

Road Traffic Safety for Work-Related Driving with Heavy Goods Vehicles – It's a Shared Responsibility

Katrine Grinerud

NORD UNIVERSITY BUSINESS SCHOOL

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Abstract

This main objective of this thesis is to examine the relationship between parties in the system surrounding road traffic safety for work-related driving with heavy goods vehicles (HGVs) and understand how different organizational factors affect this relationship and, as a consequence, influence road traffic safety.

Road traffic accidents are seen as a leading cause of death that must be mitigated to ensure general public health. In Norway, a country with almost six million people, several years of systematic work on road traffic safety has led to a decrease in road traffic accidents involving fatalities and severe injuries. However, compared to the rest of Europe, Norway has approximately 35% more fatalities per inhabitant from accidents involving HGVs. On average, approximately 688 people are injured each year in traffic accidents involving HGVs, and for every third road fatality, there is an HGV involved. These numbers show that there is still work to be done regarding increased road traffic safety on Norwegian roads.

Traditionally, interventions intended to decrease accidents involving HGVs have often been directed towards the individual driver, meaning that individual road users are responsible when crashes occur. However, potential accidents in work-related driving, such as the operation of HGVs, is influenced by a number of systematic factors. So, instead of seeing the individual road user as being responsible when a crash occurs, the focus should be on how *systematic* factors could lead to potential accidents.

This thesis contributes to road traffic safety theory by taking a holistic system approach towards road traffic safety for work-related driving with HGVs, meaning that it is recognized that there are several actors and decision makers on different levels within the system who all have the potential to influence road traffic safety. This thesis addresses this issue by asking the overarching research question: How can the relationship between parties and organizational factors influence the management of road traffic safety for work-related driving with heavy goods vehicles?

To explore this question, this thesis uses a qualitative methodology: the methods used are literature review, semi-structured interviews, and group interviews.

Article 1 seeks to identify important factors in managing road safety for work-related driving of HGVs by conducting a literature review and proposes an overall framework for how safety training for parties in the system could be executed. The findings show that important factors for the management of road safety could be arranged at different levels: governmental level, third-party level, organizational level, and driver level. A systematic approach to road safety for HGVs is essential. Every actor is jointly responsible for road traffic safety, and actors must communicate and work together to increase road traffic safety for work-related driving with HGVs. Communication, collaboration, and cooperation between the actors are important factors. By developing a safety training program for all actors in the system, the study proposes a method for increased communication, collaboration, and cooperation between the actors.

Article 2 takes the perspective of road transport organizations and identifies how management decisions can support or constrain road traffic safety for work-related driving with HGVs. The findings suggest that road transport organizations that chose a low-cost leadership strategy struggled to be profitable. Moreover, such strategies led to high rivalry between organizations. Such rivalry made it difficult to be profitable, as there were fewer resources available to invest in building a good safety culture. In contrast, road transport organizations that chose a differentiation or focus leadership strategy were more likely to be profitable. As a consequence, they had more resources to invest in building a safety culture by investing in equipment and employees.

Articles 3 and 4 are following up on Article 2, but they take the perspective of the buyer of road transport services and investigate the role of this actor in supporting or constraining road traffic safety. The findings suggest that buyers of road transport services could contribute to safe road transport by prioritizing the following characteristics and qualities: 1) the development of a detailed formal contract with the provider of road transport; 2) awareness of the possibilities of new technologies; 3) understanding that the decision criteria for ordering transport could influence road

transport safety; 4) good communication with both the road transport organization and the authorities; 5) recognition of how knowledge of and trust in a road transport organization is important but could also affect judgement regarding revisions and controls. The findings indicate that buyers of road transport services had an impact on both sustainability and safety in the chain of road transport by influencing pricing and delivery demands.

Finally, Article 5 gives an overview of all the actors in the system surrounding road traffic safety for work-related driving with HGVs. The findings suggest that communication and competence were essential for all actors in the system, especially across or between levels and actors. Control sanctions should not be seen as a primary measure for enhanced road transport safety for work-related driving with HGVs. Instead, prevention and motivation could work better than punishment and control when driver behavior is to be influenced.

As a result of the findings in all five articles, an emerging objective became to explain the complexity of managing road traffic safety for work-related driving with HGVs. Hence, the holistic complexity model was developed. The model illustrate how management choice of strategy could affect road traffic safety for work-related driving with HGVs.

On a theoretical level, this thesis contributes to road traffic safety theory by exploring the relationship between different parties in the system surrounding work-related driving with HGVs. However, the greatest contribution of this thesis is to the practical field. It is assumed that this thesis could especially impact management in road transport organizations and the buyers of road transport services. The thesis provides some essential suggestions for when management in road transport organizations decide on their business strategy, regarding what to focus on when offering their services and signing new employees. This thesis explores how different strategic choices could affect – and how organizational factors could influence – profitability and, hence, road traffic safety for work-related driving with HGVs. Also, the thesis presents the buyers of road transport services as an important party in road traffic safety work. It is suggested that

this party, by setting demands on those who transport their goods, could contribute to a better work environment for drivers, correctly equipped vehicles, better profitability for the industry, among other effects; in the end, they will contribute to safer road transport.

Sammendrag

Formålet med denne avhandlingen er å undersøke forholdet mellom ulike aktører i systemet rundt trafikkikkerhet ved arbeidsrelatert kjøring med tunge kjøretøy og forstå hvordan ulike organisatoriske faktorer påvirker dette forholdet og som en konsekvens, påvirker trafikkikkerhet.

Vegtrafikkulykker blir sett på som en ledende dødsårsak som må reduseres for å sikre generell folkehelse. I Norge, et land med nesten seks millioner mennesker, har flere års systematisk arbeid med trafikkikkerhet ført til en nedgang i trafikkulykker med drepte og hardt skadde. Likevel skades gjennomsnittlig cirka 688 personer hvert år i trafikkulykker hvor godstransport med tunge kjøretøy er involvert. Videre er det for hver tredje dødsulykke, et tungt kjøretøy involvert.

Tradisjonelt har tiltak for å redusere ulykker med tunge kjøretøy ofte vært rettet mot den enkelte sjåfør. Potensielle ulykker ved arbeidsrelatert kjøring med tunge kjøretøy påvirkes imidlertid av en rekke faktorer. I stedet for å se på den enkelte trafikant som eneansvarlig når en ulykke inntreffer, bør fokuset være på hvordan andre faktorer også kan bidra til å redusere potensielle ulykker.

Denne avhandlingen bidrar til trafikkikkerhetsarbeidet ved å ta en helhetlig tilnærming til trafikkikkerhet for arbeidsrelatert kjøring med tunge kjøretøy, i den betydning at man erkjenner at det er flere aktører og beslutningstakere på ulike nivåer innenfor systemet som alle har potensialet til å påvirke trafikkikkerheten. Denne avhandlingen tar opp problemstillingen ved å stille det overordnede forskningsspørsmålet: Hvordan kan forholdet mellom aktører og organisatoriske faktorer påvirke trafikkikkerheten ved arbeidsrelatert kjøring med tunge kjøretøy?

For å utforske dette spørsmålet anvendes kvalitativ metode. Metodene som brukes er litteraturgjennomgang, semistrukturerte intervjuer og gruppeintervjuer.

Avhandlingen består av 5 artikler. Artikkelen 1 søker å identifisere viktige faktorer ved styring av trafikkikkerhet for arbeidsrelatert kjøring med tunge kjøretøy ved å gjennomføre en litteraturgjennomgang, og foreslår et overordnet rammeverk for

hvordan sikkerhetsopplæring for partene i systemet kan gjennomføres. Funnene viser at viktige aktører for styring av trafikksikkerhet kan ordnes på ulike nivåer: myndighetsnivå, tredjepartsnivå, organisasjonsnivå og førernivå. Hver aktør har et felles ansvar for trafikksikkerheten, og aktørene skal kommunisere og samarbeide for å øke trafikksikkerheten ved arbeidsrelatert kjøring med tunge kjøretøy. Ved å utvikle et sikkerhetsopplæringsprogram for alle aktørene i systemet, foreslår studien en metode for økt kommunikasjon, samarbeid og samarbeid mellom aktørene.

