subcomponents in the system. Dekker's (2011) concept of drift into failure synthesises research on organizational accident causation in complex systems the last decades describing how seemingly well-functioning and successful organizations can drift into failure. In such thinking, the central premise is that interactions and interrelationships between subcomponents in complex systems may result in outcomes that are difficult to predict. As such, failure does not necessarily mean the existence of a broken component; on the contrary, failure can result from normal organizational behaviour influenced by pressures in the environment, complex technology, and social processes within the system.

While some organizations seem to drift into failure, other organizations seem to avoid large organizational accidents, despite their having faced many situations that could have ended in disaster. High reliability organizations (HROs) are organizations that, in spite of operating in hazardous and trying environments, have had nearly error-free performances over a longer period of time (Roberts, 1990). According to Weick and Sutcliffe (2007), the success of HROs can be explained by a continuous process of mindfulness, sustained by five distinct practices: preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience and deference to expertise. In this sense, mindfulness is described as a collective cognitive infrastructure underpinning organizations that enable them to discover and respond to unforeseen events, thereby preventing disastrous outcomes.

3. Methodology

A literature search and thematic analysis were performed in order to identify themes in the empirical literature that describe safety issues related to interorganizational complexity. Literature was obtained through Boolean searches of databases containing electronic journals, including: ISI Web of Science, PsychINFO, and Google Scholar. Search words used were: *interorganizational complexity, organizational interfaces, multi-organizations, multi-employer, outsourcing, contracting and subcontracting*, all in combination with *safety, safety management, risk, challenges, accident, organizational accident, major accident*. The literature was further supplemented by relevant publications in the reference lists of the publications collected.

Much of the literature that addresses safety within an interorganizational perspective is about emergency response or emergency management (e.g. Laakso & Palomäki, 2013; Comfort, 1994; Comfort, 2007; Comfort & Kapucu, 2006; Sydnes & Sydnes, 2012). These studies were not included because they focus on organizations that are involved subsequent to

an organizational accident as a means of mitigation. This paper focuses on exploring issues that may influence organizational accident risk. There were also several studies that addressed interorganizational aspects related to reliability in critical infrastructures (e.g. Roe, Sculman, Eeten & Bruijne, 2004; Shulman, Roe, Eeten & Bruijne, 2004), but these studies did not address safety and were therefore also excluded from analysis.

Empirical research articles, review articles, academic book chapters and conference papers addressing interorganizational aspects of safety in contexts wherein the potential for major organizational accidents is present, were selected for the study (high risk industries or industries in which failure can result in organizational accidents). Papers that did not address safety related aspects, did not include empirical findings or did not involve a context in which organizational accident risk is present were excluded from analysis. Both qualitative and quantitative studies were considered.

The literature was analysed by means of thematic analysis (Braun & Clarke, 2006; Howitt, 2010). The method was chosen because it allows for the identification and exploration of major themes across the literature in a systematic, theoretically flexible manner. The literature was imported into NVivo 9 and coded in accordance with the procedure described in Braun and Clarke (2006). The initial stage of analysis involved becoming familiar with the literature by simply reading the articles. Through a process of open coding, the material was systematically broken down into smaller sections and assigned descriptive labels or codes. Categorisation during this phase is fairly broad and open. The next stage involved focused coding, in which codes were compared, refined, and eventually clustered in emerging themes. Refining and reviewing the content of codes and themes was a continuous process during all stages of analysis. Deviations were sought, and codes constantly compared. In the final stage, a thematic map was developed to present main themes and sub themes.

4. Results

The literature search yielded a total of 22 papers, comprising 18 empirical studies and four review studies. Arguably, the number of studies is low: yet, the literature encompasses research from a broad range of industries such as offshore helicopter transportation (Gomes, Woods, Carvalho, Huber & Borges, 2009), the railway industry (Jeffcott, Pidgeon, Weyman & Walls, 2006; Cedergren, 2013a; Cedergren, 2013b), marine transportation (Kongsvik, Fenstad & Wendelborg, 2012), the aerospace industry (Garner, 2006; Vaughan, 1990), the petroleum industry (Collinson, 1999; Kongsvik & Fenstad, 2007), the nuclear industry (Macchi, Pietikäinen, Savioja, Liinasuo, Wahlström & Reiman, 2013; Oedewald, Gotcheva, Reiman, Pietikäinen & Macchi, 2011) and construction (Albrechtsen & Hovden, 2014; Mayhew, Quinlan & Ferris, 1997; Priemus & Ale, 2010). Table 1 presents an overview of the studies.

