

The limits of soft safety regulation: Does successful work with safety culture require SMS implementation?

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ABSTRACT

The Swedish Transport Agency defined contributing to a high safety culture in transport companies as a key element in its regulatory strategy. This study examines how the safety culture strategy was received and enacted by regulators and companies within each transport sector, and factors influencing this. We discuss what a regulatory agency can accomplish through a safety culture strategy, and the extent to which it is bounded by the safety management maturity level in each sector. A key question is whether safety management requires a sequential, or evolutionary development, where companies must implement well-functioning safety management systems (SMS) before being organisationally mature enough to work successfully with safety culture. Our results seem to support this assertion, as we find that transport sectors with legal SMS requirements focus on safety culture, and work with safety culture elements (e.g. reporting/just culture, continuous improvement, involvement) to ensure that the SMS is a living system. Sectors without SMS requirements (i.e. road) do not focus on safety culture. Without SMS, it seems that safety culture work equals focusing on safety commitment among managers and employees. We identify additional factors influencing organisational maturity level and safety culture focus, limiting soft safety regulation, e.g. business structure, maintaining equal conditions for competition.

1. Introduction

As much as 1.35 million people die each year on the world's roads, and between 20 and 50 million people sustain non-fatal injuries (WHO, 2018). Many also die in maritime accidents, with 24 000 fatalities in the fishing sector alone (IMO, 2015). In 2017, there were 1 855 serious railway accidents in the EU, resulting in 977 fatalities and 763 severe injuries (Eurostat, 2019). In comparison there were 472 worldwide air traffic fatalities each year from 2009 to 2018 (Statista, 2019).

Safety levels have, however, improved in all transport sectors due to the implementation of safety management and regulation strategies focusing on technology, the individual operator and systems. Several scholars perceive safety management as an evolutionary process, referring to the technical age, the human factors age and the management systems age (Hale and Hovden, 1998; Westrum 2004; Kim and Park, 2016; Borys et al., 2009). It has been argued that further safety improvements in transport, especially in the road sector, require new approaches to safety management and regulation (Parker et al., 2006; Ward et al., 2010).

Safety culture, which we define as shared and safety relevant ways of thinking and acting (Nævestad et al., 2019), has been portrayed as such an approach. It has been described as the latest phase in the evolution of safety management or a "fourth age" indicating a high level of organisational maturity, based on the work of preceding "ages" focusing on technology, the individual and systems (Hale & Hovden 1998; Fleming 2001; Kim and Park, 2016). Indeed, robust studies find that interventions to improve safety culture may reduce the risk of accidents by 81 % in the rail sector (Zuschlag et al., 2016) and 60 % in the road sector (Gregersen et al., 1996), and positive outcomes are also documented across other industries and countries (Zohar 2010).

Recognizing its importance for safety outcomes, authorities in different industries have started to consider how to account for safety culture in regulatory attempts to reduce industrial risks (e.g. Antonsen et al., 2017; Amtrak 2015, Baldwin et al., 2012). Little has been done, however, to document and learn from such efforts (cf. Nævestad et al., 2019). The present paper addresses this situation by reporting a study regulators' and companies' in aviation, maritime, rail and road experiences with the safety culture strategy of the Swedish Transport Agency

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(STA) (Transportstyrelsen).

The aim of the STA is accessible, secure and sustainable rail, air, sea and road transport. The STA issues permits to companies conducting transport operations, and is also responsible for regulations and controlling compliance. Part of STA's regulatory strategy is to stimulate for positive safety culture in transport companies. It does this by focusing on safety culture in audits and through other contact with the companies. The STA is comprised of sector-specific departments (i.e. for aviation, maritime sector, rail and road) and more general departments spanning across specific sectors (e.g. departments focusing on strategic development across sectors). The work on the general safety culture strategy was for instance developed in a strategic sector-overriding department. The different sector specific departments were assisted by human factors experts in the sector-overriding department, to adapt and tailor the safety culture strategy to each transport sector. These experts also regularly assisted the sector specific departments.

The present study focuses on how STA's safety culture strategy was received and enacted by the sector specific regulators and by the companies within each transport sector. Our aims are to examine: 1) Whether and how regulators in each sector focus on safety culture, 2) The factors influencing regulator focus on safety culture, and 3) Whether companies in each sector focus on safety culture and how this is related to the regulatory focus on safety culture in the sector. Ultimately, we consider what regulatory agencies can accomplish through a safety culture strategy, given constraints of safety management maturity level in each sector. Comparing different sectors, we discuss whether safety management requires a sequential approach in which companies first implement well-functioning safety management systems (SMS) to develop the organisational maturity required to work successfully with safety culture.

2. Theoretical approach and previous research

2.1. Safety culture

We define organizational safety management as the combination of informal and formal organizational measures to achieve safety in organisations. We refer to the formal organizational measures as safety management system, and the informal as safety culture (Antonsen 2009; Nævestad 2010). The concept of (organizational) safety culture is usually traced to the 1986 Chernobyl disaster, which led to a shift of focus in the investigations and studies of safety in organizations. Several major accident investigations subsequently identified safety culture as a major contributing factor (Cullen 1990; NASA 2003). Organizational safety culture can be defined as «safety relevant aspects of culture in organizations» (Hale 2000; Antonsen 2009; Nævestad 2010). Although these aspects may refer to a range of different cultural phenomena (e.g. behavioural patterns, norms, values), most studies define safety culture as shared and safety relevant ways of thinking or acting that are (re) created through the joint negotiation of people in social settings (Nævestad, 2010).

Previous studies indicate that safety culture has been defined and measured in a vast multitude of ways, and the concept has been linked to a large number of different theoretical concepts and approaches. To simplify this, we may draw a general line between qualitative and quantitative studies of safety culture (Nævestad et al., 2021).

Quantitative studies focus on identifying the key aspects of safety culture and their relations to safety outcomes. Quantitative studies also focus on developing and validating scales for measuring «shared and safety relevant ways of thinking or acting». The element of safety culture that can be measured is often referred to as safety climate. Thus, safety climate can be conceived of as «snapshots», or manifestations of safety culture (Cox & Flin 1998). We use the terms culture and climate interchangeably. Quantitative measurements of safety culture can provide leading indicators of safety and consequently offer predictive assessments that enable safety improvements without having to wait for

accidents or incidents to happen (Antonsen 2009). Quantitative measurements of safety culture are necessary to compare scores over time, between organizations and to quantify the relationship between safety culture and safety outcomes.

Qualitative studies focus on how safety culture guides individuals' interpretations of actions, hazards and their identities, and motivates and legitimizes behaviours that have an impact on safety (Antonsen 2009, Nævestad, 2010). These studies may give us access to the «deeper» levels of safety culture; the more implicit and taken for granted basic assumptions and «tacit knowledge» (cf. Schein 2004; Haukelid 2008). Qualitative studies focus on how safety culture provides a frame of reference that guides individuals' interpretations of actions, hazards and their identities, and which motivates and legitimizes behaviours that have an impact on safety (Antonsen, 2009, Nævestad 2010).

2.2. Safety management system

We define the formal aspects of safety management as safety structure or more specifically SMS. Safety structure can be defined as safety-relevant aspects of organizational structure. Organizational structure refers to the way tasks in an organization are divided up, how the work flows, how this flow is coordinated and the forces and mechanisms that enable this coordination to take place (McShane & Travaglione, 2003). Coordination can be achieved by: 1) informal communication, 2) formal hierarchy, involving direct control, and 3) standardization of tasks, with formal instructions, goals (standardisation of outcomes) or training (standardization of knowledge) (McShane & Travaglione 2003).

SMS describe formal routines and measures describing how the organisation *should* work systematically with safety. As safety culture, SMS is also defined in several ways. SMS describe how risk should be identified and mitigated through formal assessments, development of countermeasures (e.g. procedures, training), definition of roles and responsibilities, regular evaluation of safety outcomes and alteration as necessary (cf. Thomas 2012). In a systematic review, Thomas (2012) finds especially-two aspects of SMS (management commitment to safety and communication) to be related to safety performance.

In several high-risk sectors (e.g. aviation, oil and gas, the nuclear sector), SMS is legally required, explicitly aiming to facilitate a good safety culture. The international safety management system (SMS) rules in aviation (ICAO, 2021) states for instance that the purpose of the required SMS is to foster a positive safety culture.