Artikkel 2 tar perspektivet til transportbedriftene og identifiserer hvordan ledelsesbeslutninger kan støtte eller begrense trafikksikkerheten for arbeidsrelatert kjøring med tunge kjøretøy. Funnene tyder på at transport bedrifter som valgte en lavkost-leaderstrategi slet med å være lønnsomme. Dessuten førte slike strategier til høy rivalisering mellom organisasjoner. Slik rivalisering gjorde det vanskelig å være lønnsomme, da det var færre ressurser tilgjengelig for å investere i å bygge en god sikkerhetskultur. I motsetning til dette hadde transport bedriftene som valgte en differensierings- eller fokusleaderstrategi høyere sannsynlighet for å være lønnsomme. Som en konsekvens hadde de mer ressurser til å investere i å bygge en sikkerhetskultur ved å investere i utstyr og ansatte.

Artikkel 3 og 4 følger opp artikkel 2, men de tar perspektivet til kjøperen av transporttjenester og undersøker denne aktørens rolle i å støtte eller begrense trafikksikkerheten. Funnene tyder på at kjøpere av transporttjenester kan bidra til sikker vegtransport ved å prioritere følgende egenskaper og kvaliteter: 1) utvikling av en detaljert formell kontrakt med leverandøren av vegtransport; 2) bevissthet om mulighetene ved bruk av ny teknologi; 3) forståelse for at beslutningskriteriene for bestilling av transport kan påvirke trafikksikkerheten; 4) god kommunikasjon med både vegtransportorganisasjonen og myndighetene; 5) erkjennelse av hvordan kunnskap om og tillit til en transport bedrift er viktig, men at å velge samarbeidspartner med bakgrunn i utelukkende tidligere kjennskap til bedriften kan påvirke vurderingen av revisjoner og kontroller. Funnene indikerer at kjøpere av vegtransporttjenester hadde innvirkning på både bærekraft og sikkerhet i vegtransportkjeden ved å påvirke prissetting og leveringskrav.

Avslutningsvis gir artikkel 5 en oversikt over alle aktørene i systemet rundt trafikksikkerhet ved arbeidsrelatert kjøring med tunge kjøretøy. Funnene tyder på at kommunikasjon og kompetanse var vesentlig for alle aktører i systemet, spesielt på tvers av eller mellom nivåer og aktører. Kontroll sanksjoner bør ikke sees på som et primært tiltak for økt trafikksikkerhet ved arbeidsrelatert kjøring med tunge kjøretøy. I stedet vil forebygging og motivasjon kunne fungere bedre enn straff og kontroll når adferd skal påvirkes.

Som et resultat av funnene i alle fem artiklene ble det et fremvoksende mål å forklare kompleksiteten med å håndtere trafikksikkerhet for arbeidsrelatert kjøring med tunge kjøretøy. Derfor ble den holistiske kompleksitetsmodellen utviklet. Modellen illustrerer hvordan ledelsens valg av strategi kan påvirke trafikksikkerheten ved arbeidsrelatert kjøring med tunge kjøretøy.

På et teoretisk nivå bidrar denne avhandlingen til trafikksikkerhetsteorien ved å utforske forholdet mellom ulike parter i systemet rundt arbeidsrelatert kjøring med tunge kjøretøy. Det største bidraget fra avhandlingen er imidlertid til det praktiske feltet. Det antas at denne avhandlingen spesielt kan påvirke ledelsen i transportbedrifter og kjøpere av vegtransporttjenester. Avhandlingen fremmer bevissthet rundt valg av ledelsesstrategi når ledelsen i transportbedrifter bestemmer seg for sin forretningsstrategi. Herunder hva de kan fokusere på når de tilbyr sine tjenester og ansetter nye medarbeidere. Denne avhandlingen utforsker hvordan ulike strategiske valg kan påvirke – og hvordan organisatoriske faktorer kan påvirke – lønnsomhet og dermed trafikksikkerhet for arbeidsrelatert kjøring med tunge kjøretøy. I tillegg introduserer avhandlingen kjøpere av vegtransporttjenester som en viktig part i trafikksikkerhetsarbeidet. Det foreslås at denne parten, ved å sette krav til de som transporterer varene deres, kan bidra til et bedre arbeidsmiljø for sjåfører, riktig utstyrte kjøretøy og bedre lønnsomhet for bransjen.

List of Papers and Declarations of Authorship

Article 1:

Grinerud, K. (2022). Work-related driving of heavy goods vehicles: Factors that influence road safety and the development of a framework for safety training. *Safety*, 8(2), 43. DOI: 10.3390/safety8020043

Article 2:

Grinerud, K., Aarseth, W. K., & Robertsen, R. (2021). Leadership strategies, management decisions and safety culture in road transport organizations. *Research in Transportation Business & Management*, 100670. DOI: 10.1016/j.rtbm.2021.100670

The first author conceptualized and planned the paper with Aarseth. The first author also collected the data and conducted the analysis together with Aarseth and Robertsen. The first author wrote the paper.

Article 3:

Grinerud, K. (2021). Road transport safety in Northern Norway: How buyers of road transport services can contribute to a road transport with fewer accidents and near-misses. *Arctic & North*, 43. DOI: 10.37482/issn2221-2698.2021.42.81

Article 4:

Grinerud, K., Sætren, G. B., & Aarseth, W. K. (2020). Buyers of road transport services: Sustainability and safety responsibility? *The 30th European Safety and Reliability Conference and the 15th Probabilistic Safety Assessment and Safety Conference*, Venice, Italy. DOI: 10.3850/978-981-14-8593-0

The first author conceptualized and planned the paper with Sætren and Aarseth. The first author also collected the data and conducted the analysis together with Sætren and Aarseth. The first author wrote the paper.

Article 5:

Grinerud, K., Aarseth, W. K. & Sætren, G. B. (2021). A system view on road traffic safety of work-related driving with heavy goods vehicles. (This paper was submitted to *Safety Science* in November 2021 and will be resubmitted after revisions in autumn 2022.)

The first author conceptualized and planned the paper with Aarseth and Sætren. The first author also collected the data and conducted the analysis together with Aarseth and Sætren. The first author wrote the paper.

List of Tables and Figures

Tables:

Table 1. Research objective and research questions	6
Table 2. Overview of key findings.....	9
Table 3. Research process	11
Table 4. Overview of individual articles.....	12
Table 5. Approaches and generic strategies.....	27
Table 6. Participants.....	43
Table 7. Inclusion and exclusion criteria	46
Table 8. Overview of the analysis process.....	50
Table 9. Overview of methods	51
Table 10. Safety training program for HGV drivers	60
Table 11. Factors related to the way buyers of transport services could contribute to sustainability and safety.....	70
Table 12. Identified actors.....	71

Figures:

Figure 1. Domain theory and method theory of this thesis.....	13
Figure 2. Focus of the thesis	15
Figure 3. The Pentagon model	24
Figure 4. The system surrounding road traffic safety for work-related driving with HGVs	31
Figure 5. Buyer of road transport services as a key party in the system of road traffic safety for work-related driving with HGVs	33
Figure 6. Preliminary conceptual model	34
Figure 7. Safety training program	59
Figure 8. Negative spiral for road transport organizations with low profitability	63
Figure 9. Positive spiral for road transport organizations with high profitability	64
Figure 10. The contribution of buyers of road transport services to safer road transport	67
Figure 11. The holistic complexity model	86

