



# Adaptive non-conform behaviour in accident investigations in the road based heavy goods transport sector

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## ABSTRACT

This paper presents findings from a study of 29 accident investigations in the heavy goods transportation sector in Norway. The investigations are performed by the Norwegian Safety Investigation Authority (NSIA). The NSIA has extensive multi-modal experience with accident investigation studying the holistic systems involved. Their approach is non-blame, in which the major goal is to provide information that triggers the involved actors' learning. It is reasonable to assume that the NSIA will challenge system characteristics at the sharp end, close to the accident site, as well as characteristics towards the blunt end involving planning, managing and regulatory enterprises. The term adaptive non-conform behaviour cuts across all levels in the system and covers the outright violation of safety-related rules and regulations and activities that deviate from established good praxis. Non-conform behaviour can include strategic adaptations to external and internal socioeconomic pressures. Actors in the industry claim non-conform behaviour is a prominent characteristic of the day-to-day activities. Non-conformity with safety-related rules and regulations is currently common in the transport industry as a reaction to increased international competition. It can be regarded as an adaption to the local business environment. Thus, we subsequently claim that the NSIA investigations should reflect this context in order to reveal important risk influencing factors. NSIA rarely reflects non-conform behaviour in investigations. When non-conform behaviour is touched upon, it is not described as adaptations and established praxis in the industry. Adaptive non-conform behaviour seems not to be a systemic problem based on the aggregated analysis of the NSIA-investigations.

## 1. Introduction

Norway has some unique environmental characteristics, which have implications for heavy goods vehicle (HGV) safety. Norway contains mountainous terrain and deep fjords. There are more than 20 long subsea tunnels, as well as hundreds of other tunnels longer than one km. Tunnel fires involving HGVs occur frequently on Norwegian roads (NSIA 2018a), which indicate risk of major accidents. The recovery and repair costs to tunnels after fires are very high (Amundsen, 2017). Of 180 vehicles involved in fatal crashes in Norway in 2017, 33 (19%) were (HGVs) (Haldorsen, 2015; Ring, 2018). It is therefore important for companies, regulators and government officials to learn from complex accident scenarios involving HGVs.

### 1.1. The Norwegian safety investigation Authority

The Norwegian Safety Investigation Authority's (NSIA) mandate dictates that the purpose and limitation of the NSIA is:

*The Norwegian Safety Investigation Authority shall investigate accidents and serious incidents in the aviation, railway, road traffic marine and defence sectors. The purpose of the investigations is to elucidate matters deemed to be important to the prevention of accidents in the transport and defence sector. It is not the NSIA's task to apportion blame or liability under criminal or civil law. The NSIA decides the scale of the investigations to be conducted, and this includes making an assessment of the investigation's expected safety benefits in relation to necessary resources.*

Thus, the NSIA selects the incidents where they believe that there is a

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potential for learning from the investigation, which the sector can use to improve safety. Their choice of accidents to be investigated is partly driven by the consequences of the accidents, the damage potential and the NSIA's assessment of learning potential. Thus, their theory and prior understanding of accident causes play a major role, but are rarely elaborated in the investigation report. It is not in the mandate of the NSIA to address how the target groups shall learn and the NSIA is not responsible for the eventual use of their investigation reports. In order to carry out high quality investigations the NSIA must be able to react quickly and be on-site for initial investigations (Njå & Rake, 2008; Quarantelli, 2002).

The NSIA aspires to a system theoretical perspective and has adopted Accimap as one of its main strategies in the accident investigation of HGV crashes and tunnel fires (NSIA 2018b). NSIA accident reports are massive undertakings, involving nondisclosure information received during privileged formal interviews, in-depth examination of vehicles involved and access to the accident sites. The purpose of NSIA investigations is to clarify the sequence of events and factors, which are assumed to be important for preventing transport accidents. A central tenet in the NSIA mandate is that the NSIA shall not apportion blame or liability. The NSIA road section, has since its formation in 2005 investigated a number of crashes and fires involving HGVs. Based on their investigations, recommendations have been submitted to the Ministry of Transport, which passes them over to the Norwegian Public Road Administration (NPRA) and other interested and involved parties. NSIA investigators are supposed to work in accordance with a formalized method, advocating for using a systems theory perspective (NSIA 2018b).

The NSIA Accident investigation method combines various approaches, including well known methodological approaches such as: Events and causal factors charting and analysis, Barrier analysis, Sequential Timed Events Plotting (STEP), Man, Technology and Organisation (MTO)-analysis, and Accimap (Sklett 2004, NSIA 2018b:3). This combination of approaches is intended to be used within an analytical process as shown in Fig. 1. As such, it can be argued that that the NSIA method of accident investigation is at the forefront of accident

investigation, representing the state of the art in the field.

This article is not an analysis of NSIA's alleged working practice, but a scrutiny into NSIA's concerns for adaptive non-conform behaviour in HGV-accidents. A particular challenge in the HGV sector is the normalization of non-conform behaviour, which can be understood as any action that deviates from prescribed in-company safety-related procedures and national rules and regulations. Examples include the violation of norms, rules or regulations, such as transport companies transporting dangerous goods in unmarked vehicles, drivers exceeding speed limits, or forwarders creating long transport routes that are implausible given the current regulations (Njå et al., 2012). The extent of complete or partial non-conformity with safety-related norms, rules and regulations in the HGV sector has been understudied. Various forms of non-conform behaviour are often explained by actors embedded in the transport sectors as necessary adaptations performed to cut times and costs in a market with small margins (Kuran & Njå, 2016; Njå et al., 2012). In accident investigations with holistic aspirations, such as those using systems thinking perspectives, it is therefore necessary to uncover how adaptive non-conformity emerges in the system.

### 1.2. International trends in accident investigation

In other safety-critical domains, systems based accident causation models and analysis methods have been developed to understand the complex system of factors involved in accidents (e.g. Leveson, 2004, Rasmussen, 1997, Reason, 1997; Svedung and Rasmussen, 2002). These models and methods are underpinned by the idea that safety, and hence accidents, are emergent properties arising from interactions between multiple components across complex sociotechnical systems (e.g. Leveson, 2004). The behavior of those at the front line of system operation (e.g. drivers) is no longer seen as the primary cause of accidents, rather it is treated as a consequence of system wide interactions, created by decisions and actions at all levels of the organisational system (e.g. government, regulators, company management). These methods now represent an accepted approach for improving safety through more informed countermeasure development and prevention activities in