[Please insert Table 1 about here.]

The studies reviewed seem to focus on different aspects of safety. Two studies explore factors related to the occurrence of large organizational accidents (Garner, 2006; Vaughan, 1990), while one explored factors related to an unwanted incident with organizational accident potential (Priemus & Ale, 2010). Several studies explore aspects related to safety culture and safety climate (Collinson, 1999; Clarke, 1998; Clarke, 2003; Jeffcott et al., 2006; Kongsvik et al., 2012; Macchi et al., 2013; Oedewald et al., 2011), and four studies look at resilience and factors associated with deviance from good safety practice (Cedergren, 2013a; Cedergren, 2013b; Gomes et al., 2009; Kongsvik & Fenstad, 2007). One study addresses safety management and emergent accident prevention (Albrechtsen & Hovden, 2014). A considerable number of studies address occupational aspects of safety such as the risk of individual accidents, individual health hazards and HSE-challenges (Kochan, Smith,

Wells & Rebitzer, 1994; Mayhew & Quinlan, 1997; Mayhew et al., 1997; Nenonen, 2010; Nenonen & Vasara, 2013; Quinlan et al., 2001; Rousseau & Libuser, 1997).

Thematic analysis resulted in four themes, each comprising several sub themes: *economic pressures, disorganization, dilution of competence and organizational differences*. An overview of the themes and sub themes is presented in Table 2.

[Please insert Table 2 about here.]

4.1. Economic pressures

The literature suggests that economic pressures occurring between organizations can influence aspects such as cooperation, accidents reporting, and responsibility for safety, as well as contribute to goal conflicts and trade-offs at the sharp end. The sub themes under the theme economic pressures are *lack of shared sense of responsibility for safety-related issues and safety/production trade-offs*.

4.1.1. Lack of a shared sense of responsibility for safety-related issues

A central finding in the analysis was that economic pressures seem to deteriorate a shared sense of responsibility for safety (Clarke, 1998; Garner, 2006; Jeffcott et al., 2006; Kochan et al., 1994; Priemus & Ale, 2010). Kochan et al.'s (1994) study revealed that the management of an oil refinery delegated responsibility for safety supervision and the training of contract employees to the contractor in order to avoid co-employment liabilities, which resulted in the contract workers' receiving less safety training than core workers. Other studies describe how smaller firms tend to have fewer resources available for safety training and supervision (Nenonen, 2010; Quinlan, Mayhew & Bohle, 2001). Accordingly, the involvement of multiple organizations seems to result in fragmented supervision and

management of safety.

In interorganizational complex systems in which each organization can be regarded as a stakeholder, expenses pursuant to accidents and errors can have negative financial consequences for individual companies. Several studies uncovered that organizations sought to avoid accountability subsequent to errors and accidents. For example, Priemus and Ale's (2010) study revealed that some companies tried to erase traces of potential errors in order to avoid accountability. Furthermore, many studies address the existence of a blame culture in which organizations blame each other if something goes wrong (Clarke, 1998; Jeffcott et al., 2006; Priemus & Ale, 2010). A railway director interviewed in Jeffcott et al.'s (2006) study of the post-privatized British railway system describes such a phenomenon:

“...I feel that the blame culture has always been around in the industry to some extent, at least people have talked about it, known what it meant but recently it's magnified considerably ... Because you have produced the situation where every interface becomes a contractual one, and given the way that our adversarial legal system [operates], with letters between companies “you should have done that, we were right, you were not.” (Jeffcott et al., 2006, p. 1112)

Blame culture also seems to have influenced accident reporting, as employees expressed fearing prosecution for errors and accidents and, in turn, unemployment. For example, Collinson's (1999) study of safety and accident reporting on a North Sea offshore installation revealed that contract workers were reluctant to report accidents, because doing so could endanger their future on the oil rig.