Abbreviations

HCM – Holistic complexity model

HGV – Heavy goods vehicle

NGO – Non-governmental organization

NLIA – Norwegian Labour Inspection Authority

NPRA – Norwegian Public Road Administration

NTOA – Norwegian Truck Owner Association

OSM – Organizational safety management

SMS – Safety management system

Table of Contents

Acknowledgements	III
Abstract.....	V
Sammendrag.....	IX
List of Papers and Declarations of Authorship.....	XIII
List of Tables and Figures.....	XV
Abbreviations	XVII
Part one	1
1. Introduction	1
1.1. Background	2
1.2. Research objective and research questions	5
1.3. Key findings	8
1.4. Researcher's personal motivation	10
1.5. Research process	11
1.6. Thesis structure.....	11
1.7. Limitations.....	13
2. Theory	17
2.1. Domain theory: What is safety?	17
2.2. Systems approach to enhancing road traffic safety for work-related driving with HGVs – From a reductionist skill model approach to a systems approach	19
2.2.1. Complex sociotechnical system approach in road traffic safety for work-related driving with HGVs.....	20
2.3. Method theory: Organizational factors affecting road traffic safety for work-related driving with HGVs.....	23
2.3.1. The Pentagon model	23
2.3.2. Leadership and competitive strategy influencing road traffic safety for work-related driving with HGVs.....	25
2.4. Research problem – Research gap	30
2.5. Preliminary conceptual model.....	34
3. Methodology	35
3.1. Philosophical perspective and paradigms	35
3.2. Research design.....	39
3.3. Sampling and participant strategy	40
3.4. Data collection.....	44
3.4.1. Literature review.....	44
3.4.2. Interviews	46
3.5. Data analysis.....	48

3.6. Research design, sampling strategy, data collection, and analysis for each article	51
3.6.1. Participating industries in each article.....	51
3.7. Reliability and validity	53
3.7.1. Reliability	53
3.7.2. Validity	53
3.8. Ethical considerations.....	55
3.8.1. Researcher’s background.....	56
4. Findings and summary of articles	57
4.1. Article 1	57
4.2. Article 2	61
4.3. Article 3	65
4.4. Article 4.....	69
4.5. Article 5.....	70
5. Discussion.....	75
5.1. Important parties for managing road traffic safety for work-related driving with HGVs.....	76
5.2. The influence of organizational factors.....	77
5.3. Parties’ contribution towards road traffic safety for work-related driving with HGVs.....	81
5.4. The holistic complexity model (HCM)	83
6. Conclusion.....	89
6.1. Implications and further research	90
7. References	93
Part two.....	99
Full text og articles 1-5	99

Part one

1. Introduction

1.0 Introduction
1.1 Background
1.2 Research objective and research questions
1.3 Key findings
1.4 Researcher's personal motivation
1.5 Research process
1.6 Thesis structure
1.7 Limitations

Norway's road safety network is controlled by a vision that there shall be no fatalities or severe injuries on the roads – the “Vision Zero” ideology. As a sub-goal, the government has stated that the number of fatalities and severe injuries due to road accidents should be a maximum of 350 cases by the year 2030 (Ministry of Transport and Communications, 2017). To achieve this aim, new measures for road traffic safety must be implemented (Ministry of Transport and Communications, 2017), as traditional measures for road traffic safety are assumed to have reached a limit in preventing crashes and their consequences (Sieveneck & Sutter, 2021).

This thesis contributes to the extensive literature on road traffic safety for work-related driving with heavy goods vehicles (HGVs) by studying the relationship between parties in the system surrounding road traffic safety for work-related driving with HGVs and understanding how different organizational factors affect this relationship and, as a consequence, influence road traffic safety. Based on the empirical findings of this thesis and previous research, a model was developed to show the holistic complexity of road traffic safety for work-related driving with HGVs. The main motivation behind this

thesis was the opportunity to contribute to addressing a major safety concern in societies all over the world – road traffic accidents involving work-related driving with HGVs.

This chapter presents the background and the underlying research problem of this thesis. Then, it presents the thesis structure, research objective and questions, and process, followed by a discussion regarding the limitations of the study.

1.1. Background

Road traffic accidents are seen as a leading cause of death that must be mitigated to ensure general public health (Grinerud, 2022; Moonaghi et al., 2015; Morimoto et al., 2021; Newnam & Goode, 2015; Nævestad, Hesjevoll, et al., 2018; Sieveneck & Sutter, 2021). Road traffic accidents rank as the eighth leading cause of death worldwide, accounting for 2.2% of all deaths globally. Every year, approximately 1.35 million people are killed in traffic accidents, with an average of more than 3,000 traffic deaths every day worldwide. In addition, 20 to 50 million people are injured or disabled in traffic accidents (World Health Organization, 2018). Work-related driving is an increasingly important factor in this matter (Newnam & Oxley, 2016). Due to the great size and weight of HGVs, fatal and serious HGV crashes are over-represented in many countries (Khadka et al., 2021; Mooren, Grzebieta, et al., 2014).

In Norway, a country with almost six million people, several years of systematic work on road traffic safety has led to a decrease in road traffic accidents involving fatalities and severe injuries. In 1970, there were 570 fatalities and 4,552 severe injuries caused by road traffic accidents. These numbers have decreased to 93 fatalities and 627 severe injuries in 2020 (Statistics Norway, 2022). However, compared to the rest of Europe, Norway has approximately 35% more fatalities per inhabitant from accidents involving HGVs. On average, approximately 688 people each year are injured in traffic accidents involving HGVs, and for every third road fatality, there is an HGV involved (Langeland & Phillips, 2016). These numbers show that there is still work to be done regarding road traffic safety on Norwegian roads. Moreover, 2022 has shown that road traffic safety is fragile. After several years where fatalities and severe injuries caused by road traffic accidents decreased, the numbers are increasing again. In the first half of 2022, the

preliminary numbers show that 60 people have been killed in road traffic accidents. In the same period in 2021, the number was 31; this is a doubling in the number of fatalities (The Norwegian Public Road Administration, 2022).

One challenge for managing the safety of HGVs is the increasing amount of domestic and international road transport in Norway (Nævestad et al., 2021). National transport performance (million tons-km driven) by domestic road transport organizations has increased from 1,6979.4 million tons-km in 2012 to 1,9389.4 million tons-km in 2019 (Statistics Norway, 2021a). In addition, national transport performance by foreign road transport organizations has increased from 6,984.9 million tons-km in 2012 to 8,787.7 million tons-km in 2019 (Statistics Norway, 2021b). Forecasts for the years 2015–2030 indicate a 25% growth in traffic along Norwegian roads. Moreover, it is expected that the growth of HGVs will be significantly higher than for passenger cars. If new interventions are not implemented, there could be an increase of 175 people involved in deaths and severe injuries in 2030 compared to 2015 (Ministry of Transport and Communications, 2017). Indeed, the mere presence of HGVs in the road environment increases the potential for accidents with severe injuries. To counteract this presumed development, the Ministry of Transport and Communications (2017) has highlighted measures directed towards the HGVs industry. Also, research supports that new measures should be directed towards the HGV industry and emphasizes that there is a need to look deeper into the underlying causes of accidents involving HGVs (Grytnes et al., 2016; Newnam & Goode, 2015; Njå & Fjelltnun, 2010; Nævestad, Elvebakk, et al., 2018; Nævestad, Hesjevoll, et al., 2018; Nævestad et al., 2015).