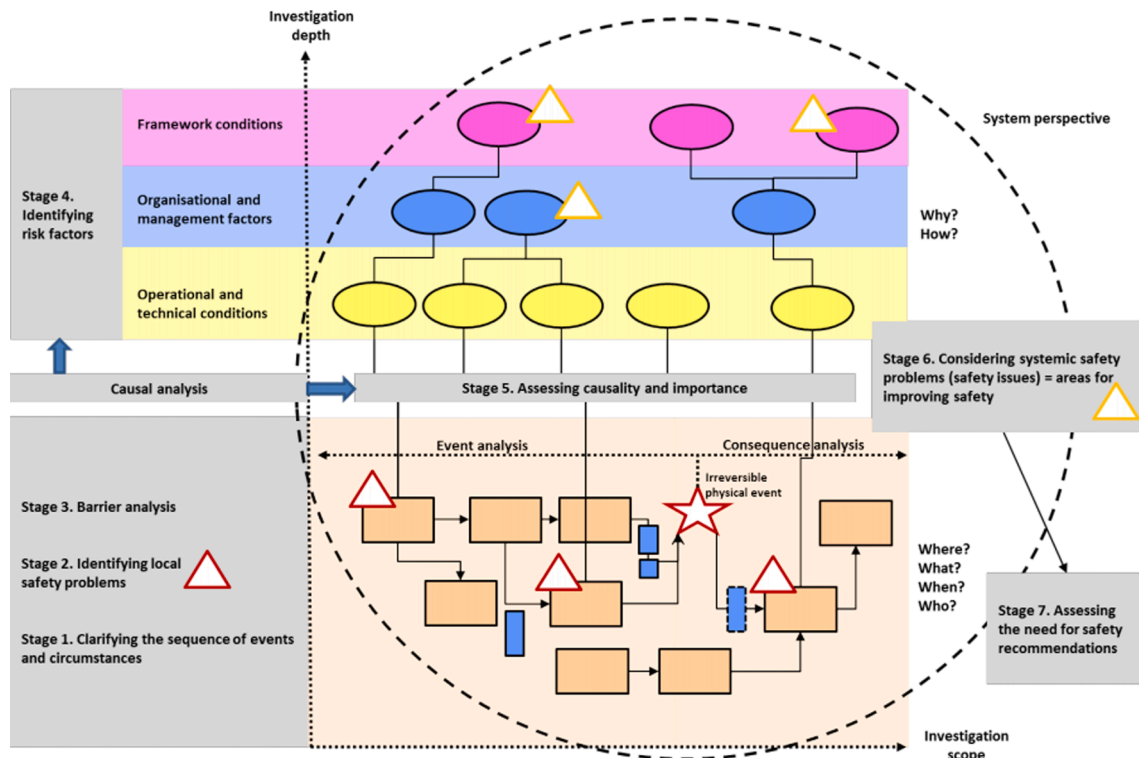


Fig. 1. The NSIA's analysis process for systematic investigations (the NSIA method). (NSIA 2018b).

many safety critical domains (Cassano-Piche et al., 2009). For example, the Functional Resonance Analysis Method (FRAM) (Hollnagel, 2018) and the Accimap technique (Rasmussen, 1997) are currently popular systems approaches that have been applied for accident analysis purposes across various safety critical domains, ranging from aviation (Lenné et al., 2008), and the emergency services (Goode et al., 2015), to rail (Baysari, 2008).

Although many have advocated a systems approach to road transport, this view has not meaningfully penetrated road safety research, practice or policy (Salmon and Lenné, 2015). While some crash analysis methods have been developed for the road traffic environment (Ljung, 2002), these approaches do not consider contributing factors and interactions between factors at all levels of the road freight transport system. Salmon and Lenné (2015) identified the lack of systems based crash data collection and analysis systems as one of the key barriers preventing systems thinking applications in road safety. This view has been supported in several papers in the heavy vehicle transportation industry (Newnam et al., 2015, 2017, 2021). Although in many countries, government investigatory agencies (which have similar remits to NSIA) officially endorse the notion that systemic factors contribute to incidents, in practice their investigation reports tend to focus predominantly on “sharp end” factors (Newnam et al., 2015; 2017).

### 1.3. Research question

NSIA is in the forefront of accident investigation and has more than 50 years of experience in accident investigations (Jacobsson 2011). This began with air accident investigations, but is now multi-modal and cross society oriented, including the defence sector from 2020.

A no-blame systems theory based approach needs to challenge how non-conformity with safety-related rules and regulations on multiple levels can influence the transport system’s risk management framework. If non-conform behaviour is a systemic problem in the HGV sector, then an ambition of systems theoretical analysis should be to detect it as such. The aim of this study is to analyse the NSIA reports, identify instances where non-conform behaviour has been reported and to map examples of non-conform behaviour and the relationship between behaviours. Using the risk management framework, adapted to the HGV sector, by Newnam and colleagues (Newnam & Goode, 2015; Newnam et al., 2017). In doing so we will uncover *how and to what extent is adaptive non-conform behaviour addressed by The Norwegian Safety Investigation Authority in its reports*. There are methodological challenges in accident investigations, which is studying the particular case of non-conform behaviour and combining this with more general or universal characteristics of non-conform behaviours. Understanding this balance is necessary to address learning points useful for target groups in the HGV transport sector.

## 2. Theory

### 2.1. Systems thinking

There has been an increased interest in systems thinking perspectives on creating and maintaining safety in complex sociotechnical systems (Leveson, 2011; Svedung & Rasmussen, 2002; Waterson et al., 2017). Central to systems thinking is a shift away from blaming individuals and identifying immediate causes and their associated human errors, to working with factors that change the system conditions and contributing to safety at all levels of the system (Catino, 2008; Leveson, 2004; Svedung & Rasmussen, 2002; Waterson et al., 2017). It is an approach to gain understanding of systems and how to design functional systems and their constraints. Higher level actors in the HGV sector include managers, auditors, regulators, controllers such as the Police, and legislators. In a Norwegian context, the Norwegian Public Roads Administration (NPRA) hold that a systems-based approach to safety has proven to be more effective at reducing the number of serious accidents, as in other

countries that have adopted a Vision Zero approach, pointing to reduced crash rates in the period 2000–2015 (Hughes et al., 2015).

A popular system thinking approach is Rasmussen’s (1997) risk management framework depicted in Fig. 2. The central premise in Rasmussen’s model is that incidents are the outcomes of the decisions and actions of actors on many levels of the system, including controllers, supervisors, managers and public servants, and accidents are not solely attributable to the actors directly involved in the incident (Rasmussen, 1997).

The hazardous process in the context of the HGV industry is HGV transport. HGV drivers, road users, transport company staff and management, terminal workers and management, consignors, consignees, operational road authorities, infrastructure owners, traffic management operators, regulators and politicians are many of the actors which must be fitted in Rasmussen’s model, but it will not be as linear as presented in Fig. 2. The interrelationships between these actors must be understood by the NSIA, in order to reveal significant and important risk influencing factors, which had a role in the incident they are investigating. A few examples of numerous factors contributing to safety at higher levels of the transportation system include fatigue management programs and legislation to regulate roles and responsibilities of key stakeholders in the management of safety (Dahling et al., 2012; Martin et al., 2013; Morrison, 2006; Rasmussen, 1982; Rasmussen & Svedung, 2000).