“...We don't tell them about accidents if we can help it. Unsafe practices go on, but they get covered up” (collinson, 1999, p. 589).

4.1.2. Safety/production trade-offs

The focus on price reduction and efficiency represents a safety paradox. One the one hand, contractor and subcontractor companies are expected to operate safely and exhibit a

good safety record, while on the other hand they are expected to deliver as quickly and cost-efficiently as possible. Consequently, fierce price competition and efficiency demands are central issues in several studies, issues that may undermine safety considerations. For example, Vaughan's study (1990) of NASA's interorganizational network suggests that underbidding and efficiency demands led to contractors' complying with NASA's production goals instead of their safety goals.

Sustaining a good safety record is crucial for contract and subcontractor companies in order to receive and renew contracts. With poor safety records, contractor and subcontractor companies risk failing to have existing contracts renewed and, in the pursuit for new ones, becoming competitively inferior (Clarke, 1998; Collinson, 1999; Mayhew et al., 1997). Findings from several studies suggest that such pressure influenced contract workers' reporting behaviour, thereby leading to employees' holding back or reclassifying information about accidents (Collinson, 1999; Priemus & Ale, 2010). Moreover, the focus on cost cutting and price was also associated with corner cutting and different forms of trade-offs for employees at the sharp end (Gomes et al., 2009; Kongsvik et al., 2012; Mayhew et al., 1997; Nenonen, 2010). Kongsvik et al., (2012) found that pressure and efficiency demands from external actors influenced reporting among contract workers on offshore service vessels and prompted neglect to report accidents when production demands were perceived to be more urgent. In Gomes et al.'s (2009) study, offshore helicopter pilots faced several safety/production dilemmas in their daily work that influenced safety on a larger scale. One helicopter pilot interviewed described a situation in which pilots had to choose between personal economy and safety:

“...Part of pilots' pay comes from hours effectively flown. (...) there are some captains that forget about safety in order to fly more (...) there are cases-with older aircraft where the pilot knows that the aircraft should stop flying because of excessive vibration. But he doesn't do that and leaves the problem to be solved during the other 15 days [when it won't impact his income].” (Gomes et al., 2009, p. 315).

4.2. Disorganization

The second theme that emerged from analysis was disorganization. The term was originally coined by Dwyer (1991) and later employed by Mayhew and Quinlan, (1997), Mayhew et al., (1997), and Quinlan et al., (2001) to describe fragmentation in the management of organizational processes as a result of outsourcing. The involvement of multiple organizations seems to influence the coordination of tasks, communication and information flow. The literature suggests that these processes become more complex and difficult to manage in interorganizationally complex systems. The theme comprises the following sub themes: *Confusion in roles and responsibilities, breakdown in communication and information flow and complex safety management systems.*

4.2.1. Confusion in roles and responsibilities

Many studies addressed ambiguity in the division of responsibilities for tasks and functions among different organizations as well as fragmented work processes, as a consequence of interorganizational complexity (Cedergren, 2013; Mayhew & Quinlan, 1997;; Mayhew, et al., 1997; Nenonen, 2010; Nenonen & Vasara, 2013; Priemus & Ale, 2010; Quinlan et al., 2001). In this regard, ambiguity and confusion concerning legal responsibility for safety training supervision and oversight among organizations was a central issue (Mayhew et al., 1997; Nenonen, 2010; Nenonen & Vasara, 2013).

Priemus and Ale (2010) found that splitting a building project into three parts with over 50 different companies compromised any shared sense of responsibility for the project. With each organization minding its own area of responsibility, no individual possessed an overview of the project as a whole. Shortly after the project's completion, the building urgently had to be evacuated and abandoned due to major construction flaws that could have precipitated a major accident. Rousseau and Libuser (1997) have noted that few contract

organizations have experience with working interdependently with other organizations, and seldom exhibit onsite coordination functions.