Traditionally, interventions intending to decrease accidents involving HGVs have often been directed towards an individual level (that is, the driver), meaning that individual road users are responsible when crashes occur (Larsson & Tingvall, 2013). This is a reductionist approach that focuses on identifying unsafe driver behavior – for example, inappropriate speed, fatigue, and drug use (Dawson et al., 2014; Newnam & Goode, 2015; Phillips et al., 2017). While this approach may correctly identify the direct cause of a road traffic accident, it does not cover the underlying causes of accidents. Newer

research emphasizes the importance of taking a more holistic and systematic approach in this matter (Kuran et al., 2022; Larsson et al., 2010; Newnam & Goode, 2015).

Work-related driving, such as the operation of HGVs, is influenced by a number of systematic factors that could lead to potential accidents. A crash caused by fatigue, for example, might not be solely the driver's fault; it could also be due to inappropriate route planning, leading to too much work pressure on drivers. In addition, supervisors' level of involvement could also contribute to potential accidents; supervisors may be restricted in their involvement due to their own workload, company policies, or pressure from higher up in the organization (Newnam & Goode, 2015; Reason, 1990). Hence, several small decisions from the top level down to the driver level may have triggered the actual accident. Other examples of such underlying systematic factors could include payment systems rewarding production, which entice drivers to take unnecessary risks and demand long working hours (Nævestad, Elvebakk, et al., 2018), and other organizational factors that influence a driver's working day that potentially lead to stressful situations (Newnam & Goode, 2015). In addition, vehicles that are not suitable for current road conditions and improper equipment to secure cargo are also factors that could contribute to accidents. Consequently, a reductionist approach to road traffic accidents involving work-related driving with HGVs is insufficient in detecting the potential causes of these types of accidents (Salmon et al., 2012). Also, such an approach makes it difficult to put corrective measures in place.

Instead of taking a reductionist approach, several scholars within the field of road traffic safety acknowledge the use of a systems approach when studying road traffic safety for work-related driving with HGVs. Instead of seeing individual road users as being responsible when crashes occur, this approach focuses on how a number of systematic factors could lead to potential accidents (Larsson & Tingvall, 2013). Research has been conducted on this matter in recent years (Goode et al., 2014; Hughes et al., 2015; Kuran et al., 2022; Larsson et al., 2010; Morimoto et al., 2021; Newnam & Goode, 2015; Nævestad, Elvebakk, et al., 2018). This thesis recognizes a systems approach and develops a holistic system approach towards road traffic safety for work-related driving with HGVs, meaning that it recognizes that there are several actors and decision makers

on different levels within the system who all have the potential to influence road traffic safety for work-related driving with HGVs.

1.2. Research objective and research questions

The key objective of this thesis was to study the relationship between parties in the system surrounding road traffic safety for work-related driving with HGVs and understand how different organizational factors affect this relationship and, as a consequence, influence road traffic safety. The purpose is to provide new insights – both theoretical and empirical – about factors affecting this relationship and explain how these factors support or constrain road traffic safety for work-related driving with HGVs.

Main research question was how can the relationship between parties and organizational factors influence the management of road traffic safety for work-related driving with heavy goods vehicles. This question was answered by developing three research objectives and four sub-questions. The first objective was to provide an overview of parties and factors influencing the system surrounding road traffic safety for work-related driving with HGVs. Two research questions were developed in relation to this objective. Hereby, who are the important parties in the system of work-related driving of HGVs and what do parties in the system of road transport perceive as important factors for managing road safety for work-related driving of HGVs? These questions are covered by article 1 and 5. The second objective was to investigate how parties on the lower levels of the system influence road traffic safety for HGVs. One research question was developed in relation to this objective. Hereby, how can parties on an organizational level and an operational level contribute to increased road safety for work-related driving of HGVs? This question was covered by articles 2, 3 and 4. The last objective was to develop a model that shows the holistic complexity of the system surrounding road traffic safety for work-related driving with HGVs. One research question was developed in relation to this objective. Hereby, how can the complexity surrounding road transport safety for work-related driving with HGVs be illustrated, and how can this complexity be managed. This question was covered in article 1 and in this current document. An overview of this thesis research objectives and research question is presented in table 1.

Table 1. Research objective and research questions

<p>Key objective</p> <p><i>To study the relationship between parties in the system surrounding road traffic safety for work-related driving with HGVs and understand how different organizational factors affect this relationship and, as a consequence, influence road traffic safety</i></p>	
<p>Main research question</p> <p>How can the relationship between parties and organizational factors influence the management of road traffic safety for work-related driving with heavy goods vehicles?</p>	
<p>Objective 1</p> <p>To provide an overview of parties and factors influencing the system surrounding road traffic safety for work-related driving with HGVs</p>	<p>Objective 2</p> <p>To investigate how parties on the lower levels of the system influence road traffic safety for HGVs</p>
<p>Research question 1</p> <p>Who are the important parties in the system of work-related driving of HGVs? <i>Articles 1 + 5</i></p>	<p>Research question 3</p> <p>How can parties on an organizational level and an operational level contribute to increased road safety for work-related driving of HGVs? <i>Articles 2 + 3 + 4</i></p>
<p>Research question 2</p> <p>What do parties in the system of road transport perceive as important factors for managing road safety for work-related driving of HGVs? <i>Article 1</i></p>	
<p>Objective 3</p> <p>To develop a model that shows the holistic complexity of the system surrounding road traffic safety for work-related driving with HGVs</p>	
<p>Research question 4</p> <p>How can the complexity surrounding road transport safety for work-related driving with HGVs be illustrated, and how can this complexity be managed? <i>Article 1 + main document</i></p>	

The reasoning and rationale for the research objective and research questions are presented in section 2.4 *Research problem and research gap*. The limitations related to the research objective and research questions are presented in section 1.7 *Limitations*.

The research questions in the articles are different than those presented above and in table 1. This distinct difference has been made because of the distinction between writing on article level and writing on thesis level. On article level, the scope is more narrow while on thesis level, the scope is to connect everything together and create “the red line”.

Article 1 seeks to identify important factors in managing road safety for work-related driving of HGVs by conducting a literature review. Hereby, article 1 provides an overview of factors previous research literature deems to be important factors and also proposes an overall framework for how safety training for parties in the system could be executed. Article 1 ask the following research question:

What are important factors for managing road safety for work-related driving of HGVs, and how can an overall safety training framework be arranged to enhance road safety for work-related driving of HGVs?

Article 2 takes the perspective of road transport organizations and identifies how management’s decisions can support or constrain road traffic safety for work-related driving with HGVs. Article 2 ask the following research question:

Which leadership strategies support and/or constrain safety culture in road transport organizations?

Article 3 and 4 are following up on article 2, however, these articles are taking the buyer of road transport services’ perspective. Hereby, investigating the role of this actor in supporting/constraining road traffic safety. Article 3 and 4 address the following research questions:

How can buyers of road transport services contribute to safe road transport in northern Norway, and how can buyers of road transport services contribute to sustainability and safety in the chain of transport and to the “Vision Zero” ideology?

Finally, article 5 has given an overview of all the actors in the system surrounding road traffic safety for work-related driving with HGVs. Article 5 ask the following research question:

Who are the actors/components in the complex sociotechnical system of road transport for work-related HGV transport, and how can they influence safer road transport?

1.3. Key findings

Table 2 presents a short summary of the main findings of this thesis. A more comprehensive explanation of the key findings is presented in Chapter 4. Also, the findings are discussed in the context of the theoretical framework in Chapter 5. For a detailed presentation of the findings, please see the respective papers.