### 2.2. Accimap

The Accimap investigation technique (Svedung & Rasmussen, 2002) addresses the systems perspective. By deploying Accimap the investigators scrutinize the decision making of actors at the six levels of the system (see Figure 2): Government policy and budgeting, regulatory authorities, companies, management of said companies, staff, and the work or operative process. Safety management occurs on all levels, but actions on one level can have unforeseen repercussions on other levels,

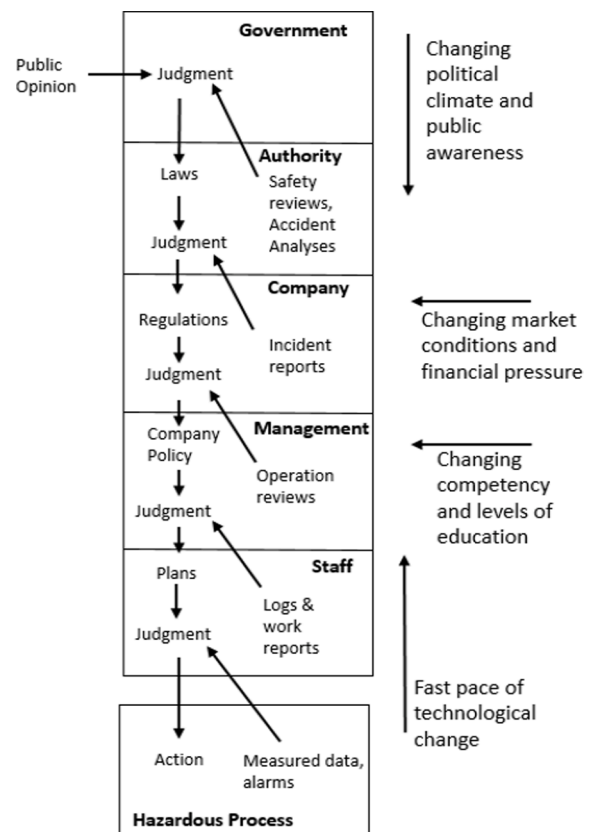


Fig. 2. The risk management framework (Svedung & Rasmussen, 2002).

and the safety management of aspects relevant for safety management in the operative process is divided on different levels. If adaptive non-conform behaviour is a transport system characteristic, it is paramount to identify where in the risk management framework adaptive non-conform behaviour is expressed.

A recent development is the use of “aggregated Accimaps”, comparing investigations within and across sectors to discover if the investigative process is informed by systems theory and if there are common points of learning (Salmon et al. 2020). The aggregated Accimap is an illustration of identified features from investigations that could be interpreted in an analysis to reveal non-conform behaviour. Since adaptive non-conform behaviour is shown in empirical studies and is recognized in the focus group interview with NSIA investigators to be a systems problem, it is important to show how and to what extent *adaptive non-conform behaviour is addressed by the Norwegian Safety Investigation Authority in its reports.*

### 2.3. Individual actors in the heavy goods transport sector

When a systems theory perspective, as employed by the NSIA, is used in the investigation of HGV incidents the investigation it will necessarily involve a wide range of actors, ranging from the sharp to the blunt end of the accident under investigation. Wåhlberg raises the question of whether individual differences are overlooked in traffic safety research, and if so that the individual can become a confounding factor in accident investigation, implying that “most researchers have a blind faith in the methods used, without any real knowledge relevant research concerning their validity” (af Wåhlberg, 2009). One such theme is that even though systems theoretical approaches to accidents are essentially no-blame (NSIA 2018b), the notion of establishing causal links in accident such as in the STEP method will nevertheless include notions such as culpability. For example, a driver’s behaviour might be investigated as a normalized praxis in the company if it is outside of the norm of what is expected in the safety regime of the HGV sector, but it is unclear whether factors such as low level of maintenance on a vehicle would be explored as a normalized praxis in a transnational sector when the accident investigators investigate a single, concrete event.

### 2.4. Applying systems thinking to non-conform behaviour

Non-conform behaviour has become a part of the day-to-day activity in the HGV sector as reported by several scholars (Kuran & Njå, 2016; Njå et al., 2012; Sørli, 2005). This behaviour, often described as the “bending of rules”, could be explained in many ways, dependent on the viewpoints of various actors. We claim that non-conform behaviour should be viewed as a symptom of a dysfunctional system, rather as the cause of crashes and accidents. What has been labelled as *migration of work practices*, can lead to practices that can be defined as *adaptive non-conform* behaviour. Adaptive non-conform behaviour refers to behaviour that in its sociocultural context is considered unsafe, but necessary to avoid the boundary of economic interests; boundary of culturally perceived success; boundary of personal features; boundary of technical competency and interests. Hence the term ‘adaptive’ non-conform behaviour. We use the term adaptive non-conform behaviour to cover individual choices at all levels of the system. Behaviour defined as the non-conformity of established rules and regulations can be described as adaptations to external economic pressures (Deaton, 1985). It may include activities such as transporters not cooperating during audits, managers not keeping up with proper maintenance of vehicles, drivers not securing goods when loading and during transport, or drivers ignoring sleep-work time regulations. These are established adaptations to external and internal socioeconomic pressures, such as financial problems in the company, or of the individual drivers (Beltzer, Sve-dung & Rasmussen, 2002). Adaptive non-conform behaviour can in more precise terms be understood as actions and informal procedures that deviate from stated norms, rules and regulations, and allow actors

to maintain production, while mitigating pressures from social, economic and regulatory constraints.

Rasmussen (1997) argues that competing pressures, such as the need for financial efficiency and the need to minimise workload, lead to migration of work practices into the error margin and toward the boundary of functionally acceptable performance according to the intent of the regulatory regime. To illustrate, when operational decisions are made, the decisions will not necessarily be based on all available information. Rasmussen notes, “*commercial success in a competitive environment implies exploitation of the benefit from operating at the fringes of the usual, accepted practice. Closing in on and exploring the boundaries of the normal and functionally acceptable boundaries of established practice during critical situations necessarily implies the risk of crossing the limits of safe practices.*” (Rasmussen, 1997:189). In the NSIA reports, one example of this is the gradual loss of focus on vehicle maintenance processes in one company leading to sub par equipment being used in day to day work, and that damaged equipment and components are regularly used in HGVs.

Table 1 shows the responsibility of various HGV sector actors according to the risk management framework, based on findings from Kuran and Njå (2016). One special case is the consignor, as the customers, in this case the consignors or consignees in the transport chain, which is difficult to illustrate in Rasmussen’s model, even though their actions affect safety in various ways. Consignors and consignees might create conditions that require extra physical or administrative work for the other actors, or they might provide economic pressure on the enterprise or individuals involved in the transport missions.