2.3. Regulation

The traditional «rule-based» regulatory approach is to develop or implement rules that companies are supposed to comply with and then to audit their compliance (cf. Antonsen et al., 2017). We refer to this as «hard» safety regulation. In response to new paradigms for safety management, function-based and systemic regulatory approaches have led to increased self-regulation by companies through SMS (Westrum 2004; Kim and Park, 2016). Regulatory focus has shifted from auditing rule compliance to auditing the more abstract management processes that companies use to ensure safe operations. In line with this shift to «softer» safety regulation, the regulator role is more advisory, even providing tools for measuring or developing safety culture (Nævestad et al., 2019).

Some studies have examined regulatory experiences with safety culture regulation in pioneer sectors like oil and gas and the nuclear industry. While nuclear safety authorities (Grote and Weichbrodt, 2013, Bernard, 2018); and aviation authorities (ICAO, 2021) are considered to be regulatory pioneers in the field, other sectors have since followed, e.g. Norwegian petroleum authorities (Kringen, 2009), US railroad safety authorities (Zuschlag et al., 2016). Studies of safety culture regulation in the Norwegian petroleum sector found that regulators used a lot of time and energy implementing the new provision that stated that companies should have a good health safety and environment culture, and that companies responded to the provision in ways that were unanticipated

and not necessarily intended by the regulator (Bye et al., 2016, Kongsvik et al., 2016). Kongsvik et al. (2016) refers to companies' responses to the Norwegian PSA as "translations". This indicates the plasticity of the safety culture concept: It lends itself to several different definitions and understandings in the academic literature, and this also applies to regulators and companies. The concept is both intuitive appealing and hard to define.

2.4. Does the regulation of safety culture require a high level of organisational maturity?

Safety culture has been portrayed as the latest phase in the evolutionary development of safety management, such that organizations with a highly positive safety culture have achieved highest level of organisational maturity (Fleming 2001, cf. Kim and Park, 2016). Thus, successful cultural approaches may only be possible where pre-existing technical and systemic aspects of safety are already functioning adequately (Fleming 2001). Similarly, if safety culture maturity depends on how information is handled in the organisation (e.g. "learning culture"), safety culture may depend on the maturity level of formal safety information systems (Parker et al., 2006; also see models of Reason 1997; Westrum 2004). The clear implication is that companies that have not implemented SMS might benefit less from a focus on safety culture. In support, Fleming (2001) states that his safety culture maturity model is only relevant to organisations which have an adequate SMS, comply with regulations (but where compliance does not drive safety improvements), and have accidents related to culture or behaviour rather than technical factors.

2.5. Status of SMS and safety culture in transport sectors

Legal requirements, often in the form of SMS legislation, are the main reason why regulators have focused on safety culture to date. In aviation, the legislation delineating SMS elements strongly imply considerations of safety culture such as open reporting, just culture or continuous learning (e.g. EU 1321–2014, part 145 Airworthiness). In the maritime sector, the International Safety Management (ISM) code of the International Maritime Organization (IMO) requires SMS in all commercial ships over 500 GT, a main aim being to develop positive safety culture in the maritime industry (Kongsvik et al., 2016; Lappalainen et al., 2012). Rail legislation in the EU, US, and Canada also requires SMS, facilitating positive safety culture (e.g. ERA, 2013).¹ In contrast, while standards are available, SMS remain voluntary in road transport (e.g. EN: ISO:39001). Indeed, regulatory authorities and companies in the road sector appear to have focused little on safety culture and organisational safety management, although exceptions exist (cf. Nævestad et al., 2018; Mooren et al., 2014).

2. Method

2.1. Interviews

We conducted semi-structured telephone interviews lasting approximately 90 min each, with 38 participants. These included three group interviews with 2–3 participants from the road and rail sectors. We interviewed 19 STA representatives and 19 Swedish transport company representatives (Table 1). These included, in the road sector, representatives of different interest and business organisations; and in aviation, representatives of airline, airport and maintenance companies.

Interviewees were informed that participation was voluntary and anonymous, that rather than official organizational views, we wanted the interviewees to give opinions based on their experiences. They were

¹ https://www.era.europa.eu/sites/default/files/library/docs/leaflets/promoting_a_positive_safety_culture_en.pdf.

Table 1

The number of authority and company interviewees in each of the sectors.

Sector	Aviation	Maritime	Rail	Road	Total
Authority interviewees	6	3	5	5	19
Company interviewees	5	5	4	5	19
Total	11	8	9	10	38

told they would be able to review and help develop our findings from the interview.

For authority representatives, questions covered:

- 1) work activities of the interviewee,
- 2) whether they: use safety culture in their work; have strategies, procedures, tools to assess safety culture; use safety culture as a regulatory concept,
- 3) how they define safety culture,
- 4) their perceptions of safety culture in the different companies; factors influencing safety culture; relationship between safety culture and safety performance,
- 5) their views and experiences on current regulatory strategies; e.g. rule-based vs function-based,
- 6) their views and experiences on their current strategies to influence safety culture in organizations, and,
- 7) pros and cons of possible (future) strategies aimed at improving safety culture in the companies (cf. Nævestad et al., 2019).

For company representatives, questions covered themes 1–4 above, and in addition:

- 1) whether the companies of the interviewees have SMS, the extent to which employees are familiar with the SMS, whether their actual behaviours are in line with the SMS,
- 2) the most risky work activities and operations that the companies are involved with, the main risk factors involved and their countermeasures to reduce the impact of these risk factors,
- 3) the status and work on safety cultural aspects: management commitment to safety, employee involvement and trust between managers and employees, reporting culture, learning culture,
- 4) views on the companies' relationship with the regulating authorities.

2.2. Analysis

We took detailed notes in each interview, and afterwards wrote an extensive summary, structuring the views of each interviewee based on the above themes. We then analysed the summaries, comparing interviewee comments on each theme. Our analysis was deductive in the sense that we based our interview guide on previous research, and examined the extent to which interviewee comments were supportive. On coding our notes from each interview, we grouped similar views into viewpoint categories. To validate and help develop our findings, we submitted texts on the empirical findings from each sector to the interviewees, who corrected, commented, supplemented and provided nuance.

3. Results

3.1. The STA strategy on safety culture

In the following, we describe the STA strategy on safety culture, as it was at the time of the study. One of the key elements in the regulatory strategy of the STA is to contribute to a high safety culture in transport companies with permits to conduct professional transport operations. It is thus important for the STA that companies in all transport sectors have a good safety culture and work systematically to improve and develop safety culture. The STA defines safety culture as:

(...) an organization's shared way of thinking and acting in relation to risk and safety, i.e. how an organization prioritizes and actually works on risks and safety in its operations.

The STA (2013) focuses on seven aspects of safety culture, e.g.

- 1) Managers' safety commitment and responsibility
- 2) Employee involvement in safety issues to create mutual trust between managers and employees
- 3) A reporting and just culture
- 4) A culture that fosters learning from your own experiences and the experiences of others.

Additionally, the STA recommends that in order to help improve safety culture, the organization should document their work in each of the four above-mentioned areas. This should happen in some form of formalized and structured safety management system. In other words, it is not enough to have formal procedures and routines in place - all relevant personnel within the organization need to know about the procedures, they must understand what they mean, why they exist, and they have to be able to act as stated in the procedures. The STA's conceptualization of safety culture underlines that the safety culture of organizations cannot be viewed separately from the safety management system. If employees lack knowledge, understanding and motivation to behave in accordance with the SMS, a discrepancy between the SMS and their safety behavior is likely to arise. Procedures and peoples' understanding of them influence how people actually behave. In addition, the STA stresses that an organization is always part of a larger social context and that safety culture therefore is influenced by several external factors, such as laws/regulations, inspections, competitive conditions and costs of possible incidents and accidents.

It is important to clarify the connection between STA and the different regulators within each subsector, to understand how far the STA strategy/requirement is binding for regulators within each sector. As noted, the STA is comprised of sector-specific departments (i.e. for aviation, maritime sector, rail and road) and more general departments spanning across specific sectors (e.g. the strategic sector-overriding human factors department, which was involved in the development of the safety culture strategy). Understanding the strategy, it is important to note that the activities of the regulators in each sector primarily was based on the sector-specific rules, e.g. related to SMS requirements. Based on this, and in order to ensure the successful implementation of the safety culture strategy, the strategy was also legitimized through a rule review carried out by the STA's «Human Factors Competence Centre». In this review, the specific rules on safety management in each sector were examined. This showed that the safety culture aspects defined by the STA were indirectly or directly covered in the legal requirements governing inspections in all the transport sectors, and that a focus on safety culture in audits was legally justified. This especially applies to the SMS rules in aviation, the maritime sector and rail, but also in some of the rules applying to the road sector. STA's rule review did not find connections to all the safety culture aspects included in the STA definition in all transport sectors. The review concluded that it is easier to justify safety culture inspections in the transport sectors with SMS requirements (i.e. all except professional road), but suggests that an SMS is indirectly required in the rules applying to professional road transport.