Table 2. Overview of key findings

Article	Main findings
1. Work-related driving of heavy goods vehicles: Factors that influence road safety and the development of a framework for safety training	The findings show that important factors for the management of road safety could be arranged at different levels: governmental level, third-party level, organizational level, and driver level. A systematic approach to road safety for HGVs is essential. Every actor is jointly responsible for road traffic safety, and actors must communicate and work together to increase road traffic safety for work-related driving with HGVs. Communication, collaboration, and cooperation between the actors are important factors. By developing a safety training program for all actors in the system, the study proposes a method for increased communication, collaboration, and cooperation between the actors.
2. Leadership strategies, management decisions and safety culture in road transport organizations	The findings suggest that road transport organizations that chose a low-cost leadership strategy struggled to be profitable. Moreover, such strategies led to high rivalry between organizations. Such rivalry made it difficult to be profitable, as there were fewer resources available to invest in building a good safety culture. In contrast, road transport organizations that chose a differentiation or focus leadership strategy were more likely to be profitable. As a consequence, they had more resources to invest in building a safety culture by investing in equipment and employees.
3. Road transport safety in Northern Norway: How buyers of road transport services can contribute to a road transport with fewer accidents and near-misses	The findings suggest that buyers of road transport services could contribute to safe road transport by prioritizing the following characteristics and qualities: 1) the development of a detailed formal contract with the provider of road transport; 2) awareness of the possibilities of new technologies; 3) understanding that the decision criteria for ordering transport could influence road transport safety; 4) good communication with both the road transport organization and the authorities; 5) recognition of how knowledge of and trust in a road transport organization is important but could also affect judgement regarding revisions and controls.

<p>4. Buyers of road transport services: sustainability and safety responsibility?</p>	<p>The findings indicate that buyers of road transport services had an impact on both sustainability and safety in the chain of road transport by influencing pricing and delivery demands.</p>
<p>5. A system view on road traffic safety of work-related driving with heavy goods vehicles</p>	<p>The findings suggest that communication and competence were essential for all actors in the system, especially across or between levels and actors. Control sanctions should not be seen as a primary measure for enhanced road transport safety for work-related driving with HGVs. Instead, prevention and motivation could work better than punishment and control when driver behavior is to be influenced.</p>

1.4. Researcher’s personal motivation

The researcher’s personal motivation for studying the relationship between parties in the system surrounding road traffic safety for work-related driving with HGVs and understanding how different organizational factors affect this relationship is a result of the researcher’s own education and work history. After working 10 years as a driving instructor on HGVs, the researcher became familiar with the challenges that everyday drivers experienced. It became clear that many of these challenges were difficult to handle for the individual driver because decisions were made by others – customers, managers, the government – on behalf of the drivers. After working another seven years in the Norwegian Public Road Administration and studying for a Master’s of Public Administration, it became clearer to the researcher that professional drivers are part of a bigger system and are dependent on parties higher up in the system to perform safe road transport. A curiosity for this phenomenon was brought to life and was the breeding ground for this dissertation.

1.5. Research process

The total length of the research process has been four years, 2018–2022 (Table 3). To address the overarching research question and sub-questions, data were collected over a period of three years (2019–2022). The main source of empirical data was collected through several different industries, with a total of 29 participants. Data were collected through semi-individual interviews and group interviews, as well as through documents and literature review. A detailed description of the methodology is presented in Chapter 3. The writing of the articles was conducted during all years, except for the first year. During the first year, an extensive document and literature review was conducted in addition to mandatory PhD courses, and the document and literature review was maintained through all four years.

Table 3. Research process

Year 1	Year 2	Year 3	Year 4
June 2018 – June 2019	June 2019 – June 2020	June 2020 – June 2021	June 2021 – June 2022
Literature review			
Mandatory PhD courses			
	Collecting data (interviews)		
	Writing and publishing Article 2, 3 and 4		
		Writing and submitting Article 1 and 5	
			Writing thesis

1.6. Thesis structure

This thesis consists of two parts. The first part consists of six chapters (Table 4), starting with an introduction chapter that describes the background, research objective, and research questions. The chapter ends with a discussion about the limitations of this thesis. Chapter 2 presents the theoretical perspectives relevant for this thesis. The chapter ends with a presentation of the research problem and research gap. Chapter 3 presents the methodological choices that have been made, including a detailed description of the research design, research approach, data collection, and analysis. The chapter ends with

a discussion regarding the reliability and validity of this thesis, as well as a consideration of ethical issues. Chapter 4 presents the main results. Chapter 5 discusses the key contributions of this thesis. Chapter 6 contains a conclusion, the implications of this thesis, and suggestions for future research. Finally, a complete reference list is provided.

The second part of this thesis consists of five individual articles (Table 4). This includes four journal articles and one conference article: three are published in international journals and one is a conference article that was presented at the 2020 ESREL conference.

Table 4. Overview of individual articles

Article no.	Title	Author	Published in	Year
1	Work-related driving of heavy goods vehicles: Factors that influence road safety and the development of a framework for safety training	Katrine Grinerud	<i>Safety</i> , 8(2), 43 DOI: 10.3390/safety8020043	2022
2	Leadership strategies, management decisions and safety culture in road transport organizations	Katrine Grinerud, Wenche Aarseth, Rolf Robertsen	<i>Research in Transportation Business & Management</i> , Volume 41, DOI:10.1016/j.rtbm.2021.100670	2021
3	Road transport safety in Northern Norway: How buyers of road transport services can contribute to a road transport with fewer accidents and near-misses	Katrine Grinerud	<i>Arctic & North</i> , Volume 42, DOI: 10.37482/issn2221-2698.2021.42.81	2021
4	Buyers of road transport services: Sustainability and safety responsibility?	Katrine Grinerud, Wenche Aarseth, Gunhild Sætren	<i>The 30th European Safety and Reliability Conference and the 15th Probabilistic Safety Assesment and Safety Conference, Esrel/Psam 2020</i> , Article number 4391	2020

5	A system view on road traffic safety of work-related driving with heavy goods vehicles	Katrine Grinerud, Wenche Aarseth, Gunhild Sætren	Article will be re-submitted to journal autumn 2022.	
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1.7. Limitations

Because the thesis is based on the analysis and results that are presented in the five articles, the thesis is limited to the topics reported in the articles. However, the development of a new model is presented based on the empirical findings of the five papers and the extensive literature review presented in Article 1.

The domain theory perspective has been a systems approach to enhancing road traffic safety for work-related driving with HGVs; it is towards this field that this thesis aims to contribute (Figure 1). However, the organizational factors affecting road traffic safety for work-related driving with HGVs have been used as a “theoretical lens” or method theory (Lukka & Vinnari, 2014).

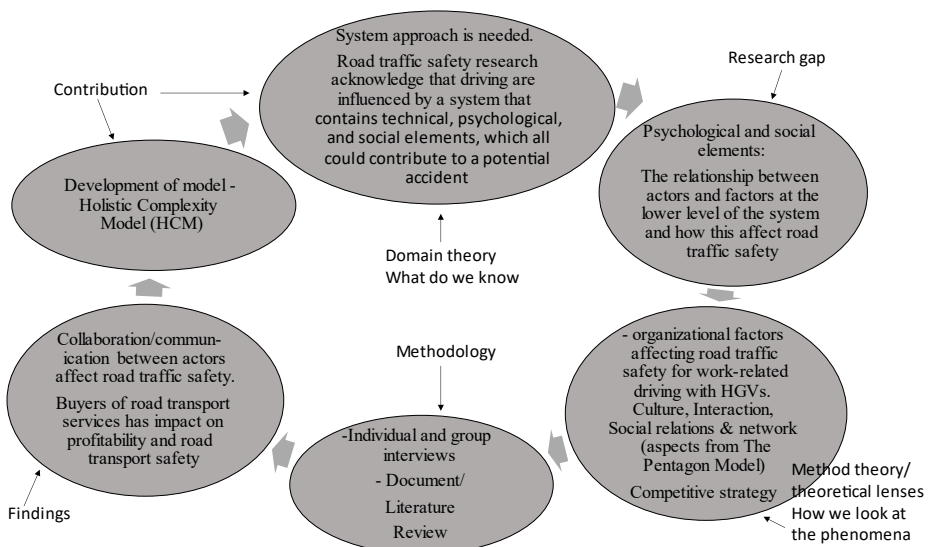


Figure 1. Domain theory and method theory of this thesis. (Figure by prof. A. Bourmistrov, doctoral academic course, Nord University, august 26, 2020)

It is acknowledged that work-related driving with HGVs is influenced by a system that contains technical, psychological, and social elements, and that these factors could contribute to a potential accident. However, to cover all these aspects in one thesis is a too broad a perspective; some limitations were therefore made. In this thesis, technical elements are excluded and are not discussed in detail in relation to factors that could influence road traffic accidents, though some technical elements are briefly mentioned in order to give a broader picture in some discussions. Also, detailed discussions regarding legal elements are mainly excluded from this thesis. Instead, legal elements are seen as something underlying that everyone must relate with. This thesis therefore does not take into account whether the current legal elements must or should necessarily be changed.

