TØI report 1664/2018

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Institute of Transport Economics
Norwegian Centre for Transport Research

Increasing the implementation of traffic safety management systems by organisations

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Sammendrag:

En bred implementering av styringssystemer for trafikksikkerhet (STS) i organisasjoner kan bidra til økt vegsikkerhet både for ansatte og andre trafikanter. Den foreliggende studien ser på effekten av STS, i hvilken grad de er implementert, og hvilke faktorer spiller sammen og begrenser implementering av STS. Rapporten beskriver tiltak som kan bidra til at flere organisasjoner implementerer STS. Studien bruker en sosioteknisk tilnærming, og er basert på litteraturgjennomgang og intervjuer.

Summary:

A broad implementation of traffic safety management systems (traffic SMS) by organisations has the potential to improve road safety for employees and other road users. To inform the choice of measures for increased uptake of traffic SMS, the current study reviews knowledge on their effects on safety and other outcomes, and factors influencing their implementation. Ways to address limiting perceptions and encourage implementation are identified. The study takes a sociotechnical approach and is based on literature review and interviews with three sector experts.

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Preface

The international traffic standard NS ISO 39001 sets out requirements for the organisational management of traffic safety risks, and is aimed not just at transport companies but all companies who influence and are influenced by road traffic. It was introduced in Norway on the 1st April 2013.

The implementation of NS ISO 39001 in Norway is occurring steadily but slowly – as of March 2016 only four companies had been certified. To stimulate increased implementation, the National Public Roads Authority (NPRA) held a seminar on workplace traffic safety culture on the 11th of March 2016. The seminar focused on how NPRA can contribute to more organisations seeing the potential in and developing traffic safety culture.

Participants at the seminar recognized that transport and other industries lacks the information needed to show workplaces the advantage of introducing a system for management of traffic safety. To what extent can these systems reduce traffic accidents? Do they lead to savings and other advantages for the transport company? Is there data that summarises the effects of relevant interventions on important organizational goals, e.g. number of accidents, sickness absence, expenses related to maintenance, insurance costs? Are there case studies and to which extent are they relevant for different types of Norwegian transport organisation? The objective of this report is to help answer some of these questions.

Ross O. Phillips has written the report, and Tor-Olav Nævestad has contributed with some text and references . Guri Natalie Nordbakke prepared the data on Norwegian goods transport companies given for the first time in the report. Vibeke Milch translated the summary and title into Norwegian. Michael Sørensen was responsible for quality assurance.

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Oslo, October 2018

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Content

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Summary

Increasing the implementation of traffic safety management systems by organisations

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A broad implementation of traffic safety management systems (traffic SMS) by organisations has the potential to improve road safety for employees and other road users. A systemic analysis identifies management perceptions and framework conditions acting as obstacles to broad uptake. These could be addressed by a coordinated effort involving key sector actors, the aim of which would be to provide organisations in the same branch with a clear and consistent message about the need for traffic SMS, the content of traffic SMS, and common measures for traffic SMS. This would provide highly fragmented industrial sectors, such as goods transport, with a common frame of reference on traffic SMS, and stimulate progress by enabling knowledge sharing and transparency on safety. The need to manage traffic safety risks needs to be better integrated into procurement processes at all levels. For optimal uptake of traffic SMS, customers, insurers, regulators, interest groups and other actors in the economic and socio-political environments of organisations also need to play a role.

Driving in traffic is the riskiest activity that employees of many transport and non-transport companies face while at work. The overt and hidden costs of road accidents in which employees are involved are considerable – for the employees themselves, their employers and society. Research suggests that there is much that transport and other organizations can do to help the situation by better managing its traffic risks. Professional driver behavior is the main cause of serious crashes triggered by heavy vehicles, and company-level factors are often implicated as root causes of this behaviour. Employers also influence traffic risks more directly in the way they manage factors such as routes, rosters, delivery schedules or fleet standards and maintenance. Despite this, research indicates that many employers fail to meet even minimum legal requirements to manage and mitigate work-related road safety risks, both in Norway and internationally.

To help structure and improve road traffic safety management by organisations, the International Standards Organization's introduced a quality standard on Road Traffic Safety Management Systems (ISO 39001). ISO 39001 lays out standard requirements for an effective traffic safety management system (SMS) and is designed for use by any organization who influences or is influenced by road traffic. The standard was launched in Norway in 2013 as NS ISO 39001, and hopes were expressed that widespread certification in the standard would result in better management of work-related road risks and improve traffic safety. The National Public Roads Administration (NPRA) commissioned a report on requirements for implementation by Nja (2015), and held a seminar in 2016 in which the problem of relatively slow uptake of the standard in Norway was raised and possible solutions discussed, one of which was a need for greater knowledge on the effects of traffic SMS on safety and business outcomes, and on obstacles to implementation.

Towards ideas for increased implementation of traffic SMS

The present report aims to verify and build on existing reports and discussions by identifying evidence-based measures that would increase the rate of implementation of traffic SMS by Norwegian organizations. To build a foundation for recommendations, the report considers what SMS are (including approaches to SMS in different transport sectors), evidence for effects of traffic SMS, and briefly reviews status of SMS implementation by firms in Norway. The report's focus is businesses or firms (organisations run for profit) involved in the transport of goods or passengers by road. It also considers firms whose main activity is not transport but who nevertheless employ work-related drivers. Since the actions of key market actors are key to the business decisions managers make (including whether to implement traffic SMS), the report pays attention to the system in which businesses find themselves.

Method

The above lines of enquiry were investigated using the methods indicated in Table S1.

Table S1. Methods used to investigate lines of enquiry addressed by our study. Interviews were conducted with three representatives from the Federation of Norwegian Transport Organisations (NHO Transport), the Norwegian truck owner's association (NLF) and an SMS accreditation service.

	Line of enquiry	Authors' knowledge of existing literature	Literature review	Theoretical analysis	Interviews
1	Description of SMS and approach in road other transport sectors	✓			
2	SMS and traffic SMS in organisations	✓	✓		
3	Evidence for effect of SMS on traffic safety and other organisational measures	✓	✓		
4	Status of traffic SMS implementation in Norwegian businesses	✓	(✓)		✓
5	Measures needed to stimulate broader implementation of traffic SMS		✓		✓
6	Market changes to ensure that management of traffic safety is the norm		✓	✓	✓
7	Case studies / good practice		✓		(✓)

What are SMS?

A safety management system (SMS) is an integrated set of organisational elements supporting and enabling risk management, along with processes for designing, evaluating and improving those elements. Common elements and processes can be identified (e.g. policy, roles and responsibilities, data-driven continuous evaluation, and safety assurance), but their extent and nature can depend on the size and activity of the organization. SMS often result in safety programs comprising safety measures, but some elements can be identified both as part of SMS and a safety management program (e.g. recruitment and selection). It is not clear whether successful implementation of SMS requires a positive safety culture and organizational-wide engagement, or whether SMS is a way to gain

improvement in these areas – it seems that SMS both can influence and be influenced by organizational culture, and this reflects the ever-evolving cyclical process of SMS. It is also worth noting that SMS support new ways of thinking about risk that account for the need to understand rapidly evolving transport systems as complex systems.

The elements and processes found to be common to descriptions of general SMS are also found in descriptions of SMS laid out in international guidelines in the air, maritime and rail sectors (policy, management commitment, roles and responsibilities, documentation, risk management, emergency preparedness, assurance), although the way elements and processes are structured and grouped varies. The idea that SMS should be the norm for commercial road transport organisations is relatively recent, and has been encouraged by the arrival of ISO 39001, a growing number of published work-related road safety programs, and the EU's PRAISE project.

Is there a need for broader implementation of traffic SMS?

A need for improved implementation of traffic SMS in firms would be justified if the following three statements were true:

i. Organizations employing people who drive for work contribute to traffic safety levels.
ii. Traffic SMS implementation reduces traffic safety problems caused by organizations employing people who drive for work.
iii. Implementation has been insufficient to date.

Support for statement (i) was presented at the start of this summary. Regarding statement (ii), we find no robust empirical evidence to show that traffic SMS implementation leads to positive effects on road safety, business or other organizational outcomes. There are, however, two main types of indirect evidence that SMS improve safety: (a) Correlations or cross-sectional studies linking SMS-like organizational processes to traffic safety outcomes, and (b) The traffic safety effects of isolated measures of the sort typically output by SMS.

There are several reasons why evaluating the effects of SMS implementation is challenging. For example, SMS are often implemented in the presence of existing safety management measures, making it difficult to isolate effects that are due solely to implementation of a "new" SMS. SMS are also intractable systems and as such it is hard to fully describe them and isolate their effects, which will also vary depending on the cultural contexts into which they are introduced. Given such challenges, one can wonder whether it will ever be possible to gather robust empirical evidence using traditional evaluation methods.

Lack of direct empirical support begs the question, why should companies implement them? The best answer comes from evidence suggesting safety measures are more effective when implemented in a supportive organizational culture, which SMS help nurture. Several authors argue that inspiration and motivation SMS give to workers is beneficial, and certainly better than doing nothing in the absence of robust empirical evidence. Finally, although traffic SMS implementation itself is hard to evaluate, the resulting measures often have good empirical support. Faced by a lack of empirical evidence of effect in the research literature, it seems that, recognizing the need for a systematic and holistic approach involving the participation of multiple stakeholders, practitioners have taken matters into their own hands and got on with things.

Support for statement (iii) comes from the fact that only eight of several hundreds of applicable transport firms in Norway have been accredited in the formal safety management certificate NS ISO 39001, despite it being launched in 2013. No non-transport firms had been certified in Norway as of May 2018.

Considering the above three statements together, the evidence supports the assumption that there is a need for broader implementation of traffic SMS by both transport and non-transport firms employing people who drive for work.

Theoretical insight

To help guide the search for factors influencing uptake of traffic SMS, as well as learn about ideal conditions for safety management in the road sector, we reviewed three main relevant theories: Risk management in societies (Rasmussen 1997), Sociotechnical systems (Davis et al. 2014), and Sociotechnical transitions and triple embeddedness of firms-in-industries (Geels 2014). Lessons drawn from each area are summarized in Table S2.

Table S2. Conclusions drawn on implementing SMS, from a selected theoretical review.

THEORY	Risk management in societies	In modern dynamic societies, safety management should be performance based, and SMS is a useful way in which organizations can help ensure they meet performance demands. In recognition of the emergence of risk in systems, safety management and SMS should be integrated across systems in which individual organisations are embedded. Regulators should collaborate with organisations to establish consensus on performance markers and ensure necessary competence is shared across system actors. Implementing SMS involves accounting explicitly for management interests in production and ensuring a shared understanding of the safety implications of this. Implementing SMS demands that companies make explicit how safety is valued against other priorities in its operations, increasing the visibility of its social responsibility, and allowing interest groups to assess the extent to which safety values of organizations and society are consistent. This is relevant since it implies ways in which SMS can be promoted to help organisations meet performance requirements effectively and demonstrably.
	Sociotechnical systems	Safety management – like safety – is an emergent property of the system and cannot be limited within organizational boundaries. To understand how SMS should be implemented in and acoss organisations, we need to consider the influence of different people involved in safety management, their competing goals, the influence of culture in society and organisations, the constraints and opportunities presented by technology and infrastructure. As much as about *things* – processes, policies, technology, vehicles, infrastructure – safety management is about relationships among things and people that span the integrated sociotechnical system.
	Sociotechnical transitions and triple embeddedness	It is important to understand the stabilizing mechanisms of *regimes*: Normative and cognitive – i.e. not only regulative – rules, shaping and reproduction of social rules, sunk investments in technology, market forces, existing competence/skills, customer value of safety, societal value of safety and so on. It is important to consider whether SMS is seen by managers as promoting or inhibiting for productivity. One way regulators can "sell" SMS to firms is as a tool for more operational flexibility in exchange for safety management that ensures they stay within "functionally acceptable boundaries of established practice". Development of a regime is a game in which moves to implement change by outsiders is likely to be countered by influential actors who – due to stabilizing mechanisms – do not see the value of change and wish to maintain the status quo. Actors who see value in change may be encouraged to implement it, and where positive sociopolitical or economic outcomes are salient, there will be social learning with other actors implementing change. Different actors have different resources with which to follow their interests, i.e. those who see the value (or not) in implementing change may be able to do little or a lot about it, depending on their priorities and resources. We should consider that each organization has a unique local context in the system, and therefore optimal solutions for implementing SMS will vary.

Factors influencing traffic SMS implementation

Systemic analysis based on interviews, literature review and theoretical insight together suggests several factors influencing SMS implementation in road transport:

- Isolated efforts to improve traffic safety management are poorly visible to other organisations due to the fragmented nature of the goods transport sector, and the lack of a coordinated effort to encourage *all* types of firm to manage safety (no "united front" presented by authorities and interest groups)
- Accepted gaps between actual practice and written regulations (i.e. between normative and regulative rules)
- Transport purchaser attitudes / contracts encouraging a compliance mindset in the operators
- Society's lack of demand for stringent levels of traffic safety from goods transport companies.
- Lack of good examples in the form of public organisations demanding traffic SMS in procurement processes.
- Lack of accounting for traffic SMS in accident investigations, regulatory audits.
- European competition laws impeding the extent to which Norway can regulate for safety management.

Implication of findings for increasing implementation

The report underlines the importance of contracts and transport purchasers in improving traffic safety management by companies. In Norwegian goods transport, most companies are local outfits with few employees and limited resource. More advanced SMS may therefore be best applied across whole transport chains, in which the risk of activities of different companies involved is managed by an integrated SMS driven by the transport purchaser. This approach is supported by findings from our theoretical review that individual companies cannot manage road safety optimally independent of other organizations in their ecosystem, as well as findings from interviews on the importance of the contract-giver.

Given the importance of transport purchasers, an important question is how we can motivate them and their customers to value road safety enough to demand it. One way forward might be to learn from those involved in the purchase of hazardous goods transport, both about their approach and experienced benefits of encouraging operators to manage traffic safety. The development of tools could also help establish a norm for customers to demand that suppliers manage road safety, e.g. national benchmarking, certification schemes that are applicable to most Norwegian transport firms, or accessible information on how to include risk monitoring arrangements in procurement procedures.

Ultimately, we see that sector-wide implementation is desirable, but its stimulation requires that we consider the large number of smaller operators and intense productivity pressures seen in many Norwegian road transport sectors. Transport purchasers alone cannot be expected to bring about change, i.e. the challenges need to be met by the industry. Change could be encouraged by a network of "big players" among purchasers, insurers, operators, trade organizations and unions selling win-win ideas to the sector, such as that promoted by NPRA's Safe Trailer (*Trygg Trailer*) project. Each type of actor can play a role and several can be considered as untapped resources with respect to traffic SMS implementation (e.g. insurers).

Finally, a recurring finding in the report is that many smaller operators in goods transport do not have the means to learn about, justify and implement formal traffic SMS. To improve safety management, managers in these companies need ready access to consistent information about what *they* can do to manage traffic safety, including how to build comprehensive safety management over time. Nævestad et al.'s (2017) "Safety Ladder" approach is informative here, as it guides the gradual development of safety management measures, starting with the simplest and least resource demanding measures first. The approach taken would ideally be consistent across smaller companies, such that they could openly learn from each other and share safety management experiences.

Ideas for broad effective implementation of traffic SMS

The report identifies lack of a single coordinated message on (i) the need for firms to manage traffic safety , and (ii) how to go about doing this. Unlike other transport sectors with a recognized SMS framework, road transport does not share a frame of reference on SMS. The Ministry of Transport could therefore initiate a meeting with NPRA, Safe Traffic (*Trygg Trafikk*), the police, the Labour Inspection Authority, Norwegian Truck Owner Association (*NLF*), Federation of Transport Companies (*NHO Transport*), Accident Investigation Board Norway (AIBN) and other key actors to agree on a plan on how to present a "united front" to road transport and other relevant sectors on traffic safety management. The plan could be based on a consideration of the complex reasons for lack of consensus to date given in this report, and could consider level of restrictiveness of regulation in relation to resources of the companies targeted. It could include concrete roles for different actors to help address sector perceptions limiting SMS implementation, also outlined in the report. A result of the plan could be that representatives of core actors form a sector task force that could meet regularly, and work on activities and communications to convey the message that all firms in that sector influencing or influenced by the transport system, need to manage traffic safety. The plan could include a strategy for encouraging widespread implementation or the distribution of information on traffic SMS approaches appropriate for different types of firm. Plans could be centered around existing collaborations, not least existing quality accreditation programs promoted by NLF.

Beyond this there is a need to identify common measures for traffic safety management, and evaluate and promote the benefits of using common markers (e.g. information sharing and learning). There is little in the literature to guide authorities on how to measure traffic safety management, but it is reasonable to expect that progression in road safety management by firms would be improved if operators in the same sector used the same safety outcomes as measures, even if the means to establish these ends may vary. Standardization on measures would increase transparency on safety management, promote learning and increase shared understanding of good safety practice. Transparency and knowledge sharing can also be promoted by new digital technologies that allow companies to share data.

Considering other activities, attempts could be made to;

- Provide national figures on the direct and indirect costs of crashes to employers for use in business cases for SMS.
- Increase the visibility of SMS and the benefits experienced by firms that have already implemented NS ISO 39001 or other traffic SMS, by profiling in trade publications, handbooks, conferences and so on.

- Profiling of transport purchasers demanding traffic SMS, as well as steps taken to make more purchasers demand traffic SMS.
- Make tools available to help address traffic safety management in procurement procedures (based on PRAISE reports). NS ISO 39001 or NLF's existing accreditation schemes could be highlighted as a way for purchasers to assess transport quality, and schemes appropriate for smaller transporters (e.g. based on Nævestad's Safety Ladder) or non-transport firms could also be developed and promoted in procurement.
- Coordinate activities of NHO Transport, NLF and NPRA, to build on NLF's efforts to provide accreditation tools.
- Establish national benchmarking of firms on traffic management activities to help in the selection of quality transport.

NPRA could also conduct a campaign targeting figurehead purchasers of transport, to promote the benefits of including traffic SMS demands in public and private procurements. Finally, NPRA could build on Safe Trailer (*Trygg Trailer*) by involving NHO Transport and other key actors in exploring other ways to involve purchasers in traffic safety management by transporters.

Addressing societal influences, Safe Traffic (*Trygg Trafikk*), NPRA or others might promote traffic safety as a social issue alongside social dumping, environmental issues and security. In terms of regulation, it may be worth working with the EU towards more explicit treatment of traffic SMS in Health, Safety & Environment (HSE) legislation, or whether accreditation in SMS may be used as the basis for regulatory opt-outs or increased flexibility (e.g. increased loads allowed, more flexible driving hours).

To encourage traffic SMS implementation, research is also needed to address the following questions:

- What are the safety, economic and sociopolitical benefits of introducing traffic SMS in Norway – what happens to firms that implement traffic SMS? Norwegian case examples demonstrating cost-effectiveness and economic benefits of work-related road risk programs.
- What constraints do transport purchasers face in demanding traffic SMS from transporters in contracts?
- What content is needed for a national benchmarking of organizational traffic safety management, and how can this best be done?
- How can we change management's safety mindset – particularly in smaller companies – from one of safety compliance to proactive safety management? How can we establish leader commitment to traffic safety management, such that there is:
    - Openness to new ways of thinking, achieving true proactive safety
    - Willingness to create and execute on a business case for implementing traffic SMS
    - Trust and openness on sharing safety data with competitors?

Transportøkonomisk institutt
Stiftelsen Norsk senter for samferdselsforskning

Sammendrag

Hvordan styrke implementeringen av styringssystem for trafikksikkerhet blant norske transportorganisasjoner?

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Forfattere: Ross O. Phillips, Tor-Olav Nævestad, Guri Natalie Nordbakke
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Bred implementering av styringssystemer for trafikksikkerhet (STS) i organisasjoner kan bidra til økt vegsikkerhet både for ansatte og andre trafikanter. En systematisk analyse peker på holdninger om sikkerhetsstyring og rammebetingelser som sentrale barrierer for effektiv implementering av STS for trafikk. For å redusere slike barrierer kreves koordinert innsats av sentrale aktører, for å i større grad tydeliggjøre (i) behovet for STS, (ii) innholdet som bør inngå i et STS, og (iii) vanlige mål på STS, overfor organisasjoner innenfor samme område. Dette kan bidra til å skape en felles forståelsesramme for STS, og på samme tid stimulere til utvikling gjennom økt gjennomsiktighet og kunnskapsdeling om sikkerhet. Styring av trafikkrisiko bør i større grad integreres i anskaffelsesprosesser på alle nivå. For å oppnå optimal implementering av STS er det viktig at kunder, forsikrere, tilsynsmyndigheter, interessegrupper og andre aktører også kommer på banen og involveres.

Å kjøre i trafikk er den mest risikofylte aktiviteten ansatte i transportbedrifter og andre virksomheter foretar seg i arbeidssammenheng. Det er mange skjulte kostnader forbundet med trafikkulykker hvor ansatte er involvert, både for de ansatte selv, deres arbeidsgivere, og for samfunnet for øvrig. Forskning tyder på at det er mye transportorganisasjoner og andre organisasjoner kan gjøre for å bedre situasjonen, gjennom bedre styring av trafikkrisiko. Kjøreatferd hos yrkessjåfører er identifisert som hovedårsaken til alvorlige kollisjoner, hvor tungtransportkjøretøy har vært utløsende part. I disse tilfellene er faktorer på bedriftsnivå ofte antydet som bakenforliggende årsaker. Arbeidstakere påvirker også trafikkrisiko mer direkte gjennom aspekter som rutevalg, timetabell, leveringsplan, flåtestandard og vedlikehold. Til tross for dette, tyder forskning på at mange arbeidstakere, både i Norge og internasjonalt, ikke imøtekommer selv minimums lovpålagte krav med tanke på å styre og minimere konsekvensene av arbeidsrelatert veitrafikkrisiko.

For å bidra til en bedre strukturering og forbedring av trafikksikkerhetsstyring i organisasjoner, har den Internasjonale Standard Organisasjonen introdusert en kvalitetsstandard for sikkerhetsstyringssystem i veitrafikk som er utformet for bruk av enhver organisasjon som påvirker og blir påvirket av veitrafikk. Standarden ble lansert i Norge i 2013 som NS ISO 39001, og tanken var at en omfattende sertifisering i standarden ville resultere i bedre styring av arbeidsrelaterte risikoer og på sikt føre til bedre trafikksikkerhet. Som et ledd i oppfølgingen, bestilte Statens vegvesen en rapport om implementeringskrav for standarden (Njå et al., 2015), og arrangerte i 2016 et seminar hvor problemet med relativt treg innføring av standarden i Norge ble lagt fram, og potensielle løsninger diskutert.

Tiltak som kan styrke implementering av styringssystemer for trafikksikkerhet (STS)

Formålet med denne rapporten er å verifisere og bygge videre på eksisterende rapporter og diskusjoner, gjennom å identifisere evidensbaserte tiltak som kan øke implementeringsraten av STS i norske organisasjoner. For å danne et godt grunnlag for anbefalinger, undersøker denne rapporten hva STS er (inkludert tilnærminger til systemer for sikkerhetsstyring i ulike transportsektorer), effekter av dem, samt status vedrørende implementering av STS av norske bedrifter. Rapporten fokuserer hovedsakelig på bedrifter og firmaer (forretningsmessige virksomheter) involvert i godstransport eller passasjertransport på vei. I tillegg ser rapporten også på firmaer der hovedvirksomheten ikke er transport, men hvor virksomhetens aktiviteter involverer at ansatte kjører i arbeidstiden. Ettersom handlingene til nøkkelaktører i industrien i stor grad påvirker beslutningstaking hos bedriftsledere, vil denne rapporten også undersøke bedriftene i lys av den større organisatoriske konteksten de befinner seg i.

Metode

De overnevnte problemstillingene ble undersøkt ved hjelp av ulike metoder som beskrives i Tabell S1.

Tabell S1. Metoder benyttet for å undersøke framlagte problemstillinger, og metoder brukt for å genere kunnskap innen hvert område. Intervjuer ble gjennomført med tre representanter fra NHO transport, NLF og en akkrediteringstjeneste for styringssystemer.

	Tema	Forfatters kunnskap av litteratur	Litteratur-gjennomgang	Teoretisk analyse	Intervjuer
1	Beskrivelse av systemer for styring av sikkerhet og tilnærming i ulike transportbransjer	✓			
2	Systemer for styring av sikkerhet og STS in organisasjoner	✓	✓		
3	Bevis for effekt av STS på trafikksikkerhet og andre organisatoriske mål	✓	✓		
4	Status av STS implementering i norske virksomheter	✓	(✓)		✓
5	Mål som trengs å stimulere for bred implementering av STS		✓		✓
6	Markedsendringer som kan gjøre at styring trafikksikkerhet blir normen		✓	✓	✓
7	Case studier		✓		(✓)

Hva er et system for styring av sikkerhet?

Et system for sikkerhetsstyring kan forstås som et integrert sett organisatoriske elementer som støtter og bidrar til risikostyring, sammen med prosesser for å utforme, evaluere og forbedre disse elementene. Vanlige elementer og prosesser kan for eksempel være policy, roller og ansvarsområder, kontinuerlig data-drevet evaluering og sikkerhetsoppfølging.

Likevel kan både utforming og omfang avhenge av størrelsen på organisasjonen, samt hvilken hovedvirksomhet den har. Et system for sikkerhetsstyring bunner ofte ut i et sikkerhetsprogram som innbefatter sikkerhetstiltak, men noen elementer kan identifiseres både som en del av systemet og som et ledd i et sikkerhetsestyrings*program* (rekruttering, seleksjon o.l.). Det er uvisst hvorvidt vellykket innføring av et system for styring av sikkerhet krever en positiv sikkerhetskultur og et bredt organisatorisk engasjement, eller om det er innføringen av systemet som bidrar til forbedringer i disse områdene. Det synes som at systemer for sikkerhetsstyring både påvirker og blir påvirket av organisasjonskultur, noe som tyder på at sikkerhetsstyring er en syklisk og dynamisk prosess. Det bør også nevnes at systemer for sikkerhetsstyring kan støtte nye måter å tenke angående risiko som tar høyde for behovet for en forståelse av transportsystemer som dynamiske og komplekse sosio-tekniske systemer i konstant endring.

Elementene og prosessene som man finner i generelle beskrivelser av sikkerhetsstyringssystemer er stort sett de samme som man finner i internasjonale retningslinjer for luftfart-, sjøfart- og jernbanesektoren (policy, ledelsesforpliktelse, roller og ansvarsforhold, dokumentasjon, risikostyring, beredskap og krisehåndtering og sikkerhetsoppfølging), selv om elementene og prosessene grupperes og struktureres ulikt. Tanken om at sikkerhetsstyringssystemer skal være normen for kommersielle veitransportorganisasjoner er relativt ny, og er blitt fremmet gjennom lanseringen av NS ISO 39001, et stadig økende antall publiserte arbeidsrelaterte sikkerhetsprogram, samt gjennom EU's PRAISE-prosjekt.

Er det behov for å styrke implementering av STS?

Behovet for å styrke implementeringen av STS kan rettferdiggjøres dersom man finner støtte for følgende antagelser:

i. Organisasjoner som ansetter arbeidstakere som kjører i arbeidstiden påvirker trafikksikkerhetsnivå
ii. STS reduserer trafikksikkerhetsproblematikk som er relatert til organisasjoner som ansetter arbeidstakere som kjører i arbeidstiden
iii. Implementering av slike styringssystemer har vært utilstrekkelig så langt.

Det er gode bevis som støtter opp under antagelse (i). Når det gjelder antagelse (ii), kan vi ikke finne robuste empiriske bevis for at implementering av STS har en positiv effekt på trafikksikkerhet, ei heller på andre organisatoriske variabler. Det er imidlertid to typer indirekte bevis som indikerer at STS kan føre til bedre sikkerhet: (a) Korrelasjonsstudier og krysseksjonelle studier hvor STS-lignende prosesser er funnet å ha en sammenheng med sikkerhetsmål, og (b) Effekten av isolerte mål som typisk er utfall av STS.