Another issue that emerged in the literature was that organizations may be unfamiliar with the roles and responsibilities of collaborating organizations. In the context of the Swedish railway industry, Cedergren (2013) revealed poor coordination and misperceptions of roles among safety authorities in issuing recommendations prior to the investigation of accidents. Such confusion contributed to only 12% of recommendations being followed.

4.2.2. Breakdown in communication and information flow

Breakdown in communication and the flow of information at organizational boundaries was found to be a central issue in the analysis (Albrechtsen & Hovden, 2014; Garner, 2006; Jeffcott et al., 2006; Kochan et al., 1994; Kongsvik & Fenstad, 2007; Macchi et al., 2013; Nenonen, 2010; Nenonen & Vasara, 2013; Priemus & Ale, 2010; Rousseau & Libuser, 1997; Vaughan, 1990). Among the issues described were misunderstandings regarding planned work tasks and inadequate checks (Priemus & Ale, 2010), uncertainty about whom should be informed (Nenonen & Vasara, 2013), different communication practices among organizations (Nenonen, 2010; Nenonen & Vasara, 2013), communication breakdown due to distrust between direct-hire workers and contract workers (Kochan et al., 1994), and slow information flow (Albrechtsen & Hovden, 2014; Kongsvik & Fenstad, 2007; Jeffcott et al., 2006). In both the *Challenger* and *Columbia* accidents, breakdowns in communication among organizations in which information was lost or not communicated to the right people, problems with coordinating changes in information, and keeping working documents updated were identified as key communication issues that contributed to the accidents (Garner, 2006; Vaughan, 1990).

4.2.3. Complex safety management systems

The involvement of multiple organizations seems to yield more complex and bureaucratic safety management systems (Jeffcott et al., 2006; Kongsvik & Fenstad, 2007). In fact, paper-work associated with accident reporting was perceived by offshore employees to function as a barrier to reporting (Kongsvik et al., 2012). Jeffcott et al.'s (2006) study suggests that the need for written procedures seems to increase with the involvement of multiple organizations, and as a result, the sheer amount of procedures grows. In Kongsvik and Fenstad's study (2007), offshore employees expressed concern for the growing number of procedures which they described as a hindrance rather than something to aid their work. As the quantity of procedures increases, it becomes cumbersome and difficult for employees to identify and use appropriate procedures.

4.3. Dilution of competence

Interorganizational complexity seems to influence the quality of competence available. Findings from several studies suggest that contract workers often lack relevant competence, workplace-specific experience, and safety training, as well as are unfamiliar with the formal rules and procedures, not to mention the workplace itself (Albrechtsen & Hovden, 2014; Jeffcott, et al., 2006; Kongsvik & Fenstad, 2007; Macchi et al., 2013; Nenonen, 2010; Oedewald et al., 2011; Rousseau & Libuser, 1997;). The theme comprises the following sub themes: *Employees unfamiliar with local work environment* and *lack of industry-specific knowledge and experience*.

4.3.1. Employees unfamiliar with local work environment

An increase in temporary workers due to outsourcing means an increase in employees who may be unfamiliar with the work and local circumstances. In Nenonen and Vasara's

(2013) study, contract workers perceived working at different worksites to be challenging due to the continuous shifts in work place that required different competencies and familiarity with different sets of procedures and rules. Jeffcott et al.'s (2006) study suggested that privatising strengthened the focus on rule-based, procedure-driven problem solving, thereby eroding conceptual knowledge in the organization:

“The new recruits are great (...) but don't have the history, the background on the rails anymore and that's a worry. You can't just learn the rules; you have to think about what's behind it, what underpins it. Do you really understand when and how to apply rules in tricky situations? (...) as the industry has gotten safer, we've gotten softer. Our operational staff, the majority of our staff will not have faced an emergency, thank God, but what that does mean is that you've got these young guys with a book-based approach to their rules and regs and no real know-how of the real dangers of the job.” (Jeffcott et al., 2006, p. 1113)

4.3.2. Lack of industry-specific knowledge and experience

Lack of industry-specific knowledge and experience among subcontractor companies was a problem described in several studies (Albrechtsen & Hovden, 2014; Oedewald et al., 2011; Macchi et al., 2013). For example, Macchi et al.'s (2013) study of design activities in the nuclear industry revealed that subcontractor companies providing design services or delivering components to the design were seldom part of the nuclear industry, and therefore unaware of common hazards and safety threats as well as how their own work could influence system safety.