## 3. Methods

To reveal how and to what extent adaptive non-conform behaviour is addressed by the Norwegian *Safety Investigation Authority*, we approached the data material from two directions. Firstly, we needed an

**Table 1**  
Examples of non-conform actions based on a wide empirical study in the HGV sector (Kuran & Njå 2016).

Actors in the systemic perspective	Non-conform actions*
Consignorstaff/management	<ul style="list-style-type: none"> <li>• Forgery of transport documents</li> <li>• Providing incomplete documentation for cargo</li> </ul>
DriversStaff	<ul style="list-style-type: none"> <li>• Providing Insufficient packaging of cargo</li> <li>• Alerting other drivers about roadside controls</li> <li>• Manipulating work- and rest hours data</li> <li>• Not making sure of cargo type or if cargo is secure</li> </ul>
Drivers and/or managers. Staff/Management	<ul style="list-style-type: none"> <li>• Using intoxicants such as alcohol or drugs</li> <li>• Counteracting audits and controls</li> </ul>
ForwardersStaff/Management	<ul style="list-style-type: none"> <li>• Managing freights in such a way that there are illegal compositions of cargo loaded on the trucks</li> <li>• Planning routes that are impossible for drivers to perform without breaking with rules and/or regulation</li> </ul>
ManagersManagement	<ul style="list-style-type: none"> <li>• Pressuring drivers to break speed limits or drive illegal routes</li> <li>• Not making sure truck maintenance comply with safety guidelines.</li> </ul>
Terminal managers Management/Staff	<ul style="list-style-type: none"> <li>• Facilitating the illegal borrowing/use of drivers’ licences</li> </ul>
Terminal workersStaff	<ul style="list-style-type: none"> <li>• Not making sure equipment is securely fastened</li> <li>• Loading and unloading equipment and or cargo without proper safety assessments and documentation</li> </ul>
TransportersCompany	<ul style="list-style-type: none"> <li>• Accepting and facilitating the transportation of cargo of dubious origin and unknown type</li> <li>• Falsifying safety course attendance of staff and/or management</li> <li>• Making use of illegal or forged documents</li> </ul>

overview of the underlying messages sent from the investigators through the reports. Secondly a scrutiny of what could be interpreted as adaptive non-conform behaviour was carried out emphasising where in the involved systems this behaviour occurred. From the latter part we used coding in NVivo software, and marked the identified non-conform behaviour in a structure based on the Accimap tool. The presentation of the results resembles the Newnam and Goode's (2015) approach in a study of accident investigation reports to explore if systems theory was used in accident investigations. A focus group interview with accident investigators from the NSIA was carried out in order to obtain a triangulation of the analysis work (Bernard, 2006).

### 3.1. Selection of NSIA reports

The current study examined 29 reports, representing all NSIA reports involving HGV crashes from the NSIA's inception in 2005 until 2018. The reports represent the investigations of major road crashes and tunnel fires involving one or more HGVs. Tunnel fires are investigated even if non-fatal, as they are considered to be of special interest due to their potential consequences. All reports describe the NSIA methodology, its investigative process and case findings. The length of the reports varies from 35 to 100 + pages in length and several have appendices of more than 20 pages on various technical matters relevant in the analysis.

The NSIA's Investigation framework consists of three phases (NSIA, 2018b):

- The collection of evidence and factual information,
- The analysis of data and conclusions, and
- Consideration of safety advice and recommendations.

Their process of accident analysis is divided into seven stages, rooted in their mandate as an investigating authority. Stages 1–3 describe what happened, stages 4–5 discuss why the accident happened and stages 6–7 discuss recommendations for prevention activities (see Table 2). The process is also iterative, with the investigators returning from stage 7 to stage 1 to increase learning (NSIA 2018a).

### 3.2. Analysis of accident reports

The NSIA method includes Rasmussen's risk management framework as a central element (NSIA, 2018b:11) and suggests that Accimap is one of several methods that can be used to uncover systemic issues in their analysis of HGV crashes and tunnel fires. Accimap models themselves are not presented in their reports. The aggregated Accimap in this study is thus not the aggregation of Accimaps presented in the 29 reports but constructed using the contributing factors and recommendations in each report.

The accident report presents a narrative and a subsequent evaluation of where and how NSIA assess weaknesses and risk contributing factors to the accidents. They use data gathering techniques, such as site evidence, interviews, post-technological analysis, simulations and expert judgements. The personal protection regime and their guideline

**Table 2**  
Stages of The NSIA method (NSIA 2018a)

Stage	Action	Stage Focus
	Clarifying the sequence of events and circumstances	What happened
	Identifying local safety problems	What happened
	Barrier analysis	What happened
	Identifying risk factors	Why it happened
	Assessing causality and importance	Why it happened
	Considering systemic safety problems	Prevention Activities
	Assessing the need for safety recommendations	Prevention Activities

promoting discussions with involved actors and individuals, omits an unknown amount of data from each report. Readers are therefore unaware of some information, which is restricted and removed from each case, and they might be presented with a distorted version of the accident story. The current study did not attempt to get access to any background information gathered by the investigators of the NSIA. Our analysis of the NSIA reports is not a study of the crashes and fires themselves, but in part as a qualitative literary study of how the investigators present their work in writing. Our focus has been to use a technique from literary studies, to explore the narratives in the reports, and code the sections of material where the investigators suggests factors that have contributed to the unfolding of events, and their suggestions on how safety can be improved. By close reading (Schur, 1998) we also analysed the reports from two perspectives; 1) identifying direct references to non-conform behaviour, and 2) indirect mentions as description of characteristics of the industry framing the behaviour of the involved actors.

The 29 NSIA reports were coded using NVivo 12, a qualitative analysis software tool. The coding focused on two levels:

- Finding contributing factors of the accident in each report; and
- Finding the relationships between the factors as stated in each NSIA report.

An analysis was undertaken to identify the contributory factors and associated relationships. The contributing factors and connections between them had to be explicitly stated in the report in order to be coded as a factor and relationship. As an example: "the vehicle had insufficiently maintained axles contributing to the accident", was coded as *contributing factors*, whereas a statement such as "lacklustre internal routines may have contributed to the reduced health state of the driver" was coded as a *relationship* between contributing factors.

The mode of data capture was based on the risk management framework (Fig. 2.) and reworked to the consideration of road safety using the framework shown in Table 3. The framework describes five system levels: Government policy, regulatory bodies; other organizations and clients, road freight transportation companies; drivers and other actors isolated by the investigators as important in the reports. The reports where each closely read in order to understand the narratives of the investigation, and special attention was given the explicit recommendations and factors that were considered to be central to the incident narrative by the investigators (see Tables 4 and 5).