Det er flere grunner til at det å evaluere effekter av implementering av STS er utfordrende. For eksempel blir STS ofte implementert som en del av eksisterende sikkerhetsstyringsopplegg eller tiltak, noe som gjør det vanskelig å vurdere effekten isolert. Sikkerhetsstyringssystemer er også komplekse og vanskelig å beskrive og forstå i sin helhet. Dermed blir det også vanskelig å evaluere effekten av innføringen av et nytt STS alene. På bakgrunn av slike utfordringer, kan man spørre seg om det i det hele tatt vil være mulig å samle robuste empiriske bevis gjennom tradisjonelle evalueringsmetoder. Manglende empirisk bevis, fordrer på den andre side spørsmålet om hvorfor organisasjoner bør implementere STS i det hele tatt? Det beste svaret kommer fra bevis som indikerer at sikkerhetstiltak er mer effektive når de implementeres i en støttende organisatorisk kultur, noe som STS bidrar til. En rekke forskere argumenterer for at inspirasjonen og motivasjonen som arbeidstakere opplever i forbindelse med STS er fordelaktig, og

definitivt bedre enn å ikke gjøre noen ting i fraværet av robuste bevis. Til slutt bør det nevnes at, selv om implementering av STS i seg selv er vanskelig å evaluere, vil ofte resulterende tiltak ha god empirisk støtte. Med utgangspunkt i manglende empiriske bevis for effekt i forskningslitteraturen, synes det å være behov for en systematisk og helhetlig tilnærming som omfatter flere aktører som har tatt saken i egne hender og fått ting gjort.

Støtte for antagelse (iii), baseres på det faktum at kun åtte av flere hundre mulige transportbedrifter i Norge har blitt tildelt det formelle sikkerhetssertifikatet NS ISO 390001, til tross for at det ble lansert i 2013. Ut fra tall fra mai 2018, har det ikke vært en eneste ikke-transportbedrift som har sertifisert seg.

På bakgrunn av de overnevnte antagelsene, er det bevis som støtter antagelsen om at det er et behov for å styrke implementeringen av STS i både transportbedrifter og andre virksomheter som ansetter arbeidstakere som kjører i arbeidstiden.

Faktorer som påvirker implementering av STS

Som et rammeverk for å identifisere faktorer som påvirker innføringen av STS, og samtidig kunne lære noe om hvilke forhold som er ideelle for sikkerhetsstyring i veisektoren, baserer vi oss på tre relevante teorier; risikostyring i samfunn (Rasmussen 1997), sosiotekniske system (Davis et al. 2014), og Geels (2004) sitt konsept om sosiotekniske overganger og multi-dimensjonalitet ved firmaer i industrier. Lærepunkter fra hver teori presenteres i Tabell S2.

Table S2. Utvalg av konklusjoner fra implementering av STS, etter en selektiv teoretisk gjennomgang.

TEORI	Risikostyring i samfinn	Sikkerhetsstyring bør målstyres. STS kan brukes til å sørge for at organisasjoner når sine sikkerhetsmål. Regulatorer bør samarbeide med organisasjoner og bli enige om sikkerhetsmål. STS bør integreres på tvers av systemene som organisasjoner befinner seg i. Implementering av STS innebærer at ledelsens interesse i produksjon regnes med, og at det utvikles en felles forståelse av betydningen av dette for sikkerhet. Implementering av STS innebærer at bedrifter må synliggjøre sine prioriteringer overfor interessegrupper og samfunnet.
	Sosiotekniske systemer	Sikkerhetsstyring er systemisk, det er ikke begrenset av organisasjonsgrenser. For å forstå hvordan implementere STS i og på tvers av organisasjoner, må vi ta hensyn til menneskene som styrer sikkerhet, deres motstridende mål, virkningen av kultur, og begrensningene og mulighetene som teknologi og infrastruktur byr på. Sikkerhetsstyring handler om forholdene blant ting og mennesker på tvers av det integrert sosiotekniske systemet.
	Sosiotekniske overganger og multi-dimensjonalitet ved firmaer i industrier	Det er viktig å forstå hvordan et transportsystem er betinget av sitt "regime", det vil si de normative, kognitive og regulative reglene som sammen skaper atferd. Ledelsen kan anse STS som fremmende eller hemmende for produktivitet. Utvikling av et "regime" er et spill – forsøk på endring blir motvirket av aktører som ikke se verdien av endringen. Om endringen sees til å ha positive sosiopolitiske eller økonomiske utfall, vil andre aktører lære av det, og de vil også implementere endringen.

Vår analyse indikerer at følgende faktorer påvirker innføring av STS i vegtransport:

- Isolerte tiltak rettet mot å forbedre trafikksikkerhetsstyring er ofte ikke så synlige på grunn av (i) At godstransport framstår som en fragmentert sektor og (ii) Manglende koordinering av arbeidet med å få bedrifter til å fokusere på sikkerhetsstyring (det finnes ingen «forent front» representert av myndigheter eller interessegrupper).

- Stor avstand mellom normative og regulative regler.
- Europeiske markedskonkurranseregler begrenser hvordan Norge kan regulere for sikkerhetsstyring.
- Det tas sjeldent høyde for STS i ulykkesgranskninger og tilsyn.
- Transportkjøperes holdninger/kontrakter som fremmer etterlevelse av regelverk blant operatører.
- Mangel på gode eksempler/gode rollemodeller i form av offentlige organisasjoner som stiller krav til innføring av STS i anskaffelsesprosesser.
- Manglende samfunnsmessige krav om strengere trafikksikkerhetsnivå fra godstransportbedrifter basert på det faktum at transportoperatører i større grad prioriterer kvalitet og miljømessige hensyn.
- Større bedrifter med tapte investeringer i egne STS. Ønsker potensielt ikke å få tilpasset en generisk ISO 39001 som i liten grad er skreddersydd for deres spesifikke behov og som krever økt transparens overfor konkurrenter.

Rapporten understreker særlig viktigheten av kontrakter og transportkjøpere når det gjelder å forbedre bedrifters trafikksikkerhetsstyring. I norsk godstransport spesielt, er de fleste bedriftene lokale virksomheter med få ansatte og begrensede ressurser. Mer avanserte STS vil derfor være best egnet over hele transportkjeder, hvor risiko relatert til aktiviteter for ulike bedrifter som er involvert styres gjennom et integrert STS drevet av transportkjøperen. Dette reflekterer funn fra vår teoretiske gjennomgang – at individuelle bedrifter ikke klarer å oppnå optimal styring av vegsikkerhet uavhengig av andre organisasjoner innenfor det samme «økosystemet» – samtidig peker funn fra intervjuer på viktigheten av kontraktsgiver. Med tanke på viktigheten av transportkjøpere, er dermed et viktig spørsmål hvordan vi kan motivere transportkjøpere og deres kunder til å verdsette trafikksikkerhet nok til å kreve det? En mulig tilnærming kan være å lære fra de som er involvert i kjøp av farlig godstransport, både om hvilke tilnærminger de har og opplevde fordeler med å oppfordre operatører til å styre trafikksikkerhet. Det å utvikle verktøy kan også bidra til å etablere en norm, slik at kunder krever at leverandører styrer vegsikkerhet. Eksempler på dette kan være nasjonal benchmarking, sertifiseringsskjema som vil være tilgjengelig til de fleste norske transportselskap, eller tilgjengelig informasjon om hvordan risikomonitorering kan inkluderes som en del av kontraktsinngåelse.

Rapporten viser at implementering på sektornivå er ønskelig, men for videre utvikling krever det at vi tar høyde for det store antallet mindre operatører, samt det høye markedspresset man ser i mange bransjer i norske vegtransport. Det er urimelig å anta at transportkjøpere alene vil kunne skape en markant endring. Utfordringene må tas tak i og løses av industrien. En måte man kan oppfordre til endring på er gjennom et nettverk av «store aktører» som representerer kjøpere, forsikrere, operatører, handelsorganisasjoner, og fagforeninger, som selger inn «win-win-idéer» til sektoren, slik som foreslått i Statens vegvesen sitt *Trygg Trailer* prosjekt. Hver type aktør vil kunne ha en rolle og flere kan ses på som uanvendte ressurser med tanke på implementering av STS (f.eks. forsikrere). Relaterte virksomheter og miljøer vil også påvirke bedrifters interesse i STS.

Et gjennomgående funn i rapporten er at mange mindre operatører innen godstransportregimer i Norge ikke har ressurser nok til å lære om eller rettferdiggjøre implementeringen av formelle STS. For å forbedre sikkerhetsstyring, må ledere i disse bedriftene ha tilgang til konsistent informasjon om hva de kan gjøre for å styre trafikksikkerhet, inkludert hvordan de kan bygge opp fungerende sikkerhetsstyring over tid. Nævestad et al. (2017) er relevant i denne sammenhengen. Den skisserte tilnærmingen vil ideelt sett være konsistent på tvers av mindre selskap, slik at de åpent kan lære av hverandre og dele erfaringer relatert til sikkerhetsstyring.

Hvordan få til en bred og vellykket implementering av STS?

Rapporten identifiserer behov for et mer samordnet budskap om at bedrifter med ansatte som kjører i arbeid skal styre sine risikoer knyttet til trafikksikkerhet. Samferdselsdepartementet, Statens vegvesen, Trygg Trafikk, politiet, Arbeidstilsynet, Norges Lastebileierforbund (NLF), NHO Transport, Statens havarikommisjon og andre sentrale aktører kunne derfor etablere en tverrfaglig innsatsgruppe som kommer fram til en plan om hvordan man skal presentere en forent front overfor transportnæringen og andre relevante virksomheter, med hensyn til behovet for trafikksikkerhetsstyring. Planen kunne innebære en strategi for å utvikle og distribuere informasjon om STS-tilnærminger for trafikk som passer for ulike typer firmaer. Planen kunne ta utgangspunkt i eksisterende samarbeid, ikke minst treparts bransjeprogram.

Innsatsgruppen kunne også samarbeide med næringen for å identifisere felles indikatorer for STS, og evaluere og fremme fordelene av å ta dem i bruk, slik som kartlegging, informasjonsdeling og kontinuerlig læring. Standardisering av mål ville øke åpenheten om sikkerhetsstyring, fremme læring og øke felles forståelse for god sikkerhetspraksis. Åpenhet og kunnskapsdeling vil fremmes av ny digital teknologi som tillater bedrifter å dele data ved hjelp av skybaserte plattformer.

Med tanke på andre aktiviteter, kan det gjøres forsøk på å i større grad synliggjøre fordelene som oppleves av bedrifter som har implementert NS ISO 39001 eller annen STS. Økt synliggjøring av STS kan også oppnås gjennomfagpublikasjoner, håndbøker, konferanser og så videre, og gjennom casestudier. Et mulig alternativ er profilering av transportkjøpere som krever STS, og iverksetting av tiltak for å få flere kjøpere til å kreve STS. Verktøy for å håndtere trafiksikkerhetsstyring i anskaffelsesprosedyrer kan utvikles med utgangspunkt i EUs PRAISE-rapporter. NS ISO 39001 eller NLFs eksisterende akkrediteringsordninger kan vektlegges som en måte for å få kjøpere til å vurdere transportkvalitet, og lignende ordninger som passer for mindre transportører (for eksempel basert på *Sikkerhetsstigen*) kan også utvikles for bruk i anskaffelsesprosesser.

Etablering av nasjonal benchmarking av firmaer på trafikksikkerhetsstyring vil kunne tilrettelegge for og forenkle valg av kvalitetstransport. Statens vegvesen kunne gjennomføre en kampanje rettet mot transportkjøpere, for å fremme fordelene med å inkludere krav for STS i offentlige og private anskaffelser. De kunne også bygge på innovative løsninger overfor transportkjøperen, slik som prosjektet *Trygg Trailer*, ved å involvere NHO Transport, forsikringsselskaper, Trygg Trafikk eller andre viktige aktører.

For å ta hensyn til samfunnsmessige påvirkninger, vil muligens aktører som Trygg Trafikk, Statens vegvesen eller andre, kunne bidra til å tydeliggjøre trafikksikkerhet som en sosial utfordring ved siden av sosial dumping, klima/miljøet og security. Når det gjelder regulering, kan det være verdt å jobbe med EU mot mer eksplisitt behandling av STS i HMS-lovgivningen. Eventuelt vil akkreditering i STS også kunne brukes som grunnlag for regulatoriske opsjoner eller økt fleksibilitet (f.eks. økt lassvekt, mer fleksible kjøretid).

For å oppfordre til å styrke implementeringen av -STS, er det behov for videre forskning på følgende problemstillinger:

- Hvilke sikkerhets-, økonomiske og sosiopolitiske fordeler vil implementering av-STS i Norge kunne gi? Hva skjer med firmaer som implementerer STS? Er det norske caser som viser kostnadseffektivitet og økonomiske fordeler av arbeidsrelatert trafikksikkerhetsstyring?
- Hvilke begrensninger står transportkjøpene overfor når de krever trafikk-STS fra transportører i kontrakter?

- Hvilket innhold er nødvendig for en nasjonal benchmarking av organisasjonsmessig trafikksikkerhetsstyring, og hvordan kan dette best gjøres?
- Hvordan kan vi endre ledelsens tankegang når det gjelder trafikksikkerhet (særlig i mindre selskaper) fra en regelbasert tankegang (*safety compliance*) til proaktiv sikkerhetsstyring? Hvordan kan vi skape engasjement for trafikksikkerhetsstyring, slik at det bidrar til:
    - Åpenhet til nye måter å tenke om sikkerhet på?
    - Villighet til å lage og utføre en *business case* for å implementere STS?
    - Tillit og åpenhet om å dele sikkerhetsdata med konkurrenter?

1 Introduction

The overt and hidden costs of road accidents involving drivers at work are considerable – for the individuals involved, employing organizations and society as a whole (Bidasca & Townsend 2014). In Norway at least 41 per cent of fatal road accidents involve an employee driving at work or to or from work (Phillips & Meyer 2012). Professional drivers of heavy vehicles in Norway are involved in over a third of fatal traffic accidents (Nævestad et al. 2015), and the risk of being injured in a heavy vehicle accident per capita is high in Norway relative to several other EU countries (Langeland & Phillips 2016).

Driving in traffic is the riskiest activity that many employees will face while at work (Murray et al. 2003), and accordingly road safety is the most important risk domain to be managed by transport companies. In Australia, for instance, 75 per cent of truck-related worker fatalities occur on public roads, compared with 15 per cent during loading or unloading, and seven per cent during maintenance activity (Edwards et al. 2014).

Professional driver behavior is the main observed risk factor related to serious crashes triggered by heavy vehicles (Mooren et al. 2015). Norwegian studies implicate speeding and driving style (Nævestad et al. 2015) and international studies implicate speeding, fatigue, distraction and other violations (Edwards et al. 2014). Failure to wear a seatbelt is often implicated in serious professional driver injuries in traffic (Nævestad et al. 2015). The following company-level factors have also been implicated as root causes of unsafe truck driver behavior and associated crash risks: productivity-based pay, route planning, fatigue/health management, scheduling, mobile phone use policy, recruitment and selection, vehicle loading planning, and communication (Mooren et al. 2015, Newnam & Goode 2015, Phillips et al. 2015). Reviewing evidence connecting organizational management practices with truck driver safety, Edwards et al. (2014) link:

- Driver training to incidents caused by technical errors
- Management support to truck driver intentions to drive safely
- Organisational pressure to truck driver injury rates
- Reporting levels to crash rates.

In addition to employee behaviour, employers also influence maintenance of vehicle tyres, brakes and steering, which often influence crash severity outcomes (Häkkänen and Summala 2001, Chen & Chen 2014, Newnam & Goode 2015). Employers also select vehicles and safety equipment, and by doing so directly influence whether speed-limiters or rear-view cameras are available to help reduce risks. They also influence trailer dimensions and load centers of gravity, which can have affect risks for e.g. road exit accidents at sharp bends (Edwards et al. 2014).

Thus by influencing professional driver behavior and vehicle safety, the actions of employers help determine the occurrence and outcomes of many serious road crashes. Despite this, research indicates that many employers fail to meet even minimum legal requirements to manage and mitigate work-related road safety risks (Davey et al. 2008, Njå et al. 2015). Studies of serious crashes triggered by professional drivers suggest that a considerable share of involved organisations have failed to manage traffic risks sufficiently (Nævestad et al. 2015).

Recently, Nævestad et al. (2018) investigated the potential consequences of goods transport companies in Norway introducing organizational safety management measures (in the stepwise approach called the "Safety ladder" cf. Section 3.4) on the number of killed and severely injured in traffic. Their example calculations were based on the effects of measures found in the few existing robust studies and current implementation of measures in Norwegian companies, and they indicated that between 7 and 56 deaths or serious injuries could potentially be avoided per year, given certain conditions[1].

1.1 Traffic safety management systems (SMS)

To help structure and improve road traffic safety management by organisations, the International Standards Organization's introduced a quality standard on Road Traffic Safety Management Systems (ISO 39001). This was launched in Norway in 2013 as NS-ISO 39001. NS ISO 39001 lays out standard requirements for an effective traffic safety management system (SMS) and is designed for use by any organization who influences or is influenced by road traffic.

At the launch of NS ISO 39001[2], hopes were expressed that widespread certification in the standard would result in better management of work-related road risks and improve traffic safety in Norway. These hopes were reflected in a Swedish analysis (Classon & Sahlqvist 2013), and in a subsequent study commissioned by the Norwegian Pubic Roads Administration (NPRA) (Njå et al. 2015). The latter also identified the following requirements for widespread implementation of ISO 39001 in Norway:

- Campaigns to increase organizational awareness of the need to manage road safety
- Buyer-driven demand for safe transport
- Certification of road administration, police, Labour Inspection Authority etc. as role models
- Traffic safety advisers to assist companies in implementing management systems
- Good practice examples of practical steps to take.

On 11th March 2016 a seminar was arranged by NPRA on traffic SMS in road transport firms, to help identify what could be done to get more transport businesses to improve safety culture and manage road safety risks in line with ISO 39001. At the time of the seminar only four Norwegian firms had been certified in NS ISO 39001 compared with several tens of Swedish firms. In addition to the requirements listed above, researchers and stakeholder representatives recommended three ways to encourage SMS implementation:

- Simplify implementation of the standard for smaller operators in Norwegian goods transport with limited administrative resource
- Provide formal programs to educate industry on how to implement SMS
- Collect evidence to convince firms of the business benefits of introducing traffic SMS.

[1] Prospective estimates are more modest due to falling rates of killed and serious injured on Norwegian roads.

[2] https://www.standard.no/nyheter/nyhetsarkiv/transport-og-logistikk/2013-10-15/ns-iso-39001-styringssystemer-for-trafikksikkerhet/

ISO 39001 is not the only traffic SMS standard. A significant alternative in Norway is "Quality and environment on the road" ("Kvalitet & miljø på veg", KMV) of the Norwegian truck owners' association (NLF). KMV is an internet-based enterprise management system designed for transport companies. The system meets most requirements for quality and environmental protection as well as road safety. In addition, it meets the authorities' requirements for an internal control system (HSE). The system is built on extracts from ISO 9001 (quality), 14001 (environment), 39001 (road safety) and government HSE requirements.

1.2 Aim and scope

The present report builds on the above recommendations for ISO 39001 by identifying evidence-based measures that would increase the rate of implementation of different types of traffic SMS by Norwegian organisations. Our concern is particularly with businesses or firms (organisations run for profit) involved in the transport of goods or passengers by road. In addition to businesses employing professional drivers transporting goods or passengers, we include firms whose main activity is not transport but who nevertheless employ work-related drivers[3] – people who drive once or more a week for work purposes (Newnam & Watson 2011).

Since the actions of key market actors – authorities, trade organisations, insurance companies, interest groups – can also encourage business uptake of traffic SMS, the report recognizes the need to consider the system in which businesses find themselves.

The aim of the report is to identify measures to stimulate implementation of traffic SMS by Norwegian businesses. On reaching its findings, the report tries to address the following:

- Lessons from implementation of SMS in other transport sectors
- Current status on implementing traffic SMS in Norwegian firms
- Effect of traffic SMS implementation on safety and other organisational outcomes
- Important cases and reference material to help Norwegian firms implement traffic SMS.

Given the above scope, the findings of the report are applicable to all firms, large or small, with employees who operate vehicles for work, drive for work, or who provide personal vehicles or operate mopeds, motorcycles or bicycles, for employment or contract services.

[3] Although research is less clear about the contribution of non-transport firms to traffic safety, non-professional work-related drivers were estimated to be involved in six per cent of fatal road accidents in Norway occurring between 2005 and 2010 (Phillips & Meyer, 2012). There has been less focus traditionally on getting non-transport firms to manage their road safety risks, presumably because the light vehicles that most of their employees drive are less likely than heavy vehicles to cause serious injury or death. Yet research in Australia shows that the fleets of these firms account for half of the traffic stream at peak traffic times Newnam, S. and B. Watson (2011). "Work-related driving safety in light vehicle fleets: A review of past research and the development of an intervention framework." Safety Science **49**(3): 369-381.. Work-related driving also requires less training, is less regulated, and is subject to fewer controls. By managing their road safety risks effectively, these firms can also help improve road safety.

1.3 Structure of the report

Following the methods (Chapter 2), Chapter 3 gives a brief background to the development of SMS. We describe what we mean by (traffic) SMS, i.e. what it is that firms should be implementing. We describe progress in implementing SMS in road transport internationally, relative to air, maritime and rail transport, identifying any lessons to learn for road transport. Chapter 4 asks what firms and society have to gain from organizational implementation of traffic SMS – what evidence is there that SMS actually have an effect? Chapter 5 reviews selected theory pertaining to our theme. Chapter 6 – the core of the report – updates the situation on implementing traffic SMS in Norway and identifies measures for broader implementation using three methods:

i. Assembly of knowledge, approaches, recommendations from research literature.
ii. Theoretical analysis.
iii. Interviews with three road sector experts from Norway.

In Chapter 7 we summarise and draw conclusions.

2 Methods

We address the project aims using seven lines of enquiry, which are listed in Table 1 along with the methods used to generate knowledge addressing each line of enquiry.

Table 1. Methods used to investigate lines of enquiry addressed by our study, and the methods used to generate knowledge in each area.

	Line of enquiry	Authors' knowledge of existing literature	Literature review	Theoretical analysis	Interviews
1	Description of SMS and approach in road other transport sectors	✓			
2	SMS and traffic SMS in organisations	✓	✓		
3	Evidence for effect of SMS on traffic safety and other organisational measures	✓	✓		
4	Status of traffic SMS implementation in Norwegian businesses	✓	(✓)		✓
5	Measures needed to stimulate broader implementation of traffic SMS		✓		✓
6	Market changes to ensure that management of traffic safety is the norm		✓	✓	✓
7	Case studies / good practice		✓		(✓)

2.1 Literature review

A literature search was conducted to identify peer-reviewed publications and research reports relating to the objectives. The search was made using the scientific online libraries ScienceDirect, ISI Web of Knowledge, Google Scholar and Springerlink, in the period from June to September 2017. The relevance of each publication was assessed against the lines of enquiry by reviewing titles and abstracts. When using Google Scholar we reviewed only the first ten pages of returns for relevance. We searched for studies relevant to the lines of enquiry 2, 3, 5, 6 and 7 by combining the terms "safety management" and "risk management" with terms such as "road transport", "occupational transport", "occupational driving", "occupational travel", "work-related driving", "driving at work", "professional transport", "occupational transport" and "truck driver". We performed separate searches using each of the terms "work-related road safety" and "fleet safety". References were supplemented by (a) "snowballing" – retrieving articles from reference lists of articles retrieved where they were judged as key to a line of enquiry; and (b) research literature we were already familiar with, and which we perceived as relevant to the study objectives.

2.2 Theoretical analysis

The theoretical analysis in Chapter 5 is selective, i.e. there is no attempt to cover all relevant theory. Informative and relevant theory was selected based on existing knowledge of the authors and a review of associated articles. There was no new search for relevant theory in this area.

2.3 Telephone interviews

Semi-structured telephone interviews lasting 40-60 minutes were carried out with one resource person each from:

- The national trade organization *NHO Transport*
- The national truck owner's federation *Norges lastebileierforbund* (NLF)
- A company assisting in certifying transport organisations in NS ISO 39001.

A topic guide for the interviews was created by identifying questions that would elicit answers to help address the report's aims, with emphasis on the situation in Norway (see Table 1). We also drew on our own experience, as well as anecdotal evidence from previous projects.

2.3.1 Template analysis

A single researcher typed notes as interviewees responded to the topic guide. The topic guide was used to construct an initial template, according to the method of template analysis (King 1997). Responses were coded according to the initial template and a revised template developed, which was then used for structuring the initial reporting of responses (Table 2).

Table 2. Initial and revised templates, developed according to template analysis (King 1997).

Initial template	Revised template
1. Current traffic safety management	1. Current traffic safety management
1.1. How do organizations manage traffic safety today?	1.1. Who does systematic traffic safety management?
1.2. What makes them do it?	1.2. Drivers of systematic traffic safety management
1.3. The need for broader implementation of formal systems for managing traffic safety	1.3. Barriers of systematic traffic safety management
2. Work by supporting actors in the transport system	1.4. The need for broader implementation of formal systems for managing traffic safety
2.1. Work of system actors	2. Work by supporting actors in the transport system
2.2. Cooperation and collaboration among actors	2.1. Work of individual actors
3. Ideas for broader systemic management of traffic safety by companies	2.2. Collaborative work
3.1. Role of concrete actors (NHO, NLF, SVV, politiet, Arbeidstilsynet)	3. Ideas to broaden implementation systemic management of traffic safety by companies
3.2. Knowledge	3.1. Role of concrete actors (NHO, NLF, SVV, politiet, Arbeidstilsynet)
3.3. Market changes	3.2. Knowledge and tools
3.4. Address awareness by companies	3.3. Market changes
3.4.1. Awarenss of ISO 39001	3.4. Tailor-made measures
4. Case studies	4. Case studies
5. Others we should talk to	5. Others we should talk to

This structure was again reorganized as the report was written, in order to allow reporting of interview responses according to Triple Embeddedness Framework (Chapter 5).

3 What are SMS?

In Scandinavian and several other OECD countries[4] road administrations take a "Safe Systems" approach, where attempts are made to design a road system that better accounts for human errors and vulnerabilities (OECD/ITF 2008). There is increasing recognition, however, that organisations other than road administrations also influence road safety outcomes: trade associations, government transport departments, public safety departments, police, transport organizations, Labour Inspection Authorities, private motorist organisations and so on (Newnam & Goode 2015). Firms employing plumbers, nurses, salesmen and many other roles that involve driving for work also have in important influence on road safety outcomes. Together private organisations are responsible for (a) the presence in traffic of many heavy vehicles that are more likely than lighter vehicles to cause accidents with serious outcomes (Nævestad et al. 2015, Langeland & Phillips 2016); and (b) large shares of traffic volumes during busy workday periods (Newnam & Watson 2011). Thus many firms have an important role to play in improving road safety, by managing road safety risks effectively (Nævestad & Phillips 2013). Reflecting this, many argue that road safety risks should be managed by employing organizations in the same way as any other work-related risk, as part of employers' duty of care to employees and society. In many countries the legislation supports this (Haworth et al. 2000). Further, there is increasing recognition among practitioners that the most effective way to manage work-related risks is through implementation of organizational-level Safety Management Systems (SMS; Thomas 2012).

In this chapter, we consider what SMS are, identifying some common features. We then consider the features of SMS in air, maritime and rail sectors, before considering those of SMS in the road sector (traffic SMS). Our aim is to understand what it is that needs to be implemented according to different transport sectors, before we consider in subsequent chapters why SMS should be implemented in many road transport organisations, and ways to encourage implementation.

3.1 General SMS

Rooted in occupational health and safety management, there are two central ideas to SMS:

1. An incident results from a dynamic network of interacting proximal and distal causes, i.e. are not due to a single hazard occurring immediately prior the incident.
2. Long-term safety improvements are thus rarely achieved by one-off interventions – a systematic approach is needed to manage interacting factors and reduce risks.

[4] Member countries of the OECD (Organisation for Economic Cooperation and Development) are: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

Two other developments have also contributed to the rise of SMS: an improved understanding of the organisation's role in the generation of risk (Rasmussen 1997, Reason 1997); and a shift in emphasis by regulatory regimes from prescriptive to performance-based regulations (Thomas 2012, ITF 2017).