4.4. Organizational differences

Different practices and work habits, variations in organizational culture and differing perceptions regarding safety were described as being problematic in the literature (Cedergren, 2013a; Cedergren 2013b; Macchi et al., 2013; Oedewald et al., 2011; and several studies indicated that organizational differences were associated with distrust, conflict, and tension

among employees from different organizations (Clarke, 2003; Collinson, 1999; Jeffcot et al., 2006; Kochan et al., 1994; Kongsvik & Fenstad, 2007; Nenonen, 2010). The theme organizational differences include the subthemes: *Fragmented decision-making processes* and *distrust and conflicts*.

4.4.1. *Fragmented decision-making processes*

Differences between organizations with regard to roles, responsibilities and different areas of expertise were in one study found to result in disagreements and decision-making problems. Cedergren (2013a) found that contrasting viewpoints among decision-makers from different organizations led to difficulty in agreeing upon safety measures in railway tunnel projects. No one had superior authority to make final decisions. Consequently, decisions were largely based on negotiations and compromise to resolve local conflicts of interest instead of safety analyses. In this instance, local issues between organizations led to decisions that were not necessarily optimal for safety.

4.4.2. *Distrust and conflicts between organizations*

Clarke's (2003) review of research on contingent workers indicates that organizational differences among workers from different organizations stifled trust among workers and commitment to safety. Such situations were primarily related to the derogatory stereotyping of contingent workers from core workers. Collinson (1999) found similar results. A statement from a scaffolder illustrates the perception of an "us-versus-them" division between contract and core workers:

"The idea that we're all one company, that everyone is treated the same is just not true. There's a big division on here between them and us." (Collinson, 1999, p. 588)

Status differences were also found to influence workers willingness to share safety-related information. On this point, several studies revealed that contract workers found that their opinions were rarely taken seriously (Collinson, 1999; Nenonen, 2010).

5. Discussion

The first aim of this paper was to identify interorganizational safety challenges in the literature. A clear limitation was that the literature search only yielded 22 papers which met the selection criteria. This suggests there are few empirical studies that have addressed interorganizational safety in contexts in which failure could result in major organizational accidents. Consequently, more research is needed in this area. Nonetheless, the sample includes studies from many different industries, thereby providing a broad research context. Several interorganizational safety issues were described in the literature and four main themes were identified: Economic pressures, disorganization, dilution of competence and organizational differences.

The second aim of this paper was to explore how interorganizational issues identified in the literature relates to organizational accident risk. In the following, findings from the literature review will be discussed in light of theoretical perspectives on organizational accident risk. Each theme will be discussed separately, followed by a summary and conclusion.

5.1. Economic pressures

Production pressure and economic constraints are features of complex organizations associated with drift into failure (Dekker, 2011). Analysis revealed that economic pressures arising among organizations may serve to deteriorate any shared sense of responsibility for safety, an issue also associated with the existence of blame culture in several studies. The

tendency to assign blame and shirk responsibility seems to shift focus away from learning from accidents and can result in a blind system in which latent conditions may go unnoticed (Reason, 1997).

HROs have displayed an ability to pick up on and react to sometimes very weak indicators of potential threats to safety before minor problems escalate into uncontrollable situations. In this respect, reporting small errors, accidents, and near-misses is an important element (Weick et al., 1999; Weick & Sutcliffe, 2007). Fear of prosecution or weakened job security due to a focus on blame and accountability may result in employees' being less comfortable with reporting accidents. Since trust has been found to be crucial to encouraging accident reporting, (Carmeli & Gittell, 2009; Reason, 1997) blame culture among organizations can upset trust building among those same organizations and, as such, influence reporting behaviour. In the same sense, distrust and status differences among employees may also be influential, for they may also hinder open communication among organizations about accidents and incidents. For example, two studies in the analysis indicated that cover-ups and reclassification of accidents had occurred (Collinson, 1999; Priemus & Ale, 2010) which can complicate determining the actual course of events subsequent to an accident and obscure contributing latent conditions.