3.2. Aviation

3.2.1. Regulator focus on safety culture

The most important strategy authority representatives used to regulate safety culture was audits. When asked how they understood and defined safety culture, interviewees either referred directly to a 28-point safety culture checklist that they used to audit safety culture, or aspects of safety culture evaluated in this checklist. The checklist comprises seven main themes (each measured using four items): 1) reporting

culture, 2) just culture, 3) learning culture, 4) managers' and employees' safety commitment, 5) internal and external communication, 6) the organisations' resources, competence and qualifications for doing their safety work and 7) the organization's systematic work with safety.

In their audits the inspectors also used a separate 24-point checklist comprising six themes to assess the SMS, focusing on whether: 1) the SMS is adapted to the size, complexity and character of the organization, 2) management responsibility is clearly defined, 3) the organisation's system for compliance monitoring is used in the daily work, 4) internal SMS-revisions are conducted, 5) the organization can identify deviances, detect risks and implement countermeasures, and 6) the organization enacts safety policy in daily work.

Scores on both checklists are ascribed a color code (green, yellow and red), which is then used to help companies understand the feedback. The color codes reflect the potential for improvement on each question, based on the inspector's assessment.

Inspectors from aviation reported positive experience with safety culture as a regulatory concept, that it fits with a transition from a rule-based to a more principle- and advisory based approach to safety regulation. Importantly, several of the interviewees mentioned that function-based regulation, involving a high degree of company self-regulation, requires a high level of maturity from the companies. Self-regulation, involving internal audits conducted satisfactorily, depends on trust, knowledge and goals being shared between regulators and companies. One interviewee noted that the legislation they base their audits on has become more function-based:

The rules were much more detailed previously. Now the companies have more opportunities to adapt to the existing conditions. They found it hard at first, but then they started to appreciate the possibility to adapt. Previously, what they did was either right or wrong. Now there is more dialogue, and we evaluate their answers and provide our thoughts; creating a positive dialogue between authorities and companies. We never say what they should do, we help them interpreting the rules. (Interviewee 3).

Interviewees also stated, however, that detailed rule-based regulation is necessary in several areas, for instance in the design of physical infrastructure, technical maintenance of equipment and so on. Thus, a combination of the two approaches to safety regulation is necessary.

3.2.2. Factors influencing regulator focus on safety culture

First, interviewees said that the focus on safety culture in inspections was the result of the central STA strategy concerning safety culture. The decision to focus on safety culture in the inspections was based on an assumption that this would provide a valuable perspective, supplementing the existing regulatory strategy.

Second, the decision to focus on safety culture in inspections appeared to be based on a consideration of how this could be justified in light of the existing legislation in the sectors. The view from aviation was that the STA conceptualization of safety culture in the 28-point checklist summed up all the different SMS requirements relating to different aspects of safety culture (e.g. EU 965/2012; EU 1321-2014 part 145 Airworthiness).

Third, the focus on safety culture required training of STA inspectors and company representatives. Interviewees said that the STA's human factors competence was crucial, providing information about safety culture in the organization and educating the inspectors in how to use the concept in inspections.

3.2.3. Company focus on safety culture

All of the company interviewees in aviation focus on safety culture in their organizations, as a response to SMS requirements. These requirements do not directly refer to safety culture, but to elements of safety culture, e.g. reporting, just and learning culture. Indeed, interviewees indicated that safety cultural aspects described in the SMS

regulations were deeply ingrained in their organisations. Another key SMS aspect, also related to safety culture, is the continuous improvement process (e.g. continual analysis of and response to reported incidents, flight data). External and internal audits are important elements of this process. Asked to describe the most important aspect of their safety culture, most company interviewees mentioned an open, non-punitive environment stimulating trust, reporting of incidents and subsequently learning.

3.3. Maritime

3.3.1. Regulator focus on safety culture

Authority interviewees in the maritime sector contended that the safety culture concept is not normally used in the maritime sector, where people instead refer to the ISM code when talking about the informal (and formal) aspects of maritime safety. Interviewees also stressed that they do not have strategies or procedures specifically aimed at safety culture. Neither do they have procedures or tools to evaluate safety culture.² They do, however, use a checklist for «safety organisation». This evaluates how vessels work with their SMS; whether officers and crew are familiar with it and use it in daily work; and whether they receive and evaluate incident reports and implement changes. In this way, the checklist assesses components of safety culture in terms of informal aspects of safety – not just formal aspects of the SMS such as routines, roles, procedures and so on:

Everybody knows who has a good and a bad safety culture, but we do not use the concept directly, the inspectors know where they have to spend longer time; there is an informal evaluation of the shipping companies and the vessels that we are in contact with, even though we do not use the [safety culture] concept. (Interviewee 15b).

When asked about the basis for these assessments, Interviewee 15b answered «gut feeling» and the «overall impression». Interviewee 15a said that:

You perceive the line of thinking as soon as you are on the vessel; whether they «think safety» (...) you see it when you talk with people on board. You see it if anyone has stated scrimping, and barely get by. In the Nordic countries and the Baltic Sea, we often see very good vessels of high quality, reflecting a high national level (Interviewee 15a).

Interviewee 14 said that his perception of vessel safety culture was based both on the number of nonconformities found through on-board audits as well as a crew's reactions when he writes reports; e.g. some may not understand why he asks for a lot of documentation that they find unnecessary.

3.3.2. Factors influencing regulator focus on safety culture

Although they did not use the safety culture concept, interviewees agreed that many of the SMS-requirements of the ISM code concern safety culture, and that they indirectly focus on this in their ISM-code audits. When asked about strategies or procedures related to safety culture, Interviewee 15b stated:

[We do not have these] directly, but we examine whether they have a safety policy, which includes safety and environment, and then we examine whether they live up to that policy in their ISM manual, or the safety manual; that is the basis of a good safety culture. (...) The most important thing is that they continuously work with improving

their safety work, a good effort on improvement means a good safety culture. The opposite of this is to use ISM as a «dead document». It is important to learn from incidents, both your own and from other vessels, and to develop routines and procedures based on this. (Interviewee 15b).

3.3.3. Company focus on safety culture

All of the company interviewees said that they have SMS, as required by the ISM code. Their main view on the relationship between SMS and safety culture was that safety culture follows from successful implementation of ISM code. In line with this, Interviewee 19 said that:

Safety culture is that you have a system that is so well implemented that you actually live by it and do not need to go to the bookshelf to find out what to do, every-one is comfortable with it, it sits in every-one's backbone. I don't think we have written «safety culture» anywhere, we have written the «safety system», but the culture will develop if you have a good system. (Interviewee 19).

All company interviewees emphasized that employee familiarity with and sense of ownership of SMS is essential to successful implementation, given the comprehensiveness of SMS and associated procedures. All interviewees also discussed the importance of a «living SMS» that is used in daily work and not just a document on a shelf. However, interviewees also mentioned that the long tradition of hierarchical command on board vessels can challenge development of open safety culture, which requires that safety issues are communicated freely, independent of rank. Vessels are also isolated communities, and thus it is the role of the captain to implement shipping companies' plans and intentions for SMS and safety culture on board.

3.4. Rail

3.4.1. Regulators' focus on safety culture

All but one of the rail authority interviewees said that they use the safety culture concept systematically in their work, that they seek to evaluate safety culture in their inspections, and that they talk a lot about it. Several mentioned that safety culture has been often been a topic in the seminars hosted by STA over the last five years, and has supplanted SMS in this respect. One stated that one of their most important tasks was to improve safety culture in rail companies, as part of facilitating better performing organizations.

Rail authority interviewees noted that the use of subcontractors is common in the rail sector, and that this may impede a learning culture. There are over 500 actors involved in the railway sector: 370 involved in infrastructure, 100 operators using the tracks, and tens of actors involved in tram and metro transport.