3.1.1 SMS process: Plan Do Check Act

While it is hard to define the exact origin of SMS, the approach of the UK's Health and Safety Executive has been influential in the EU (Managing Health and Safety, HSE[5]). The HSE define a management system as "*a set of integrated or interacting elements of an organization, to establish policies and objectives and processes to achieve those objectives*". The HSE describe a universal framework for managing safety in consultation with employees, to help employers meet legal obligations to assess and take steps to control health and safety risks. The extent of arrangements and the resulting SMS depends on the size and nature of the organization, and the risk activities and related products or services. The HSE use a continuous cycle of four steps to represent the SMS process (HSE 2013):

- **Plan.** Determine policy, plan for implementation, resources required, identify performance criteria
- **Do.** Profile risks and organizational needs for health and safety; carry out plan
- **Check.** Before-after analyses
- **Act.** Review performance, act on lessons learned from analyses, investigations.

This basic structure is evident in several international guidelines, such as the Policy-Organize-Plan & implement / Evaluate / Act-to-improve framework of the International Labour Authority.

The Do step is the core risk management process central to all SMS. Here the company should identify main risk domains, breaking each into subdomains until a suitable unit size is obtained for risk analysis. In this way the organisation will identify its unique risk profile, such that they know the nature and level of the most important risks the organization poses and faces, the costs associated with each risk, and the effectiveness of controls in place to manage them[6]. The Plan, Check and Act steps ensure that *doing* evolves and is fully supported by the people – managers, employees and anyone else sharing the workplace – and processes in the organisation. Establishing this support requires engaged leadership, trained and skilled workers, and a work environment in which people are informed, trusted and involved. Safety management is not a stand-alone system, but part of the everyday process of running an organization; it is an integral part of workplace behaviours and attitudes (culture). For the HSE, SMS comprise organizational elements that are structural (e.g. selection, training, performance review, key point indicators) and cultural (e.g. safety climate, management commitment, peer-to-peer exchange).

3.1.2 SMS definitions and cyclical nature of SMS

Attempts to define SMS can vary. For instance, while the HSE define SMS as a set of elements to *establish* policies, procedures and objectives, Fernández-Muñiz et al. (2007) define SMS as "a set of policies and practices aimed at positively impacting employees' attitudes and behaviours with respect to risk". The latter suggests that the aim of SMS is to

[5] http://www.hse.gov.uk/pubns/books/hsg65.htm

[6] Employers are not expected to assess risks that could not be foreseen, but those they could be reasonably expected to know.

change behavior and culture. These seemingly contrasting definitions reflect that SMS process is often described as cyclical – policies, procedures and culture must be established to implement practices, the output of which will be improvements in policies, procedures and culture, and so on.

3.1.3 SMS elements and the uniqueness of SMS

Although the precise nature of SMS varies according to the organization involved, we can consider certain elements as common (Fernández-Muñiz et al. 2007, Lerman et al. 2012):

- Safety policy
- Explicit roles, responsibilities, practices and procedures
- Risk management
- Communication
- Monitoring – often data-driven
- Reporting
- Incident investigation
- Planning (preventative and emergency)
- Control, internal and external auditing, assurance.

Safety policy sets out safety standards and how these will be achieved by SMS. Procedures for executing policy are explicitly delineated and documented, along with who is responsible for doing what. SMS are increasingly associated with continuous data-driven monitoring of safety-related outputs (e.g. ongoing performance variability, incident investigations, nature of insurance claims), which evaluates the effectiveness of risk mitigation measures and informs the evolution of SMS in terms of output safety measures and programs. More advanced SMS comprise safety assurance to ensure the systematic and ongoing monitoring and recording of safety performance, and continuous evaluation of safety management processes and practices (Stolzer et al. 2011).

3.1.4 SMS Generator

The SMS Generator model recently presented by Maurino (2017) illustrates that strategic decisions and actions resulting from SMS will depend on the organization's unique goals, existing systems and operational context (Figure 1). In this way SMS affords the organization tailor-made ways to manage safety that account for its business goals.

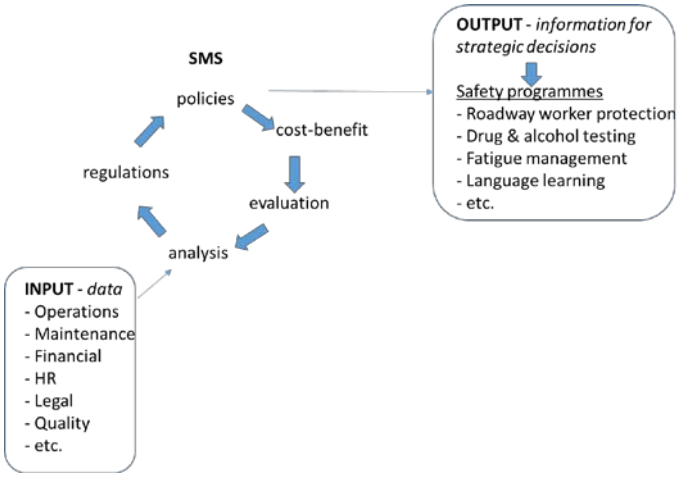


Figure 1. The SMS Generator taken from ITS (2017), in turn based on Maurino (2017).

Figure 1 also shows that SMS and safety management programs are two different things: SMS provide management with an information system on safety and tools to proactively identify, measure and manage hazards, while a safety program – often output from SMS – implements measures to reduce risks.

3.1.5 The relationship between formal and informal aspects of safety

Safety culture and SMS

Safety research often discerns between formal and informal aspects of organisational safety management (Antonsen 2009). SMS are often equated to the formal aspects of safety ("how things should be done"), as formulated in procedures, routines and organisational charts etc. The informal aspect of safety ("how things are actually done") are often equaled to safety culture, which includes safety-relevant aspects of the larger organisational culture (Hale 2000). Safety culture can be defined 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).

Denoting the formal aspects of safety, SMS can also be referred to as safety structure. Just as we define safety culture as aspects of culture in organisations that are relevant to safety (Hale 2000), safety structure can be defined as safety-relevant aspects of organisational structure. Organisational structure refers to the way tasks in an organisation are divided, how work flows, how this flow is coordinated and the forces and mechanisms that allow this coordination to happen (McShane & Travaglione 2003). According to McShane and Travaglione (2003), coordination can be achieved by:

1. Informal communication
2. Formal hierarchy, involving direct control and
3. Standardization, with formal instructions (standardisation/specification of tasks), goals (standardisation of outcomes) or training (standardization of knowledge).

In a systematic review of safety culture intervention in all transport sectors, Nævestad et al. (2018) conclude that the formal and informal aspects of safety are (cf. Antonsen 2009) tightly inter-woven in organisations, and that it therefore may be difficult to tell which comes first, and subsequently how to influence the safety level of a given transport sector. In a review of the safety outcomes of SMS, Thomas (2012) conclude that SMS typically include management policy, appointment of key safety personnel, reporting systems, hazard identification and risk mitigation, safety performance monitoring etc. (Thomas 2012). These aspects are not very different from the four key activities of safety culture interventions that Nævestad et al. (2018) identify in their study. They suggest that all their reviewed interventions seem to focus on increasing risk awareness among managers and employees through four key activities:

1. Appointing a key person 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.
4. Maintain effective communication about safety issues in the organization, in line with Reason's (1997) depiction of an informed safety culture.

Thus, based on the common features of safety culture interventions and SMS elements, they conclude that it may be hard in practice to discern between safety culture interventions and SMS, although they note that both refer to more or less formal measures implemented to influence how safety is dealt with in practice, i.e. organizational members'

shared (and informal) ways of thinking and acting in relation so safety. Finally, to complicate, it should also be mentioned that some argue that SMS audits also include informal aspects of safety (i.e. safety culture), as they evaluate how SMS are used in practice; whether they comprise "living systems" that are used and adhered to in practice. This applies, e.g. to interviewees in the maritime sector, in a study conducted by Nævestad & Phillips (2018).

Discrepancies between formal and informal aspects of safety

Numerous accident investigations point to a discrepancy between formal and informal aspects of safety to explain why accidents come about (Nævestad et al 2015). The discrepancy between formal and informal aspects of safety is also referred to as practical drift (Snook 2000). Nævestad et al. (2018) describe how discrepancies between formal and informal aspects of safety may be related to several different factors, denoting six different analytical levels:

i. Human errors, or more specifically, lapses or violations (Reason, 2000). Lapses are missed actions or omissions, e.g. because of inattention or memory failure. These may refer to situations where procedures not are used, as they were forgotten, or because they are unknown, or not used in practice ("sleeping rules"). Violations are actions deviating from accepted rules, standards or procedures. Violations may be carried out either intentionally or unintentionally
ii. Poor safety culture. The importance given to the discrepancy between formal and informal aspects of safety in accident investigations (cf. Nævestad et al 2015) indicates that although organizations' formal descriptions of how to achieve safety; the "safety structure" may seem to be well functioning, it is the implementation of these principles into the daily work practices; "the safety culture", which is decisive for safety. Thus, procedure violations and sleeping rules may be an indication of a poor safety culture. "Sleeping rules"; situations where rules are not used in practice by the crew may indicate collective practices, and may thus be described as safety culture, according to our definition.
iii. Professional identity. Lappalainen et al.'s (2012) study of the introduction of the ISM code for international shipping notes that in the early ISM-code period, seafarers regarded the safety manuals as useless, as they considered themselves professionals. The ISM-code faced employee resistance in the early implementation phase, as seafarers felt that their professional pride was discredited.
iv. Competition and efficiency demands. Studies from rail and road indicate an important relationship between procedure violations and work accidents (Lawton 1998). This research also found that self-imposed or external pressure to do the job more efficiently or quickly was the most important factor influencing violations (Lawton 1998). Størkersen et al. (2011) also find that efficiency demands are the most important reason procedures are violated to get the job done.
v. Company size. Research indicates that management using formal measures (e.g. procedures, predefined safety roles) is less important than informal modes of management (e.g. culture, attitudes) in smaller companies (Fourie et al. 2010). This research also indicates that the smaller companies have less resources (applying to e.g. personnel, money and expertise), compared to larger companies. Moreover, we may hypothesize that small companies, e.g. with a handful of employees are less reliant on formal systems for standardizing (e.g. training, procedures) and coordinating behavior. We may hypothesize that much of this can be done informally in smaller companies, through direct personal contact between managers and employees. As a consequence, formal safety management systems may hypothetically be perceived as less relevant in smaller companies.

vi. Low experienced ownership of the procedures. This may both be a symptom of a discrepancy between formal and informal aspects of safety, and a cause. Almklov et al. (2014) argue that as small companies often are short of legal competence in-house, but still must comply with safety management regulation, many rely on consultants to translate the regulations into practice. Safety management systems developed as inexpensively as possible with the objective to be found flawless by any auditor, often become standardized and complex with more procedures and reporting than necessary for a particular company's activities. They may result in proceduralization and bureaucracy that marginalize practical safety work and leave the seafarers to avoid compliance and dislike the safety management systems (Knudsen 2009, Bieder & Bourrier 2013, Almklov et al. 2014, Dekker 2014, Vandeskog 2015).

Based on survey data and interviews from the Norwegian coastal cargo sector Nævestad et al. (2018) examine the factors influencing procedure negligence in the coastal cargo sector, and discuss how to reduce the gap between formal and informal aspects of safety. Their survey results indicate that procedure negligence is related to work pressure and demanding working conditions. It is also related to outcome measures like personal injuries and perceptions of risk and safety. A positive organizational safety culture is experienced by respondents reporting of frequent use of procedures. Interview results indicate that formal procedures are ignored or violated because of for example efficiency demands and low-quality procedures, and that procedures more often are followed when they are perceived as useful and timely. They argue that a positive safety culture includes an alignment of formal and informal aspects of safety, which requires time to comply with practical procedures. Their interviewees suggested that appropriate procedures are: 1) Developed by the users, 2) Continuously improved, 3) Simplified and 4) Supervised by local expertise instead of general experts.

3.1.6 SMS and "new" safety thinking

Our mental model of safety, what it is and how it is enhanced, is fundamental to the nature of the SMS implemented (ITF 2017). In particular, the way SMS supports the management of safety will depend to a large extent on how risk is conceptualized in core risk management processes. Traditional conceptualizations assume that risk can be managed by identifying hazards from the analysis of previous accidents and incidents. Recognition of the limitations of learning from past events has led to newer ideas such as resilience engineering, which involves a change in focus from collection and analysis of accident and incident data to collecting data on normal variations in day-to-day behavior and processes (Hollnagel et al. 2006). A central idea is that it is best to increase safety by understanding deviations in normal daily operations, rather than learning from extreme one-off events (Vicente 1999). Hollnagel refers to traditional approaches to risk management as "Safety I" thinking, and the complementary approach that seeks to identify actions and conditions leading to safe performance such that they can be supported and enhanced as the future of safety, the "new way" or "Safety II".

The concept of *drift* – rooted in sociotechnical systems models of safety (see Section 5.2)– also challenges traditional mindsets on risk generation (Rasmussen 1997, Dekker 2011). According to drift into failure (DIF) theory, accidents are not predictable events arising from failures or adverse behavior, but the result of non-linear interactions between what seem locally to be normal variations in behavior (Dekker 2011). Multiple decisions and actions, occurring over time, in different contexts, under different constraints, and with only limited knowledge of effects, gradually lead the system towards adverse events. DIF describes how workarounds which seem fine in local contexts of the system, can over time lead incrementally away from intended procedures for which safety defenses are designed.

Accepting DIF implies that SMS should seek to account for how humans adapt their behaviour with experience of systems over time, increasing discrepancies between practice and procedures.

An important advantage of SMS is that they can be adapted to new ways of thinking about safety like resilience and drift, and in particular calls to move away from a reductionist search for the broken component (and in particular driver error) towards the need to manage safety in complex sociotechnical systems (Dekker 2011). SMS are particularly suited to accommodate a probable growth in "Safety II" or resilience mindsets by organisations[7]. Another advantage is that they provide a framework that structures how to conserve safety in the face of (i) increasing lag times between technological developments and new regulations that account for them; (ii) increasingly unpredictable effects of technology in systems; and (iii) confusingly complex regulatory structures (Salmon et al. 2012).

3.2 Content of SMS used in air, maritime and rail transport

In March 2017, the International Transport Forum (ITF) organized reports and a roundtable discussion with 50 experts to better understand the concept of SMS in a transport context. Though participants could not agree on an exact definition, the report from the meeting defines SMS as (ITF 2017, p.6):

> "*…a suite of systematic, explicit and comprehensive processes for managing safety risks…providing management with a directed and focused approach to safety with a clear process for setting goals, planning and measuring performance.*"

While the emphasis here is on structural rather than cultural elements, the report explains that SMS supports risk management by accounting for surrounding data, social and management processes in the organization (ITF 2017). Further the report states that safety culture, continuous data-driven learning, leadership commitment and sufficient safety resource are each important to the support that SMS can provide – as are relationships among these factors. SMS treat employees as an important resource in safety management, actively contributing and responding to data systems, openly and proactively managing safety with each other and with management. These descriptions imply that SMS both influence and are influenced by the cultural character of the transport organisation.

ITF (2017) identify that SMS requires transport operators to change their approach to safety from a passive compliant approach with a focus on rules and following them, to a performance-based approach with a focus on proactive, engaged safety management, in which accountability can be documented and demonstrated. They summarise the key features of this change as:

- Management commitment to establishing safety policies and objectives
- Inclusion of explicit, non-punitive safety reporting procedures
- Identification of accountable management employees

[7] For example, Safety II is partly about what a system needs for its continued existence and growth, and, like SMS, recognizes the need to account for productivity goals as part of safety management. The following four abilities are necessary for resilient performance and can also be accommodated by SMS (Hollnagel, 2015): Response – know what to do in response to irregular challenges, disturbances, opportunities; Monitoring– know what to look for (inside and outside the system), to recognize imminent challenges to systems performance; Learning – know what has happened and learn from the right lessons from the right experience; Anticipation – know what to expect from possible changes to operating conditions.

- Implementation of a risk management process to identify hazards and associated risks
- Documentation of the SMS structure and safety assurance processes and procedures
- Coordination of the SMS safety with emergency response planning
- Safety training at management and employee levels
- Effective change management.

3.2.1 Air

The ITF report goes on to compare content and implementation of SMS in the main transport sectors. The approach to SMS in the **aviation sector** is underpinned by the 4-pillars of safety management: policy, risk management, assurance and promotion (Table 3).

Table 3. Aviation sector's "4-pillar" approach to SMS (e.g. ICAO Global Aviation Safety Plan).

SMS Pillar	Content
Safety policy	Sets out management commitment, roles and responsibilities; appointment of safety personnel; how emergency responses are planned for; and how SMS is documented
Safety risk management	For hazard identification, risk assessment and mitigation
Safety assurance	Ensures safety performance monitoring and measurement, change management processes required to accommodate and support SMS implementation; and continuous improvement of the SMS
Safety promotion	Involves training and education and safety communication

Relative to other sectors, aviation SMS are highly structured and based on global guidelines. Aviation regulators are currently attempting to better account for how the many interacting organizations comprising aviation ecosystems influence each other's risks and safety management activities (ITF 2017).

3.2.2 Maritime

In the **maritime sector**, the approach to safety is shaped by the International Safety Management (ISM) code[8], which aims to achieve safe shipping for reduction of risks to humans and the environment. The ISM code comprises two main parts, together covering 16 elements (Table 4).

Table 4. ISM code, summary of elements to be addressed[9]

	PART A - Implementation		PART B – Certification & verification
1	General	13	Certification and periodical verification
2	Safety and environmental protection policy	14	Interim certification
3	Company responsibilities and authority	15	Verification
4	Designated Person(s)	16	Forms of certificates
5	Master's responsibility and authority		
6	Resources and personnel		
7	Shipboard operations		
8	Emergency preparedness		
9	Reports and analysis accidents and incidents		
10	Maintenance of the ship and equipment		
11	Documentation		
12	Company verification, review and evaluation		

[8] http://www.imo.org/en/OurWork/HumanElement/SafetyManagement/Pages/ISMCode.aspx

[9] http://www.imo.org/en/OurWork/HumanElement/SafetyManagement/Pages/ISMCode.aspx

The ISM code ensures that people know who does what to manage safety. The master is typically given overriding safety authority for the vessel and a Designated Person (Ashore) is given responsibility to manage the company SMS. The code provides a common safety language for the sector, but it delineates SMS elements generally to allow companies of different sizes, resources and activities to develop their own systems. This means that SMS are often augmented in riskier operations, and that a strategy of minimum compliance is taken by more skeptical companies. ITF (2017) concludes that the ISM code has introduced risk-based thinking and safety awareness in shipping, and helped change the culture from evasion to compliance, and in some cases proactive safety. As can be seen from Table 4, the emphasis is again on structural rather than cultural elements.

3.2.3 Rail

In the **rail sector** safety responsibility has traditionally been shared by train operators, infrastructure providers and regulators (ITF 2017). This, together with recognition of the role of safety organization and culture in several major railway incidents, seems to have eased the introduction of SMS as part of operations and infrastructure management, and there is a high degree of standardization of SMS across actors in individual rail regions. The European Railways Agency is influential in implementation of rail SMS at national level, and uses the "three pillars" model of design, implementation and operations. A summary of the wheel is given in Table 5, and again structural elements are emphasised.

Table 5. Essence of the European Railway Agency's SMS wheel.

SMS Pillar	Element	Content
Processes for design and improvement	Leadership	Management commitment, safety policy, corporate safety targets, decision taking, management control
	Risk assessment	Control of risks, risks arising from activities of other parties, change management, compliance with legislation, rules and standards, coordination tasks
	Monitoring	Data collection and analysis, accident/incident reporting and investigation, internal auditing
	Organisational learning	Continuous improvement, safety recommendations, change management
Processes for implementation	Structure and responsibility	Distribution of responsibilities, management / supervisory accountability, organizational structure, workload planning
	Competence management system	--
	Information	Configuration and control of safety information, involvement of staff and their representatives, internal and external communication
	Documentation	SMS documentation, document management, annual safety report
Operational activities	Operational arrangements & procedures	Compliance with applicable rules (delivery), use of contractor / control of suppliers, asset management.
	Emergency plans	Emergency management, coordination tasks

The elements of each pillar are managed through a Common Safety Method, which aims to standardize safety management and improve transparency across the different organizations responsible for operating trains and managing rail infrastructure. Use of the wheel can reveal, for example, how an increase in the number of signals passed at danger might be due both to inadequate consideration of risks at the interface between train and infrastructure management ("risks arising due to the activities of other parties") and inadequate train driving skills ("competence management").

3.3 SMS in road transport

Road transport is more fragmented than other transport sectors, and there is no international governing body. The closest one comes to overarching legislation for SMS is the EU Framework Directive on Safety and Health at Work (Directive 89/391/EEC) and corresponding national legislation that sets out the need for employers of drivers at work to manage accident risks associated with road user, journey and vehicle. Even though road risks are one of the greatest risks faced by drivers at work, health and safety legislation historically has not been interpreted as applying to road safety – seen rather to be the responsibility of individual drivers. Passenger and freight transport in the road sector is also resource-scarce and competitive in relation to many other transport branches, and this has contributed to poor transparency and lack of shared understanding about how risk management should be executed and supported. The situation has been exacerbated by lack of accounting for the role that system actors such as transport purchasers have on road safety. Recent times have, however, seen promising moves towards a systemic, harmonized approaches to road safety management, which have been stimulated particularly by formal traffic SMS frameworks and high-profile work-related road safety programs, most notably formal traffic SMS and work-related road safety programs. After considering each in turn, we go on to outline other concepts / developments that could also help contribute better safety management in the road sector, namely those based on hierarchy of control; process benchmarking; and safety management for occupational driving.

3.3.1 Formal traffic SMS and ISO 39001

International certification standards (e.g. ISO 18001, ISO 9001, ISO 39001) form the basis of formal approaches to the management of quality and safety, as do branch standards (e.g. Energy Institute's framework for process safety management) in-house standards, procedures and codes. Implementation of a formal SMS may help progress towards effective safety management, but it is not obligatory.

The road safety management standard ISO 39001 is the closest to an accepted international standard on organisational SMS in the road sector. The standard is based on a harmonized structure for a management system agreed on by the International Standard Organisation's 39 member countries (includes Norway). ISO 39001 is a way of extending the Safe Systems approach beyond national road authorities to all organizations influencing or influenced by the road traffic system[10] (Murray et al. 2010). The standard recognizes that causes of accidents are intrinsic to individual system components and the interactions between them (Njå et al. 2015). As a tool for standardization ISO 39001 has the potential to encourage sharing and communication on road safety by providing firms, regulators and interest groups with a common frame of reference on road safety management. The purported benefits of ISO 39001 certification include reductions in road accidents; staff absence; repair bills and insurance costs; reduced risk of being sued for negligence; and improvement of corporate social responsibility credentials. Certification may also lead to a competitive advantage and be used for promotional purposes. Certification in ISO 39001 is a continuous process, in which actual certification is preceded by training and pre-assessment[11].

[10] Transport operators, logistics service providers, emergency service providers, companies with sales fleets, road authorities, infrastructure maintainers and providers, schools, councils and so on.

[11] https://www.bsigroup.com/en-GB/iso-39001-road-traffic-safety/

ISO 39001 structures safety management in line with HSE's Plan-Do-Check-Act framework (Table 6). It demands strong safety commitment from management. To begin the process, managers identify the organisation's role in the road traffic system[12], the risks to be prioritized and an initial mitigation plan. Continuous learning is then driven by data-based risk management processes, and supported by tailor-made structural elements. Policies and procedures underpin the SMS. ISO 39001 specifies safety performance factors covering "those aspects of road safety backed by evidence of their capacity to improve road safety" (third column, Table 6) (Small et al. 2013). ISO 39001 corresponds to the US standard, ACS ANSI/ASSE Z15.1, which gives guidance on similar aspects of a safety intervention (Hammer et al. 2014).

Formal SMS have been criticized as being difficult to understand and apply, especially for firms with limited resource (Nævestad et al. 2017, Nævestad et al. 2018). Users have to integrate new technologies in their practices, organisations and routines, and this involves learning and adaptation of standards to fit in with concrete routines and application contexts. The standards must be integrated cognitively and practically, and codified locally (Griffin et al. 2015). Adoption is not passive, but requires effortful innovation in local contexts. Lack of understanding about how to apply formal standards and fear of failing to document compliance, can lead to too much focus on paperwork or on the process or system itself, rather than on the control of risks (HSE 2013 p.12).

Table 6. Some central features of the safety management standard ISO 39001

Structure safety management to cover:	Ensure underpinning policies & procedures address:	Consider as safety performance factors:
Scope & context	Safety mission statement	Road design, safe speed
Leadership	Who does what	Use of appropriate road for the vehicle, user, cargo and equipment
Planning	Driver recruitment	
Implementation	Orientation and training	Use of safe driving speed for vehicle type, traffic and weather conditions
Monitoring & Evaluation	Organizational procedures and rules	Use of personal safety equipment (restraints, helmets, lights)
Continual Improvement	Crash and incident review	
	Rewards and recognition	Driver fitness (fatigue, distraction, alcohol)
	Vehicle specification and selection	Safe journey planning (need, amount and mode of travel)
	Inspection and maintenance	Safe vehicles (occupant protection, crash avoidance and mitigation, roadworthiness)
		Appropriate vehicle authorization (training)
		Post-crash readiness, recovery and rehabilitation

3.3.2 Work-related road safety programs and the occupational Haddon matrix

As we have discussed, SMS are distinct from safety *programs* in that the former generate the latter. The term "work-related road safety (WRRS) programs", however, refers to *systems* for supporting risk management, as well as the measures those systems generate. WRRS programs build on practitioner recognition that there are "no golden, silver or even bronze bullets" for improving road safety, something which is rather achieved using combinations of factors addressing cultural, management, driver, vehicle, journey and societal aspects of

[12] Processes, activities and functions of the organization that influence or are influenced by traffic; and the sequence of interaction of these.

work-related road safety. This is in line with SMS thinking. WRRS programs are associated with an increasing number of case study evaluations from the UK and Australia (Murray, et al. 2009, Murray et al. 2012, Wallington et al. 2014) and studies described in several other countries by the EU-PRAISE project (Bidasca & Townsend 2014)[13]. WRRS programs emphasise the importance of a strong business case for program success, and often target non-professional work-related driving such as sales or delivery personnel and nurses on call (Murray et al. 2010). Each of the programs for which evaluations have been published addresses most of the following issues (Haworth et al. 2000, Newnam & Watson 2011, Stuckey et al. 2013):

- Data-led incident monitoring
- Tailoring programs to risks
- Management engagement
- Community engagement
- Safer vehicle selection
- Driver coaching or training.
- How road safety is linked to quality management and other occupational health and safety programs.

Some programs are structured on the WIPE model, developed from practitioner experience from around the world (Table 7).

Table 7. Murray's WIPE model to structure implementation of a work-related road safety program (Murray et al. 2009).

Process element	Description
Why focus on road safety?	Business case – outline societal, business, legal and financial reasons to focus on fleet safety
Initial / continuing status review	Safety audit and process benchmarking; data analysis and outomces benchmarking; focus groups; driver, vehicle and journey risk assessments; employee safety climate survey.
Pilot, implement and manage change	Select countermeasures based on occupational Haddon matrix, and support implementation with necessary organisational change.
Evaluate	Crash data, costs, qualitative indicators, proactive indicators.

This and several WRRS programs use the occupational Haddon matrix – a version of the Haddon matrix adapted for occupational driving – to structure thinking on different influences on road safety risks (Bidasca & Townsend 2014). According to the matrix, the safety manager should consider how management culture, journey planning, human factors, recruitment and training, roles and responsibilities, vehicle aspects and societal-, community- or branch-level aspects, each influence traffic risk levels. Further, these influences should be considered for risks occurring before the driving journey begins; during the journey; at the scene of an accident; and post-collision. The UK telecommunications company BT reported that both ISO 39001 and the occupational Haddon matrix were key factors in their successful implementation of a WRRS management program (Wallington et al. 2014).