We believe that given that this qualitative approach to the reading of the reports is a necessary method based on the premiss that since the reports is the central medium used for communication by the NSIA to

**Table 3**  
The Risk Management framework used in data capture from the NSIA reports

Level of the HGV system	Definition	Examples of contributing factor	Example of factor relationship
Government Bodies	Parliamentary Committees	Unclear legislation	Unclear legislation and Road not fit for purpose
Regulatory bodies	Road and Transport Authorities	Road not fit for purpose	Road not fit for purpose and speeding
Other Organizations and Clients	Police	Insufficient roadside controls	Insufficient roadside controls and speeding
Heavy Vehicle Companies	Company Management	Insufficient maintenance of vehicles	Insufficient maintenance of vehicles and unclear legislation
Drivers and other actors at the incident	HGV-Drivers, Weather conditions, other drivers	Speeding	Speeding and road not fit for purpose

**Table 4**  
Contributing factor relationships in NSIA reports

Contributing factor relationships as reported by NSIA			Number of reports where the relationship is found
Driver Speeding	and	road not fit for purpose	4
NPRA not risk analysed the road	and	Road not fit for purpose	2
Transport company no formal routine for securing cargo	and	Cargo not sufficiently secured	2
Driver intoxication	and	Exceeding speed limit	1
GP not reporting to Police or NPRA about driver mental state	and	Driver mental state	1
NPRA has not made improvements to road as requested	and	Road insufficient line of sight	1
NPRA has not regulated line of sight in exits	and	Road insufficient line of sight	1
Potentially dangerous cargo exempted regulation	and	Transport company insufficient HS&E	1
Unclear regulation of vehicle maintenance and control	and	Vehicle insufficient maintenance	1
Transport company insufficient HS&E	and	Vehicle insufficient maintenance	1
Transport company Insufficient HS&E	and	Driver fatigue and sleep rest time	1
Transport company Insufficient HS&E	and	Driver intoxication	1
Transport company No safety og risk analysis performed	and	Vehicle not fit for purpose	1

**Table 5**  
Systems levels for the Heavy goods transport sector used in the Accimap. (See Newnam & Goode, 2015)

Level	Description
Government Bodies	Decisions, actions, and legislation actions relating to road transportation
Regulatory bodies	Decisions and actions etc. made by personnel working for road transportation regulatory bodies and policies and guidelines
Other Organizations and Clients	Decisions and actions made by commercial organizations relating to transportation activities
Heavy Vehicle Companies	Decisions and actions made by managers and personnel in transportation companies as well as company policies, procedures etc
Drivers and other actors at the scene of the accident	Activities, decisions, and actions etc. made by personal in the 'sharp end'
Equipment, environmental and meteorological conditions	Level describing contributory factors associated with vehicle, the physical road conditions prior to accident

disseminate the results of their investigation and speak to a wider audience covering all actor levels of the HGV-sector, that it is also where a meta-analysis should start. A different approach to the problem statement in this paper could be a qualitative field work with the intent of observing ongoing investigations of the NSIA. While certainly valuable, and arguably a next step following this papers conclusion, it is also very labour intensive. In order to discuss the findings of the paper a focus group interview of investigators in the NSIA was also performed. While being a far cry from in-field observation, it allowed for the discussion of adaptive nonconform behaviour in the HGV-sector, and the investigative process of the NSIA

### 3.3. Focus group interview

A qualitative focus group interview (Krueger and Casey, 2015) was held in February 2018 with four members of the NSIA road accident investigation team in their offices in Lillestrøm, Norway. The purpose of the focus group interview was to see if the investigators understanding of non-conform behaviour in the HGV-sector had similarities with academic work on the phenomena (Kuran & Njå, 2016; Njå et al., 2012). Methodical considerations were made to ensure that the focus group facilitator could:

1. Create an atmosphere, where the investigators could speak openly about their day-to-day work, without the theme of adaptive non-conform behaviour being brought up by the focus group facilitator.
2. Ask open questions relating to accident investigators about the NSIA method, discuss their interview techniques and their considerations of HGV corporate culture and economic pressures on the sector.

The justification for including a focus group interview in this study was twofold. First, to see if the empirical context described in 2.2 was known to investigators, and if so how they included adaptive nonconform behaviour in their analyses.

## 4. Results

### 4.1. Descriptive results

The NSIA reports were investigations of four different accidents involving HGVs: 15 crashes, 4 fires, 3 run-off-road collisions and 7 tip scenarios. The NSIA only investigates a subset of all HGV crashes in Norway and they focus on crashes that involves at least one fatality and/or extensive property damage. None of the reports singled out other vehicles as contributing to the crash. The NSIA reports follow a set format with few deviations:

1. **FACTUAL INFORMATION** with sub chapters such as: Course of events, Registrations at the accident site, Personal injuries, Survival aspects and Implemented measures after the accident. Also, all reports start with a short description of how the NSIA first learned of the event and when the investigators arrived on the scene.
2. **ANALYSIS** with sub chapters such as: Introduction, The interaction in the traffic system, Safety management and leadership, Regulations, Control and supervision.
3. **CONCLUSION** with sub chapters such as: Operational and technical factors, Underlying factors and Other investigation results.
4. Safety Recommendations.

In summary all reports present a narrative that starts and ends with the investigators from arrival to recommendations. In this way, the NSIA frames the event in the NSIA framework and method, which also has the effect that the focus is on the events and context of the accident, not on external forces presented in the risk management framework. The narrative format of NSIA reports has been consistent over time since the start of NSIA investigations. Also, the average length of NSIA reports have decreased in length over time.

Some safety recommendations as shown in the NVivo coding do link to the top levels of the risk management framework, but even though Accimaps are mentioned in the NSIA-method, none of the reports make explicit use of the method. The STEP method is mentioned in a few reports. Only one report mentioned the changing and challenging economic situation of Norwegian companies; this report did imply that this might affect the transport company's ability and willingness to comply and invest in HS&E activities and procedures.

Also, reports do not use any single term such as nonconform behaviour to describe actions that deviate from prescribed in-company safety-related procedures and national rules and regulations. Although

there are examples of this type of behaviour in some reports, some are provided below, the context where such behaviour is normalised, as it is believed in the sector, it is not reflected in the reports.

**Example I:** Where a company had unregulated made to a vehicle: “The general manager of Transport AS states that the company itself had been responsible for assembling the new superstructure after they bought the truck on April 26, 2005.”

**Example II:** Where a company used a truck that was not fit for purpose: “The unit for transporting heated asphalt mass was mounted on the car’s load carrier and secured with the container brackets. The truck was not approved for transporting dangerous goods in a tank / tank container.”

**Example III:** Where a driver was deemed not to have gotten sufficient training: “According to the tour coordinator in XX AS, they do not teach the drivers to drive, but to secure the load, as well as to withstand the pressure from the client. It is not economical in the industry to have two paid people in one car. The training time is therefore set to a minimum, except in those cases where, for example, A municipal vocational training programme is involved in, and possibly pays for, the training. In these cases, a more thorough training is carried out”

4.2. Nvivo coding results

The NSIA reports focus on the narrative of the incident, and the most common contributing factor was “Road not fit for purpose”, which was concluded to be of relevance in seven crashes. The next most common factors were “Driver speeding” and “Vehicle insufficient maintenance”, both found in six investigations. “Transport Company Insufficient HS&E” and “Vehicle not fit for purpose” were both found in four investigations. Other contributing factors are found in fewer reports, most only in one. All Contributing factors are shown in the aggregated Accimap below (Figure 3).