Analysis suggests that safety/production trade-offs occur as a result of inter-organizational complexity. Organizations must continually balance production demands with safety demands. At the same time, different organizations may have separate goals in addition to shared objectives, which may conflict, thereby creating trade-offs and double binds for employees at the sharp end, as well as situations in which the safety goals of the customer organization contradict production goals in the employer organization. Such conflicting goals have been associated with corner cutting and found to influence the accident-reporting behaviour of contract workers (Collinson, 1999; Kongsvik et al., 2012). Dekker (2011) argues

that such local ways of handling conflicting goals may result in deviations becoming normative behaviour, and the accumulation of such small variations over time can be described as a decremental process of small steps. Accordingly, such conditions can be difficult to detect and may contribute to a slow drift toward failure.

5.2. Disorganization

Findings suggest that interorganizational complexity can contribute to disorganization (Mayhew et al., 1997; Mayhew & Quinlan, 1997, Quinlan et al., 2001) characterised by confusion in the division of roles and responsibilities between organizations, breakdowns in communication and slow information flow across organizational boundaries.

Fragmented work processes in which no single individual possesses an overview of the total organization can pose implications for sustained monitoring systemic processes and may consequently hinder the discovering of and thus response to safety threats. The safety literature generally agrees that the management of organizational accident risk requires the people who manage the system to have sufficient knowledge of the factors that influence it as a whole (Dekker, 2011; Reason, 1997; Weick & Sutcliffe, 2007). Studies of HROs suggest that one practice associated with success on this point is remaining sensitive to operations (Weick & Sutcliffe, 2007), which is described as broad operational awareness involving a collective mind-set in which operations are integrated and understood at all levels. By contrast, a poor division of responsibilities across organizational boundaries can represent a hindrance in this respect.

Complexities in the protective structures of complex systems may also push the system closer to organizational failure (Dekker, 2011; Perrow, 1984; Reason, 1997). Analysis suggests that safety management systems in interorganizationally complex systems can be elaborate and difficult to navigate. In this sense, an obvious consequence is that important

information may be lost or difficult to retrieve. One study in this analysis suggested that the amount of written procedures increased after the company under study was privatized into several smaller companies (Jeffcott et al., 2006). Some studies suggest that too many procedures can result in information overload and employees finding alternative ways to execute their duties (Antonsen, Almklov & Fenstad, 2008; Wold & Lauman, 2014). Again, this is an arena in which deviant behaviour can become normative and contribute to drift toward failure (Dekker, 2011).

5.3. Dilution of competence

Interorganizational complexity seems to impact the quality of competence within a system. Outsourcing and involvement of subcontractors and temporary workers were associated with less experienced employees who were unfamiliar with the local work-place, rules, and procedures. Knowledge and experience on the part of employees have been emphasized as important elements of a system's capacity to respond to unexpected situations. For example, HROs have been found to redirect decision making to experts at the sharp end of operations in urgent situations (Weick et al., 1999; Weick & Sutcliffe, 2007), which requires that employees have thorough knowledge of the competencies of coworkers. Accordingly, in interorganizationally complex organizations with employees from different organizations who are both unfamiliar with the work-place and with each other, such a situation can pose a substantial challenge. Furthermore, it requires that employees have the experience and skills necessary to handle new and unexpected situations. Findings from the analysis also suggest an association between increased outsourcing and subcontracting, on the one hand, and a sharpened focus on procedure-driven problem solving on the other, which may corrode conceptual knowledge within the system. Adherence to procedures as rule-based problem solving may hinder employees with little experience or competence in developing

the skills necessary to handling unforeseen situations. Dekker (2003) has argued that standardisation through procedures represents an important step toward the development of safe practices, but also underscores the importance of acknowledging how procedures alone are insufficient to achieving safe practice. Knowing when to apply which procedures across different situations is a cognitive activity requiring great skill and an important requirement for the successful application of procedures. Since procedures cannot describe every possible scenario in any given situation, some situations will require improvisation. At the same time, relying blindly on procedures may hinder any worker's ability to understand what is going on and thereby prompt unsafe behaviour in the face of unexpected situations.