Murray et al. (2009) gives a detailed description of the process and elements of a WRRS program (Table 8). The content of WRRS reflects the emphasis of the programs on achieving practical results with business benefits. While they recognize that measures

[13] We review the results of evaluations of work-related road safety programs in Chapter 4.

should be tailor-made to individual organisations, common traffic risk measures can be identified and these often involve management by both the organisaton *and* the individual. According to Bidasca & Townsend (2014) these are: training, journey management (hierarch of controls, see below), journey planning, speed management, fatigue management, vehicle management, and monitoring and evaluation. Progress in each risk area and safety results are monitored by lag and lead Key Performance Indicators (KPIs) to monitor road-related safety performance (Bidasca & Townsend 2014 p.30). The need to coordinate the management of interdependent risk areas is emphasized, e.g. speed reduction or enabling sufficient rest often depends on journey planning.

WRRS programs often focus on environmental benefits, in addition to safety benefits, presumably because this helps make a business case – a prerequisite first step for any WRRS program. The programs often emphasize, for example, that effective speed management leads not only to reductions in collision frequency and severity, but in wear and tear, fuel use and air and noise pollution (Bidasca & Townsend 2014). Though counter-intuitive for many business managers, traffic safety management can therefore make business sense – in terms of both profit and reputation. There is lack of robust empirical evidence, however, that implementation causes safety improvements (See 4.1.1).

Table 8. Typical WRRS program, based on (Murray et al. 2009).

Year	Description
1	Gap analysis undertaken by the insurer's fleet engineer to set objective baseline for benchmarking processes. This involves managers responding to 30 questions on 14 elements[14] assessing fleet safety, e.g. "My organisation has a comprehensive, written, dated and published fleet safety policy signed by the CEO." Percentage responding "no", "moving towards", or "yes", used to benchmark status and prioritise areas for improvement.
2	Financial, legal and moral business case developed to engage board. This can include a detailed insurance claims analysis undertaken to target risks that cost the most, e.g. collision type.
	Launching of policy statement on safety linked to a concrete action plan for improving fleet safety with measures, such as driver handbooks, risk assessment training, newsletter, incentives etc.
3	Initial comprehensive measures introduced.
4	Measures evolve based on practical experience.

3.3.3 Hierarchy of control

As for other risks, there is recognition that traffic risk management should be in accordance with the "hierarchy of controls"[15]. Accordingly, exposure to transport environments should be eliminated where it is reasonable to do so. If not, the safest transport mode should be selected. Only then is driver, vehicle and journey risk management applied. While this may be implicit in the risk management processes supported by ISO 39001, some approaches to safety management are based more explicitly on hierarchy of controls. In the road sector, Royal Dutch Shell are known for following this approach, by reducing exposure to road travel by providing accommodation for

[14] Fleet safety policy, occupational health and safety policy and risk assessments, legal compliance, organizational leadership and culture, journey and mobility planning, driver recruitment and induction, driver management and wellbeing, vehicle management, claims reporting and investigation, community involvement, reversing, crashes, agency drivers, annual 3rd party claims rate.

[15] Accepted by many industries, says safety should be managed by considering in order: (i) elimination of the hazard; (ii) substitution of the hazard; (iii) engineering controls; (iv) administrative controls; (v) protective equipment.

personnel on project sites (Bidasca & Townsend 2014). In a similar approach described by Small et al. (2013), companies who want to reduce the road risk faced by employees should in order of priority:

1. Reassess the need for travel
2. Reorganise work journey to reduce exposure to risk or lower risk journey options
3. Invest in safe vehicles
4. Engage staff about risk management on the road as they would about any other aspect of workplace.

Hierarchy of controls is particularly relevant for work-related driving, where there may be some degree of choice about travel mode.

3.3.4 Process benchmarking for continuous improvement

Blewett & Shaw (1996), cited in Mooren et al. (2012), identify seven steps that transport companies can use to benchmark their safety management processes in order to compare them with those of others in the sector, and identify areas for improvement and mitigating measures. The steps are:

1. Establish project
2. Select and train teams
3. Identify processes to benchmark
4. Analyse own processes
5. Select benchmarking partners
6. Build relations
7. Analyse gaps and plan improvements.

The steps are based on the premise that to reduce risks, we need to monitor changes in processes that lead to the risks – not only changes in the risks themselves (Mooren et al. 2012). Process benchmarking also therefore supplements outcome indicators with process indicators. The benchmarking approach is particularly suited to encourage cross-sectoral cooperation on innovative solutions to complex problems. There are few examples of this approach in the literature, however.

3.3.5 Safety management for occupational driving

Newnam & Watson (2011) criticize data-driven attempts to improve road safety for light vehicle fleets, such as those based on the Haddon matrix. While risk assessment and benchmarking is an important aspect of company safety management, they argue that it does not suffice to react to poorly understood data trends, and these attempts should therefore be supplemented by a proactive theory-driven safety management. They argue that the mechanisms that (a) lead drivers to change behavior and (b) link leadership safety commitment to safety outcomes have been ignored. To help address this, they establish an evidence-based model that can be tested (Figure 2).

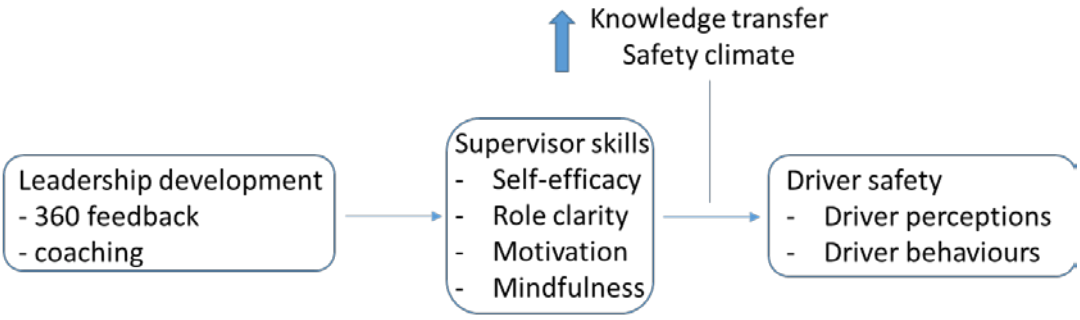


Figure 2. Evidence-based model of Safety Management for Occupational Driving (Newnam et al. 2014)

Newnam & Watson (2011) also present a useful intervention framework to guide future approaches (Table 9).

Table 9. Intervention framework for improving safe work-related driving (Newnam and Watson 2011)

Level	Organsiation	Group	Individual
Focus	Senior management	Supervisor	Driver
Target group	Director, CEO	e.g. pool fleet manager, pool supervisor	e.g. Salary-sacrificed drivers
Strategy	Risk management strategies, SMS	Leadership training	Discussion groups, feedback, goal setting

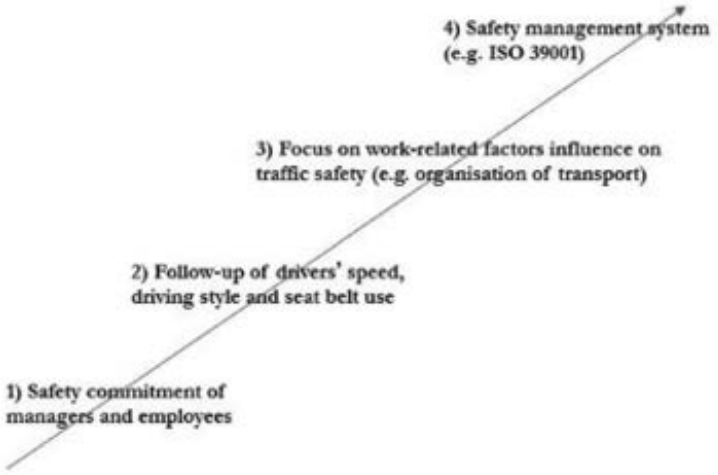
The framework emphasizes that safety should be managed by thinking explicitly about how different levels of the transport company interact, communicate and influence each other to reduce traffic risks.

3.3.6 The Safety ladder for goods transport

Recognizing the importance of systematic organizational safety management for improving traffic safety in Norway, Nævestad et al. (2017) have previously suggested an approach termed the "Safety Ladder" for goods transport, consisting of four steps. It is based on a systematic literature study of organizational safety measures, an analysis of studies of accidents with drivers at work, and Norwegian goods transport industry characteristics (86 per cent of companies have fewer than five employees). Developing an organisational management strategy for small haulier companies, they sought to identify a set of evidence-based organisational safety measures that fulfil five criteria. They:

1. Address the most important risk factors found in previous research.
2. Have been proved to have effect on (or be closely related to) safety outcomes in previous research (based on a sound methodology).
3. Are attainable at a relatively low cost, both in terms of financial and human resources even to small enterprises.
4. Are not too complex, context-dependent or comprehensive.
5. Can complement the existing safety management standards in such a way that they can serve as an introduction to the formal standards, but also be effective in cases where they do not eventually lead to full certification (of e.g. ISO 39001).

Based on these criteria they conclude that four main measures aimed at organizational safety management have the greatest transport safety potential and are most realistic for regular goods transport companies. The first step in the ladder, "Managers' commitment to safety", is the most basic step in the Safety Ladder, because research shows that this is usually a prerequisite for the company's safety work to be successful. The second step in the safety ladder is "Follow-up of driver speed, driving style and seat belt usage". This is aimed at the main risk factors associated with drivers identified in the analysis of fatalities involving drivers in work. The third step in the Safety Ladder is "Focus on work-related factors influence on transport safety". Given little focus on organizational safety management in goods transport companies, it is important that managers and employees in these companies develop an awareness the importance of work-related factors in transport safety. This applies, for example, to the organization of transport, with the consequences for drivers' experience of stress, time pressure, fatigue, etc. The fourth step in the Safety Ladder is to implement a "Safety Management System", such as NS ISO 39001, or other similar alternatives. As we have noted, Nævestad et al. (2018) studied the potential fatalities and serious traffic injuries that could be avoided if Norwegian road goods transport companies implement measures in the Safety ladder, finding that between 7 and 56 deaths and severe injuries could have been avoided annually in Norway in the period 2007-2016.



3.4 Summary and discussion

In this chapter we have considered what SMS are, in order to understand what it is that firms are expected to implement. From our review of general SMS, we can conclude that:

1. An SMS is an integrated set of organisational elements supporting and enabling risk management, along with processes for designing, evaluating and improving those elements.
2. Common elements and processes can be identified (e.g. policy, roles and responsibilities, data-driven continuous evaluation, and safety assurance), but their extent and nature can depend on the size and activity of the organization.
3. SMS *output* safety programs comprising safety measures, but some elements can be identified both as part of SMS and a safety management program (e.g. recruitment and selection).
4. Some describe SMS as structural aspects of safety, as distinct from informal aspects or how things are done in practice. It is not clear whether successful implementation of SMS requires a positive safety culture and organizational-wide engagement, or whether SMS is a way to gain improvement in these areas – it seems that SMS both can influence and be influenced by organizational culture, and this reflects that the continuous cyclical process of SMS.

5. SMS support new ways of thinking about risk that account for the need to understand rapidly evolving transport systems as complex sociotechnical systems.

The elements and processes found to be common to descriptions of general SMS are also found in descriptions of SMS laid out in international guidelines in the air, maritime and rail sectors (policy, management commitment, roles and responsibilities, documentation, risk management, emergency preparedness, assurance), although the way elements and processes are structured and grouped varies. The maritime sector appears to place more emphasis on certification, but affords greater room for interpretation on how SMS are implemented by different companies. Depending on the company's motivation, this can lead to both enhanced SMS or minimal compliance.

Interestingly, the European-level guidelines for the rail sector attempts to increase transparency by supplementing a description of SMS elements and processes with a common procedure for managing safety across all types of organisation in the rail system. Aviation recognizes that even when operated independently by individual organisations, SMS cannot account for the safe co-existence of all stakeholders within a given ecosystem. The ICAO's Global Aviation Safety Plan recognizes the importance of implementing and integrating SMS across a variety of service providers operating within the aviation safety ecosystem, i.e. not just aircraft operators, but training and maintenance organisations, aircraft manufacturers and so on (ITF 2017 p.14). This implies that any attempt to manage safety by road sector organisations should account for other actors in the ecosystem in which they operate. In some ways this is a natural extension of occupational health and safety thinking that safety management involves "cooperation and coordination of plans with anyone who shares your workplace" (HSE 2013).

The idea that SMS should be the norm for commercial road transport organisations is relatively recent, and is in part supported by the establishment of the international road safety management standard ISO 39001 in 2012. The standard essentially describes the same SMS elements and processes as those guidelines found in other transport sectors, but provides "road context" to the process, and details road-specific evidence-based safety performance factors to be considered, e.g. safe speed, use of helmets, safe vehicles. An important potential advantage of ISO 39001 or similar national standards is that wide implementation would give the road sector a common language and frame of reference on managing road safety, which occupational health and safety legislation has failed to provide to date.

Traffic SMS as norm for organisations employing drivers at work has also been promoted by WRRS and EU's PRAISE project. Practitioner-driven, these programs may be attractive to businesses since they emphasise the importance of ensuring that safety management is driven by business needs. However, descriptions of the programs are often presented as tailor-made lists of safety measures identified for individual companies, and as such may have confused attempts to provide a reference for safety management for use by all road transport organisations. Work-related road safety programs are also criticized for a traditional conceptualization of risk e.g. Haddon matrix (Newnam & Watson 2011, Mooren et al. 2012).

Becnhmarking of companies on traffic safety can help make a business case for traffic SMS, and motivate companies to play their role in managing safety as an integral part of the road sector. Newnam & Watson (2011) point out, however, that data output by benchmarking or traditional risk analyses are often poorly applied, and there is a need for proactive theory-driven safety management. This concerns how SMS can promote leadership engagement in safety, which can in turn influence safety culture and behavior among employees.

Finally we would like to point out an observation made in preparing this chapter. SMS are *systems,* which are commonly defined "a set of interacting or interdependent things, items or components sharing a common purpose"[16]. Such definitions suffice for systems that can be reduced to understandable components, but SMS cannot: they are *intractable* (Hollnagel 2012). Attempts to describe them are inevitably elaborate and – accepting that people are a fundamental part of SMS – we cannot completely describe *how* SMS do what they do. Intractable systems are best understood as a set of interdependent *functions* sharing a common purpose (Hollnagel 2012). In practice, SMS are described as a mixture of both functions (e.g. recruitment and selection; leadership, monitoring, evaluation) and things (e.g. KPI, safety mission statement, rules) and this – in our opinion – has caused confusion and prevented our understanding of safety management systems. A way to improve future descriptions may therefore be to clearly distinguish between functions and things when describing SMS.

16 www.merriam-webster.com/dictionary/system ; www.en.oxforddictionaries.com/definition/system

4 Effects of traffic SMS

Evidence of beneficial effect would serve to promote implementation of traffic SMS by transport companies and other employers of people who drive for work. There are, however, different ways of measuring effect. Whereas researchers and authorities are often interested in the effects of SMS on crash numbers or injury severity as indicators of safety outcomes, organisations may be more interested in economic measures as indicators of business performance. This implies that those interested in increasing implementation of traffic SMS in companies to improve road safety for all should be concerned with both the extent to which SMS implementation is shown to improve road safety *and* the extent to which it is shown to lead to beneficial business outcomes. In this chapter we examine evidence that attempts to implement SMS by organizations result in improvements in road safety and other organizational outcomes.

4.1 Does SMS implementation improve road safety?

As we have seen in Chapter 3, SMS comprise things (e.g. policies, documentation of responsibilities and procedures) and processes (e.g. risk management, continuous learning, safety assurance) that together identify and evolve sets of measures to reduce risks in traffic, and embed them in a supportive organization. We have also seen that it is useful to distinguish between core safety management elements and processes, many of which will be common across organisations, and the risk mitigation measures that they output, which will tend to depend on organizational needs and contexts (see Figure 1). To assess the effects of implementing SMS, however, we should look for evidence of the effects on road safety of implementing both core safety management processes *and* output measures resulting from them. After presenting closest available evidence for the effects of whole SMS implementation (i.e. core processes and output measures together), we look at the isolated safety effects of implementing road safety measures at organizational level.

4.1.1 Evidence that SMS implementation improves road safety

Longitudinal studies

In Section 3.3.2 we described a case study of a comprehensive work-related road safety (WRRS) program by Murray et al. (2009). It is claimed that implementation of the program in a large fleet increased positive fleet safety audit results from 53 to 78 per cent (compared to an industry average of 68 per cent). The proportion of vehicles involved in third party collisions fell from 65 to 35 per cent over a 4-year period, despite a doubling in fleet size. In a similar study, Wallington et al. (2014) demonstrate a halving of collision rates and costs after implementing a long-term work-related road safety program for 95,000 staff in a UK telecommunications company.

While these effects are impressive, the evaluations can be criticized for lack of robustness, e.g. lack of controlled studies, national trends in crash statistics, or regression to the norm effects. Banks et al. (2010) add that management interventions introduced in large organisations are hard to evalutate, since the effects of measures implemented as the result

of SMS activity cannot be isolated from the effects of parallel organizational changes not directly linked to the SMS. Grayson & Helman (2011) claim that the evaluation of multiple, overlapping measures, such as those typically implemented by the continuously evolving programs that result from SMS, is extremely challenging – "proper evaluation becomes difficult when the silver bullet is replaced by blunderbuss". Likewise, Newnam et al. (2012) claim that proper evaluations are becoming scarce due to a perceived need for multiple interventions, and because case studies are seen increasingly as a way to demonstrate good practice and induce social change (Robson et al. 2007, Murray et al. 2003).

The aim of the evaluations published on WRRS programs indeed seems to be to describe the implementation processes to inspire, rather than actually evaluate the effect of interventions on crash outcomes. The mindset is that, for companies, money is best invested in measures than on evaluation (Murray et al. 2003). Murray et al. (2010) also point out that road safety agencies requiring peer-reviewed evidence, typically based on serious injuries and fatalities, demand a different level of evidence than does the private sector, whose aim is to improve business and financial measures.

Ultimately, the body of studies evaluating WRRS do not provide an evidence base to justify organizational interventions; they say nothing about the ratio of successful to unsuccessful programs, and therefore nothing about their value (Grayson & Helman 2011). Even if we accept positive developments in safety indicators as support for SMS implementation, we should be careful when assuming that programs rolled out over several years by large multinational, resource-rich organisations will lead to similar effects for the smaller, resource-scarce outfits often found in road transport.

Cross-sectional studies

Unfortunately, it seems that results from evaluations of WRRS programs are the closest we have to evidence from longitudinal studies that implementation of whole SMS by an organization has positive effects on road safety. In a comprehensive review on the topic concerning safety outcomes for heavy vehicles, Mooren et al. (2014) found that the most robust, relevant empirical studies look only for cross-sectional correlations between positive aspects of organizational safety management (e.g. management commitment, training, scheduling) and road safety indicators (self-reported performance or crash records). These are the 37 studies in groups 1 and 2 summarised in Table 10.

Correlative studies give only indirect support to the idea that SMS implementation would improve road safety. Indirect support can also be found in a review by Edwards et al. (2014) describing characteristics of high performance safety companies that resemble SMS functions reviewed in Chapter 3, e.g. safety-based recruitment, selection and training, incentivizing safe behavior, and policies on particular transport risk areas such as loading and unloading.

Ultimately, however, correlations are not causation and there is little direct evidence that SMS implementation improves road safety indicators. Mooren et al. (2014) conclude that despite a range of formal, auditable traffic SMS, none has been shown empirically to *produce* safety outcomes, either in goods transport or other sectors. Likewise Stuckey et al. (2013) conclude that, "the lack of peer-reviewed outcome evaluations [for traffic SMS] is a major research gap…while employers are being asked to implement comprehensive fleet safety programs, the evidence base supporting the efficacy of specific program elements is limited." Banks et al. (2010) sum up the situation by saying, "the evaluation literature…offers little support to organizational-level introductions to improving work-related road safety…which is at variance with the number of case studies claiming marked improvements in safety outcomes as a result of instituting changes in organizational policies and procedures".

Table 10. Summary of results from Mooren et al. (2014).

Group	Study type	No. of studies	Study characteristics	Overall results
1	Studies linking differences in characteristics between organisations to organizational safety performance.	17	Most use self-reported safety outcomes, some use pre-existing crash data. 9 studies address heavy-vehicle safety.	Factors most often linked to organisational safety indicators, in rank order: safety training, management commitment, scheduling, vehicle conditions, risk analysis, incentives, hiring and retention, safety management accreditation.
2	Studies measuring effects of driver attitudes on behavior of individual employees	20	Most based on survey responses, 8 studies involve heavy vehicle drivers.	Factors most often linked to individual safety behavior: management safety attitude, leadership trust, safety and return to work, and scheduling and work demands.
3	Controlled before-and-after evaluations of the effect of specific safety management interventions on safety outcomes	5	Robust, longitudinal studies in "commercial fleet context". 4 studies use crash costs as outcome, 1 uses behavior as outcome.	Positive safety outcome effects found for the following individual measures: worker discussion, financial incentives, driver training and in-vehicle monitoring.

Not only researchers, but representatives from regulatory authorities, transporters and independent consultancies have each pointed to the scarcity of objective data demonstrating benefits of management systems (Fourie et al. 2010). What is more, there are studies suggesting that implementation of a full SMS in road transport may not be effective in and of itself. Mooren et al (2014) compared the characteristics of heavy vehicle operators who claimed insurance often with those who did not make claims often. The frequent claimers were *more* likely than infrequent claimers to have policies and in-vehicle monitoring – typical SMS elements – in place, whereas the infrequent claimers were more likely to focus on proactive risk assessment, to pay drivers for time worked and to consult drivers on safety issues. This implies that mere SMS implementation alone is not sufficient for good road safety; what is important is that the most appropriate types of measure are implemented – in this case those promoting driver trust and responsibility. If the core safety management processes resulting from SMS implementation do not support implementation of effective road safety measures, then SMS implementation will not be effective. (This is related to the alignment of formal and informal aspects of safety that we discussed in section 3.1.5). Few, if any, studies in the empirical literature address this issue.

A further warning about assumptions that SMS implementation are effective can be found from an interview study on research into SMS implementation in the maritime sector. Looking at the effect of SMS regulation in maritime safety, Størkesen et al. (2016) found that increased regulation for SMS is more effective in reducing personal injuries than ship accidents, but also that changes can be detrimental to safety critical tasks where they lead to procedures that distract navigators or divert safety resource.

What about evidence that SMS can improve occupational health and safety, where their use is more established? In a comprehensive review, Robson et al. (2007) found little evidence of effect, in terms of controlled longitudinal studies, but based on characteristics of "SMS organisations" concluded that it was "likely that safety management characteristics may be able to predict good safety outcomes" (cited in Mooren et al. 2012). Similar conclusions were drawn by Hale et al. (2010) in a study describing patterns of the most successful – in terms of accident reductions – of 17 safety management and culture interventions subsidized by a Dutch ministry between 2004 and 2008 (again not focused on the transport sector). Interventions increasing constructive dialogue between worker-management, providing motivation to line managers and strengthening the monitoring and learning loops

in SMS appeared to be more successful. The amount of energy and creativity injected by top managers and above all the safety champion, was key.

4.1.2 Evidence that individual organisational safety measures improve road safety

Group 3 in Table 10 contains the few available robust evaluation studies of organizational interventions to improve road safety outcomes. Given that the outcome of SMS is often a program comprising such measures (c.f. Figure 1), these studies give partial support for the effects of SMS implementation. Several of the studies in group 3 are also reviewed by Newnam & Watson (2011) and Grayson & Helman (2011), the latter finding much of the evidence for single measures in the robustly designed controlled study by Gregersen et al. (1996) (Table 11).

Table 11. Summary of evidence for single measure interventions, based on a review by Grayson & Helman (2011)

Intervention	Evidence
Driver training	Gregersen et al. (1996)'s study suggesting that this measure leads to a 40 per cent reduction in accidents is widely quoted as evidence of effectiveness of training, but the impressive tailor-made approach to training this study takes is often ignored. Other studies show more equivocal results.
Group discussions	Also included as a measure in Gregersen et al. (1996)'s study, in turn based a study by Misumi, again influenced by Lewin's action research approach, with commitment and knowledge being generated through participation. This has a solid theoretical basis. Gregersen et al. (1996) found a 56 per cent reduction in accidents 2 y following intervention, but it was "complex to disentangle the effects of other [contributing] factors". Other studies e.g. Salminen (2008) also show positive results, but some are based on small accident numbers or on self-reported behavioural outcomes.
Incentives	Positive reinforcement. Gregersen et al. (1996) find a 23 per cent reduction in accidents for a group given a safety-related bonus. Supported by cross-sectional study by Lynn & Lockwood (1998) showing 21 per cent less accidents among drivers getting a bonus for accident-free driving than among other drivers.

Taken together, studies in Group 3 of Table 10 suggest that the following organisational characteristics – most of which are potential safety measures output by core SMS processes – are each linked to organizational road safety: management commitment, risk analysis, safety training, worker participation, incentives and pay, work scheduling, vehicle technologies, recruitment and worker characteristics. Overall the best weight of evidence, in terms of theoretical support and empirical support of effect, is for participative group discussion. Despite clear potential cost-benefits, however, there is little indication that participative discussions are widely used systematically to improve road safety. When considering the effectiveness of isolated measures, we should bear in mind that effects may be underestimated where they are not embedded in the organization as part of a SMS and supportive culture. Reviewing the evidence for the effects of training of all types of driver, for instance, Christie (2001) states that:

> "The research evidence suggests that most current driver training contributes little to reductions in accident involvement or crash risk among drivers…Low individual crash risk and decay of learning work against the potential effectiveness of driver training programs that concentrate on car control skills or deal with rare events such as emergencies. The high motivation which trainees usually bring to driver training does not compensate for these factors."

Data-driven training addressing needs that are continually monitored for as part of evolving safety management may be more effective than training interventions that aim to improve driver behaviour with little back-up from an employing organisation. Those aspects of SMS that serve to support safety measures with rules, policies, management engagement and cultural change can be expected to improve the success of measures used

in isolation such as driver training, campaigns, toolbox meetings or online profiling[17] (Davey et al. 2008). This is also supported by a study of in-vehicle data recorders that give drivers instant feedback on driving showing accident reductions, and other non-controlled studies showing reductions in accident levels (Wouters & Bos 2000). Authors found it was important to consider social conditions surrounding such interventions to optimize success. In particular there are issues of trust that need to be dealt with by effective leadership and openness, and such issues can be dealt with when measures are implemented as part of a wider SMS.

4.2 Evidence that SMS implementation has beneficial spillover effects

The potential of SMS implementation to improve organisational or business indicators other than safety is addressed in detail by the work-related road safety case studies published in the peer review literature and EU-PRAISE reports (Bidasca & Townsend 2016). Bidasca and Townsend (2014) outline the variety of organsiational outcomes that have the potential to be improved by addressing safety e.g. reduced asset damage, increased business efficiencies, improved legal compliance and reduced insurance premiums. Murray et al. (2009) observe other organizational benefits from increasing road safety:

- Brand enhancement and protection
- Fewer lost working days
- Increased employee welfare and engagement
- Consistent and timely external and internal reporting
- Improved risk management
- Improved performance management.

A study by Fernández-Muñiz et al. (2009) suggests that general worker safety and corporate competitiveness are compatible. They detail data suggesting how improved safety leads generally to less disruption of work processes, and specifically to reduction in insurance costs, accidents, damage, liabilities, absenteeism, medical costs and legal costs. These changes lead in turn to increased productivity, efficiency, quality, innovative capacity, and enhanced company image. In short, improved HSE performance leads to improved company performance due to improvements in generic internal processes.

In terms of empirically robust evidence, however, there is little to show SMS implementation leads to positive effects on business outcome indicators. What evidence there is comes again from the literature on WRRS programs, and is therefore subject to the same criticisms described in Section 4.1.1.

4.3 Conclusion: Why should companies implement SMS?

We have no solid evidence to show that SMS implementation leads to positive effects on safety, business or other organizational outcomes. Indirect evidence that SMS work comes from (i) correlations, (ii) cross-sectional studies linking SMS-like organizational processes to safety outcomes, and (iii) the effects of isolated measures that SMS typically output.