In addition, 13 relationships between contributing factors were described in 18 reports. The relationships were only registered in this study when explicitly stated in the reports. The relationship between factors “Driver Speeding”<sup>1</sup> and “Road not fit for purpose” was most frequent, appearing in four reports. Two other relationships were each found in two reports: the relationship between “NPRA not risk analysed the road” and “road not fit for purpose”, and the relationship between “transport company no formal routine for securing cargo” and “cargo not sufficiently secured”. The two connections show an association between failure of regulation, and subsequent issues that have a more direct impact on the incident. The other connections were only noted once in the dataset.

4.3. Accimap and overview of contributing factors by level

The contributory factors were aggregated onto an Accimap, using the risk management framework adapted for the HGV sector (Fig. 2). The number of times each contributing factor was identified is indicated in the bottom right corner of each factor. Relationships between factors are indicated by the arrows, and numbered according to the times the relationships were identified in the reports. The subsections below provided a more detailed discussion of factors and relationships at each level. The systems levels used in the aggregated Accimap are the same as utilized in Newnam and Goode’s (2015) study, as adapted to the HGV-sector (Table 5).

4.3.1. Government bodies

(continued on next column)

<sup>1</sup> Any inappropriately high speed for road conditions, including exceeding speed limit.

(continued)

Contributing factors	N
Unclear regulation of cargo safety	2
Unclear regulation of vehicle maintenance and control	2
Unclear regulation of road markings	1
Potentially dangerous cargo exempted regulation	1
Unclear regulation of training and certification	1
No regulation for Type 2 diabetes	1

The contributing factors on the highest level of the risk management framework show a use of the systems theoretical perspective. The contributions all involve regulatory issues, and all were singled out by NSIA investigators as clear recommendations for regulatory improvement in the reports. A relationship was found between how potentially dangerous cargo was exempt from regulation and that a transport company had insufficient formalized Safety, health and Environment procedures (SH&E), and unclear regulation of vehicle maintenance and control and vehicle showing insufficient maintenance.

4.3.2. Regulatory bodies

Contributing factors	N
NPRA speed limit not fit for purpose	2
NPRA had not risk analyzed the road	2
NPRA had not made improvements to road as requested	2
NPRA performed insufficient audit of vehicle	1
NPRA did not have a SiS for registration of deviances from protocol	1
NPRA has not regulated line of sight in exits	1
NPRA has not a SiS on “line of sight in exits”	1
NPRA had not regulated ramp in according to geometrical values	1
Insufficient auditor control	1
NPRA has no system to pick up dangerous curves on low-traffic county roads	1

The NSIA reports show the above contributing factors on the second level of the risk management framework focus on the NPRA, pointing both to regulatory tasks and day-to-day management, case by case. Three relationships between this and lower levels were found in the reports.

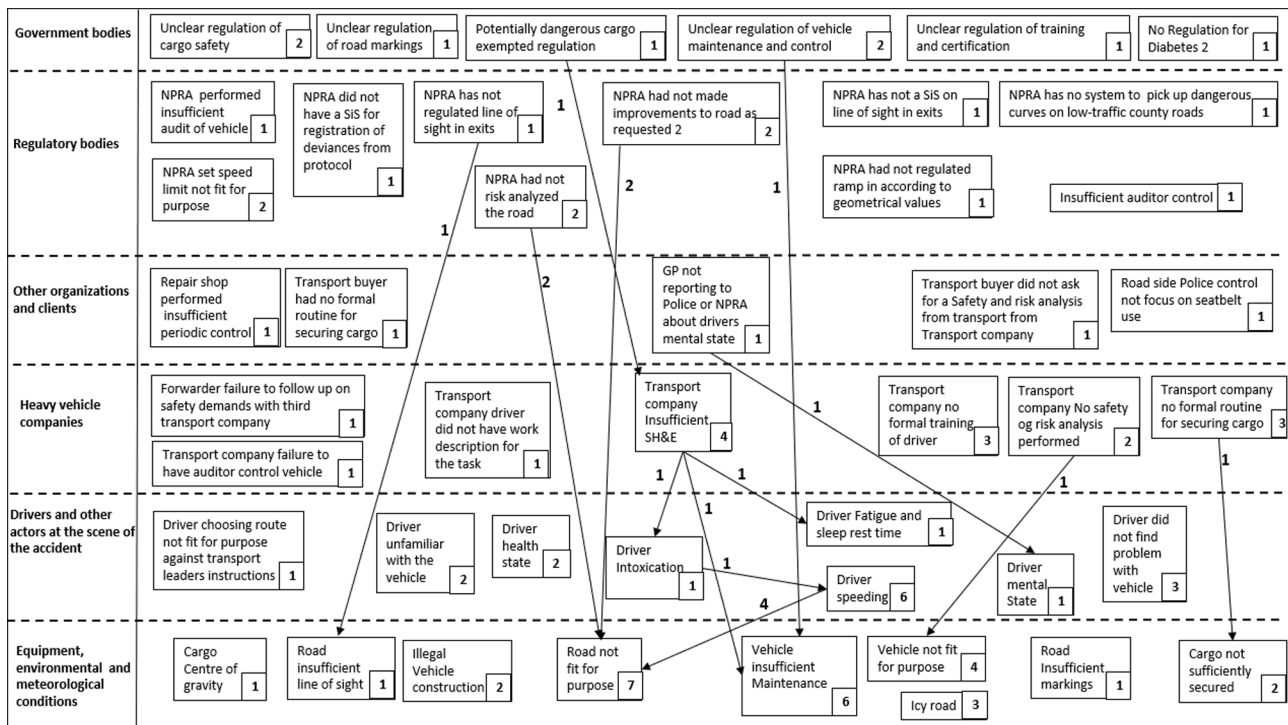
4.3.3. Other organizations and clients

Contributing factors	N
Repair shop performed insufficient periodic control	1
Transport buyer had no formal routine for securing cargo	1
GP not reporting to Police or NPRA about drivers’ mental state	1
Transport buyer did not ask for a Safety and risk analysis from transport from Transport company	1
Roadside Police control not focused on seatbelt use	1

The contributing factors on the third level of the risk management system framework point to various actors in the system, such as roadside police. One relationship between this and lower levels was found in the reports.

4.3.4. Heavy vehicle companies

Contributing factors	N
Transport company Insufficient SH&E	4
Transport company no formal training of driver	3
Transport company no formal routine for securing cargo	3
Transport company no safety or risk analysis performed	2
Forwarder failure to follow up on safety demands with third transport company	1
Transport company failure to have auditor control vehicle	1
Transport company driver did not have work description for the task analyzed/ the road	1



**Fig. 3.** Aggregated Accimap showing contributing factors and contributing factor relationships. Numbers indicate the number of reports the factors have been mentioned. Abbreviations: Health, security and safety (HS&E), Safety information System (SIS), Norwegian Public road Administration (NPRA).

The contributing factors on the heavy vehicle companies level focused on the routines and SH&E processes. The contributing factors all singled out by NSIA investigators as clear recommendations for the individual companies. Five relationships between this and lower levels were found in the reports.