Different levels of maturity among company safety cultures were noted, especially related to the aspects of reporting and learning culture. Interviewees noted that a main challenge to improving safety culture in some companies is getting them to understand the relevance of safety culture for them, i.e. that it is not something that they should do just to «please the authorities». Thus, it seems that organizations' maturity level is crucial in this respect.

Discussing the mix of rule-based versus principle- and advisory-based regulatory strategies, interviewees again alluded to the importance of the maturity level of the companies, suggesting that they employ a more rule-based strategy when working with companies that they know have a poor safety culture.

3.4.2. Factors influencing regulator focus on safety culture

Rail authority interviewees report that they focus more on safety culture, partly as a response to the STA strategy. Explaining the increased focus, some interviewees recalled recent visits from the human factors section of STA. In some cases safety culture had been evaluated. One effect of this was that it raised their awareness and

² The STA's safety culture audit strategy also applies to the maritime branch of the STA, and thus it seems that the maritime authority interviewees also should have been familiar with this. What seems to be a lacking focus on this could, however, be due to a delayed implementation process, delayed communication etc. in the maritime branch.

knowledge about safety culture and its elements.

Although most interviewees said they have increased their focus on safety culture in audits only quite recently, it is important to note that the rules governing their audits focus on SMS, and not directly on safety culture. Interviewee 21 said for instance that:

Many of the SMS requirements match the content of safety culture. There are requirements for reporting, monitoring activities, examine non-conformities, have a management commitment to safety, and horizontal and vertical communication in the company. This is very close to safety culture. Safety management and risk management are described in the EU-legislation for the rail sector; the SMS rules for rail [Article 9 in EU directive 2016–798]. These are also included in a Swedish provision. (Interviewee 21).

Discussing the relationship between safety culture and SMS, Interviewee 22 said that: “Safety culture is what you may read between the lines”, “It is more than what is written”.

3.4.3. Company focus on safety culture

Although rail company interviewees understood clearly what the safety culture concept means, they said the concept was rarely used explicitly in their companies, and especially not by frontline employees such as train drivers or shunters. Most said that regulatory authorities focus little on safety culture. Interviewee 29 said that regulating authorities mention safety culture, but that there is no material which directly supports this. All interviewees said that their companies have SMS, and this is required by law of all rail companies in Sweden and in other EU and EEA countries. Interviewee 29 noted, however, that the regulatory authorities in the Scandinavian countries have different interpretations of these requirements.

3.5. Road

3.5.1. Regulator focus on safety culture³

Authority interviewees reported that they do not use the safety culture concept in their work, neither do they assess the safety culture of the companies that they audit. Instead they use the concepts «traffic safety» in goods transport and «passenger safety» in taxi and bus transport. These concepts are derived from the legislation that the interviewees base their inspections on.

The interviewees from the road sector are involved in rule-based regulation. The issue of trust between regulators and the regulated was a recurring theme in the interviews from all the sectors. When talking about this, road authority interviewees contrasted their relationship with the companies to the relationship between the regulators and the regulated in the rail sector stating that:

The rail companies felt that it was useful to cooperate with the STA, without feeling that they just got an index finger and a scolding. This was appealing and inspirational for the road sector; that the companies got something from us too.

It seems that the distribution of responsibilities in the road sector involves that the authorities work through a (detailed) rule-based approach, while the business associations are involved in what we in other sectors refer to as an advisory-based approach; providing information to companies, supervising etc. This corresponds with the fact that authorities do not apply a function-based approach to the professional road sector.

³ It is important to emphasize that the results here apply to the regulation of professional road traffic, and that they cannot automatically be transferred to other road traffic inspection areas, such as e.g. the inspection of training, vehicles or infrastructure. The STA regulation of professional road traffic has special conditions, e.g. as it primarily involves desktop inspections, which does not apply to other inspection areas.

3.5.2. Factors influencing regulator focus on safety culture

First, when asked why they think that there is little focus on safety culture in the road sector, interviewees from the road sector underlined the importance of equal conditions for competition in all EU-countries. Interviewee 30 said that:

The problem is that there is a golden rim on the EU-legislation; and that we would not fulfil the requirement of neutral competition. We are supposed to facilitate neutral competition and free flow of goods across countries and mobility. Sweden is quite strict compared to other EU-member countries, but if we are stricter than Denmark, a lot of companies will settle there instead of in Sweden. And that violates the intention of a free market according to EU-law. (Interviewee 30).

Interviewees suggested, however, that it would be interesting and useful for them to focus more on organizational safety management and safety culture, if the rules governing their audits had allowed them to do that, like they do in other sectors like aviation and rail. Although certification schemes for organizational safety management and safety culture, like the ISO:39001, seem promising, national authorities cannot recommend such schemes without violating the principle of equal competition between hauliers in all EU countries. Interviewees noted that the legislation for aviation and the maritime sector is different; involving a stronger focus on SMS and safety culture.

Second, it was mentioned that there are thousands of small companies with little resources in the road sector. In the other transport sectors, there is a smaller number of large companies, which work in a totally different manner with safety culture. Interviewees also mentioned additional obstacles, e.g. lacking political focus, views on their role as a rule-based authority, and that it is the role of the business associations to engage in activities that we previously have described as advisory-based regulation (e.g. providing information and advice). Some of the interviewees mentioned a previously difficult relationship with the transport companies.

3.5.3. Company focus on safety culture

Interviewees in the road sector had a clear understanding of what the safety culture concept means, but generally asserted that the concept seldom was directly used in their companies. It seems that the business structure and company size influence the focus on safety culture and SMS in road transport, in addition to e.g. lacking SMS requirements. One company interviewee said that there are about 10 000 road transport companies in Sweden.

It seems that the heterogeneity related to safety culture and SMS implementation in the road sector is considerable, as neither is required by the legislation or regulating authorities. Thus, some companies may have well developed SMS, based on their own choice, or because it is required by transport procurers. This is largely the case in the bus sector. Additionally, the business organization in this sector has also developed a set of safety policies for the companies, going beyond what is required by the legislation.

It should also be mentioned that there is a special focus on the driver (or the transport operator) in the road sector, which is in contrast to the other transport sectors, which focus more on the organizational context surrounding the transport operator, e.g. procedures, routines and organizational training.

4. Discussion

4.1. Regulator focus on safety culture

Table 2 sums up whether, why and how regulators and companies in the different sectors focus on safety culture. The differences between the sectors are in line with those found in previous research from other countries, indicating a well-developed focus on safety culture in aviation (Reason 1997; Westrum 2004), an ISM-based SMS focus in the maritime

Table 2
The focus of safety culture in the studied sectors. (ERA = European Rail Agency).

Sector	Level	Whether they focus?	Why they focus?	Views on the strategy of the agency	Definition/Assessment
Aviation	Authority	Yes/«test»	SMS-rules & STA strategy	Positive	7 themes/28-points
	Company	Yes	SMS-rules	Positive	Reporting, just, learning
Maritime	Authority	Not directly	ISM-focus	ISM-focus	«Living system»
	Company	No/little	ISM-focus	ISM-focus	Not applicable
Rail	Authority	Yes	SMS-rules & STA strategy	Positive	STA & ERA
	Company	Not directly	Challenges?	Few reported experiences	Not applicable
Road	Authority	No	Equal conditions of competition	Unrealistic (?)	Not applicable
	Company	Heterogeneous	Transport buyers, industry organisations	Unrealistic (?)	Not applicable

sector involving an indirect focus on safety culture (Lappalainen et al., 2012), an emerging focus on SMS and safety culture in rail (Zuschlag et al 2016) and little to no focus on safety culture and SMS in the road sector, both among companies and regulators (Mooren et al., 2014; Nævestad et al., 2018).

4.2. Which factors influence the regulatory authority's focus on safety culture?

Based on the interviews, it is evident that several different factors influence the different sectors' inclusion of safety culture in their regulatory repertory. Fig. 1 provides an illustration of factors influencing regulators' use of the safety culture concept in audits and companies' use of safety culture as a safety management strategy. The depicted relationships are based on the interview data, and we should thus treat them as hypothesized relationships that should be examined further in future research.