There are reasons why evaluating the effects of SMS implementation is challenging:

[17] Safety climate, driver behavior and attitudes, risk-taking and sensation-seeking, skills and feedback.

- SMS are often implemented in the presence of existing safety management / measures, making it difficult to isolate effects that are due solely to implementation of a "new" SMS.
- SMS are intractable systems and it is hard to fully describe them and thus to isolate their associated effects.
- SMS are by nature meant to achieve continuous improvement – there is never a point at which full effects can be said to have been achieved and little is known about the dynamics of effect.
- Many links between safety and work or management practices can be plausibly proposed for inclusion in an SMS.
- What works one place may not work elsewhere due to e.g. cultural contexts.
- Difficulties in distinguishing SMS processes from the measures they output; and from describing SMS as collections of functions and things.

This has led to debate about whether it is fair or possible to apply strict evaluation criteria when assessing SMS interventions, e.g. contrast Grayson & Helman (2011) with Murray et al. (2003). The nature of this debate reflects a tension between business needs for practical action to realise safety and other benefits as soon as possible, and the time and resource needed for thorough evaluation of complex SMS processes.

Lack of empirical support begs the question, why should companies implement them? The best answer we have is indirect evidence that safety measures are more effective when implemented in a supportive organizational culture (cf. Section 3.1.5). We can also point to the many positive aspects of WRRS approaches. An advantage of longer term WRRS programs is that they can evolve based on practical experience of what has proven to be successful for that company. There is reason to believe the inspiration and motivation such programs give to workers is beneficial, and certainly better than doing nothing in the absence of robust empirical evidence. Reviews of WRRS practice also show that, even though they are not properly evaluated, fleet safety interventions focus on measures for which there is good empirical support. Faced by a lack of empirical evidence of effect in the research literature, it seems that, recognizing the need for a systematic and holistic approach involving the participation of multiple stakeholders, practitioners have taken matters into their own hands and got on with things.

We end this chapter with the observation that lack of robust evidence of effect has not impeded progress of generic implementation of SMS in other transport sectors. In the air sector especially it seems rather that progress depends on a need to be proactive, because public perceptions of poor safety would be catastrophic for business. If road companies also do what is best for business, it may simply be that safety excellence is not as important for business in most domains of road transport as it is in the air sector. This implies that if the consequences of poor safety outcomes were as bad for business in the road sector as they are in the air sector, SMS might be more likely to be implemented as part of proactive safety management.

5 SMS implementation: Theoretical insight

In this chapter we consider a selection of theory giving useful insight into understanding how to encourage SMS implementation in systems. We observed previously from our research into the organization of safety in road transport, that a lack of accounting for system complexity restricts the extent to which clear solutions can be identified (e.g. (Nævestad et al. 2014, Phillips 2014, Nævestad et al. 2015, Nævestad et al. 2015). A main reason we have been unable to account for complexity has been a lack of directly relevant theory. There are two reasons to believe that this issue needs to be tackled if we are to arrive at useful recommendations that can lead to widespread implementation of traffic SMS in firms. Firstly, in Section 3.1.6 we explained how SMS can accommodate "new" safety thinking that safety is the product of interactions between components in the system (human operators, vehicle maintenance, delivery terms and conditions etc.), rather than the failure of any one component in a system (Leveson 2002). Accepting that in open road systems and transport chains, these components can be owned by different organisations, it follows that SMS should be implemented across systems in such a way that relationships among components can be managed coherently. Secondly, modern transport organisations are open sociotechnical systems (see Section 5.2) – their actions are influenced by market, regulatory forces and other framework conditions (Emery 2000, Bjørnskau & Longva 2009). We should account for these influences when incentivizing these organisations to take positive action.

Over the last 20 years systems-based safety models have emerged that are appropriate for understanding the emergence of risk and therefore the systems needed to manage those risks (e.g. Reason 1997, Rasmussen 1997, Leveson 2004). In a parallel development, models explaining how change occurs in sociotechnical systems in industries and society have also been developed, emphasizing the importance of combining different analytical dimensions to understand sociotechnical change (Geels 2004). In this chapter we introduce seminal works in each area: Rasmussen's work on risk management in a dynamic society (Rasmussen 1997); and Geels' work on the co-evolution of firms in industries (Geels 2014). By giving insight into the nature of component relationships, the hope is that these models can be used to identify clear solutions for encouraging the implementation of traffic SMS.

5.1 Risk management in a dynamic society

Since real world organizations rarely produce risks in isolation, they cannot effectively manage safety in isolation. To manage safety, many levels of politicians, managers, safety officers, and work planners have traditionally acted to control risks with formal laws, rules and instructions (Figure 3), and there has been an emphasis on educating or guiding behavior, or shaping behavior by equipment design, in order to constrain it (Rasmussen 1997).

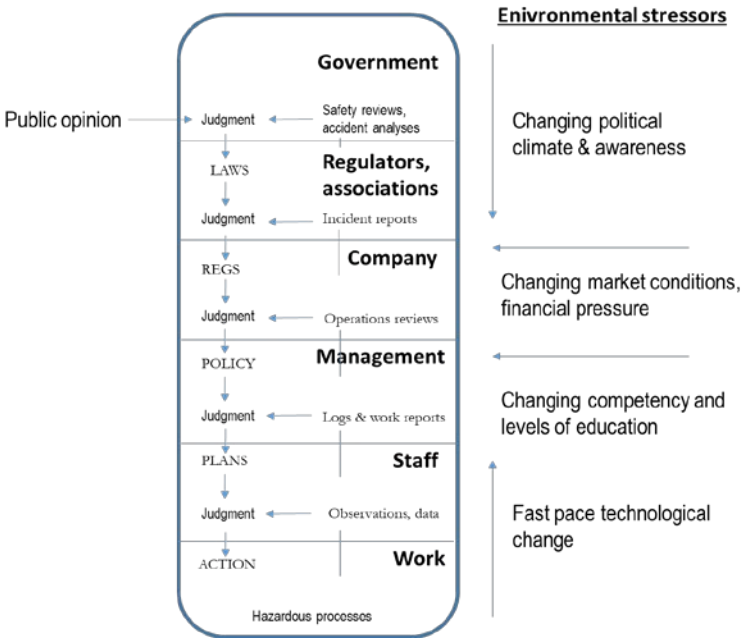


Figure 3. The sociotechnical system involved in the management of safety (Rasmussen 1997).

At the highest level, national and international government assesses society's wish to control safety against other priorities (economic, environmental, mobility needs etc.), and creates laws that make explicit conflicting priorities and sets boundaries for acceptable safety. Next, at the level of authorities, associations (trade, worker) and other interest organisations, laws are interpreted and implemented in rules to control activities in certain work places. Rules then have to be interpreted and implemented in the context of a particular company, attending to local conditions and processes. At lower levels policies must be interpreted by staff in order to make plans for productive and safe processes, which are finally implemented by those doing the work.

Rasmussen (1997) recognized that traditional top-down command and control will only be effective in stable societies where instructions and work tools can be prescribed, and that there are two problems with this. First, in most real work situations deviation from normative work instructions and rules are common and necessary for effective operational functioning. Second, societies are becoming less stable over time; the systems in which modern work takes place are increasingly adaptive and dynamic, in which laws, rules and company policies fail to keep up with the increasing effects of technological change on work and market forces[18]. Given this, rather than a top-down model for rule-based regulation, Figure 3 should be seen by forward-looking safety managers as a model illustrating the different levels of actors responsible for controlling risk to which the company is exposed. Complete vertical integration across Figure 3 is required so that systems do not lose control of processes they are designed to control (Cassano-Piche et al. 2009). Those at the bottom must be aware of legislatory and regulatory changes, while

[18] The main characteristics of dynamic societies identified by Rasmussen (1997) apply more than ever today: (1) Very fast pace of change of technology at operative levels with long lags in response to change found in legislation and regulation (e.g. distracting in-vehicle technology); (2) Rapid development of information technology leading to high transparency, integration and coupling of systems with the effects of single events propagating rapidly through global society, making it difficult to model systems in isolation; (3) Companies in aggressively competitive markets, which focus the incentives of decision makers on short term financial and survival criteria rather than longer term criteria concerning sustainability (safety, welfare or the environment).

governments must be informed about how constraints on managers and employees limit the intended effects of legislation.

Two further contributions of Rasmussen's work are relevant to us:

i. Real firms must strive to balance a need to limit resource use (time, money, people, technology etc.) in order to compete, against a need to use resources in order to be safe. As Rasmussen (1997) states, "commercial success [in less stable societies] implies exploitation of the benefit from operating at the fringes of the usual, accepted practice". A similar idea was expressed by Reason (1997) as the "production-protection" conflict.
ii. Single measures cannot address safety problems generated by systems, but "…a new approach to the representation of system behavior is necessary, not focused on human errors and violations, but on the mechanisms generating behavior in the actual, dynamic work context…"

Implications for SMS implementation

Rasmussen (1997)'s article implies that to be effective in complex sociotechnical systems, safety management should be based on regulatory **performance requirements**, in which the company is required to carry out generic functions to avoid accidents, but where the details to how the functions should be carried out are left to the company. SMS can be a tool to facilitate and structure a shift in rule-making from regulators and policy-makers to those who understand work contexts best. Making safety a performance objective means it becomes a criterion alongside other criteria that managers need to make decisions about, and thus is merged in the line organization.

Rasmussen's work also emphasizes the importance of **integration of safety management** not only at all levels of the organization, but both horizontally and vertically with the system in which the organization is embedded. In terms of implementation of SMS, Rasmussen's article implies broad implementation is required to improve safety in any one company, the safety-related activities of which will inevitably be influenced by the activities of others – implementation of SMS by single organizations in isolation will only have limited effects. The need for integration of safety management across systems is also implied by recognition that accidents in complex sociotechnical systems are often released by combinations of behaviours – which locally seem to be normal – dispersed throughout the system and not confined to a single organization (Dekker 2011). This all implies that safety management (and SMS) should be integrated as part of a wider system safety management approach.

Integrated safety management implies two needs.

i. A need for shared understanding and learning among managers in an industry or regime, using common safety measures that give managers feedback on safety levels to inform on the need for improvements and as the basis of evaluation of risk mitigation measures. In helping develop performance-based management paradigm, a main role for regulators could be in helping to develop these markers, which will also be useful when auditing companies for key SMS functions, such as whether they get feedback on safety performance information and whether performance is commensurate with objectives and constraints set by the regulators.
ii. A need for shared safety competence among the controllers of risk (decision makers) throughout the management system in Figure 3 on page 32, to ensure that generic regulation is interpreted correctly when delegated to local decision makers. Competence to understand the response of the system to various control actions also implies integration across systems. There is a need for those controlling risks not only to possess formal knowledge and the heuristic know-how and practical skills acquired

during work to be able to perceive and act quickly in work contexts, but also to know about the competence of actors in the system around them, so that they may communicate effectively and coherently on safety.

The role of **management's safety engagement** in implementing SMS arises from recognition of questions arising from Rasmussen concerning the production-protection conflict: Are priorities right, and what role does the regulator play in ensuring this? Is management prepared to allocate resources to maintain defences? Are decision makers aware of safety constraints? Are decision makers prompted to consider risk in the dynamic flow of work (considering nature of "naturalistic decision making"?) Are they made aware of the safety implications of their business and every day work planning decisions? Do regulatory efforts serve to control management priorities adequately? Executed correctly, SMS should give companies an increased understanding of safety in terms of how local decisions made in the company at varying times and in varying locations contribute to the total safety picture, affording potential for improving safety and operations. It allows them to maintain "defences in depth" by identifying constraints on where to look for operational cost savings.

5.2 Triple embeddedness of firms-in-industries

To introduce Geels' (2014) triple-embeddedness model we will give a short explanation of sociotechnical thinking, followed by an account of how sociotechnical transitions theory describes the path of innovations in complex systems (Geels 2004).

Sociotechnical systems – a simplified explanation

Davis et al. (2014) provide a framework that helps us think about sociotechnical systems (Figure 4).

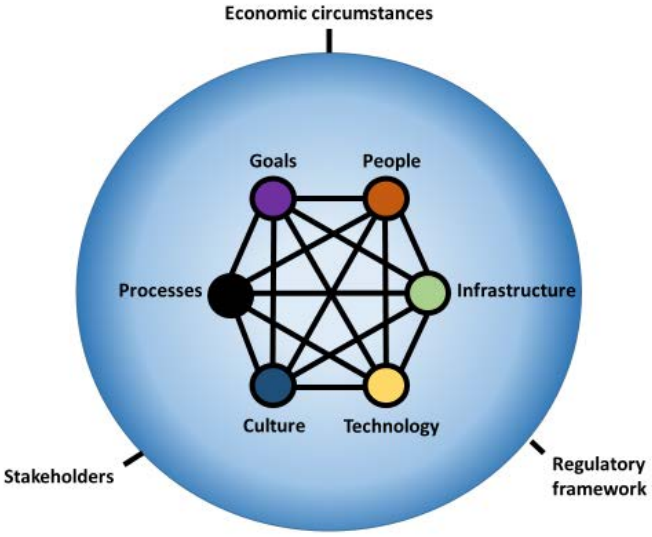


Figure 4. Dimensions for understanding sociotechnical systems. Adapted from (Davis et al. 2014).

If we take as the system of interest safety management by a bus company, for example, we may ask how safety management fits in with competing company **goals**. To what extent is safety a priority, which **people** are involved in safety management, and to what extent do other people encourage them to integrate the management of safety and productivity? The answers to such questions will influence how "ready" a company is to implement SMS. We

might also consider how SMS implementation by the bus company is influenced by the goals of people working for other **stakeholders** e.g. other transport companies, employee representatives (trade unions), employer representatives (trade organisations), SMS certifiers / consultants for SMS standard implementation, Labour Inspection Authority, road administrators, other public authorities, trade media, societal interest groups, national government, ministries, departments, European Commission, research institutions and so on. Likewise, we should consider how aspects of physical **infrastructure**, such as buildings, stations, roads, or organizational infrastructure influence the management of safety, how organizational **culture** influences the interpretation of regulations or communication and reporting on safety, or the role of **technology** (data systems, vehicle technologies, schedule analysis software etc.) in safety management. A fundamental principle when seeking to understand the dynamics of sociotechnical systems is that relationships within and among dimensions are important as well as the actual dimensions themselves.

Sociotechnical transitions (Geels 2004)

Sociotechnical transitions theory seeks to explain the co-evolution of technology and society. It is interesting to us because the multi-level perspective it provides highlights the complexity of dynamics involved when wishing to achieve change in complex sociotechnical systems, such as the widespread implementation of SMS. This perspective is given by the use of three mutually influential dimensions to understand sociotechnical change: (i) technological systems, (ii) rules and institutions, and (iii) human actors, organisations and social groups. In particular, rules and social groups are important in understanding system transition.

According to transition theory, rules are not completely coherent, because they are not only regulative (explicit, formal, e.g. rooted in government regulations), but normative (the rules internalized through social processes based on values, norms, role expectations, duties, rights, responsibilities) and cognitive (the frames we use to make sense of reality [heuristics, bias], how meaning is shaped by symbols i.e. words, concepts, myths, signs, gestures). When the regulative, normative and cognitive rules align, a *regime* results – a semi-coherent set of rules, linked together. Importantly, change in one type of rule will not change the regime unless other types change in line e.g. a regulatory change will not necessarily lead to coherent change unless accompanies by normative change.

Social groups can be identified based on members reading similar trade journals, attending similar meetings, and sharing aims, values and problem agendas. Group members are likely to share a set of rules about safety i.e. each can be said to have a particular [safety] regime – the "deep structure" or grammar [of safety] carried by the social group. The regime guides actions and is formed by earlier social (inter)actions by or between collectivities, which take place in concrete interaction settings (conferences, trade journals etc.). Through implementing shared rule systems, the members of collectivities generate patterns of activity that are similar across local contexts.

To understand how sociotechnical systems change, we should consider the role of people who are figureheads for the inter-organisational community, and the general social infrastructure necessary to enable innovations to be implemented broadly (Geels 2004). More importantly, we should emphasise the *constraining* and *enabling* contexts in which actors are embedded. Constraints and opportunities can be formed by prevailing sector norms, technology, market forces, societal values etc. Such factors populate a framework constraining or enabling any human action aimed at changing the system.

Although constrained/enabled by structure, actors act to create variation in local practices e.g. a firm invests in new process or technology for strategic advantage or to improve control of resources, or a public authority makes a new policy plan or regulation. Such

variations cause misalignment in a regime. They may also in turn structure the actions of other actors or influence the shared rule system (normative) e.g. through imitation or exchange of experiences, to cause social learning. Actor structuring and social learning describe how new practices can spread exponentially (positive feedback loop). Geels (2004) claims that these actions are both shaped by *and* serve to maintain or shape sociotechnical contexts, and that sequences of actions by different actors are like moves in a game:

> *"*Rules and regimes constitute a game, which is played out by actors, firms, public authorities, users, scientists, suppliers, etc. The different social groups each have their own perceptions, preferences, aims, strategies, resources, etc. Actors within these groups act to achieve their aims, increase their resource positions, etc. Their actions and interactions can be seen as a game in which they react to each other.*"*

In each round actors make "moves" e.g. make an investment, implement a new procedure, introduce new regulations, to maintain or change aspects of the sociotechnical system in which they are embedded. Importantly, games occur both within (e.g. firms gaining competitive advantage) and between regimes (e.g. one company opts for a stricter environmentally friendly production, making it more feasible for public authorities to introduce stricter regulations). Different actors do not have equal power or strength, they have unequal resources (money, knowledge, tools) and opportunities to realise their interests and influence social rules.

In sum, it is **important to understand stability ("lock-in") of existing sociotechnical systems in order to understand how to change them**. *Regimes* provide stability by guiding perceptions and actions. Rules are again reproduced by these actions (through social influence) – this is the *deep grammar* of sociotechnical systems. Sociotechnical systems are stabilized not only by rules (Table 12), but by mutual dependencies between actors and organisations embedded in networks; and the "hardness" of sociotechnical systems ("concreteness" of implemented technology etc.).

Table 12. How rules stabilize sociotechnical systems, according to Geels (2004).

Rule type	Example of stabilizing effect
Cognitive	Established mindsets make safety professionals blind to possibilities;
	Sunk investment in established competencies, skills, knowledge;
	Learning tends to happen gradually and builds on existing knowledge
Normative	Mutual role perceptions and expectations e.g. not seen as proper to raise safety issues
	Perceptions of customer value of safety
Regulative	Lock-in to fulfil existing contractual obligations

According to Geels, the forces acting to stabilize regimes means that "as long as actors expect that problems can be solved within an existing regime, they will not invest in radical innovations, and continue along existing paths". But how, then, are breakthroughs achieved, how does change occur? The answer is that variations occurring in the internal dynamics of regimes, though often dampened by the linkages with other regimes (e.g. safety regime with policy regime), can produce tensions when the activities of different social groups go in different directions (in relation to the direction of the trajectory along which the sociotechnical system is moving). Tensions are mirrored as tensions in rules (cf. Table 12), creating more space for interpretive flexibility. (An example is if the safety preferences of a large transport purchaser are picked up by marketing department of one transporter but not by others.) Where tensions and mis-matches occur in the activities of social groups and in sociotechnical regimes, there will be a window of opportunity for radical change. Competitive games between firms may open up the regime or there may be pressure from negative effects of the regime on other systems (Geels, 2004):

> "…negative externalities and effects on other systems may lead to pressure on the regime. Actors inside the regime tend to play down negative externalities, which have to be picked up

> and problematised by outsiders e.g. societal pressure groups, outside professional bodies, or outside firms…to get negative externalities on the agenda…there may be a need for consumer pressures and regulatory measures."

Triple embeddedness (Geels 2014)

Geels (2014) develops ideas about how industrial regimes shape and are shaped by the sociotechnical systems in which they are embedded. Firms-in-industries are "horizontally" embedded in (i) economic and (ii) sociopolitical environments, and "vertically" embedded in the internal environment of their industrial regime (Figure 5).

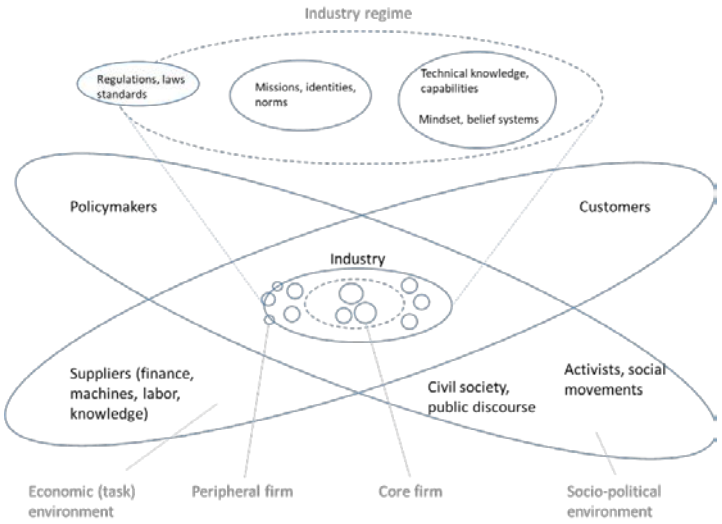


Figure 5. Triple Embeddedness of firms-in-industries (Geels 2014).

Firms can respond strategically to external environments using economic positioning strategies, such as marketing and sales or supply chain management. Firms can influence policymakers or public discourse, as well as suppliers and customers. Importantly, rules of industrial regimes are affected by the positive or negative effects of the strategies its firms use, i.e. there is learning in response to how actions affect the contexts in which a regime is embedded. This is explained by Figure 6.

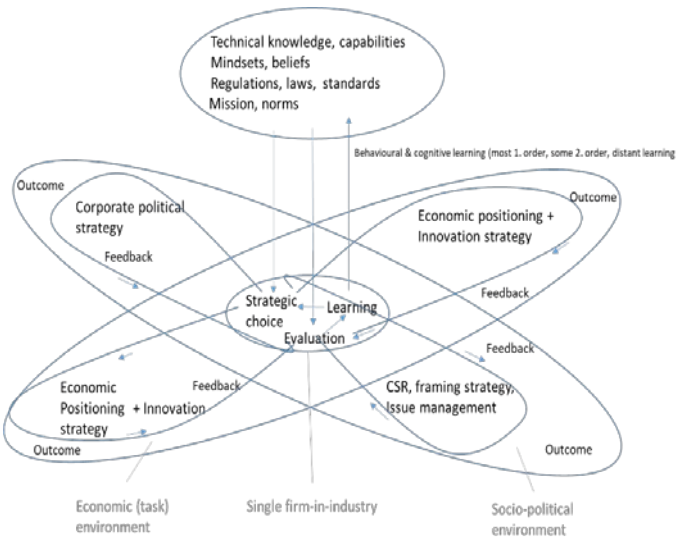


Figure 6. How regimes change by learning from effect of actions on contexts (Geels 2014).

Firms-in-industries often resist external pressures for substantial reorientation in the early phases of issue lifecycles, and use a range of strategies to defend their interests and sunk investments. *Firms will rarely reorient merely to solve societal problems*. Geels (2014) cites as an example that American automakers did not include air pollution problems in their core beliefs or mission statements because the problem did not affect consumer preferences and was externally imposed by regulators. Similarly, despite tough federal regulation, they were initially reluctant to reorient to fit seatbelts, head restraints, but 20 years later, when safety concerns began to affect consumer preferences, they began to believe that "safety sells".

Implications for SMS implementation

The following implications are identified for encouraging broad implementation of traffic SMS in firms, based on a sociotechnical systems understanding and Geels' work:

- SMS will themselves be implemented in systems; the likelihood and effectiveness of implementation will be influenced by the people involved in/affected by SMS, the role of their conflicting goals, the influence of organizational/societal culture, technology (e.g. fleet management systems, data collection and analysis) and infrastructure (e.g. smart infrastructure, placement of sensors); and by relationships among these factors.
- There is a need to understand the social rules and "deep safety grammar" of the regime (transport branch) of interest, and how sector norms, technology, market forces, perceptions of customers and societal values, sunk investments etc. will act to constrain or enable implementation of SMS.
- Moves by external actors to encourage implementation of SMS are likely to be countered by regime actors who will in turn move in an attempt address concerns while maintaining the status quo of the regime; such moves are more likely to be made by actors with the most resources available to protect their interests.
- Actors with sufficient resources who perceive value in SMS, may attempt implementation; if those actors perceive positive economic or sociopolitical outcomes of implementation, tension may be created in the regime, which may then be exploited to bring about social learning and regime change (i.e. widespread implementation of SMS).

5.3 Discussion and conclusions

Conclusions from our theoretical review are collected in Table 13. To these we wish to add two additional points of discussion. Firstly the conclusions can be supplemented by other systems-based theories highlighting the importance of integrating the activities of producers and users when managing safety (e.g. Leveson 2004). The actions of transport purchasers and those of transporters, for example, are related through delivery contracts; the actions of vehicle purchasers and vehicle manufacturers are similarly related, and we should consider how actions influence each other in terms of safety. The production of standards for SMS in relation to their actual implementation and use is another area in which closer integration could result in improved safety management. Although potential users of standards may be involved in their production, they often appear to be produced for a market which is assumed to be "out there", i.e. standards are issued no explicit plan for how the standard will be implemented by the market (ITF 2017).

Table 13. Conclusions drawn on implementing SMS, from a selected theoretical review.

THEORY	Risk management in societies	In modern dynamic societies, safety management should be performance based, and SMS is a useful way in which organizations can help ensure they meet performance demands. In recognition of the emergence of risk in systems, safety management and SMS should be integrated across systems in which individual organisations are embedded. Regulators should collaborate with organisations to establish consensus on performance markers and ensure necessary competence is shared across system actors. Implementing SMS involves accounting explicitly for management interests in production and ensuring a shared understanding of the safety implications of this. Implementing SMS demands that companies make explicit how safety is valued against other priorities in its operations, increasing the visibility of its social responsibility, and allowing interest groups to assess the extent to which safety values of organizations and society are consistent. This is relevant since it implies ways in which SMS can be promoted to help organisations meet performance requirements effectively and demonstrably.
	Sociotechnical systems	Safety management – like safety – is an emergent property of the system and cannot be limited within organizational boundaries. To understand how SMS should be implemented in and acoss organisations, we need to consider the influence of different people involved in safety management, their competing goals, the influence of culture in society and organisations, the constraints and opportunities presented by technology and infrastructure. As much as about *things* – processes, policies, technology, vehicles, infrastructure – safety management is about relationships among things and people that span the integrated sociotechnical system.
	Sociotechnical transitions and triple embeddedness	It is important to understand the stabilizing mechanisms of *regimes*: the normative and cognitive – i.e. not only regulative – rules, the shaping and reproduction of social rules, sunk investments in technology, market forces, existing competence/skills, customer value of safety, societal value of safety and so on. It is important to consider whether SMS is seen by managers as promoting or inhibiting for productivity. One way regulators can "sell" SMS to firms is as a tool for more operational flexibility in exchange for safety management that ensures they stay within "functionally acceptable boundaries of established practice". Development of a regime is a game in which moves to implement change by outsiders is likely to be countered by influential actors who – due to stabilizing mechanisms – do not see the value of change and wish to maintain the status quo. Actors who see value in change may be encouraged to implement it, and where positive sociopolitical or economic outcomes are salient, there will be social learning with other actors implementing change. Different actors have different resources with which to follow their interests, i.e. those who see the value (or not) in implementing change may be able to do little or a lot about it, depending on their priorities and resources. We should consider that each organization has a unique local context in the system, and therefore optimal solutions for implementing SMS will vary.

The second point of discussion is philosophical. Achieving a broader implementation of SMS is very much a "wicked" problem in the sense that the solution is implicated in the way we define the problem (Rittel & Webber 1973). We have made a value judgement when deciding that the way the system is, is not the way it ought to be. Defining a "problem" after Rittel and Webber (1973), as a discrepancy between the way the state of affairs as is and ought to be, leads us to the process of resolving the problem, which starts with the search for a causal explanation of the discrepancy. The problem is that in complex systems there are many interacting causal explanations, and identification and resolution of one cause of the problem poses another problem, of which the original problem was a symptom. This challenge is one reason why Dekker (2011) argues that attempts to address safety problems can introduce new problems into systems, pushing it closer towards failure. With this in mind is worth asking, what new safety problems are introduced by asking businesses to introduce traffic SMS?