**4.3.5. Drivers and other actors at the scene of the accidents**

Contributing factors	N
Driver speeding	6
Driver did not find problem with vehicle	3
Driver unfamiliar with the vehicle	2
Driver health state	2
Driver chose route not fit for purpose against transport leader's instructions	1
Driver intoxication	1
Driver fatigue and sleep / rest time	1
Driver mental state	1

The contributing factors singled out by the NSIA investigators on this level focus entirely on the drivers of HGV, with driver speeding (e.g. exceeding speed limits, or having a higher speed than recommended on the road in question), as the contributing factors mentioned second most often on this level (six times) in all 29 reports.

**4.3.6. Equipment, environmental and meteorological conditions**

Contributing factors	N
Road not fit for purpose	7
Vehicle insufficient maintenance	6
Vehicle not fit for purpose	4
Icy road	3
Cargo not sufficiently secured	2
Illegal vehicle construction	2
Cargo Centre of gravity	1
Road insufficient line of sight	1
Road Insufficient markings	1

The contributing factors singled out by the NSIA investigators on the lowest level show a focus on the road system, with the road not fit for purpose factor as the contributing factor mentioned most often.

**4.4. Focus group findings**

In the focus interview with investigators of the NSIA, the investigators recognized the difficulties with getting in-depth knowledge of the inner cultural workings of a transport company when investigating a crash or fire. This is readily understandable, for even if the NSIA is recognized by transporters as investigating on a mandate without judicial or procedural power, the investigators always enter a transport company immediately or shortly after an event that might have had tragic or fatal consequences for the one or more of the companies' employees. To ask questions of non-conform behaviour that could have been a casual component in the crash or fire, is especially sensitive.

The most experienced investigator however did acknowledge that adaptive non-conform behaviour was indeed considered normal in the transport sector, while adding that it also that it had gotten better with time, with more companies recognizing the need to follow safety related rules and regulations. Also, he added that economic pressures could lead the non-national actors in the sector to use more "rule bending" to cut costs and compete with the Norwegian actors on unfair terms.

**4.5. Summary of of data, method, analysis and results**

See Fig. 4.

**5. Discussion**

Is the phenomenon of adaptive non-conform behaviour isolated as a systemic problem in accident investigations? The current study adopted both a qualitative reading of the reports, and a systems-based approach to analysing NSIA investigation reports. Consistent with Newman and Goode's (2015) previous attempt at using systems approaches to analyse National Transport Safety Bureau investigation reports, we have shown



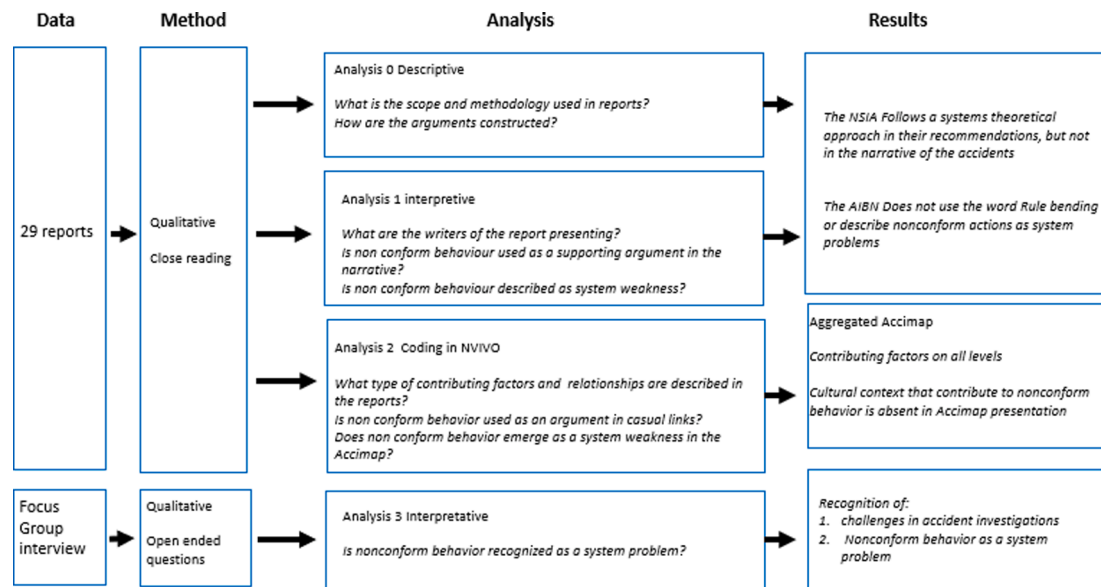


Fig. 4. Overview of Data, Method, Analysis and results of the paper.

that even though formal Accimaps are not created, the accident investigators do explore and find contributing factors on all levels of the risk management framework. Fig. 4 illustrates the methodology, analysis and results in the paper.

Thus, we can argue that the NSIA uses a systems theoretical approach to accident investigation, demonstrated by how the aggregated Accimap includes contributing factors on all levels of the system, showing that there is clear connection between the levels. This approach discovers potential changes to regulation, regulators, and other actors external to the company of the HGV involved in crashes, as well as the standard Road-Driver-Vehicle triangle approach to accident investigation. Close to half of contributing factors uncovered by NSIA are on the top three levels of the system framework and several relationships identified are between the top two levels of the and the lower half. The recommendations from NSIA were mostly toward road and vehicle aspects though some were to the top-level suggesting changes in regulation, policy standards and regulator behaviour.

While we cannot expect to study adaptive non-conform behaviour as a systemic problem when investigating single crashes, we should perhaps be able to uncover it in looking at many. Surprisingly, what the aggregated Accimap analysis of the reports does not show is if adaptive non-conform behaviour can be considered to be endemic to the transport industry. Surprisingly, as adaptive nonconform behaviour is considered to be common modes of operation in the sector by Specialist and workers in the business, as indicated in the focus group interview and by studies into the phenomena (Njå et al., 2012). As suggested in the introduction one of the benefits of using a systems theory to increase knowledge in the HGV domain should be to uncover not only risk problems on all levels of the system, but to uncover truly systemic risk problems that are recognized by experienced investigators.

The systems theory perspective of the NSIA can be described as having a good grasp of the levels of the framework but falls somewhat short on including or considering the external pressures from outside of the risk management framework. This is not surprising as an accident investigatory approach that includes these more elusive forces of gradual or rapid economic, political, competency opinion changes is so far not established in the literature.

Adaptive non-conform behaviour occur on several levels of the framework as shown in the reports, but the context the sector is in, where adaptive nonconform behaviour is normal behaviour is not considered. Examples include Transport Company not having formal training of the driver, no formal routine for securing cargo, driver

speeding or violating sleep and rest time regulations. An investigative interview referred to in one of the reports also notes that forces and influences outside of the framework are considered important by the actors situated in the system, and that adaptive non-conform behaviour can be considered a system issue of importance.