In line with previous research, we find that SMS legislation is one of the main factors influencing organisational maturity level and focus on safety culture (cf. Lappalainen et al., 2012). A key result of the study is, however, that regulators' and companies' within each sectors maturity level and focus on safety culture is influenced by a range of different factors. The identification of these factors is the main unique

contribution of the present study. Thus, discussing what the Transport Agency can accomplish through their safety culture strategy, it seems that the success of this effort is contingent on these other factors. These additional factors define the limits of "soft safety regulation". Finally, we find that regulators' focus on safety culture is related to companies' focus on safety culture, as indicated in previous research (Nævestad et al., 2019).

4.3. What are the key drivers for success when it comes to regulator focus on safety culture?

Discussing the limits of soft safety regulation, a relevant question is whether the capacity of the regulators to impose a focus on safety culture in the regulator-regulated relationship is related to safety culture itself (e.g. the abstract nature of the concept), resources and competence, or to the overall level of the authority of respective regulators. Some examples from the study (e.g. from the road sector) suggest that the transport sector is more company driven than regulator driven, when it comes to focus on safety culture. Discussing what the STA can accomplish through their safety culture strategy, it is also important to remember that the activities of the regulators in each sector primarily was based on the sector-specific rules, e.g. related to SMS requirements. That is why the STA's «Human Factors Competence Centre» carried out

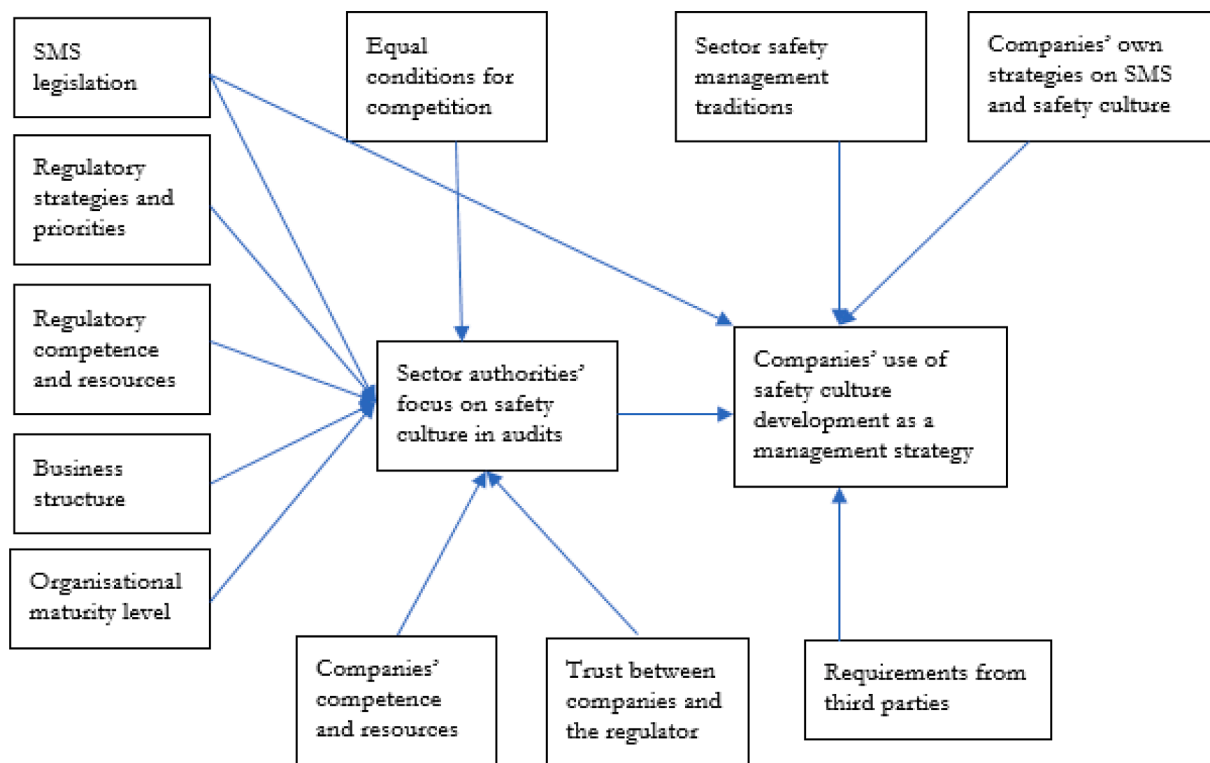


Fig. 1. Illustration of factors influencing regulators' use of the safety culture concept in audits and companies' development of safety culture as a safety management strategy. The figure depicts hypothesized relationships, based on the interview data.

a “rule review” of the specific rules on safety management in each sector, examining whether the safety culture aspects defined by the STA were indirectly or directly covered in the legal requirements governing inspections in all the transport sectors. The review concluded that the SMS rules in aviation, the maritime sector and rail, but also some of the rules applying to the road sector justified a focus on safety culture in audits. Despite this, the analysis which is summed up in Fig. 1 illustrates that several other factors influence the success of the STA strategy on safety culture. Key drivers for success when it comes to regulator focus on safety culture are e.g. SMS rules, regulatory competence and resources, the business structure in the sector (e.g. not thousands of small companies, but fewer big companies). Our study also indicates that these factors influence the relationship between the regulators and the companies, or in other words: these factors influence the level of trust between regulators and companies. Trust is related to organisational maturity in the regulated companies, and our study indicates that a high level of trust is required for regulation of safety culture to be successful. We expand further on these issues below.

4.4. Does successful work with safety culture require SMS implementation?

The line of reasoning that safety culture is the latest phase in an evolutionary development of safety management; succeeding SMS implementation (Fleming 2001) seems to resonate well with our results in several ways. First, the competence of regulators and companies was listed as important influencing the focus on safety culture in all sectors. The interviews indicate that if regulators and companies already are familiar with the key aspects of safety culture through existing SMS requirements, it is easier for them to start working actively with safety culture.

Second, successful utilisation of the safety culture perspective is contingent on SMS implementation, as it concerns the informal aspects of safety; “how things are actually done”, as opposed to formal descriptions of “how things should be done”, found in procedures, manuals etc. i.e. in the SMS (Antonsen 2009). Several of the interviewees mentioned that the main benefit of the safety culture perspective was this “extra dimension”; capturing “more than what is written” in formal procedures. Thus, it could perhaps be argued that if the formal aspects are not in place; the companies will not have a very high utility of focusing on the informal aspects (to assess whether the SMS is a “living system”). The reason is that the safety culture perspective concerns the informal aspects of safety; “how things are actually done”, and it also presupposes that crucial system aspects are in place, e.g. the systems for reporting (routines, technology, reporting systems, routines for analyses of reports, for developing measures, for disseminating information), the systems for training and the systems for learning (cf. Reason 1997; Westrum 2004; Parker et al., 2006). Without an SMS in place, focusing on and providing the formal infrastructure for a positive safety culture, a positive safety culture seems to involve management and employee commitment to safety, which is a prerequisite of successful safety work, but which only constitutes the first step in developing a positive safety culture or a comprehensive SMS (cf. Fleming 2001).

Third, as indicated by the interviews, companies’ work with safety culture can be viewed as continuous improvement, facilitated by companies’ self-measurement of and self-development of safety culture. Nævestad et al. (2019) refers to the regulatory facilitation of these activities as advisory strategies to regulate safety culture. It could be argued that the success of such efforts to some extent is contingent on an existing approach to continuous improvement in the companies; for employees to report truthfully and trust that the managers will make use of the information to improve their organisation. Moreover, the quality of companies’ processes of continuous improvement can also be used as an indicator of the maturity level of the safety culture (cf. Parker et al., 2006).

Fourth, the maturity level of the companies influences the level of

trust between the regulator and the regulated companies. As noted, companies’ compliance becomes more abstract in the context of continuous improvement and self-regulation (Nævestad et al., 2019). As a consequence, the role of the regulatory authority also changes, from focusing on companies’ specific rule compliance to companies’ general safety management processes. Additionally, the role of regulators also changes more into an advisory role (Nævestad et al., 2019). An important issue that was mentioned by several of the authority interviewees, is that function-based regulation, involving a high degree of company self-regulation requires a high level of maturity from the companies. Self-regulation, involving internal audits conducted satisfactorily, is dependent on a high level of trust, knowledge and shared goals between regulators and companies. It seems that many of the interviewees held the view that organizational maturity evolves through a gradual implementation of measures aimed at developing organizational safety management.