6 Traffic SMS implementation: Status and influential factors

Given the importance of systemic influences on SMS implementation reviewed in the previous chapter, we will structure our findings from the literature review and interviews as follows:

- Immediate **industrial environment** (the general industrial regime and its implications for production-protection balance, leadership safety engagement, and harmonization of safety management across the industry; evaluation and learning by the business about the system in which it is embedded; and the business's strategic choice).
- **Economic environment** (role of suppliers, customers).
- **Socio-political environment** (role of policymakers and regulators of the industry, social movements, interest groups, public discourse).

Results from interviews with three road transport representatives, from NLF, NHO Transport and an NS ISO 39001 certification service provider, are presented in separate text boxes headed "Situation Norway" (in green) to distinguish them from literature review findings. We begin, however, by reviewing knowledge on the status of traffic SMS implementation in organisations.

6.1 Status of implementation

Traffic SMS are not easy to define and it is not easy to tell whether a company "has" traffic SMS or not. To get an idea of the state of implementation of traffic SMS in companies, we can use data available on the international road safety management standard, NS ISO 39001. The International Standard Organisation has published an overview of ISO 39001 certification data for 2016. According to this, 478 organisations were certified in the standard as of 2016, of which about half were European. Countries with the greatest number of certified organisations were UK (92), Spain (49), Italy (38), Greece (27), and Bulgaria (11). Scandinavian countries lagged behind with only six Swedish and one Danish organisation certified. These data are incomplete, however, since not all countries replied to the survey (personal communication, Standards Norway). Moreover, attendees of the seminar held at NPRA in 2016 (see page 2) claimed that many more than six Swedish companies were certified.

Situation Norway

According to a contact at Norway's main supplier of certification (*Kiwa Teknologisk Institutt*) ISO 39001 implementation is spreading "slowly but steadily" in Norway. As of April 2018, eight firms had gained certificates issued by Norwegian Accreditation, from both goods and passenger transport, representing a total of 3800 staff. These were: Hans Ivar Slåttøy Transport AS, Sømna Transport AS, Litra Gass AS, Litra Gas AB, Nettbuss AS, Østfold Taxitjenester AS, Ruuds Transport AS and TrønderBilene AS. Another 3-4 organisations were in the process of becoming certified, including another taxi company. One company had deferred its SMS certification.

Based on ISO 39001 uptake, it is clear that a few high-profile large bus companies prioritise road safety management, and there are positive developments in the taxi branch. Though Norway lacks high profile goods transport companies who are certified in traffic SMS, it was thought that larger companies tend to manage traffic safety using their own systems (i.e. not certified in ISO 39001). Overall, however, it was thought that goods transport companies do not seem to have equally good systems as bus companies for road safety management. It seems there is less traffic safety management in non-transport organizations. One representative expected more especially from contractor firms whose employees often use the road for work, since these were well represented on the committee responsible for introducing ISO 39001 in Norway.

6.2 Factors in the industrial environment influencing SMS implementation

6.2.1 Nature of the industrial environment in Norway

Previous reports have illustrated the diverse, fragmented nature of Norwegian road transport (e.g. Bråten et al. 2013), emphasizing the large number of small operators. Table 14 shows that from 2007 to 2015, 85 per cent of goods transport firms in Norway had less than five employees, representing 29 per cent of market share; most other companies had less than 20 employees. Companies with less than 20 employees represented 63 per cent of the market share, based on turnover.

Table 14. Size of Norwegian goods transport companies related to share of firms, share of market (turnover), and share of all employees in market, for the years 2007-2015. The table was prepared especially for this report.

	År	Number of employees							
		0-1	2-4	5-9	10-19	20-49	50-249	250 +	Total
Total firms	2007-2015	63 %	22 %	8 %	4 %	2 %	1 %	0 %	100 %
Total turnover	2007-2015	13 %	16 %	16 %	18 %	23 %	14 %	0 %	100 %
Total employees	2007-2015	15 %	18 %	17 %	17 %	21 %	13 %	0 %	100 %

Interviews with sector experts in our previous studies indicate that there is a safety regime of minimal compliance among "less serious" actors in goods and passenger transport in Norway (e.g. Phillips et al. 2015). We have little direct empirical evidence, however, either about small firms or less serious actors, since low levels of organization make it hard to reach them through unions or trade organisations.

Situation Norway

Our three representatives pointed out that the **branch organisations** have an important influence on the state of systematic road safety management in the industry due to: (i) their ability to influence high-profile actors; (ii) position as champion for advantages of managing road safety for the organization and the branch; and (iii) their role in providing member organisations with the knowledge, information, tools and other support they need on the way to certification.

The **Norwegian Truck Owner's Association (NLF)** has 3300 member companies, each with 1-500 vehicles, and has been active in this area in goods transport branches in Norway, promoting its own safety accreditation programs and more recently ISO 39001. NLF works especially on strategies oriented towards the economic systems in which branches are embedded (Figure 5). NLF appears to have been a central coordinator promoting the need for systematic road safety management and accreditation, and intends to develop its collaboration with the main certifier of ISO 39001 in Norway, and increase the number of NLF member firms certified to date (2 so far).

NHO Transport – a combined branch and employer organization for Norwegian goods, bus and some taxi companies – works mainly to strengthen the sociopolitical framework conditions and local branch agreements on behalf of its member firms. Like NLF it has worked with traffic safety, but focused mostly on individual measures (e.g. seatbelt use by drivers, safety courses) and establishment of evidence-based knowledge for these measures. Potentially, NHO Transport could adapt the activities of NLF (inviting members to talks etc.) to help market SMS accreditation to its member organisations – generally larger than those of NLF. Like NLF, NHO Transport participate in the "three-part branch program", involving collaboration on road safety with the **National Public Roads Administration (NPRA)**, governmental departments and three driver organizations.

NPRA is also an influential actor concerning whether and how road safety is managed by transport and other companies. It is the publisher of the Trucker's Guide, which gathers information that heavy vehicle operators need in order to drive safely in Norway. The national interest organization Safe Traffic (**Trygg Trafikk**) is another influential actor, which has focused on the need to manage road safety in the public sector – especially by public councils. Councils are important because they influence its many workers, as drivers for work, as well as the many public organisations – schools, hospitals etc. – who affect and are affected by the road system.

6.2.2 Awareness, motivation and means

In Norway and elsewhere, traffic safety management has traditionally been excluded from risk profiles by organisations evaluating their main risk areas, despite driving in traffic being the main work-related risk for many employees (Phillips et al. 2015). Clearly, SMS implementation cannot be encouraged where firms do not recognize their need or responsibility for managing traffic risks (Njå et al. 2015). As part of identifying barriers to SMS implementation we should therefore assess whether employers in an industry are **aware** that they are responsible for managing road safety risks of their employees – do they understand their obligations for road safety management? Given that there is this awareness, we can then address whether there is **motivation** within a regime for the management of road safety – are there discrepancies between regulative and normative rules, and if so why? Motivation may be related to leaders' safety engagement or production-protection issues, for example, or saliency of cases where firms in a regime have implemented SMS to the benefit of safety and the business. Then, given that a firm is motivated to manage road safety, do they then have the **means** to do so (ITF 2017)? Can they access the tools and information necessary to implement SMS, do they have the competency and resource to retrieve and apply information on the risks of outcomes

occurring and effect of measures to reduce the risks [19], and to achieve organizational changes to policies and procedures or the functioning of its people, processes and technology? To understand factors influencing SMS implementation in the industrial environment, it is therefore useful to consider firms within a regime along three dimensions of safety management: **awareness, motivation** and **means**.

6.2.3 Awareness

Investigating the lack of resource allocated to fleet safety, Davey et al. (2008) find that management perception of fleet safety is a main barrier to investment and implementation of programs. Managers see road safety as separate from occupational health and safety for which managers accept their "duty of care" responsibility. In a study of Norwegian fleets by Njå et al. (2010), 35 per cent of managers saw no alternative to existing methods for improving health and safety work.

The need to engage leaders in traffic SMS implementation would be key to any large transition involving the change of normative rules (Njå et al., 2105). ITF (2017) describe that managers in many transport regimes have a "compliance mindset"– a belief that existing operations already meet regulatory requirements and no further action is needed. This implies a need to change the normative rules of regimes from compliant to proactive safety management so that SMS is perceived as a tool to improve organizational performance and not an administrative burden. Safety management networks and positive case studies may help in this regard, as will any other attempt to make explicit the value of safety versus productivity (Jiang & Probst 2015).

Situation Norway

Our three road transport representatives generally agreed that there is a need to increase the extent of systematic traffic safety management in commercial road transport in Norway. The reasons they gave were the cost of road accidents to society; a need to raise the profile or improve public perceptions of goods transport companies; and to increase visibility of road safety management for transport purchasers.

One representative commented, however, that some transport companies – especially smaller ones – may have a "blind spot" concerning their need to manage the traffic risks of their employees. Another pointed out that the contracts many companies work on limit awareness of the need to manage road safety. Another pointed out that evidence of lack of awareness of other high-profile social issues – e.g. minimum wage legislation – implies a lack of awareness of road safety responsibilities among many goods transport employers.

One representative pointed out that it is mostly transport companies who are aware of and interested in SMS and certification – all ISO 39001-certified in Norway as of April 2018 are transport companies.

[19] Risk = likelihood x severity. In practice this will mean an assessment of the chance of principal behaviours resulting in fatal, serious, light or material injury per km traveled according to schedule of (e.g. seatbelt use, driving 5 km/t too fast).

6.2.4 Motivation

Motivation to manage road safety depends on the **branch** and what is being transported. This is supported by research showing:

- Multinationals use an SMS approach already developed for the production of hazardous materials when transporting those same materials (ITF 2017)
- High safety ratings for transporters of hazardous goods, who supplement regulations with internal safety rules and tend to rate safety culture highly (Nævestad & Bjørnskau 2014)
- Less "serious" goods transporters in several other branches, who may comply minimally with safety regulations in order to focus on surviving in increasingly competitive markets (Jensen et al. 2015).

There is strong evidence that regime-dependent variations in motivation for safety management is mediated by the level of management engagement in each organization (Nævestad 2016). Some studies go further and examine the mechanisms by which manager engagement in safety management is transmitted across organisations (Newnam et al. 2008, Newnam et al. 2012).

Situation Norway

If the findings of a study of haulage and passenger transport company managers by (Njå and Fjelltun 2010) still hold, there is a clear need to address manager attitudes in Norway:

- 34 per cent of managers agree that health & safety investments would not pay off;
- 25 per cent feel that it would decrease competitiveness;
- 50 per cent view mandatory safety work as already too expensive, with no need for further investment; and
- 75 per cent of managers in Norwegian road transport companies felt that health and safety work was important for reputation, but only 40 per cent that it was positive for productivity.

Njå and Fjelltun (2010) point out that managers are concerned with compliance with training or documentation requirements, but unless they also believe that safety work produces positive economic results, they comply only to convince employees, authorities and clients that they are concerned and act accordingly. Similarly, Huang et al. (2005) describe a similar top-down management "telling" and "selling" on safety, in which boardroom focus is on compliance with safety regulations rather than the content of safety management or consideration of truck driver needs and attitudes.

Evidence that safety management has economic benefits may help change management perceptions. Arguments can be made about the hidden costs of collisions (e.g. loss of expertise of injured drivers, absenteeism, downtime, reputation), and the fact that SMS can act as a conduit for other improvements in the company such as increased staff wellbeing and reduced turnover (Bidasca & Townsend 2014). Arguments can also be made that driving techniques that make drivers safer are "exactly the same as those that make them more fuel efficient" (Bidasca & Townsend 2014). Indeed, the comprehensive WRRS program evaluated by Wallington et al. (2014) was implemented to promote "safer and more fuel efficient" travel practices. As we saw in Chapter 4, the evidence for WRRS program effects is not empirically robust.

Many practitioners believe that **benchmarking** of transport companies on SMS implementation or risk levels can also help motivate managers to improve safety (Bidasca & Townsend 2014). An example of this is the UK's Fleet Safety Benchmarking is an ongoing national survey benchmarking national progress of different sections (e.g. policy)

of a 30-question gap analysis on safety management by firms[20]. By participating in the survey firms get immediate feedback on areas for improvement relative to other firms.

The Newnam studies inform on factors constraining the extent to which management engagement can improve safety management (Newnam et al. 2008, Newnam et al. 2012). The more a supervisor values safety, the more likely there is to be exchange of safety information with drivers, but this relationship is moderated by role overload. While leadership-driven interventions are cost-effective ways of improving safety management, employees must experience a real need to prioritise safety, e.g. SMS implementation will not work if people have other more important things to do that are not related to safety.

Finally, to understand motivation for SMS implementation, it is interesting to ask what convinced management in large international organizations such as Wolseley or BT to invest heavily over several years in work-related road safety (Murray et al. 2009, Wallington et al. 2014)? Internal champions seem to play an important role. In the Wolseley study, for instance, the arrival of a new HSE manager recognizing that driving is the biggest injury risk both for the company and the people it meets, was a main driver for program initiation.

Situation Norway

A representative of a ISO 39001 service provider explained that an emphasis on beneficial internal effects of traffic SMS helped when "selling" certification in SMS to managers. They emphasise that though the standard is relatively narrow in scope, it is a management tool that leads to broad positive consequences – both in terms of culture and specific processes at all levels of the organization. It is often possible for managers to observe improvements that are internal to the organization; in contrast to market forces, management will perceive that they can control internal processes. Moreover, better internal processes often lead to improved relations with the external (market and sociopolitical) environment.

A different representative observed that the largest operators are good at managing road safety, but other than as an exercise in reputation management, they do not see a clear benefit from doing this. The same firms may also look at their Swedish counterparts – a higher share of whom have implemented ISO 39001 – and fail to see visible business benefits of doing so. Accepting that lower profile firms in Norwegian transport branches will look to learn from larger operators in their branch, a lack of salient benefits of certification may be a challenge to achieving widespread traffic SMS implementation. This will be more important where there is lack of pressure for demonstrable systematic road safety management from the contract-giver (see Section 6.3). Motivation may be further reduced by perceptions that the threshold or demands for becoming certified are very high. Certification in traffic SMS is not perceived as something that smaller firms can become involved with – and there are many smaller firms in Norway. A further issue noted was the need to compete with increasing shares of foreign actors in Norwegian goods transport. In the lack of opposing evidence, many Norwegian actors may perceive that their foreign counterparts benefit economically from paying *less* attention to road safety management, thus making it harder to motivate Norwegian companies to improve safety management.

6.2.5 Means

By determining available resource levels, company size and branch (e.g. degree of competitiveness) will influence whether it has the means (capacity, competency, information, technology) to implement SMS.

Otherwise relevant literature on means aims at providing case studies and methods and tools for SMS implementation, especially illustrating methods and content and focusing on

[20] http://www.fleetsafetybenchmarking.net/main/audit_results.php

obtaining and maintaining engagement by the business. The EU's PRAISE report on the business case for managing road safety at work is notable in this regard (Bidasca & Townsend 2014). The report aims to help large and small transport firms, or any firm with employees who drive for work, understand "their exposure to work-related road risk and then make a business case for managing it" using a work-related road risk program. It appears to be based on a clear premise that there are savings to be had (without robust empirical support). It outlines a need to account for the fact that CEOs, finance managers and other senior managers will need to understand the business reasons for managing road risks (financial savings, efficiency gains, fulfilment of legal obligations, addressing corporate social responsibility to improve company profile and attractiveness to customers), while safety managers, fleet operators, human resource managers or transport managers will need a framework for how to invest and conduct work-related road safety management. Murray et al. (2009) points out that when engaging the board it is important to account for all hidden costs to the business, and to express costs in terms that the board readily understand[21]. Smaller companies or those who do not have established safety systems may not have enough data on which to base a business case, or may lack competence to investigate collision costs and draw conclusions.

In the US, the *Cost of Motor Vehicle Crashes to Employers – 2015*[22] was prepared for the Network of Employers for Traffic Safety (NETS) by the Pacific Institute for Research and Evaluation, funded by a grant to NETS by the National Highway Traffic Safety Administration. It updates the report *The Economic Burden of Traffic Crashes on Employers,* published in 2003. It gives figures at US national and state level on the costs to employers of crashes in terms of health fringe benefit costs (compensation to employee and family, health insurance, disability, life insurance, insurance administration, sick leave etc.) and other costs such as vehicle damage, liability insurance, legal expenses, vehicle replacement. It gives the annual costs to employers per million vehicle miles, per crash, per injury, and per fatality. It makes it easy for employers to calculate their (potential) cost burden – they just need to multiply tabulated costs by their total crashes, crash injuries or millions of vehicle miles travelled[23] The report also lists costs by branch, allowing for more accurate calculations e.g. crashes cost agriculture industry almost 3000 dollars per employee, cf 145 dollars in retail industry.

[21] E.g. a wing mirror costing £185 is multiplied by 3 to account for hidden costs to the business (=£555). Considering there is 8per cent profit from return on sales, it would cost the business £9,250 in sales (= (100/8)*555) to replace one wing mirror. For the company in question this equates to selling 1,140 bags of cement. Bidasca & Townsend (2014) describe how to break down direct and indirect costs e.g. insurance costs in terms of incident type (e.g. at-fault crash in transit, being hit by third party while parked, hitting fixed object, theft, vehicle damaged by clients etc.). Once all costs are understood and quantified, return-on-investment arguments can focus on interventions for high cost areas. However, this assumes that sufficient data are available with which to do this, which in turn depends on (i) the quality of record-keeping and (ii) that the company has been involved in collisions from which to draw conclusions.

[22] https://trafficsafety.org/road-safety-resources/public-resources/cost-of-motor-vehicle-crashes-to-employers-2015/

[23] Total costs are calculated as 45,000 dollars per million vehicle miles travelled

Addressing means directly, Nævestad (2016) builds on a recognition that one reason for poor SMS-uptake in Norwegian road transport is that the concept may be too daunting and resource-demanding for all but the largest companies, of which there are few (Jensen et al. 2015). This is also reflected by findings from interviews with experts in the UK road sector, that SMS are viewed as inappropriate for small operators, and that initial cost and efforts are too excessive for these. (Nævestad 2016) argues instead for a pragmatic, structured uptake of safety management, building in four steps from leadership engagement towards full SMS implementation. This is based on a review of the evidence from multiple sources, and much literature underscoring the fundamental importance of leadership commitment. The idea is supported by Small et al. (2013) who argue that many companies will only implement ISO 39001 if they can adjust existing systems without too much trouble.

Situation Norway

Our three road transport representatives agreed that there is no single consensus approach to implementing traffic SMS in Norway. On the whole goods transport companies will struggle most to find appropriate tools and knowledge, both to manage road safety systemically or to enable them to consider accreditation in traffic SMS. Smaller goods companies will certainly lack the time or resource to become certified, and sole proprietorships will view SMS as irrelevant. Many of the largest companies have the competence and means to become certified, but may already have their own systems in place to manage road safety. While one representative commented that it may be easier to make a case for certification to those firms that already have systems in place for managing environment and HSE, another commented that the overlap between certification systems is such that managers may perceive little benefit from yet another resource intensive certification process, when internal processes are already optimized by implementation of other standards. There is no single recognized source of information on traffic SMS in Norway, and one representative commented that consensus might be established by naming sources of information on traffic SMS in accepted industry literature e.g. Trucker's Guide.

6.3 Factors in the external economic environment influencing SMS implementation

We have seen that implementation of SMS by individual firms might be promoted by manager perceptions that they offer benefits to productivity. The Triple Embeddedness Framework (Figure 5), however, suggests that industry-wide change may be more effectively achieved if we also look to the economic environment in which the industry is embedded to leverage SMS implementation. The economic environment comprises suppliers of vehicles, staff, training, insurance, storage and finance, as well as customers and transport purchasers (e.g. Figure 7). Rasmussen's framework suggests that each actor influences the behavior of management and employees – and can therefore both be used to persuade managers to implement SMS and be included in any attempt at road safety management (Rasmussen 1997).

"The transport buyer must ask for [traffic SMS], it is important that they set things going."

- NLF representative

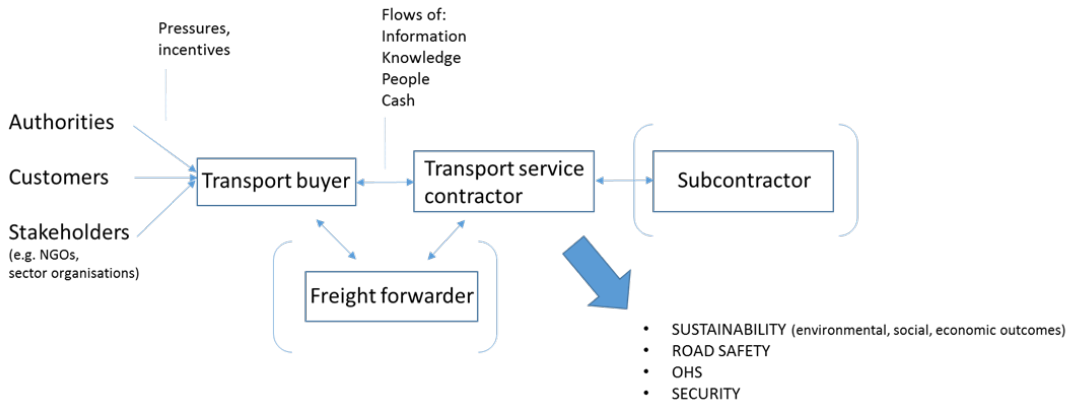


Figure 7. The economic environment of transporters (source: Gøril Hanås, University of Agder).

6.3.1 Selling safety

Bidasca & Townsend (2014) highlight the potential for enhanced business reputation through proven safety record or including accreditation in SMS in marketing materials. The importance of "selling safety" to customers will, of course, vary depending on the value of safety in a particular transport branch (compare passenger transport by air with fish transport by road, for example). Some providers of transport services report experiencing a conflict between effective traffic safety management on the one hand and addressing customer needs on the other (EU-OHSA 1998).

Situation Norway

In a Norwegian study on the potential of the ISO 39001 standard, Njå et al. (2015) claim that the desirability of certification in SMS can be increased by leveraging customer demand for safety and establishing certification as a way to eliminate "non-serious" actors from the business. The question remains, however, of how to motivate the transport purchasers and their customers to value road safety enough to demand it – especially if those demands would result in a limited pool of more expensive suppliers. When considering this we also need to account for the varying conditions in which different transport branches compete – particularly how what they transport determines the extent to which they compete on safety.

The level of conflict will depend on transport branch. Research indicates that transport providers to oil or hazardous goods producers experience far more understanding about the need to manage safety than providers to other sectors do. Shell Transport in Denmark, for instance, demand that transport suppliers maintain the company's quality and safety standards, including incident reporting, driver training and risk management (EU-OHSA 1998). In other sectors, measures for safer driving may mean that extra time is demanded for deliveries, and this may not be popular with customers or good for business, e.g. transport of perishable goods. On the other hand, it may mean reduced fuel and insurance costs, and savings could be passed on to customers. Rather than expecting transporters to demonstrate the value of SMS to customers, however, implementation would probably be most effectively encouraged by a norm for customers to formally demand that suppliers demonstrate road safety management.

6.3.2 Supply chain's role

Transporters are ultimately dependent on other chain actors to achieve specific performance outcomes. The need for employers to collaborate with other chain actors to "de-speed transport" and increase buffer times in the supply chain is a fundamental requirement if journey planning risks are to be managed. Recognizing this, Murray et al. (2009) state that benchmarking fleets against those in other organizations, and using the results as the basis for improvements or improved chances of winning contracts can be an incentive for transport managers, but it assumes that other transporters are willing to be benchmarked and that buyers' productivity concerns are addressed.

> *"We have said [SMS is] important for sustainability, cabotage, an important competitive advantage for Norwegian companies in Norway. The problem is when Norway must compete in the rest of the world where there is no demand [for SMS]."*
>
> - NLF representative

IOSH research shows several transport purchasers can also influence health and safety of their suppliers through the use health and safety standards to procure contractors, supporting certification schemes aiming to verify supplier safety competence, or setting requirements for risk assessment and communication. Such arrangements are more effective where they are (i) supported by adequate monitoring and control; and (ii) the buyer-supplier relationship is collaborative and trust-based. This implies that buyers are well placed to influence transporter safety where they have an established business relationship with the supplier, and where there is a high level regulatory scrutiny and pressure. Buyer influence will be **limited where suppliers see that the risks of failing to comply are low**.

From our brief review of the literature it seems that evidence on criteria for selection of transporters by transport purchasers of different types is required. The principle that transport services can be subcontracted but responsibility for this cannot be outsourced is already included in legislation on driving and resting hours (Bidasca & Townsend 2016), but what evidence is there that this is the case? Is there a need to consider the safety culture of those in procurement roles as well as those carrying out the actual work?

> *"We can only assume for most companies, traffic safety is not where companies feel pressure from the contract-giver, so it needs to be made visible and the smallest of companies must be able to do something about it."*
>
> - Certifier supplier representative

In Norway, customers and all other members of transport chains are legally responsible for transport safety, but sector stakeholders report that this is not how things are perceived in practice (Phillips et al. 2015) – an example of a change in regulations resulting in little regime change due to misalignment with normative rules. Experiences in Australia may show the way forward. There road sector experts recognize that regulators cannot drive the change towards SMS uptake directly; instead a group of "champions" is required, comprising "big players" among buyers, operators, trade organisations and unions who can sell the idea to the sector (Fourie et al. 2010). In Australia also Walker (2012) argues that the *industry* as a whole is best placed to improve road safety given the large number of smaller operators and productivity pressures. In other words, only the industry can tackle on-road safety performance of individual truck operators (not subject to health and safety legislation) through strategies that see the

industry working in partnership with government, related businesses and communities. Such thinking also lies behind the UK's Driving for Better Business[24] – a network involving collaboration between an array of public agencies and private companies who work together to "demonstrate the dramatic business benefits of managing work-related road safety more effectively". The idea of safety management networks is compatible with theories on regime transition and social persuasion, i.e. when viewed positively, actions by important others in the regime can stimulate transition (Cialdini 2009, Geels 2014).

Given the complexities of leveraging for increased systematic safety management and the strong influences whole transport chains impose on individual (especially smaller) transport firms, systemic solutions to these challenges are necessary. Collaboration is required, both among individual organisations in a transport chain and among branch organisations. In Norway there are encouraging signs that diverse branch actors are collaborating to encourage systemic SMS uptake – the challenge will be in ensuring that uptake is widespread i.e. is not limited to companies with extensive resources, or who already have high safety standards prior to uptake.

6.3.3 Insurer's role

The insurance markets for transporters are hardening, with compulsory third part insurance and increased civil liability legislation and worker compensation procedures (Newnam & Watson 2011). Since this obviates the need for companies to implement safety management systems for work-related driving, Bidasca and Townsend (2014) argue that transport companies should turn to insurers for help. One way to do this could be to use a business case for SMS to ask the insurer, leasing company or vehicle suppliers to support the development of SMS, or ask for data analyses to help identify targets for risk management (Wallington et al. 2014). Agreements can also be made with the insurer to reduce insurance premiums once traffic risk reduction has been demonstrated, or that money from at-fault third parties be invested in SMS. Insurers may also be persuaded to reduce insurance premiums in exchange for proven SMS accreditation. Bidasca and Townsend (2014) make the point that dealing with insurance companies can be more cumbersome for small companies, and larger more powerful transporters would need to take a lead role.

[24] https://www.drivingforbetterbusiness.com/

Situation Norway

The Norwegian truck owner association (NLF) is fronting branch organisation efforts towards traffic safety management, wanting buyers to be held responsible for choosing legal, safe transport, and promoting accreditation in safety management for its members to help in this process. A comprehensive mark promoted by NLF is *Fair Transport*. The following is taken from their website (translated to English):

> *With Fair Transport NLF will emphasise and clarify safe transport for responsible transporters – transporters who drive safely in traffic, have limited emissions, and offer good working conditions. In an unhealthy competitive situation, where prices are cut in an increasingly tough market, both buyers and sellers of transport reduce the demands placed on safety, the environment and social responsibility. NLF wants to help put a stop to such unhealthy relations…Fair Transport will make it easier for transport buyers to make the right choice.*

NLF's strategy is based on a belief that a tool is necessary to help transport actors meet their legal responsibilities for road safety management – if transport purchasers ask for "Fair Transport companies", then they know that the supplier will satisfy demands for road safety management. In this way NLF are trying to narrow the gap between the buyer and the operators as regards legislation and responsibility.