On an organizational level, external contractors and subcontractors may lack industry-specific knowledge and experience, being unfamiliar with the industrial context and relevant safety hazards. Findings from the analysis suggested that subcontractor companies were unaware of ways in which their work could influence system safety. An obvious consequence may be that these external companies are unable to detect if something goes wrong. Again, latent conditions may occur and go unnoticed (Reason, 1997).

5.4. Organizational differences

Employees from different organizations have different practices and work habits, as well as possibly different perceptions regarding safety. Analysis suggests that organizational differences among employees from different organizations can contribute to conflict and tension due to distrust and status differences. Such issues may hinder the sharing of safety-related information among employees from different organizations, while distrust in particular can limit the degree to which employees dare to ask critical questions should they discover something amiss. Such elements contradict the HRO principle of resisting oversimplification, in which scepticism and a questioning culture have been described as central features (Weick

et al., 1999; Weick & Sutcliffe, 2007).

Furthermore, issues stemming from organizational differences may also hinder the development of shared safety practices. For example fragmented decision-making due to diverse roles and perspectives among organizations may result in local conflicts of interest clouding more fundamental safety concerns. The mindfulness of HROs has been described as a collective cognitive infrastructure shared by employees at all levels of the system (Weick et al., 1999; Weick & Sutcliffe, 2007). Accordingly, mindfulness may be difficult to attain in interorganizationally complex systems comprising multiple organizations.

6. Summary and conclusion

The aim of this paper was to examine the connection between interorganizational complexity and organizational accident risk. A literature search and thematic analysis of empirical literature addressing safety issues in interorganizationally complex systems were performed and four main themes were identified: economic pressures, disorganization, dilution of competence, and organizational differences. In addition, the findings were viewed in light of theoretical perspectives on organizational accident causation and organizational safety.

This study's findings indicate that safety issues due to interorganizational complexity can have implications in terms of organizational accident risk and also hinder functions associated with the successful management of organizational accident risk. The findings suggest that interorganizational complexity is associated with characteristics of drift toward failure. In large systems comprising many individual organizations, economic pressures among organizations create numerous trade-offs and goal conflicts that are handled locally in the different organizations. The accumulation of such small trade-offs over time can slowly erode a system's defences. Furthermore, safety management systems shared by many

different organizations can become complex and cumbersome to the point that they can function against their purpose and result in information overload and improvised work practices. Issues such as blame culture and lack of shared safety responsibility among organizations, as well as confused roles and responsibilities, breakdown in communication, and organizational differences, can contribute to latent conditions in the system, and at the same time, preclude the discovering of pre-existing latent conditions.

Several of the issues identified in the literature contradict HRO principles, which have been associated with successful management of organizational accident risk. Since mindfulness is described as a collective cognitive infrastructure in the system, it implies an overall, unified safety strategy. In this regard, fragmented responsibility for safety can constitute a challenge. Moreover, blame culture and distrust among employees from different organizations may discourage scepticism and a questioning culture, as well as shift focus away from learning from errors and accidents. At the same time, interorganizational complexity seems to influence the degree to which available expertise in the system is fully used in critical situations. A prevalence of employees who lack sufficient training and skills and, are unfamiliar with the local work-place, each other, and the competencies of coworkers from collaborator organizations, in combination with a sharpened focus on procedure-driven problem solving, may weaken the system's capacity to respond to unforeseen situations.

Taken together, it seems that interorganizational complexity poses challenges that may prevent the successful, overall management of system safety in terms of the discovery and response to safety threats. Accordingly, such issues may contribute to the occurrence of organizational accidents. To date, few studies have addressed interorganizational issues in relation to safety and organizational accident risk. Findings from this study strongly suggest that more research is needed in this area. Greater awareness of safety challenges associated with interorganizational complexity can provide valuable insight that can better equip

organizations for managing organizational accident risk.

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