4.5. How can we assess organisational maturity?

Elaborating further on these issues, it is interesting to recall that one of the most common ways of evaluating organizational maturity is to use measurements of safety culture, e.g. as pathological, (reactive), bureaucratic/calculative, (proactive) and generative safety culture (Westrum 2004; Parker et al., 2006). The STA checklist for safety culture also measures «safety culture maturity», as its scores are based on the “potential for improvement” in each specific area. Measuring or assessing «safety culture maturity», is a central aspect of auditing safety culture. Thus, the paradox seems to be that to be able to be an effective subject of quantitative measurements of safety culture and safety culture audits, organisations should already have reached a certain safety culture maturity level. Does this mean that organisations (or sectors) with poor safety culture are unprepared or not mature enough for safety culture regulation? Our interviews indicate this. Based on the views of the interviewees, organisations with poor safety cultures are not likely to have much use of regulatory efforts to facilitate safety culture development. This is interesting, and should be examined in future research. How can we improve the safety level in poor performing organisations, if we cannot focus on their safety culture? Perhaps by focusing on their SMS first?

Based on this, we may perhaps conclude that the road sector in general does not seem to have reached the level of maturity that it seems that a successful focus on safety culture requires, with the exception of companies that have implemented some type of, or degree of SMS (e.g. ISO:39001). When an SMS is in place, safety culture work concerns working to ensure that the SMS is a “living system”. This involves e.g. to ensure proactive treatment of information, learning and continuous improvement. Without the formal aspects of SMS in place, a focus on safety culture in road equals a focus on managers’ and employees’ safety commitment. Thus, it seems that the focus in road should be to implement SMS to make the sector mature for safety culture.

4.6. Practical implications: Future potential of increasing the focus on safety culture in the sectors

4.6.1. Is it possible to give general advice on safety culture development?

In line with previous research, the present study indicates that each transport sector is unique with different legislations, key actors, technologies and histories. Accordingly, we see that the sectors’ work on safety is adapted to these contexts. Our discussions with the authority interviewees also indicates the importance of remembering that each company is unique. Authority interviewees were very concerned that the different companies have different histories, managements, organizational structures, traditions and cultures. The companies each have their own ways of solving things (e.g. their legal requirements), their respective strengths and weaknesses, and they should be able to do things their own way. This is a reason that authority interviewees were

reluctant to give concrete advice to the companies, but instead said that the companies “should do what is best for your company, in their unique situation.” In line with this line of argumentation, Nævestad et al. (2018) argue that safety culture interventions are very different depending on the sector in question and the companies in question. They conclude, however, that future research should develop simpler interventions by focusing on the basic requirements of safety culture change. They contribute to this by identifying four key elements which seem to be common in all the reviewed interventions, independent of sector and company:

- 1) Appointing a key person (generally a manager) to be responsible for implementing the intervention,
- 2) Institutionalizing joint discussions and risk assessments of work place hazards, involving managers and employees,
- 3) Implementing and monitoring measures based on these discussions and joint risk assessments, e.g. reporting systems, training and
- 4) Maintain effective communication about safety issues in the organization, in line with Reason’s (1997) depiction of an informed safety culture

4.6.2. *Is a good safety culture the same as successful SMS implementation?*

Our discussion suggests that facets of safety culture (e.g. reporting and just culture) cannot be viewed separately from the facets of SMS (reporting system). Moreover, research indicates that many of the key aspects of safety culture and SMS are similar (e.g. management commitment to safety) (Thomas 2012; Flin et al., 2000). This is interesting, as it indicates how tightly interwoven formal (structure) and informal (culture) aspects of safety are (cf. Antonsen 2009). It may therefore be difficult to tell which comes first, and subsequently how to influence the safety level of a given transport sector. Thus, it may be hard in practice to discern between safety culture interventions and SMS. Then it may be tempting to ask what does the safety culture perspective add, and why we should focus on both SMS and safety culture? Based on this, authority interviewees in aviation noted that the safety culture perspective provide them with a very useful complementation to their SMS inspection, as it provides them with an assessment of how the SMS «works in practice». This illustrates how the focus on safety culture in the inspections also may serve as a way of assessing the actual SMS implementation throughout the organization. Safety culture is a symptom of this, as it denotes the informal aspects of safety («how things are actually done»), while the SMS denotes the formal aspects of safety («how things should be done») (Antonsen 2009).

4.6.3. *Is an explicit focus on safety culture necessary in the maritime sector?*

Based on the argument that each sector is unique; it is tempting to ask whether an explicit focus on safety culture necessary in the maritime sector. Company interviewees were content with the current ISM code focus, and they said that regulators currently cover the «informal aspects of safety», focusing on lacking ISM familiarity and lacking ISM practice in the companies. Company, interviewees were content with ISM, and they seemed to want «everything» to be channeled through ISM, in order to avoid unnecessary extra work and bureaucracy. Again, it should be asked what the safety culture perspective adds to ISM. The safety culture concept includes more than ISM familiarity and compliance, e.g. management commitment, employee involvement. It can however be said that these elements also can be seen as part of SMS (cf. Thomas 2012).

More research should be done on this, but it nevertheless seems well suited to conclude that a further safety culture focus in the maritime industry would require the concept to be incorporated into the ISM code. A key challenge for the STA here is of course that their influence is smaller in the maritime sector, as they only inspect some of the vessels in Swedish waters in flag state controls, e.g. the small national vessels, and as their abilities to “heighten the bar” in port state controls is limited by IMO laws and the Paris Memorandum of Understanding (MOU).⁴

4.6.4. *Is safety culture a concept that fits best in aviation?*

The safety culture perspective seems to be most well adapted in aviation, from which Reason’s (1997) description of an informed, reporting, just and learning culture originates. Thus, it is perhaps not surprising that our study indicates that the safety culture perspective is most successfully implemented in aviation. It should be noted that Reason’s safety culture aspects also are well aligned with the legislation from other transport sectors with SMS requirements (e.g. the SMS requirements of the European Rail Agency, and the ISM-code in the maritime sector). However, when comparing the practical development of these safety culture aspects in the sectors, it seems that the functioning of their reporting systems, for instance, are not as good as in aviation. We have also seen that the companies in the other sectors use aviation as a model, trying to develop a similarly good reporting culture. But should they strive to be as aviation? When asked whether the system from aviation could be transferred to other sector, one of the authority interviewees from aviation underlined that it is important to remember that we should not forget that generations of SMS that have brought the companies in the aviation sector to the high level where they are today. Thus, their systems may perhaps not be directly transferrable to other sectors (e.g. road). He suggested that other sectors would have to go through the same stages first, to reach the level of aviation; starting with compliance monitoring, ISO standards, educating managers and so on before they be included in a system involving self-regulation and safety culture. This is an interesting hypothesis that could be followed up in future research.

4.6.5. *(How) can safety culture be introduced as a regulatory concept in the road sector?*

In sum, most of the eight factors that we have identified in the present study, influencing regulatory focus on safety culture (cf. Fig. 1) seem to make it difficult for regulators to focus on safety culture and organisational safety management (OSM) in general in the road sector. These factors are: strategies, rules, organisational size, resources, competence, maturity, trust, equal conditions for competition. Taking these eight factors as the point of departure, we can discuss the possibilities to include safety culture as a regulatory concept in the road sector. In the following, we discuss three approaches.

First, we suggest that regulators should use the «Safety ladder» approach for the small road companies with few resources and low organisational maturity (Nævestad et al., 2017). Previous research indicates that many of the small goods transport companies often are run by owner-drivers with little interest in administrative issues and organisational safety management (OSM), reflected in the fact that these companies have little focus on OSM and more focus on the individual driver (cf. Nævestad & Phillips 2013). The same result has been reported in international research (e.g. Gregersen et al., 1996; Newnam and Watson 2011). Nævestad et al. (2017) have suggested a Safety ladder approach for safety management in small goods transport companies

⁴ The Paris Memorandum of Understanding (MOU) is a port state control agreement, which maintains a list of port state control results, scoring different flag states on a white list, a grey list and a black list, depending on the port state control results. Black listed flag states and vessels are not allowed to enter the ports. Canada and 26 European states are members of the Paris MOU. There are eight other MOUs, in eight other oceans/areas.

with few resources and little focus on safety. This «Safety ladder» for goods transport companies provides a solution to the «organisational maturity» dilemma, as it suggests that companies which do little with OSM should start at the bottom of the Safety ladder, and then gradually implement more measures at the higher levels. The most basic steps of the Safety ladder address the most important safety challenges in goods transport, by means of the most basic OSM measures. Thus, the Safety ladder is implicitly based on an «organisational maturity» development idea, as it depicts a development from no OSM measures to a full SMS (e.g. ISO 39001). Based on this approach, we could suggest that small road transport companies with no OSM measures probably should start by focusing on the most basic safety culture aspects (e.g. management commitment for safety, which is the first step of the Safety ladder).