To become a Fair Transport firm, NLF members must have an approved traffic safety program. In a recent development, NLF has incorporated two such programs – "On the right side" (*På riktig side*) and "Working together for fewer injuries" (*Dugnad for færre skader*) into a new safety program resulting from a collaboration with the insurance company IF, called "IF Active Safety" (*IF Aktiv Sikkerhet*). NLF help ensure that member companies working under *IF Aktiv Sikkerhet* meet the required standards. To be approved, a company must show it owns a safety management program and works actively with safety. NLF does not influence directly what companies pay for insurance, but the insurance company is free to adjust elements in the insurance system on the basis of knowledge of companies who have signed under the safety program with NLF. Companies insured with IF get more out of the program in the form of resources such as e-learning tools. As members of NLF, they also have access to NLFs management training programs, its HSE system "Quality and environment on the road" (*Kvalitet og miljø på veg*) (KMV). KMV is an internet-based enterprise management system designed for transport companies. The system meets most requirements for quality and environmental protection as well as road safety. In addition, it meets the authorities' requirements for an internal control system (HSE). The system is built on extracts from ISO 9001 (quality), 14001 (environment), 39001 (road safety) and government HSE requirements. Only those companies with sufficient available resource will tend to seek to become a Fair Transport firm – many companies will never attain the standard. Thus NLF's work is unlikely to result directly in industry-wide implementation of traffic SMS, but it may stimulate spread of such programs or the call for standards that can be applied by everyone in the industry.

NLF is also working to persuade larger purchasers of transport to be selective, as well as give them the means to identify which transporters to choose. It is hoped that this will afford Norwegian companies a competitive advantage in Norway, but does not address the problem of competition between Norwegian and foreign companies elsewhere, where transport purchasers are less likely to demand that its operators can demonstrate effective road safety management.

6.4 Factors in the socio-political environment influencing SMS implementation

The socio-political environment in which firms-in-industries are embedded comprise regulators, other authorities or administrative organizations, policymakers, civil society, interest groups and social movements (Figure 5). Systems analyses based on frameworks like Rasmussen's also emphasize the importance of government departments, regulators and associations in providing optimal conditions for safety management by transport

companies (Edwards al. 2014, Newnam & Goode 2015). Of the literature we retrieved, that which was relevant to the influence of the socio-political environment on transport safety concerned three domains: (i) regulation, (ii) contributions from public authority (not related to regulation), and (iii) corporate social responsibility.

6.4.1 Regulation

Pathways towards SMS regulations and standards taken by different transport sectors

The main transport sectors are each governed to some extent at international level. We summarise key factors in the development of SMS in each of the four transport sectors in Table 15.

Table 15. Summary of development of SMS in each of the main transport sectors - from text of ITF (2017).

Air	Maritime	Rail	Road
NAV Canada first commercial entity to introduce SMS in 1997-1998 Transport Canada require all airlines to implement SMS in 2005 (based on 4 pillars cf. Table 3). International Civil Aviation Organisation (ICAO) – a body established under United Nations representing 191 nations – publishes its Safety Management Manuals in 2009; includes SMS as "4-pillars" approach. Annex 19 of the Chicago Convention – applicable as of 2013 – includes all requirements for an SMS in each of the various areas of activities of international aviation i.e. applies to service providers operating within the aviation safety ecosystem.	International Management Code for the Safe Operations of Ships and Pollution Prevention (ISM Code) adopted by IMP in 1993 in response to capsizing of Herald of Free Enterprise (1987); it replicates spirit and substance of SMS. SMS ship-centric, rather than shipping company-centric. Shipping lines and ship management motivated to document SMS, since ISM code requires SMS documented for internal and external auditing, for document of compliance from flag state, safety management certificate, ultimately license to operate.	EU Directive 2004/49/EC require operators and infrastructure managers to have SMS, assessed by national authority using standard EU method. For traffic between EU and non-EU countries, the Convention of International Carriage by Rail is being developed to enourage co-management by infrastrucutre owners and rail operators, where SMS will be certified and overseen by regulatory unit of country where the traffic is.	There is no international regulatory or standard setting like IMO or ICAO. EU social driving rules, but not SMS. ISO 39001:2012 specifies SMS for any organisation interacting with the road system, but it is not a mandatory requirement.

We know little about the extent of SMS implementation among the various sectors, as there is no clear way to assess this. If we assume, however, that a greater share of "firms" in the air, maritime and rail sectors have implemented SMS than in the road sector, then it is interesting to observe differences among regulatory steps towards implementation. We see that each route is different but consistent with Geels' theory on transitions in sociotechnical systems reviewed in Chapter 5. In the air sector, a single firm saw the value in and implemented SMS, facilitating a move by the national regulator to require its airlines to introduce SMS. This was then taken up internationally by the ICAO and is now being broadened to include all types of firms in the industrial ecosystem – not just airlines. In the maritime sector moves towards requirements for SMS were made by the international regulators in response to a major accident with a high sociopolitical profile. EU legislation in the rail sector has built on a tradition for safety excellence and a sharing of safety management among different actors in the industrial ecosystem – not just train operators. There is a high level of coherence on SMS throughout the rail system, at national levels at least, because of this tradition. There is no evidence in any sector, however, that industrial regimes will evolve towards SMS voluntarily. **In all sectors, there has been regulation for SMS, and in the case of the rail – and arguably the air sector – changes have been facilitated by close alignment between normative and regulative rules**. In the maritime sector, although there may be less alignment in this sense, a requirement of

documented compliance in exchange for an operating license may have stimulated broader uptake.

Turning to the road sector, the 89/391/EEC framework directive on the health and safety of workers requires every employer in Europe to undertake a risk assessment that should include all employees travelling for work (Bidasca & Townsend 2014). Although the degree to which individual member states regard the vehicle as part of the workplace may vary, 89/391/EEC is an overarching legal minimum framework for reviewing road safety risks faced by organisations. In Norway, 89/391/EEC aligns with Norwegian Work Environment Act (WEA) of 1977, which requires transport companies to facilitate good transport safety for their employees through their HSE work. The Internal Control (IC) Regulations of 1996 require the managing director of an enterprise to ensure that the enterprise obliges with the WEA and works systematically with HSE. Employees must actively participate in this. Working actively with HSE means for instance to set safety objectives, defining responsibilities, identifying HSE problems, obtaining overviews of laws, planning HSE measures, following up and undertaking annual reviews of the company's HSE work together with safety representatives. Per the law, measures should be developed in collaboration with employee representatives, and all phases in the work should be documented formally. The systematic work comprises 4 phases: implement work with HSE; map existing regulations, HSE routines and risk; plan and prioritise domains for risk analyses and development of action plan; implement measures to tackle problems. The aim is continuous improvement in HSE work as a normal part of operations. The WEA can be considered as a legal requirement for systematic risk management for firms with over 5 employees. The law does not, however, cover specifically the management of traffic safety and does not specify at which level the work should be systematic. Road sector interviewees in studies conducted by Phillips et al. (2015) and Elvebakk et al. (2017) asserted that although employers have a wide-ranging responsibility for their workers' safety per the WEA, this is rarely enforced in practice. The Road Traffic Act, which places responsibility with the driver, is more often enforced through controls and in police investigations. Road sector interviewees stressed that organizational responsibility was poorly defined for work-related road accidents. Others believed that in theory, responsibilities were well-defined, but that the practical follow-up was inconsistent. Most of the informants in Elvebakk et al. (2017)'s study claimed that employers should take more responsibility for their employees' behaviour.

On top of health and safety law there are an array of transport regulations, especially for heavy vehicles through the national and EU social legislation on working hour limits, certificates of professional competence, and tachograph use. Organisations in most countries have a regulatory duty of care to ensure employees understand these regulations and comply with them. In both Norway and EU, however, safety for employees driving cars or vans is poorly specified in rules describing how work-related safety should be managed. The regulatory approach regarding work-related road safety is piecemeal as described for Australia, UK and USA, with responsibility for managing and regulating work-related road safety spread across health and safety and transport government agencies with no single coordinating body (Stuckey et al. 2013). Stuckey et al. (2013) argue that policy-makers should form a visibly coherent policy on work-related road injury by integrating the current set of disparate policies that address it; further that this can be achieved by greater integration of management of work-related road risk into regulatory and non-regulatory occupational health and safety initiatives. They also highlight that regulations for employees driving light vehicles for work are insufficiently developed by all countries, in either health and safety or transport regulations, creating inconsistencies between work-related road safety regulations for heavy and light vehicles. In Norway too,

Njå et al. (2015) recognize the need to modify the WEA, the IC regulations and the occupational traffic law (*Yrkestrafikkloven*), to give a coherent message, grounds for enforcement, and regulation of safety management.

Based on this brief review we identify the following sociopolitical barriers to SMS implementation:

- No legislative requirement for SMS implementation, but rather diverse regulations on road safety management
- Insufficient enforcement of WEA rules and the IC provision
- No single regulator responsible for high-profile accidents
- No broad tradition of safety excellence / poor alignment between normative and regulative rules on safety management (e.g. low belt use by truck drivers)
- No tradition for sharing of responsibility for safety management among actors in the industrial or road ecosystem, i.e. traditional focus on the driver and the heterogeneous nature of actors[25] presents challenges for systemic safety management
- Low coherence, i.e. low transparency, extremely fragmented, diverse industries and public actors varying greatly in number of employees.

Regulatory burden and frameworks

Insight into management strategies towards the sociopolitical environment relevant to the implementation of safety management systems can be inferred from Hale et al. (2011)'s article on regulatory burden. According to this, managers seek to balance costs of assessing and complying with new regulations with productivity gains from process improvements. Managers view new activities as consuming time and energy of managers and employers, and diverting resource from other activities. Evidence shows that the costs of new regulations have been found to fall disproportionately on small businesses, which lack the internal management and resources necessary to translate complex rule sets taking too little account of their contexts, to keep records or to report to regulators on compliance. Costs can reduce competition and increase prices for products and services. The situation is not helped by the fact that it is often difficult to demonstrate the effects of true regulatory requirement, such as mandating formal SMS, on accident rates. Hale's study implies a need to study not only the effect of whole management systems on safety, but on productivity outcomes and competitiveness. Hale et al. (2011)'s findings are consistent with Geels' (2004) claims on the resistance of industrial regimes to sociotechnical transition.

Hale et al. (2011) also informs about implications for safety management of different regulatory frameworks, describing that regulations expand where agencies focus on rule- rather than goal-based outcomes (see Figure 8).

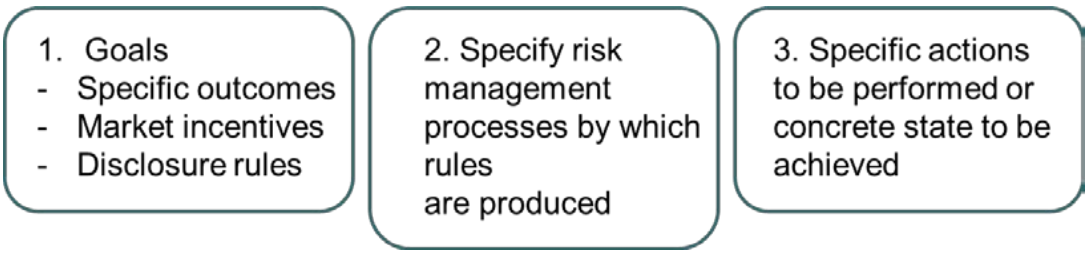


Figure 8. Continuum from least to most restrictive forms of regulation. From Hale et al. (2011).

[25] "Operators" can vary from a single pedestrian to national express bus services; infrastructure providers can be small villages, national governments or private companies; enforcement can be carried out by general police, traffic police, or regional and national road authorities.

Regulatory burden is reduced by encouraging companies to achieve desired outcomes by means they see fit, rather than complying with action rules, and doing this accepts that firms have better information than regulators about their own industry, especially regarding increasingly rapid change in technological advances and branch conditions. Goal-based regulation encourages management ownership of risk, and a focus on methods to reduce risk, rather than compliance and reaction to regulations. It is supported by studies showing that management often view imposed rules as "not invented here", to be compiled with to the letter and not the spirit, with least possible commitment.

Regarding SMS, the difference between 1 and 2 in Figure 8 is presumably that companies would be free to define their own SMS in type 1 regulation, where aspects of SMS are laid out by the regulators in type 2 regulation. Disclosure rules are an interesting option included in type 1 legislation, where firms must make public the number of accidents or work practices, making it easier for workers to determine risk and to provide market incentives to firms to mitigate risks. Regulators may also use incentives such as tax credits to encourage voluntary compliance. Relating to the above, and to Section 3.2, it seems that regulators in aviation, maritime and rail sectors are attempting to implement regulation type 2 for SMS, whereas in the road sector there is either no regulation, type 3 regulation (e.g. social rules legislation) or type 2 (WEA).

Hale et al. (2011) argue that SMS are a way to promote ownership of regulation and innovation in safety management processes. A requirement for SMS uptake could indeed change the "compliance mindset" of management, as has been shown in maritime transport. However, type 1 SMS legislation would require that outcomes are described in concrete rather than generic terms, such that they do not leave too much room for interpretation. Performance should thus not be based on outcomes that cannot be measured directly, or where there is a lack of evidence about what safe limits to performance are[26]. Type 2 SMS regulation implies some form of external auditing using tools such as developed by Mitchell et al. (2012) for auditing safety in light vehicle fleets with measures monitoring and assessment; employee recruitment and training; vehicle technology, selection and maintenance; vehicle journeys. Audits have been criticized, however, as reducing complex systems to linear cause-effect chains and failing to capture how effectively the implemented systems manage safety (Mooren et al. 2012).

A further challenge for performance-based regulation is that it favours larger firms, who tend to dislike detailed specific regulations that reduce the company's ability to define its own rules (Hale et al. 2011). Small companies, however, often prefer concrete regulations that make clear exactly what to do – they don't have the resources to translate abstract goals and risk management process rules into detailed rules.

In sum, if outcome rules can be formulated in concrete terms, in a specific, accessible and measurable way, then a shift towards type 1 or 2 regulation may be optimal for larger companies, and may help shift the regulatory burden. For smaller firms a compromise between a few abstract goals and management process regulations (type 1 and 2), and a larger number of concrete, detailed action rules (type 3) may be best.

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[26] The European Aviation Safety Agency (EASA) rules on pilot fatigue, applicable on 18th February 2016, arguably falls foul of this recommendation – there has been a lot of controversy because of it. The rules state that airlines should not roster their pilots for fatiguing duties, and that pilots should not fly if they are or expect to be so fatigued such as to endanger the safety of the aircraft or its occupants. In addition, the rules prescribe some limits of maximum duty hours that pilots can work, and the requirement of an SMS that allows operators themselves to determine what the safe limits of pilot fatigue are. Although the method of this determination should be "data driven, relying on scientific principles and operational experience", the move towards performance-based regulation – in absence of a proper operational evidence base in this area – means that airlines can essentially set their own parameters on how to define, measure and record data on fatigue.

Challenges of regulating for SMS

SMS have been seen as "a valuable management tool in moving to performance-based regulation" (ITF 2017). SMS have the potential to give operators the flexibility to decide how to deliver safety performance objectives set by regulators, while at the same time giving regulators increased oversight into the operator's safety performance and how this is achieved. Many recognize the potential of SMS to increase the extent to which responsibility for safety is owned by operators and regulators together, and not just regulators. The ideal is learning to improve safety in an apolitical partnership through internal changes in the culture of both the regulator and operator (ITF 2017 p.3).

What is not clear, however, is how much the framework conditions and real political contexts of both actors limit the extent to which this can be achieved in practice. Another challenge is that regulators choosing an SMS approach are in danger of being seen as shirking their responsibility for safety, leaving operators to their own devices – at best promoting a safety deregulation. There can also be a perception that SMS is adding "more layers but not removing those that aren't working" (ITF 2017 p.27). Regulators that have introduced SMS (i.e. in sectors other than road) focus on operator adherence to documented processes. This can still equate compliance with reliability and reliability with safety – the old mindset – with a danger that SMS compliance becomes institutionalized (ITF 2017). It is important to remember that processes are the means to low risk outcomes, not the ends themselves. ITF (2017) observe that despite regulating for SMS, the problem remains that operators "prefer a regulatory approach to which they can comply and then turn their attention back to doing business". To avoid this – to achieve real progress – regulators must accept that SMS changes everything: the regulatory framework, the nature of inspections, skill sets of inspectors, tools and processes regulators use, and how and what safety and enforcement data is shared (ITF 2017). There are several challenges to this transformation: political pressures, economic pressures, resistance to change (regulator and industry), applicability of SMS to small operators, challenges of standardizing a fragmented industry, need for openness between regulator and operator, perceptions by regulator that new safety risks may be created in current safe systems (ITF 2017). Openness is a challenge in competitive, fragmented goods transport sector markets (Sternberg & Andersson 2014).

Accreditation

The existence of numerous accreditation programs and certification schemes indicates quality assurance has become important part of safety compliance in Australian trucking, where a range of voluntary and mandatory programs regarding safety, maintenance and general business practices are available from government and trucking industry associations (Walker 2012). Branch programs also operate in animal welfare, food transport and hazardous goods. A government national accreditation program providing regulatory concessions – e.g. extra mass allowance – is successful because it provides incentives to join. It is normal for firms to be members of the national program as well as industry-based programs since the content of each is similar (e.g. fleet safety management).

Research into mandatory programs shows that their resource intensiveness limits their impact, leading Walker (2012) to claim that voluntary programs are the way forward since they supplement regulations, can be adapted to individual firms, and also engage industry in the delivery of higher safety standards. Rufford & Bass (2006) suggest that if all non-accredited vehicles in Australia became accredited, there would be a 50 per cent reduction in the crash rates of articulated vehicles (Rufford & Bass 2006); such statistics can be used to inventivize trucking industry associations and lead firms, who are best placed to increase take-up of voluntary accreditation programs.

Situation Norway

There were comments that fewer larger transport firms are certified in the management of safety than of quality (9001) or the environment (14001), but may be more reluctant to become safety certified. We have already given reasons for this, but a contributing factor appears to be that safety has a lower sociopolitical profile than the environment. It can be seen that "everybody is concerned about the environment", and so it is important to show customers and others that you take it seriously. Environmental management is more established, it is easier to define the problem, the organisation's contribution to it, and to measure its management. Nevertheless, branches perceived as having a poor reputation for traffic safety may still see the benefit of safety management certification. The main motivator for taxi firms to become certified in road safety management appears to have been a need to raise the public profile of the branch in this area.

Benchmarking

In addition to accreditation, benchmarking can also be used as a regulatory tool by the industry. In a fleet safety program from New Zealand, the police, Department of Labour and Accident Compensation Corporation worked together to reduce road accidents. A numerical fleet risk level was assigned to companies' fleets based on an algorithm developed for the program. The algorithm was itself based on fleet and owner-company characteristics and past safety records. Fleets were assigned a low, medium or high risk level. Owners of meduim-risk fleets were directed to a government website with information and resources that could be used to improve safety management. High-risk fleets were visited by the agency who assisted in mitigation.

6.4.2 Contribution from authorities not related to regulation

Stuckey et al. (2013) claim that businesses need regulatory or commercial inducements to implement road safety strategies. In the absence of regulations, governments and other public authorities can do two things to encourage SMS implementation: (i) **lead by example**, by managing work-related road safety risks faced by its employers, and (ii) ensure the integrated enforcement of the chain of responsibility by ensuring that work-related road safety management is addressed in **procurement and operation of contracts** by suppliers (Stuckey et al. 2013). Government could demand, for example, that supply chain partners purchase only 5-star vehicles, demonstrate robust recruitment and induction procedures, and have adequate risk assessment and auditing processes in place.

Situation Norway

Many consider regulatory authorities as beacons of good road safety management practice, which private firms look to and learn from. Njå et al. (2015) recommends that Norwegian public organizations like NPRA, police, Labour Inspectorate should therefore lead by example and implement ISO 39001. This is in line with Bidasca and Townsend (2014)'s recommendation that government agencies and organisations should lead by example and implement SMS. As we have seen in Chapter 5, however, Geels' sociotechnical transition theory suggests that firms will be most influenced to change by observing the effects of implementation of other firms in their sector, rather than authorities in the sociopolitical system in which they are embedded. Whatever the case, at the time of writing no figurehead organizations are yet certified in ISO 39001 in Norway, although in Sweden the Swedish Transport Administration (*Trafikkverket*) – responsible for long-term planning and building, operating and maintenance public roads and railways – has recently been asked by the government to implement ISO 39001 in their organization. Apart from safety improvements, implementation could afford the Administration a comprehensive understanding of traffic SMS and how transport and other firms can best implement and benefit from such systems.

Representatives also claimed that public authorities can do more to stimulate SMS accreditation, not least by demanding through procurement that their own suppliers become certified. There is as yet little evidence that demands for systematic road safety management are made in public procurement practice in Norway. Some pockets of systematic road safety management exist in taxi and hospital transport, but even here procurement has failed to play a role. One representative pointed out that contract for tender issued by public bodies should in theory demand road safety management as much as they do HSE management. One idea is for NPRA to publish a procurement guide (innkjøpsguide), explaining how those issuing contracts for tender can go about demanding road safety management from their suppliers.

At EU level, authorities have also attempted to help work-related road safety through **initiating and funding projects** – most notably ETSC's PRAISE – and through the European Road Safety Charter, which aims to encourage and support European associations, schools, universities, companies of all types and sizes, and local authorities to take actions for road safety in Europe. Over 3,400 public and private entities have committed to the European Road Safety Charter (http://www.erscharter.eu/), and carried out road safety actions and initiatives targeted at their members, employees and the rest of civil society.

Public authorities can also help by **validating SMS** through cases and evaluation studies. This requires agreement on standard risk indicators, also required for surveillance and benchmarking of occupational road safety standards, particularly in the case of grey fleets (Murray, Pratt & Dubus, 2010). To be able to apply the results of evaluations across different transport companies would first require consensus on SMS dimensions to be evaluated, and this may be challenging. Fernández-Muñiz et al. (2007), for example, argue that SMS can be evaluated along the dimensions of policy, employee incentives, training, communication, planning and preparedness, control and benchmarking – implying a comprehensive SMS that may not be applicable for smaller firms. The way in which the overall SMS and each of its element is implemented will also influence ultimate safety effects, and this also needs to be evaluated (process evaluation). In line with this Mooren et al. (2014) claim that the main challenge for evaluation of SMS is (i) agreeing on and measuring the effects of a range of different elements making up the systems; and (ii) generalizing the effects of tailormade measure sets. Hammer et al. (2014) criticize SMS audits in the US, which are often based on collective experience developed from years of consultancy or management rather than on explicit management models. Thus public authorities could start promoting evaluation of traffic SMS by helping to identify and achieve consensus on common risk indicators, process elements and safety outputs, that can be used to measure the effect.

Situation Norway

Despite lack of self-certification in ISO 39001, both the Labour Inspectorate and NPRA in Norway are actively involved in moves to encourage uptake of traffic SMS by firms in other ways. Through the Safe Trailer (*Trygg trailer)* project, NPRA has successfully engaged the purchasers of transport services in working with foreign drivers actively at depots to increase road safety (tyre, load checks, information on tunnels etc.). It is also financing a research program on road safety management by organisations of which this report is part. Other reports include evaluation of traffic SMS to help increase the perceived value of formal safety management (Nævestad et al. 2017). The Labour Inspection Authority in Norway has had a focus in from mid-2015 on profiling the responsibility of transport purchasers and transporters (goods and coach passenger transport) for road safety management, and there are increased site visits to firms and increased collaboration with NPRA on roadside inspections. Here the focus is more traditional i.e. more on control and inspection than on seeking to ensure conditions necessary for performance-based regulation, e.g. vertical integration of a coherent understanding and measurement of traffic safety management throughout an industry.

In encouraging implementation, authorities and regulators need to recognize the conditions in which the industry operates, by for example providing practical information about the time, costs and other demands of certification, to save time on understanding ISO 39001. Or, it could explain or generate data on how better internal control can be established in a firm through certification, to facilitate reporting for NPRA or Labour Inspection Authority inspections, reduce the number of failed inspections or bring about other concrete business benefits. It might be able to learn from Sweden in this regard, where authorities have attempted to encourage implementation with an understanding of business constraints. Authorities may also learn from NLF's activities in attempting to encourage implementation while accounting for different business contexts. Otherwise, one representative called for increased coherence in the sociopolitical work to raise the profile of road safety management, with messages from the NPRA, Norwegian Labour Inspection Authority and Safe Traffic (*Trygg Trafikk*) in danger of detracting from each other.

One represented that there may be space for the Labour Inspection Authority to emphasise that road safety should be managed systematically under existing law, i.e. HSE and Work Environment Law para. 2.2, which states that employers have a responsibility for own employees / those hired in to have routines in place for traffic safety, loading etc.

Authorities can also play a role in increasing cooperation and sharing of information across country borders, making it easier to assess the extent of road safety management by foreign companies – especially from southern and eastern Europe – sending consignments to Norway.

Public authorities can also stimulate SMS implementation indirectly, by ensuring that **investigation processes** for accidents involving work-related driving account sufficiently for the employing organisation's safety management. This would provide evidence for the link between SMS and road safety, and increase regulatory momentum towards SMS. Investigators need to consider the extent to which (ITF 2017, p 31):

- Risks and appropriate control measures were identified by the SMS
- The control measures were documented, understood and applied
- The organization has attempted to learn from previous experience
- Relevant safety assurance processes were in place (SMS efficacy monitored and reviewed)
- The regulators themselves have attempted to understand and address the company's safety challenges.

6.4.3 Corporate social responsibility (CSR)

Only 40 per cent of the costs of work-related crashes are covered by the employer, the rest being paid for by society and the employee (Wheatley (1997) cited in Newnam & Watson 2011). The potential loss of reputation from a catastrophic accident for which the firm is at fault can be devastating. Conversely, a good safety reputation could help gain customers and recruit better employees and accreditation in safety management could have marketing and branding benefits (Murray & Watson 2016). Synergistic benefits to the environment of

accounting for safety (e.g. fuel efficiencies, speed reduction) can also help improve reputation.

Road safety management can help corporations address a need to be (seen as) socially responsible (Murray et al. 2010). This has not been a priority to date. For example, Bidasca & Townsend (2014) describe how a case for SMS implementation should be made centered on clear business and legal arguments, rather than social responsibility although, given increasing social and environmental concerns, the importance of CSR will probably grow. CSR has been emphasised most to date in the work-related road safety studies. Murray et al. (2010) claim there is need to measure the real and perceived importance of CSR.

6.5 Summary and discussion

We cannot be precise about current levels of SMS implementation, partly because it is hard to know when a company "has" an SMS or not, and partly due to insufficient data. Using the relative degree of implementation of a formal certificate in traffic SMS (NS ISO 39001) as an indicator of progress, however, we observe steady but very slow progress towards traffic SMS implementation in Norwegian transport companies. There is even less sign of progress in companies whose main aim is not transport, but who never the less employee people who drive for work. We can say little about the status of implementation for the over 80 per cent of goods transport companies with five or fewer employees – these have insufficient resource for NS ISO 39001 implementation.

Factors influencing traffic SMS implementation have been reviewed according to whether they are present in the immediate industrial, economic or sociopolitical contexts in which the transport companies are embedded (Geels 2014). Reviewing the industrial contexts of transport companies in Norway, we see that the Norwegian Truck Owner's Association (NLF), the national federation of transport companies (NHO Transport) and the National Public Roads Administration (NPRA) are key actors in the landscape in which the larger transport companies operate, and are therefore important for helping to set traffic safety standards in the sector. For non-transport companies with employees who drive for work, the NPRA, Safe Traffic (*Trygg Trafikk*), and actors normally influencing HSE – such as the Labour Inspection Authority (*Arbeidstilsynet*) or company health service providers (*bedriftshelsetjenseter*) – are key.