This thesis focuses primarily on psychological and social elements. However, there are also some limitations linked to these terms. Since the main objective of this thesis is to study the relationship between parties in the system surrounding road traffic safety for work-related driving with HGVs and understand how different factors affect this relationship and, as a consequence, influence road traffic safety, the thesis does not discuss psychological and social elements on a personal level. Instead, it examines the psychological and social elements that have influence on an organizational level – the elements influencing the relationship between parties/organizations on same and different levels in the system that influence road traffic safety for work-related driving with HGVs.

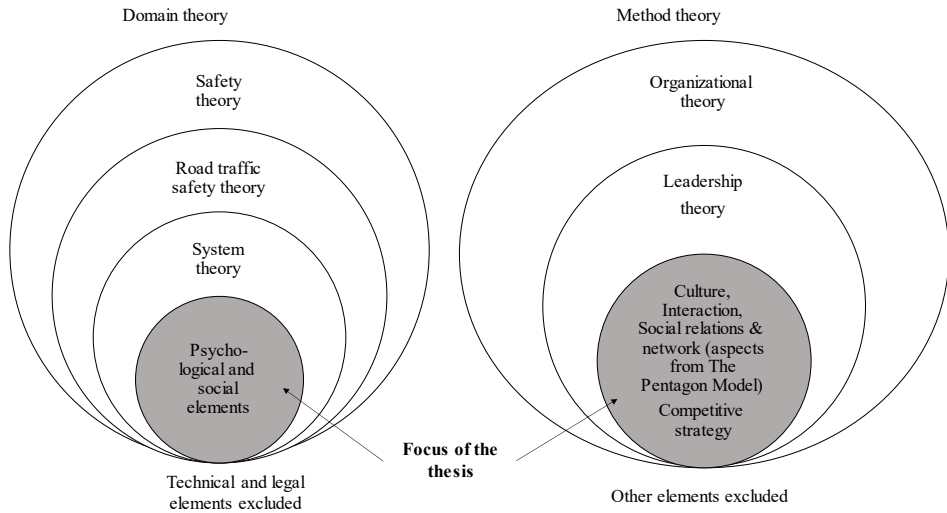
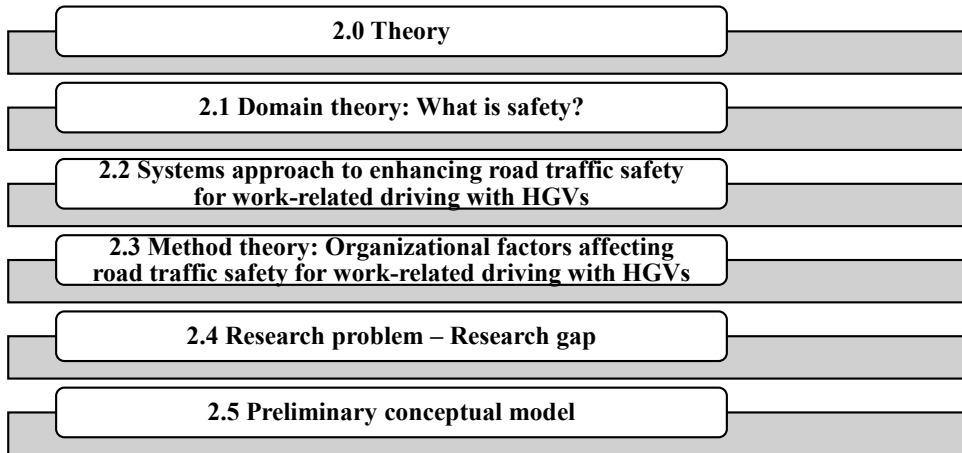


Figure 2. Focus of the thesis

In order to keep the thesis within its scope, it was also important to limit the meaning of the terms of physiological and social elements. Elements from organizational theory have been used as method theory in order to narrow the meaning of the terms – specifically, elements from the Pentagon model (Rolstadås et al., 2014): culture, interaction, social relations, and network. Figure 2 illustrates the scope and focus of this thesis. The following chapter will provide a more detailed presentation of the theoretical lenses used in this thesis.

2. Theory



This chapter presents the domain theory and method theory used in this thesis (Lukka & Vinnari, 2014). First, it presents a short overview of the historical development of the term “safety” and the specific role of “safety” within road traffic safety theory, showing the shift from a reductionist approach towards a systems approach for improving road traffic safety. Then, the chapter provides a justification for why road traffic safety for work-related driving with HGVs should be seen as a complex sociotechnical system and why taking a system approach could contribute to road traffic safety. After that, the chapter presents the elements from organizational theory used as theoretical lenses (method theory) in this thesis. Finally, it elaborates a preliminary conceptual model.

2.1. Domain theory: What is safety?

In order to increase safety, it is important to understand the history of safety. How we experience and think about safety in 2022 is not the same as we did just a few years ago. Many of today’s safety challenges occur because of the increasingly interconnected world (Le Coze, 2020). Safety has been defined in different ways by different researchers over the years. Most commonly, safety is defined as the absence of accidents and incidents. However, this definition has been proven inadequate by several researchers, as an absence of accidents and incidents does not necessarily mean that something is safe. Consequently, an alternative definition was given of safety as

freedom from unacceptable risk (Aven, 2022). In order to place this thesis in the theoretical landscape, it is important to dig deeper into definitions of safety.

The abovementioned definitions are concerned with having as few things as possible going wrong; it is termed as Safety I (Hollnagel et al., 2015). According to Safety I, if things do go wrong, it is because of identifiable malfunctions or failures in a system, such as malfunctions or failures in technology, procedures, or human errors. In this approach, problems can be fixed by establishing a cause-and-effect relationship. Consequently, learning and improvements regarding safety result from failure and mistakes. Therefore, this approach makes management reactive regarding safety work, responding when something goes wrong or is categorized as unacceptable risk (Aven, 2022). The term Safety II is a development of the thinking around Safety I. In the Safety II approach, there is a move from making sure as few things as possible go wrong to ensuring that as many things as possible go right (Hollnagel et al., 2015). In this approach, humans are seen as an important resource to ensure that things go right under varying conditions. Humans are capable of adapting to variable conditions; therefore, things go right. In this approach, management is proactive in trying to anticipate developments and events (Aven, 2022).

There are some criticisms of the terms Safety I and Safety II. In particular, Leveson (2021) disagrees with these approaches to safety. She claims that these approaches do not reflect reality and practice, and that they are a step backwards when working with safety. As a counterargument, Leveson presents the term Safety III, which is based on systems theory and is defined as freedom from unacceptable losses as identified by the system stakeholders. The goal is to eliminate, mitigate, or control hazards, which are the states that can lead to such losses (Leveson, 2021). In this approach, accidents are caused by inadequate control over hazards, and there is no root cause. Instead, there are errors in the system, with several factors or decisions leading up to an accident (Aven, 2022).