Second, we suggest that regulators mainly should focus on safety culture in their regulation of the larger road transport companies. Given that the many small companies provide an argument against focusing strongly on safety culture in the road sector, a solution could be that the regulator only targets the large companies when focusing on safety culture in their regulation. The larger companies are likely to have more resources and to be more organisationally mature. This would probably also allow a certain degree of self-regulation and a high level of trust between the regulator and these companies. Additionally, because of their size, the large companies employ a high share of the drivers in the sector, and thus a fair share of people would be covered by this focus. This could be a way of gradually introducing safety culture thinking within this sector.

Third, we suggest that the regulator role of advisory-based assistance with safety culture measurement and development could also be the role of business organisations in the road sector, and not only the regulator. It is difficult to avoid the road sector argument regarding equal conditions for competition, stating that domestic companies could complain that additional requirements imposed on them (and thus additional costs) could make them more vulnerable to competition from companies in other countries. We have also seen that the main argument for focusing on safety culture in the audits in the other transport sectors is that the set of rules governing the audits legitimize a focus on safety culture. This does not seem to be the case in the road sector. Based on these two arguments, it seems that the best current alternative for the road sector, is that working, with and focusing on safety culture is voluntary for the companies, and that for instance the business associations could assist the companies with this. Of course, regulators could also provide such voluntary help, but in the road sector this has traditionally been provided by the business organisations. Moreover, regulators may also provide assistance to and support the business organizations in their efforts to assist member organisations wishing to focus on safety culture.

4.7. Are safety culture assessments more subjective than assessments of compliance with rules?

Previous studies of safety culture regulation has pointed to the plasticity of the concept and the frustrations of people involved, often culminating in a discussion of whether it is a good idea to try to regulate safety culture (Kringen 2009; Grote and Weichbrodt 2013; Antonsen et al., 2017; Bye et al., 2016, Kongsvik et al., 2016). Interviewees in several of the studied sectors, both from authorities and companies mentioned that assessments of safety culture are subjective. As noted, authority interviewees in some sectors, e.g. rail were skeptical to regulating safety culture, as the concept is abstract, while they stated that SMS components are very specific and easier to evaluate. One authority interviewee from rail said for instance that: «Safety culture is what is not in the documents. It is what you may read between the lines in interviews with employees in a company.» One of the maritime authority interviewees said that «Everybody knows who has a good and a bad safety culture». Several interviewees also used the word «gut feeling» when they talked about assessing safety culture in companies, providing an impression of «how things are actually done» in the regulated

organizations. Other interviewees, e.g. authority interviewees from aviation underlined that safety culture assessments also are made systematically, based on the 28-point checklist, summing up seven themes. Using this checklist requires a lot of knowledge, and it is important that the inspectors using the checklist have a relatively similar understanding of the content of each of the 28 points, and how to evaluate them. Inspectors are therefore educated on the safety culture concept and in the use of the checklist. Nevertheless, these interviewees also underlined the importance of subjective assessments when using the checklist. Based on the interviews, it seems that this is a contention which may mean several different things, and that we may depict these different meanings on a «subjectivity scale», which has two «ideal typical» ends. First, subjectivity may mean imply that assessments of safety culture are (solely) based on individuals' personal or subjective views, and thus personal and contestable («strongly subjective view»). Second, subjectivity may mean that assessments of safety culture require a certain degree of personal judgment («mildly subjective view»). The first view indicates that safety culture assessments are arbitrary, and that a certain safety culture assessment is «in the eye of the beholder». According to this former view, different people may describe the safety culture in a company differently, and that there are no standards to guide the judgements. The second view indicates that safety culture assessments require a certain amount of discretion, but that this not necessarily is subjective in the sense that it may vary strongly between individuals, or that it is arbitrary. Rather, safety culture assessment are done according to a known common standard (e.g. a 28 point checklist). Such an assessment is also made in inspectors' assessments of rule compliance. This also involves a certain extent of subjective discretion. Thus, it can be argued that authority inspectors' assessments of safety culture not necessarily are more subjective than other assessments that they conduct in their audits. This is also indicated in previous studies of safety culture regulation, which remind us that other types of regulation (rule-based and function-based) also involves subjective discretion and regulatory judgment (Antonsen et al., 2017; Nævestad et al., 2019).

The interviews seem to indicate that both of these views on subjectivity exist among the interviewees. Authority interviewees who do not use the 28-point safety culture checklist (e.g. road) were more inclined to lean towards the first view, while those who did use the checklist (e.g. aviation) were more inclined to lean towards the second view. It is generally acknowledged that the more general rules or principles are, the more discretion is required. Thus, for authority interviewees who do not use the safety culture checklist a lot of discretion is required to describe safety culture, perhaps to the extent that descriptions become «arbitrary», individual and potentially contested. For authority interviewees who do use the safety culture checklist, less discretion is required. For them, safety culture assessments (also) involves making specific assessments of 28 specific issues. In principle, we may perhaps assume that this is not necessarily very different from making assessments of compliance with specific rules. However, making these assessments is a new activity for the inspectors and not the least for the companies. Several authority interviewees indicated that «written rules are objective». Such statements signify that «objective» (versus subjective) is what «is known», «agreed upon» and «uncontested». When interviewees say objective, they seem to mean «established», or «what authorities and companies are well aware of and agree upon». Safety culture has not yet reached this status, as it is a relatively new concept for both regulators and companies. To sum up, it seems that the two views on subjectivity involved in safety culture assessments may indicate a possible paradigm shift when it comes to safety culture. The first view represents the «old way» of approaching safety culture, while the second view represents the «new way» of approaching safety culture. It seems that currently, interviewees held both views but that authority interviewees from aviation (who both held the first and second view) leaned most heavily to the second view. The contention that aviation authority interviewees held both views is indicated in the statement that the 28- point checklist provide a way of conceptualizing what they

previously referred to as their «overall impression», or gut feeling. It seems that the challenge for the aviation authority interviewees was that some of the companies that they relate to leaned more heavily to the first view, questioning their assessments of safety culture. Thus, it seems that in order to normalize the second view and spread the notion that safety culture also can be a very concrete and specific concept, more education and information is needed. Focusing on safety culture requires, however, an «extra effort» as it is new, and it is perhaps challenging to legitimate a focus on this (requiring time, money, competence, education, possible conflicts with companies) when the inspectors also have to focus on the inspections that they actually are legally required to do.

4.8. Questions for future research

In the preceding discussions, we have listed several important questions for future research. We will sum these up in the following:

- 1) Are organisations, or sectors with poor safety culture unprepared, or not mature enough for safety culture regulation?
- 2) (If so:) How can we improve the safety level in poor performing organisations, if we cannot focus on their safety culture?
- 3) Have companies in the professional road sector (bus, trucks) reached the level of maturity that a successful focus on safety culture requires, or does this only apply to large companies, or companies that have implemented SMS (e.g. ISO:39001).
- 4) Is a more explicit focus on safety culture necessary in the maritime sector, or is the ISM code sufficient? (Thus, how can safety culture be a more visible aspect of the ISM code?)
- 5) Given our results on SMS implementation and organisational maturity, should companies in other sectors use SMS and safety culture in aviation as a model, and strive to be as aviation?
- 6) Given our results on the unique nature of each transport sector, (how) should each sector do something unique and sector-specific in their efforts to develop a good safety culture? Additionally, which lessons apply across sectors?

4.9. Methodological weaknesses and possible bias

It is important to note that the descriptions of the situation in the different transport sectors in this study are based on interviews with limited groups of people at a given point in time. Thus, the current situation may be different from what we describe: strategies, efforts, experiences, relationships etc. may have changed. It is, for instance, important to note that the safety culture audits in aviation were not fully implemented at the time of the interviews. At the time of the interviews, some sectors within aviation had started to focus on safety culture. It must also be noted that the sample of interviewees is very small in several of the studied groups. This influences the basis from which conclusions can be drawn, e.g. our abilities to generalise about each sector, based on the interviews and also our comparisons between sectors.