The absence of a traffic SMS may be due to management in a company lacking awareness, motivation or means to manage traffic safety. Nja's (2015) research in Norway consolidates international findings that management in many transport companies operate in a regime dominated by a compliance mindset, in which SMS may be perceived as an administrative burden. This could be because managers do not know about the potential benefits of managing traffic safety – in terms of company efficiency gains or improving reputation – but the contracts they carry out do little to discourage a compliance mindset.

Motivation to manage traffic safety varies with its perceived importance to the core business. Unless managers believe safety produces positive economic results, they may comply with regulations only to convince employees, authorities and clients that they are concerned. Perceptions that traffic safety management has economic benefits may therefore help change compliance attitudes. Perceptions that foreign companies benefit economically from not managing road safety, and that the company's internal efficiency gains are already optimized by certification in other areas, may also encourage mere compliance. These, and other perceptions to be tackled to encourage implementation of SMS are presented in Table 16.

Table 16. Management perceptions that may obstruct SMS implementation (normative-regulative rule discrepancies) and proposed measures to help tackle them. Extracted from findings presented in the current chapter.

	Perception as barrier to SMS implementation	Perception enabling increased implementation	Ideas for action
1	We address safety concerns sufficiently by complying with HSE and sector-specific regulations.	We have a legal obligation to manage employee safety proactively and systematically.	Assessment of existing legislation in Norway in relation to 6.4.1. Examine use of accreditation in other countries in relation to regulatory opt-outs. Work with EU to assess regulatory opportunities. Clear up confusion about what HSE legislation says about employer's obligation to manage traffic safety risks. Are there relevant successful prosecutions / investigations by Accident Investigation Board?
2	Traffic safety is not normally managed systematically in our industry.	As a main risk area, proactive traffic safety management is an essential in our industry.	Build on regime "tension" created by the companies already certified in ISO 39001 in Norway. Evaluate and promote the benefits this has offered, campaign and inform key leaders in the regime. Consider national benchmarking as way to promote systematic traffic safety management as norm. Build on NLF's existing attempts to establish accreditation in traffic safety management as norm, e.g. NHO Transport could hold similar workshops for its members to promote accreditation / certification. Trade publications, handbooks (e.g. Truckers Guide) to raise profile of systematic traffic safety management.
3	Minimal compliance with HSE law is best for business.	Systematic, proactive traffic safety management above and beyond that required by law, improves productivity and makes us more competitive.	Arrange branch workshops to present case study evidence (e.g. PRAISE) and cross-sectional analyses from the research literature – learn from NLF for other content. Collect Norwegian evidence – what happens to companies who implement traffic SMS? Present branch organization's / high profile company's experiences on the effects of minimal compliance versus proactive traffic safety management. Profile transport purchasers who seek companies who have implemented traffic SMS.
4	Expense and high demands of SMS certification will reduce resources needed for productivity and make it harder to compete.	See above	See above, though this will not address the problem of competing foreign transporters.
5	Our customers do not contract us to manage traffic safety.	Systematic traffic safety management is one of the activities we are contracted to do.	Research transport purchaser constraints on demanding suppliers are traffic SMS accredited. NPRA campaign targeting figurehead purchasers of transport, to promote the benefits of including demands for traffic SMS in private and public procurement. Provide tools for this (can base on PRAISE reports) and use procurement to promote accreditation schemes already underway (NLF). Build on innovative ways to involve buyer in traffic safety – NPRA's Safe Trailer / *Trygg Trailer*. Examine why legislation on joint responsibility for traffic safety by transport chain actors doesn't work, how to enforce. Evaluate effects of including traffic SMS in procurement demands. Profile transport purchasers who already seek companies who have implemented traffic SMS. Promote traffic safety as a social issue alongside social dumping, environment (Safe Traffic?)
6	We do not see how others have benefited from SMS / ISO 39001 certification.	We see that other businesses have benefitted from SMS accreditation / certification.	Research is underway, more is needed.
7	After certification in quality and environmental management, there is no point in safety management certification.	Certification in safety management offers unique benefits to the organization, independent of improvements in internal processes.	Work with certifier service providers to identify solutions, e.g. combined certification processes.
8	We are a large company and can most effectively manage safety in isolation with our own systems.	Large companies benefit from sharing common data on safety management, to promote learning.	Begin by surveying companies to benchmark status and different approaches to traffic safety management Cross-industry collaboration to identify common safety markers, evaluate and promote benefits of using common markers.
9	We are a small company with insufficient knowledge and capacity for systematically managing traffic safety.	We are a small company but systematic traffic safety management is feasible for us and applies to us.	- What exactly do we expect of small companies? - Consider ways to apply The Safety Ladder (Nævestad) as a way to structure phased implantation of SMS in smaller transport companies.

This table also proposes measures to help change perceptions, such as national benchmarking on traffic safety management, and nurturing internal champions of traffic safety.

Larger transport companies may already manage traffic safety effectively using their own SMS. Managers in these companies will understandably be reluctant to move away from systems in which they have invested, which are tailored to their business, and which they know to work. Such "home grown" traffic SMS will be poorly visible to others in the sector. A single coherent, cross-sectoral traffic SMS would, on the other hand, provide a common safety language and the sharing of safety data and experiences. Encouraging companies to agree, use and report on common traffic SMS measures (without having to change existing traffic SMS) might help address this issue.

In addition to the firm's intrinsic motivation to manage road safety of its employees, there will be extrinsic motivation from the surrounding regime, sociopolitical and economic systems in which the firm is embedded. As we have seen, the value of safety to business performance in a branch will be paramount, and in some cases customer interests (e.g. rapid delivery) may fly in the face of safety. The importance of contracts and transport purchasers is a recurring theme in improving traffic safety management by companies. How should we motivate transport purchasers and their customers to value road safety enough to demand it despite potential economic losses in the shorter term? A shift in emphasis might help, from how transport *operators* can learn about traffic safety management from those involved in the transport of hazardous goods, for example, to how transport *purchasers* can learn from those involved in the *purchase* of hazardous goods transport. Similarly, those interested in encouraging widespread uptake of traffic SMS should consider how to establish a norm for customers to demand that suppliers manage road safety. The use of benchmarking, certification schemes, or risk monitoring arrangements in procurement procedures may be useful tools in assessing this criterion. Purchasers should take care to recognize traffic safety management attempts by smaller companies, and ensure that criteria they use do not lead to the selection of those with greater resources but those who manage traffic safety effectively.

Research in Australia implies that, despite their power, even purchasers or regulators cannot drive the change towards traffic-SMS-as-norm in isolation, but this is best achieved by a network of "big players" among purchasers, insurers, operators, trade organizations and unions selling win-win ideas to the sector. In Norway, as in Australia, the industry is best placed to improve road safety given the large number of smaller operators and intense productivity pressures. Each type of actor can help and several can be considered as untapped resources with respect to traffic SMS implementation (e.g. insurers). Related businesses and communities can also play a role (e.g. UK's Driving for Better Business).

In Norway, NLF is already fronting efforts to increase the extent to which buyers are responsible for choosing safe, environmentally and socially responsible transport, and is working to give them the tools they need to do this in the form of the Fair Transport accreditation mark and associated safety accreditation (IF Active Safety). These efforts exemplify the potential of a systemic approach, with branch organisations, insurers, operators and purchasers working together. While the number of companies with sufficient resource to qualify as Fair Transport may be limited, such efforts help change normative rules in a regime and awareness of and motivation for traffic SMS for everyone. These effects might be increased by further coordination of efforts with other important actors, e.g. NPRA and NHO Transport.

Questions of awareness and motivation aside, management in smaller companies may perceive that they do not have the means to implement traffic SMS. While literature is available to guide on risk management, mitigation measures, and safety assurance, it is

dispersed and inaccessible to managers in smaller companies. These managers may also lack the time, competence or finance needed to investigate, or lack data on which to base a business case for traffic SMS. As a result they will view much of the trade and research literature on traffic SMS as irrelevant. To address this, the implication is that managers in smaller companies need access to consistent information from a highly visible source, about what *they* can do to manage traffic safety, including how to phase in comprehensive safety management over time. This latter issue is addressed by Nævestad's Safety Ladder, currently being validated empirically.

An analysis of sociopolitical factors influencing progression towards SMS uptake by other transport sectors reveals that progress is triggered by events creating turbulence in industrial regimes (e.g. early voluntary implementation by NAV Canada in the air sector, and a major accident in the maritime sector) or close alignment of normative and regulative rules (rail). The fragmented nature of the road sector, however, means that implementation of traffic SMS by even large companies is poorly visible. Large-scale catastrophic accidents are rare, and there is poor alignment of normative with regulative rules. There has been a tradition for individual driver responsibility for traffic safety, reflected by lack of accounting for company responsibility in accident investigations, and the poor coherence of regulation relevant to traffic safety and SMS.

National efforts to make SMS a regulatory requirement for road transport companies may help change manager's compliance mindsets, but these efforts are impeded by European competition laws. Moves towards performance-based regulation may also favour larger firms with the resource to demonstrate effective traffic safety management. SMS regulation would be hard to get right first time, and regulators would have to avoid continuing to focus on compliance documentation. Real progress would need to address a key challenge – that managers prefer a regulatory approach to which they can comply and then turn their attention back to "doing business". Change would require a fundamental shift in such "tick-list" thinking. Change in the way regulators conduct audits would also be required, and there would have to be increased openness in the dialog between regulators and industry, to which a high fragmented, poorly transparent road transport sector may not be suited. On the other hand, progress towards shared digital solutions e.g. cloud-based fleet management platforms, could be exploited to improve openness and data sharing.

Previous research has found that public authorities should lead by example and implement formal traffic SMS to encourage uptake by companies, but implementation by other firms in a regime would be more likely to cause spread in SMS uptake. Public authorities and administrations would do better to focus their efforts in ensuring public procurement practices make clear demands for traffic SMS in the transport services they hire – there is little evidence in Norway that such practice is the norm.

There is evidence of increased activity by NPRA, NLF, the Labour Inspection Authority and Safe Traffic (*Trygg Trafikk*) in Norway to encourage management of traffic safety and the implementation of traffic SMS. While these efforts are being coordinated more and more, more can be done, to present a united front to the road transport and other relevant sectors, and to achieve a better vertical integration of traffic safety management throughout a sector. Innovative activities like NPRA's Safe Trailer (*Trygg Trailer*) project should be encouraged, and there should be increased focus on providing the awareness, motivation and means companies need to implement traffic SMS. To help with these efforts, there is a need for research to establish tangible benefits of implementing traffic SMS, and to develop common risk indicators, process elements and safety outputs for use in evaluation and benchmarking.

A final important question we have considered relates to corporate social responsibility. Road safety management can help corporations address a need to be seen as socially

responsible, but what if society does not demand stringent levels of traffic safety from transport companies? Environmental certification certainly seems to have been prioritized over safety certification by companies in many sectors, and this may reflect how managers perceive the values of its customers and society. This raises important questions, e.g. are traffic safety problems caused by companies poorly visible in society, or is society more likely to accept that transport incurs traffic safety risks than other types of risk?

7 Summary and conclusions

The main aim of this study has been to identify measures to stimulate the implementation of traffic safety management systems (SMS) by Norwegian businesses, and in particular transport firms. To provide a foundation on which to base conclusions about what these measures should be, we have both (i) described what SMS are, and (ii) presented evidence that there is a need for more firms to implement traffic SMS.

7.1 SMS reviewed

An SMS is an integrated set of organisational elements supporting and enabling risk management, along with processes for designing, evaluating and improving those elements. An SMS will be unique to the organisation that implements it, but common elements and processes can be identified, e.g. policy, roles and responsibilities, data-driven continuous evaluation, and safety assurance. While successful implementation of SMS benefits from a positive safety culture and organizational-wide engagement, SMS can also be a way to gain improvement in these areas, i.e. SMS can influence and be influenced by organizational culture, and this also reflected in the continuous cyclical process of SMS.

The elements and processes found to be common to descriptions of general SMS are also found in descriptions of SMS laid out in international guidelines in the air, maritime and rail sectors (policy, management commitment, roles and responsibilities, documentation, risk management, emergency preparedness, assurance), although the way elements and processes are structured and grouped varies. The maritime sector appears to place more emphasis on certification, but affords greater room for interpretation on how SMS are implemented by different companies. Depending on the company's motivation, this can lead to both enhanced SMS or minimal compliance. European-level guidelines for the rail sector attempts to increase transparency by supplementing a description of SMS elements and processes with a common procedure for managing safety across all types of organisation in the rail system. Aviation recognizes that when operated independently by individual organisations, SMS cannot account for the safe co-existence of all stakeholders within a given ecosystem. This implies that any attempt to manage safety by road sector organisations should both provide cross-sectoral coherence on SMS and account for other actors in the ecosystem in which they operate.

The idea that traffic SMS should be the norm for road transport firms or other firms employing people who drive during worktime is relatively recent, supported by the establishment of the international road safety management standard ISO 39001 in 2012. The standard essentially describes the same SMS elements and processes as those guidelines found in other transport sectors, but provides "road context" to the process and details road-specific evidence-based safety performance factors to be considered, e.g. safe speed, use of helmets, and safe vehicles. A potential advantage of ISO 39001 is that wide implementation would give the road sector a common language and frame of reference on managing road safety, which occupational health and safety legislation has failed to provide to date.

SMS-as-norm for organizations employing drivers at work has also been promoted by the growing number of work-related road safety programs, not least those described by the EU's PRAISE project. Practitioner-driven, these programs may be attractive to businesses since they emphasise the importance of ensuring that safety management is driven by business needs. However, descriptions of the programs are often presented as tailor-made lists of safety measures identified for individual companies, and as such may have confused attempts to provide a reference for safety management for use by all road transport organisations. Work-related road safety programs have also been criticized for a traditional conceptualization of risk.

Finally, we should consider that SMS are intractable, i.e. attempts to describe them are inevitably elaborate and – accepting that people are a fundamental part of SMS – we cannot completely describe *how* SMS do what they do. Intractable systems are best understood as a set of interdependent *functions* sharing a common purpose, but in practice, SMS are described as a mixture of both functions (e.g. recruitment and selection; leadership, monitoring, evaluation) and things (e.g. KPI, safety mission statement, rules). This has caused confusion and prevented our understanding of safety management systems as *systems*. A way to improve future descriptions may therefore be to clearly distinguish between functions and things when describing SMS.

Need for implementation of traffic SMS

A need for improved implementation of traffic SMS in firms would be justified if the following three statements were true:

i. Organizations employing people who drive for work contribute to traffic safety levels.
ii. Traffic SMS implementation reduces traffic safety problems caused by organizations employing people who drive for work.
iii. Implementation has been insufficient to date.

In the Introduction, we briefly reviewed strong evidence supporting the first statement (i), from Norway and elsewhere. Chapter 4 has addressed the second statement (ii), and concludes that while there is no direct evidence that SMS implementation leads to positive effects on traffic safety, research design challenges mean that we lack suitably designed evaluation studies. There are, however, several streams of indirect evidence implying that traffic SMS improve traffic safety levels. These include cross-sectional studies linking SMS-like organizational processes to safety outcomes, showing that safety measures are more effective when introduced into a supportive organizational culture. Support for statement (iii) comes from the fact that only eight of several hundreds of applicable transport firms in Norway have been accredited in the formal safety management certificate NS ISO 39001, despite it being launched in 2013. No non-transport firms had been certified in Norway as of May 2018.

Considering our three statements together, the evidence supports the assumption that there is a need for broader implementation of traffic SMS by both transport and non-transport firms employing people who drive for work.

7.2 Theoretical basis for understanding factors influencing implementation

The report has reviewed three main theories to guide and structure the identification of factors influencing implementation of SMS by firms: Risk Management in Societies, Sociotechnical Systems Theory and Sociotechnical Transitions / Triple Embeddedness. Together these theories imply the following:

- There is a need to account explicitly for management interest in production when encouraging implementation of SMS – do managers see SMS as promoting or inhibiting for productivity? Implementing SMS demands that companies make explicit how safety is valued against other priorities in its operations, increasing the visibility of its social responsibility, and allowing interest groups to assess the extent to which safety values of organizations and society are consistent. This is relevant since it implies that SMS can be promoted to help organisations meet performance requirements effectively.
- There is a need to integrate safety management across systems in which organisations are embedded; consensus should be established on common performance markers and ensure necessary competence is shared across system actors.
- As much as about things – processes, policies, technology, vehicles, infrastructure – safety management is about relationships among things and people that span the integrated sociotechnical system. For people deciding on safety management, normative rules are just as important as regulative rules, as are sunk investments in technology, market forces, access to competence, and customer and societal value of traffic safety relative to other social issues.
- Moves to accomplish change in a regime are likely to be countered by influential firms who do not value change and wish to maintain the status quo. These moves can be countered when change is visibly valued by a network of influential champions representing key actors in a regime, and when change is visibly implemented with positive sociopolitical or economic outcomes.
- Firms that value change may lack resources with which to follow their interests; optimal solutions for implementing SMS will vary depending on available resources and local business contexts.

7.3 Management perceptions to be addressed to motivate for SMS implementation

A literature review and interviews suggest certain prevailing perceptions need to be addressed to improve how motivated managers in some sectors are to implement traffic SMS. Typical perceptions include:

- *We address traffic safety concerns adequately by complying with HSE and sector-specific regulations.*
- *Traffic safety is not normally managed systematically in our sector.*
- *Expense and high demands of traffic SMS certification would reduce resources that we need for productivity, making it harder to compete. Minimal compliance is best for business.*
- *Our customers do not contract us to manage traffic safety.*
- *We do not see how other have benefitted from traffic SMS implementation.*
- *After certification in quality and environmental management, there is no point in traffic safety. certification – our internal processes are already optimized.*

- *We are a large company and can most effectively manage safety using our own tailor-made systems.*
- *We are a small company; with our resources we cannot be expected to manage traffic safety.*

We have not attempted to quantify the prevalence of these attitudes.

7.4 Factors influencing SMS implementation in road transport

We have classified factors influencing SMS implementation according to whether they are rooted in the industrial regime, or its economic or sociopolitical environment. A review of regime and economic factors underlines the importance of contracts and transport purchasers in improving traffic safety management by companies. In the Norwegian road sector in particular, most companies are local outfits with few employees and limited resources. More advanced SMS may therefore be best applied across whole transport chains, in which the risk of activities of different companies involved is managed by an integrated SMS driven by the transport purchaser. This reflects findings from our theoretical review – that individual companies cannot manage road safety optimally independent of other organizations in their ecosystem – and findings from interviews on the importance of the contract-giver. Given the importance of transport purchasers, an important question is how we can we motivate transport purchasers and their customers to value road safety enough to demand it. One way forward might be to learn from those involved in the purchase of hazardous goods transport, both about their approach and experienced benefits of encouraging operators to manage traffic safety. The development of tools could also help establish a norm for customers to demand that suppliers manage road safety, e.g. national benchmarking, certification schemes that are applicable to most Norwegian transport firms, accessible information on how to include risk monitoring arrangements in procurement procedures.

Ultimately, we see that sector-wide implementation is desirable, but its stimulation requires that we consider the large number of smaller operators and intense productivity pressures seen in many Norwegian road transport sectors. Transport purchasers alone cannot be expected to bring about change, i.e. the challenges need to be met by the industry as a whole. Change could be encouraged by a network of "big players" among purchasers, insurers, operators, trade organizations and unions selling win-win ideas to the sector, such as that promoted by NPRA'sSafe Trailer (*Trygg Trailer*) project. Each type of actor can play a role and several can be considered as untapped resources with respect to traffic SMS implementation (e.g. insurers). Related businesses and communities should also be involved. Steps towards such a broad, systemic approach can be taken, for example, by coordinating activities of key actors such as NHO Transport and NPRA, with NLF's efforts to provide the tools that buyers need to be able to select quality operators (i.e. accreditation in safety management *If Aktiv sikkerhet*, NS ISO 39001). NPRA could, for instance, inform transport purchasers and their customers about the need to demand quality transport, and how they can go about this using accreditation schemes like NLF's, while NHO Transport could promote similar accreditation among their members.

A recurring finding in the report is that many smaller operators in goods transport regimes in Norway do not have the means to learn about, justify and implement formal traffic SMS. To improve safety management, managers in these companies need ready access to consistent information about what *they* can do to manage traffic safety, including how to build comprehensive safety management over time. The approach taken would ideally be consistent across smaller companies, such that they could openly learn from each other and share safety management experiences.

Our analysis also suggests the following factors influencing SMS implementation in road transport:

- Isolated efforts to improve traffic safety management are poorly visible to other organisations due to (i) fragmented nature of the sector, and (ii) lack of coordinated efforts to encourage firms to manage safety (no "united front" presented by authorities and interest groups)
- Large gap between normative and regulative rules
- European competitions laws impeding the extent to which Norway can regulate for safety management
- Lack of accounting for traffic SMS in accident investigations, regulatory audits
- Transport purchaser attitudes / contracts shaping a compliance mindset in the operators
- Lack of good examples in the form of public organsiations demanding traffic SMS in procurement processes
- In terms of purchase power, society does not necessarily demand stringent levels of traffic safety from goods transport companies (e.g. accreditation in environmental or quality management prioritized by transport operators)
- Larger companies with own systems may have "sunk investment" in their own safety management system. May not wish to adapt generic ISO 39001, which is not tailored to their needs and demands increased transparency with competitors.

7.5 Recommended measures to stimulate increased implementation of traffic SMS

In the following we attempt to develop the report's implications into ideas for encouraging firms to implement traffic SMS.

One message coming out of the report is the lack of a single coordinated message on the need for firms to manage traffic safety. To improve matters, the Ministry of Transport, NPRA, Safe Traffic, the police, the Labour Inspection Authority, NLF, NHO Transport, AIBN, and other key actors could establish a system task force that agrees on a plan on how to present a "united front" that conveys the need for all firms influencing or influenced by the transport system to manage traffic safety. A consistent message can only be presented if the task force first agrees on (i) a strategy for encouraging widespread implementation; and (ii) traffic SMS approaches appropriate for different types of firm.

The force could also work with the industry to identify common measures for traffic safety management, and evaluate and promote the benefits of using common markers (e.g. information sharing and learning). There is little in the literature to guide authorities on how to establish vertically coherent understanding and measurement of traffic safety management, but it is reasonable to expect that progression in road safety management by firms would be improved if operators in the same sector used the same safety outcomes as measures, even if the means to establish these ends may vary. Standardization on measures would increase transparency on safety management, promote learning and increase shared understanding of good safety practice. ITS (2017) also recommend common methods in conducting these cost/benefit analyses to ensure the results are consistent across companies. Transparency and knowledge sharing can be promoted by new digital technologies that allow companies to share data using cloud-based platforms. In the fragmented and competitive road haulage sector, however, there is no tradition of

openness, and this raises is important questions about ways in which sectoral culture might limit data sharing (Sternberg & Andersson 2014).

Considering other activities, attempts could be made to increase the visibility of benefits experienced by firms that have already implemented NS ISO 39001 or other traffic SMS. Visibility of traffic SMS could also be increased in trade publications, handbooks, conferences and so on, case studies could be collected and presented. Transport purchasers who seek companies who have implemented SMS should also be profiled, as should steps taken to make more purchasers demand traffic SMS.

NPRA could build on Safe Trailer (*Trygg Trailer*), by involving NHO Transport and other key actors in exploring other ways to involve purchasers in traffic safety management by transporters. NPRA could also conduct a campaign targeting figurehead purchasers of transport, to promote the benefits of including traffic SMS demands in public and private procurements. Tools for how to address traffic safety management in procurement procedures can be provided based on PRAISE reports. NS ISO 39001 or NLF's existing accreditation schemes could be highlighted as a way for purchasers to assess transport quality, and schemes appropriate for smaller transporters (e.g. based on Nævestad's Safety Ladder) or non-transport firms could also be developed and promoted in procurement. Establishment of a national benchmarking of firms on traffic management activities could also help in the selection of quality transport.

Safe Traffic, NPRA or others might promote traffic safety as a social issue alongside social dumping, environmental issues and security.

In terms of regulation, it may be worth working with the EU towards more explicit treatment of traffic SMS in HSE legislation, or whether accreditation in SMS may be used as the basis for regulatory opt-outs or increased flexibility (e.g. increased loads allowed, more flexible driving hours).

Research could also be funded on the following:

- Determining the safety, economic and sociopolitical benefits of introducing traffic SMS – what happens to firms that implement traffic SMS? Case examples demonstrating cost-effectiveness and economic benefits of work-related road risk programs.
- Assessing the constraints transport purchasers face in demanding traffic SMS from transporters.
- Establishing groundwork for a national benchmarking of organizational traffic safety management.
- More research is needed on how to achieve cultural change, from safety compliance to a proactive safety management mindsets in smaller companies, for which formal SMS are too complex. In other words, how to establish leader commitment to traffic safety management, as well as address:
    - Compliance mindset, new ways of thinking, achieving true proactive safety.
    - Willingness to create business case.
    - Willingness to invest, given positive outlook for return on investment.
    - Expertise to manage organisational change from existing to new systems.
    - Change resistance (at lower levels).
    - Trust and data-sharing issues.

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Appendix: Case studies

We found no published case studies of traffic SMS implementation in Norway. Interviewees mentioned the EU PRAISE project and RSA Ireland's efforts as good sources of case studies, but also pointed out that these depend on culture, context and company size. Putting aside the need for empirical evidence of effect, case studies can be a valuable source of inspiration and motivation for those managers who wish to learn from the practical experience of others in their sector. For example, in a detailed description of a long-term WRRS program in a multi-site work fleet, (Murray, Ison et al. 2009) outlines how the program was rolled out following an initial pilot study and evaluation at a single site. The value of doing this (helps evaluate effectiveness of program, make appropriate cost trade-offs, and develop the implementation process) was apparent from previous unpublished case studies.

Sources of case studies

Bidasca & Townsend (2014) contains case studies, but these often lacking in detail, and based on single or few measures rather than management system implementation. E.g. describe that the

- Spanish goods manufacturer Henkel, with 1100 employees, spent 10,000 Euro on short driving courses and leaflets, and saved 80,000 Euros a year on commuting accidents. They claim a cost-benefit of 8:1.
- Logistics business investing in training, coaching and mentoring of new drivers in safety, and recruiting services of a dietician. Resulted in a 10 per cent saving in insurance costs and reductions in administration costs, with increased achievement of KPIs.
- Mark Group, installer of energy saving technology, with 1000 vehicle fleet and over 2000 employees. ISO-39001 helped them reduce at-fault collisions from 60 to 40 per cent, reduce waste and resource costs in the fleet department, reduce accidents, repair bills and the risk of being sued, and allowed them to differentiate themselves in the marketplace, and gain access to new tender processes and markets.
- Mervielde Transport case in which measures are detailed, but no independent evaluation is given. Reportedly leads to 5 per cent decrease in fuel use, 27 per cent reduction in collisions and 9 per cent drop in CO2 emissions per km driven, 21 per cent decrease in number of fines.
- Thorntons recycling (SME) Ireland, 400 staff, 100 trucks, introduced Driving for Work Policy with KPIs, analysis, certification and risk management. Integrated safety needs with selection and recruitment processes, and published a driver handbook, which was reviewed every 12 months. Other measures included a workshop on safe driving for managers and their drivers, fleet maintenance checklist prior to leaving depot, and GPS and video monitoring of fleet. Reported effects was a reduction in collisions from 35 in 2011 to 6 in 2013. Fuel savings of 8 per cent over a 2 y period, and 10 per cent reduction in maintenance costs.

Peer-reviewed publications such as(Wallington, Murray et al. 2014) detail process and measures for a comprehensive decade-long programs. Wallington's study follows a detailed collision analysis in 2003, BT used the Haddon matrix to inform, structure and target its

long-term work-related road risk program. Costs reduced by £12 mill. / y (2001-2014). The injury/asset damage collision rate was reduced from 60 less than 30 over same period. (Murray, Ison et al. 2009) and (Murray, White et al. 2012) are similar examples. Twenty other examples of such programs can be found at www.virtualriskmanager.net .

Another source is https://osha.europa.eu/en/tools-and-publications/publications/reports/managing-risks-drivers_TEWE11002ENN.

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