One NSIA report mentioned how the changing economic pressures on Norwegian companies have led to a competitive environment with constrained margins. It is implied that this might affect a transport company's ability and willingness to comply and invest in HS&E activities and procedures. This relationship points to the way adaptive non-conform behaviour can be interpreted as the consequences of forces external to the system. This unwillingness has previously been studied and found to be a significant challenge in the sector. In a study of managers' attitudes toward safety measures in the commercial road transport sector, interviewees perceived the implementation and focus on furthering safety measures to be expensive, and one quarter of the subjects as compromising competitiveness of the individual companies (Njå & Fjelltn, 2010).

This study considers adaptive non-conform behaviour, normalized in the transport sector as a possible explanatory factor for these contributing factors in the NSIA, established as informal procedures and 'business as usual' mode of working due to economic pressures outside of the risk management framework. Analysing forces and pressures external to the risk management framework in standalone accident investigations is a challenging problem. Uncovering the extent of adaptive non-conform behaviour in the HGV sector has been the result of longitudinal ethnographic fieldwork and focus group interviews, as suggested by Njå and colleagues (Kuran & Njå, 2016; Njå et al., 2012). This method of enquiry is unsuitable for single accident investigations. A possible approach is to perform aggregated studies of several reports, informed by external studies.

The NSIA investigations have matured and absorbed the system theoretical perspectives currently in vogue in the field. Still, adaptive non-conform behaviour, which is a possible and prevalent overarching type of contributing factor, is a multi-level phenomenon. Some argue it complicates investigation of accidents involving HGVs, making it difficult to create a complete picture of the system. One tentative explanation for this is the difficulties with getting in-depth knowledge of the inner cultural workings of a transport company when investigating a crash or fire. This is readily understandable, for even if the NSIA is recognized by transporters as investigating on a mandate without judicial or procedural power, the investigators always enter a transport

company immediately or shortly after an event that might have had tragic or fatal consequences for the one or more of the company's employees. To ask questions of non-conform behaviour that can be interpreted as been a casual component in the crash or fire, is especially sensitive.

Based on the reading of the NSIA reports, it can be argued that a challenge is how the accident investigations of NSIA describes the risk management framework and uncover relationships between levels also can include the results of forces and pressures that contribute to migration and non-conform behaviour (Kuran & Njå, 2016; Njå et al., 2012; Rasmussen, 1997). Some safety recommendations as shown in the nvivo coding does link to the top levels of the risk management framework, but even though Accimaps are mentioned in the NSIA method, none of the reports explicitly present one. The STEP method is mentioned in a few reports. Also, all reports start with a short description of how the NSIA first learned of the event and when the investigators arrived on the scene. In summary all reports present a narrative that starts and ends with the investigators from arrival to recommendations. In this way, the NSIA frames the event in the NSIA framework and method, which also has the effect that the focus is on the events and context of the accident, not on external forces presented in the risk management framework. As only one report mentioned the changing and challenging economic situation of Norwegian companies. Further, it does imply that that this might affect the transport company's ability and willingness to comply and invest in HS&E activities and procedures.

It must also be considered that the NSIA reports were not written with this type of aggregated Accimap in mind. Meaning that they do not necessarily report all the contributing factors even if they exist. This can explain that there are relatively few interactions revealed – they may exist but are not reported, because this type of analysis is not considered necessary for the original report format. This type of *meta*-study of accident investigations can also be in danger of the “what you look for is what you find” fallacy (Lundberg et al., 2009). A qualitative fieldwork study of NSIA investigators, and NSIA investigative interview techniques could possibly be of great value to further explore the process of accident investigation. Also, it may be worth considering a semi-structured approach to accident investigation; for example, using a generic list of contributing factors such as the Accimap classification scheme recently proposed by Salmon et al. (2020). This type of semi-structured approach could help ensure that all relevant contributing factors are identified, including systemic issues such as adaptive non-conform behaviour.

## 6. Conclusion

Adaptive nonconform behaviour is an established systemic phenomenon in the HGV sector recognized both by actors in the business and by NSIA investigators. This paper has explored whether the perspective used in accident investigations of the NSIA, has system theoretical elements, and if the investigations are able to include the adaptive nonconform context as a systemic emergent phenomenon.

Non-conform behaviour of safety-related rules and regulations is currently normalized in the behaviour transport industry due to increased international competition and adaption to the local business environment. Adaptive non-conform behaviour is performed in the transport industry, across all levels from basic process to strategic levels. This context only enters the accident investigations of NSIA to a very limited extent. While the investigator's mandate is concerned with the individual accident under investigation, nonconformity with rules and regulations as a systemic problem is not considered. While the concept of noncompliance might occasionally be used as contributing factor in accident investigations, it is only a description of a symptom and does not enter the grey and difficult to access areas of causality that influence the unintended, unwanted and costly events of heavy vehicle accidents.

Since adaptive non conform behaviour is not shown to be a systems problem in the aggregated Accimaps it should be considered whether

aggregated Accimap analysis is ill suited to explain complex sociocultural emergent phenomena such as adaptive non conform behaviour or if it is because the NSIA does not include the context of adaptive non conform behaviour in accident investigation. Thus, answering the research aim, adaptive nonconform behaviour as a system problem is not addressed as a system problem in the NSIA reports, but single instances of “rule bending” or rule breaking are treated as single events, and not placed in the sociocultural context they occur.

Is it troubling that a systemic aggregation of systems theory based reports fail to uncover what is a system issue? It can perhaps be argued that the NSIA simply has not chosen crashes and fires where this is a theme. Another explanation could be that adaptive nonconform behaviour has a low level of criticality and contribute little to crashes and incidents. If the goal of system theoretical approach is to provide safety recommendations suggestions on all levels of the risk management framework, then perhaps a systems theoretical approach such as the Accimap is ill suited to uncover systemic issues, as long as the narrative of the accident, and not its wider cultural context is the focus of the accident investigation.

The aim of the paper, to apply the novel concept of aggregated Accimaps to see if adaptive nonconform behaviour is uncovered in the in-depth and comprehensive accident investigations of the NSIA has shown that this so far, is not the case. This raises new research questions such as: Is rule bending not a considerable risk problem in the sector even though people involved in day-to-day activity believe it is, or that are the investigative methods used are not as “fit for purpose” as is intended., and if there are other methodologies available to NSIA that are better suited to uncover if nonconform behaviour indeed is a systemic problem. We believe that since the NSIA method (see Fig. 1), is an state of the art approach to accident investigation that points to the recommendation of the establishment and continuous refinement of Accimaps for investigative panels, the establishment of, and continuous refinement and updating of aggregated Accimaps should be prioritized by accident investigator panels as an important activity between investigations, as long as the wider context where the accidents and investigations take place is also considered a part of a wider narrative. Such maps, and meta analyses of investigations will be of much value as they provide much needed relationships in accident data providing support to anecdotal data about systemic issues. We also see that other national equivalents of the NSIA such as NTSB in the US, ATSB in Australia or the TAIC in New Zealand have not been the subject of studies that include a wider context of sociocultural adaption and nonconform behaviour. This points to the need for systematic meta studies of investigative reports, methods and methodologies in a transnational context, as the HGV sector is inherently transnational.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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