5. Conclusion

Our study seems to support the assertion that organisational safety management requires a sequential, or evolutionary development, where companies must implement well-functioning safety management systems (SMS) before being organisationally mature enough to work successfully with safety culture. The study identifies additional factors influencing organisational maturity level and safety culture focus, limiting soft safety regulation.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Tor-Olav Nævestad reports financial support was provided by Swedish Transport Agency.

Data availability

Data will be made available on request.

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References

- Amtrak, 2015. Safety and security: opportunities exist to improve the Safe-2-Safer program (Audit Report OIG-A-2015-007, February 19, 2015).
- Antonsen, S., 2009. The relationship between culture and safety on offshore supply vessels. *Saf. Sci.* 47, 1118–1128.
- Antonsen, S., Nilsen, M., Almklov, P.G., 2017. Regulating the intangible. Searching for safety culture in the Norwegian petroleum industry. *Saf. Sci.* 92 (2017), 232–240.
- Baldwin, R., Cave, M., Lodge, M., 2012. *Understanding Regulation: Theory, Strategy, and Practice*. Oxford University Press, Oxford.
- Bernard, B., 2018. Safety culture oversight: an intangible concept for tangible issues within nuclear installations. *Safety* 4 (45).
- Borys, D., Else, D., Leggett, S., 2009. The fifth age of safety: the adaptive age? *J. Health Saf. Res. Pract.* 1, 19–27.
- Bye, R.J., Rosness, R., Dalseth Røyrvik, J.O., 2016. ‘Culture’ as a tool and stumbling block for learning: The function of ‘culture’ in communications from regulatory authorities in the Norwegian petroleum sector. *Saf. Sci.* 81, 68–80.
- Cox, S.J., Flin, R., 1998. Safety Culture: Philosopher’s Stone or a Man of Straw? *Work Stress.* 12 (3), 189.
- Cullen (1990). The public inquiry into the Piper Alpha disaster, Department of Energy, HMSO, London.
- ERA (2013). EUROPEAN RAILWAY AGENCY Safety Unit Application guide for the design and implementation of a Railway Safety Management System DEVELOPING AND IMPROVING SAFETY CULTURE IN THE ORGANISATION.
- Eurostat (2019) https://ec.europa.eu/eurostat/statistics-explained/index.php/Rail_accident_fatalities_in_the_EU.
- Fleming, M (2001). Safety Culture Maturity Model, Offshore Technology Report, Health & Safety Executive, UK, 2000. <http://www.hse.gov.uk/research/otopdf/2000/oto0049.pdf>.
- Flin, R., Mearns, K., O’Connor, P., Bryden, R., 2000. Measuring safety climate: Identifying the common features. *Saf. Sci.* 34, 177–192.
- Gregersen, N.P., Brehmer, B., Morén, B., 1996. Road safety improvement in large companies. An experimental comparison of different measures. *Acc. Anal. Prevent.* 28 (3), 297–306.
- Grote, G. & Weichbrodt, J. (2013). “Why regulators should stay away from safety culture and stick to rules instead”, in *Trapping Safety into Rules: How Desirable and Avoidable is Proceduralization of Safety?*, Editors: Corinne Bieder, Mathilde Bourrier, pp. 225-240, Ashgate.
- Hale, A.R. & Hovden, J. (1998). Management and culture: the third age of safety. A review of approaches to organizational aspects of safety, health and environment. In Feyer & Williamson (eds.) *Occupational Injury, Risk, prevention and intervention*. London: Taylor & Francis.
- Haukelid, K., 2008. Theories of (safety) culture revisited—An anthropological approach. *Saf. Sci.* 46 (3), 413–426.
- ICAO, 2021. ICAO Annex 19, Safety Management https://www.skybrary.aero/index.php/ICAO_Annex_19_Safety_Management. (accessed on Jan. 21).
- International Maritime Organisation (2015). Fishing vessel Safety. <http://www.imo.org/en/OurWork/Safety/Regulations/FishingVessels/Pages/Default.aspx>.
- Kim, Y.J., Park, M.P., 2016. Creating a Culture of Prevention in Occupational Safety and Health Practice. *Saf. Health Work* 7, 89–96.
- Kongsvik, T., Gjøsend, G., Vikland, G.M., 2016. HSE culture in the petroleum industry: Lost in translation? *Saf. Sci.* 81, 81–89.
- Kringen, J., 2009. Culture and control: Regulation of risk in the Norwegian petroleum industry. Ph.D. Dissertation, Center for Technology, Innovation and Culture, Faculty of Social Sciences. University of Oslo.
- Lappalainen, F.J., Kuronen, J., Tapaninen, U., 2012. Evaluation of the ISM Code in the Finnish shipping companies. *J. Maritime Res.* 9 (1), 23–32.
- McShane, S.L., Travaglione, A., 2003. *Organizational Behaviour On The Pacific Rim*. McGraw-Hill, Sydney.
- Mooren, L., Grzebieta, R., Williamson, A., Olivier, J., Friswell, R., 2014. Safety management for heavy vehicle transport: a review of the literature. *Saf. Sci.* 62, 79–89.
- Nævestad, T.-O., 2010. Cultures, crises and campaigns: Examining the role of safety culture in the management of hazards in a high risk industry. Ph.D. Dissertation, Centre for Technology, Innovation and Culture, Faculty of Social Sciences. University of Oslo.

- Nævestad, T.-O., Phillips, R.O., Storesund Hesjevoll, I., 2018. How can we improve safety culture in transport organizations? A review of interventions, effects and influencing factors. *Transport. Res. Part F: Psychol. Behav.* 54, 28–46.
- Nævestad, T.-O., Hesjevoll, I.S., Ranestad, K., Antonsen, S., 2019. Strategies regulatory authorities can use to influence safety culture in organizations: lessons based on experiences from three sectors. *Saf. Sci.* 118, 409–423.
- Nævestad, T.-O., Phillips, R.O., 2013. Trafikkulykker ved kjøring i arbeid - en kartlegging og analyse av medvirkende faktorer, TØI rapport 1269/2013. Transportøkonomisk institutt, Oslo.
- Nævestad, T.-O., Phillips, R.O., 2018. The relevance of safety culture as a regulatory concept and management strategy in professional transport: Comparing the experiences of regulators and companies from four sectors TØI rapport 1668/2018. Transportøkonomisk institutt, Oslo.
- Nævestad, T.-O., Phillips, R.O., Elvebakk, B., 2017. The safety ladder: developing an evidence-based safety management strategy for small road transport companies. *Transp. Rev.*
- Nævestad, T.-O., Storesund Hesjevoll, I., Elvik, R., 2021. How can regulatory authorities improve safety in organizations by influencing safety culture? A conceptual model of the relationships and a discussion of implications. *Accid. Anal. Prev.* 159.
- Nasa, 2003. Report of the Columbia Accident's Investigation Board. NASA, Houston.
- Newnam, S., Watson, B., 2011. Work-related driving safety in light vehicle fleets: A review of past research and the development of an intervention framework. *Saf. Sci.* 49 (3), 369–381.
- Parker, D., Lawrie, M., Hudson, P., 2006. A framework for understanding the development of organisational safety culture. *Saf. Sci.* 44, 551–562.
- Reason, J., 1997. *Managing the Risk of Organisational Accidents*. Ashgate, Aldershot.
- Schein, E.H., 2004. *Organizational Culture and Leadership*, Third ed. Jossey-Bass, San Francisco.
- Statista (2019) <https://www.statista.com/statistics/263443/worldwide-air-traffic-fatalities/>.
- Thomas, M. J.W. (2012). A systematic review of the effectiveness of safety management systems. No. AR-2011-148. Australian Transport Safety Bureau.
- Ward, N.J., Linkenbach, J., Keller, S.N., Otto, J., 2010. White Paper on Traffic Safety Culture in the series: White Papers for Toward zero deaths: a national strategy for highway safety – White Paper, No. 2. Montana State University.
- Westrum, R., 2004. A typology of organizational cultures. *Qual. Saf. Health Care* 13, 22–27.
- WHO (2018). https://www.who.int/violence_injury_prevention/road_safety_status/2018/en/.
- Zohar, D., 2010. Thirty years of safety climate research: Reflections and future directions. *Accid. Anal. Prev.* 42 (5), 1517–1522.
- Zuschlag, M., Ranney, J., Coplen, M., 2016. Evaluation of a safety culture intervention for Union Pacific show improved safety and safety culture. *Saf. Sci.* 83, 59–73.