In this thesis, where the key objective is to study the relationship between parties in the system surrounding road traffic safety for work-related driving with HGVs and understand how different organizational factors affect this relationship and, as a

consequence, influence road traffic safety, the main emphasis is on Leveson's Safety III approach.

2.2. Systems approach to enhancing road traffic safety for work-related driving with HGVs – From a reductionist skill model approach to a systems approach

The common approach to improving road traffic safety has slowly changed over the past 10 to 20 years from being built on the view that individual road users are responsible when crashes occur – *a reductionist approach* – to a view where a number of systematic factors could lead to potential accidents – *a systems approach* (Larsson & Tingvall, 2013). The early systems approach towards improving road traffic safety was underpinned by the kinetic energy model (Salmon et al., 2012), where improved road traffic safety could be improved by separating sources of kinetic energy and, if such separation is not possible, control the energy so it is not transferred to road users and cause injuries. This way of thinking is the reasoning behind national policies like the Vision Zero ideology – a vision that there shall be no casualties or severe injuries in road traffic (Larsson & Tingvall, 2013; Salmon et al., 2012). In recent years, the systems approach towards improving road safety has evolved even more. Road safety research has looked towards high-risk organizations (Sætren & Laumann, 2015; Weick & Sutcliffe, 2001) in order to understand how safety is maintained in such organizations and adopt this approach to road traffic safety (Newnam & Goode, 2015) – looking deeper into the underlying causes of road traffic accidents and identifying latent failures (Reason, 1990). In this context, latent failures refer to errors that may occur due to actions and decisions made by management or others who are removed from the direct control interface. Examples of latent failures could include scheduling less driving time than the route actually need or providing drivers with insufficient equipment and trailers. Such latent errors could, in the next step, lead to active failures. This is where the consequences are instantly visible and where there is a clear relationship between cause and effect (Reason, 1990) – for example, when an HGV driver is involved in a road traffic accident. With this new development in improving road traffic safety, it is acknowledged that the road transport system should be seen as a complex sociotechnical

system (Leveson, 2004; Rasmussen, 1997), meaning that the system contains technical, psychological, and social elements and that all elements could influence road traffic safety (Newnam & Goode, 2015; Nævestad, Elvebakk, et al., 2018).

2.2.1. Complex sociotechnical system approach in road traffic safety for work-related driving with HGVs

A more thorough application of systems thinking to road traffic safety would lead to a better understanding of the reasons for road traffic safety's lack of success and result in solutions for new interventions and measures (Salmon et al., 2012). This argument is applicable especially for work-related driving with HGVs. In Norway, there is on average 688 people that are injured in road traffic accidents involving HGVs each year, and for every third road fatality, there is an HGV involved (Langeland & Phillips, 2016). In a systematic view, the answer cannot be found by detecting the errors that the driver made that led to these accidents. Instead, a systematic approach considers the interaction between all the actors within the system, including the broader organizational, social, or political interactions that might contribute to unsafe road transport leading up to an accident (Larsson & Tingvall, 2013).

A system that includes technical, psychological, and social elements is a sociotechnical system (Salmon et al., 2012). A *complex* sociotechnical system is defined by six specific traits. First, the system is open. This means that the system can be influenced by the environment in which it operates and, conversely, can influence this same environment. Second, the system's components are *ignorant* of the system as a whole. Third, the actors/components themselves are not complex but are integrated in a system, which itself is complex. Fourth, there must be inputs from the actors/components at all times to maintain a functional system. Fifth, complex systems are path dependent. This means that their past behavior influences their present behavior. Finally, interactions within complex systems are non-linear. Input and output are not symmetric, and small events can produce large results.

These six characteristics can be found in the road transport system (Salmon et al., 2012). Moreover, road transportation can be classified as a complex sociotechnical system

since it is comprised of technical, psychological, and social elements that inform goal-directed behavior, and the system is influenced by a high degree of uncertainty and independence (Newnam & Goode, 2015). When road traffic accidents are seen as complex phenomena, there is no longer an obvious relationship between the behavior of parts in the system and system-level outcomes. Instead, system-level behaviors emerge from the multitude of relationships and interconnections deeper inside the system (Dekker et al., 2011).

Rasmussen (1997) developed a framework showing the complex sociotechnical system that is involved in the control of safety. The idea behind the framework is that accidents are caused by the decisions and actions of all actors within the system and by multiple contributing factors (Newnam & Goode, 2015). This framework helps identify actors who interact or have interdependencies, and any actor who can affect or is affected by the actions, decisions, policies, practices, or goals within the system. In this sense, the actors have the possibility to help or harm the functioning of a system (Gibson, 2000; Aarseth et al., 2015).

This risk management framework has been used previously in several disciplines and domains, including the mining industry (Donovan et al., 2017), food industry (Cassano-Piche et al., 2009), aviation (Thoroman et al., 2019), and road traffic (Newnam & Goode, 2015).

The framework identifies the actors in the system, including the government, departments, regulators, CEOs, managers, supervisors, and workers. Safety is maintained through a vertical integration process, meaning that decisions made at higher levels are reflected at the system's lower levels. In addition, information and experiences realized in the lower levels of the system are communicated to the higher levels so that they can be known at the higher levels before decisions are taken (Newnam & Goode, 2015; Rasmussen, 1997).

At the top level, governmental institutions attempt to control safety through legal systems. In road transport, for example, there are national laws. Legislators pass acts that affect different aspects of safety. In road transport, these include acts pertaining to

driving time, loading capacity, and driver training. In addition to legal regulations concerning safety, legislators and other agents (e.g., non-governmental organizations) are concerned with general economic health in terms of employment and trade balance. Legislation then makes explicit the priorities of conflicting goals (Rasmussen, 1997). It is common for regulators to use safety reviews and accident analyses to guide their work. At the next level, the legislation is interpreted and implemented through specific rules that control activity in certain kinds of workplaces. Interpreters and implementers at this level are e.g. national (local) regulators, interest organizations, and non-governmental organizations (NGOs). The next level, the company, is where the legislations and rules are interpreted and implemented in the context of a specific company. This thesis focuses on this level and downwards; it excludes the legal perspectives. At the lowest levels, “hands-on” workers develop operating procedures regarding how the work task should be carried out in practice. For road transportation, this includes management in the companies, supervisors, and drivers.

Rasmussen (1997) explains the use of the framework to control safety in five steps. The first step is about identifying the decision makers in the system, which could be done by mapping the relationships between the decision makers. The second step is having information about the proper action targets for all actors, including production and safety-related objectives. The third step is sharing information, both top-down and bottom-up, in the system. It is especially important that decision makers be well acquainted with information about work processes at the lower levels. The fourth step is establishing the competence and capability of the various actors. This is not only a matter of formal knowledge but also tacit knowledge and practical skills. The last step concerns commitment and includes whether the actors and decision makers are committed to safety and whether they are aware of safety constraints.

This system is premised on the fact that it is difficult to detect when mitigation towards the boundaries for safe performance occurs, especially in complex and challenging systems like work-related driving with HGVs. The main emphasis of this thesis is on the lower levels of the system, from the company level and downwards, since it takes a management perspective and does not cover the legal perspectives.

2.3. Method theory: Organizational factors affecting road traffic safety for work-related driving with HGVs

Organizational factors affecting road traffic safety for work-related driving with HGVs have been used as method theory in this thesis because of the thesis objective to study the relationship between parties in the system surrounding road traffic safety for work-related driving with HGVs and understand how different organizational factors affect this relationship. The “parties” in this context are mainly organizations, which are defined as systematically arranged frameworks relating people, things, knowledge, and technologies in a design intended to achieve specific goals (Clegg et al., 2021; Aarseth, 2012). Organizations consist of a complex of important dimensions: internal dimensions include goals, structure, leadership, and motivation, and external dimensions include relationships, networks, and external environment (Aarseth, 2012). Some of these dimensions are important for this thesis, but the body of knowledge in organizational theory is tremendous. Thus, this thesis uses two theoretical frameworks from organizational theory – the organizational Pentagon model and aspects from leadership and competitive strategy theories – to shed light on the overall research question: How can the relationship between parties and organizational factors influence the management of road traffic safety for work-related driving with heavy goods vehicles?

2.3.1. The Pentagon model

When an unwanted incident occurs, it is crucial that its cause be found to prevent it from happening again. It is possible to investigate an incident on an individual or system level. When investigating on an individual level, the aim is to understand why humans act like they do. When investigating on a system level, the aim is to investigate the whole organization in order to identify its ability to avoid unwanted incidents (Kongsvik et al., 2018).

The Pentagon model is an assessment tool that can analyze why unwanted incidents occur from a system-level perspective and how to prevent them (Figure 3). Moreover, it can be used for planning and organizational development – for example, by

determining what kind of organizational characteristics must be in place to achieve certain qualities (Kongsvik et al., 2018; Rolstadås et al., 2014).

A Pentagon model analysis combines a system-oriented approach and a social constructivist theoretical approach to understand the working situation for the different actors involved. The model places special emphasis on keywords like interpretation, sense-making, and interests, and it takes both formal and informal aspects into account (Rolstadås et al., 2014). The model analyzes five different aspects: structure, technologies, culture, interaction, and social relations and networks. These are the most important variables that characterize an organization (Kongsvik et al., 2018).

Structure covers how the organization has defined roles, responsibility, and authority. *Technologies* refer to tools, equipment, IT systems, and infrastructure that are essential to the activities of the organization. *Culture* consists of attitudes, values, norms, and knowledge; it establishes expectations for how “work is done here.” *Interaction* involves communication and cooperation, while *social relations and networks* refer to important factors in all kinds of work, such as trust, friendship, and access to knowledge (Kongsvik et al., 2018; Rolstadås et al., 2014).

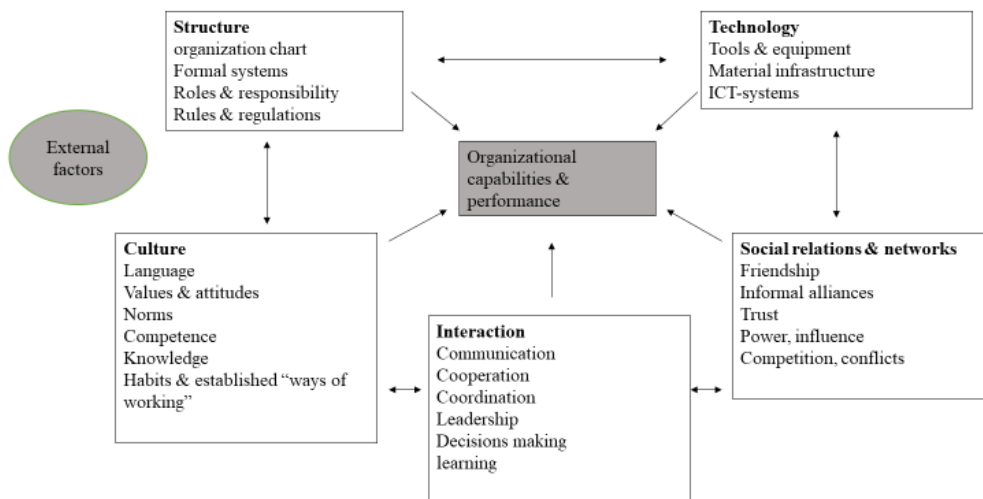


Figure 3. The Pentagon model (adopted from Schiefloe in Aarseth, 2012)

These aspects are all interrelated but can also be investigated separately (Aarseth, 2012). This thesis mainly focuses on the aspects of culture, interaction, and social relations and networks, as these are the aspects most related to the main objective of the thesis.

In addition to using the Pentagon model as a framework for answering the research question, this thesis also emphasizes management's choice of strategy – which leadership strategy the organizations choose and how this choice affects road traffic safety for work-related driving with HGVs.

2.3.2. Leadership and competitive strategy influencing road traffic safety for work-related driving with HGVs

Leadership and strategy are key factors that influence an organization's ability to compete in a market. To execute leadership, at least three social conditions must exist: (1) there must be a group of two or more people; (2) the group must work on a common task; and (3) group members must have differentiated responsibilities (i.e., members must have different duties) (Stogdill, 1950). All of these conditions are present in road transport organizations (and in all other organizations), and the leader is the person who is differentiated from other organizational members by his or her influence over goal setting and goal achievement for the organization (Stogdill, 1950). Therefore, leadership can be defined as “the process of influencing an organization in its efforts towards achieving an aim or goal” (Johnson et al., 2011).

However, in the road transport industry, the performance of workers is often difficult to see because drivers work outside the physical boundaries of their organizations. This limited visibility makes executing leadership challenging in these organizations (Zohar & Luria, 2005), as the management must lead workers and implement any needed changes from afar.

Nevertheless, the leaders of such organizations must make decisions regarding the direction in which they want to go, which affects employees working both inside and outside the physical boundaries of the workplace. For road transport organizations, such decisions could include how they recruit their customers, how they educate their drivers,

how they prioritize safety work, and so forth. Together, these decisions shape an organization's overall strategy.

Strategy has been defined in several ways throughout the years. One definition describes strategy as “the long-term direction of an organization” (Johnson et al., 2011); another describes it as “the determination of the long-run goals and objectives of an enterprise and the adoption of courses of action and the allocation of resource necessary for carrying out these goals” (Chandler in Johnson et al., 2011). Building on these definitions' general understanding of strategy, this thesis uses a more precise definition of competitive strategy in order to examine the relationship between all actors in the system surrounding road traffic safety for work-related driving with HGVs and understand how different organizational factors affect this relationship and, as a consequence, influence road traffic safety.

2.3.2.1. Competitive strategy approaches used by road transport organizations

Porter (1992) argued that business decisions are only strategic if they involve doing something different than one's competitors. He claimed that competitive strategy is about being different – deliberately choosing a different set of activities in order to deliver a unique mix of value. In particular, Porter (1992) emphasized that organizations' strategic choices play an important role in their ability to be competitive in markets – that is, to be profitable. Organizations can be competitive in markets (i.e., develop a competitive advantage) by taking one of two main approaches: a low-cost strategy or a differentiation strategy. For the low-cost approach, organizations recruit customers by delivering a product or service at the lowest possible cost; for the differentiation approach, they offer a product or service with especially high quality (Reitsperger et al., 1993). These two approaches lead to three generic strategies to achieve above-average results in an industry: low-cost leadership, differentiation leadership, and focus leadership (Porter, 1992) (Table 5).

Table 5. Approaches and generic strategies

Approaches	Generic strategies	Competitive advantage
Low-cost strategy	Low-cost leadership	Compete in the market by delivering a product or service at the lowest possible cost
Differentiation strategy	Differentiation leadership	Compete in the market by offering something unique/special
	Focus leadership	Compete in the market by focusing and specializing on a certain aspect

When a road transport organization chooses low-cost leadership as a long-term strategy, the organization focuses on achieving the lowest production costs in its industry (Porter, 1992). An example is using equipment and vehicles over a longer period of time and/or carrying out the road transport of goods for the lowest price. If the organization succeeds in achieving and maintaining the lowest costs, it will receive above-average results and be the cost leader in the industry. However, the pitfall is whether the organization's customers perceive its service or product as comparable to those of other organizations. If not, the organization may have to lower its price well below average to win customers. The strategic logic underlying low-cost leadership usually means that only one organization can be the cost leader in an industry. In the road transport industry, several organizations compete to obtain this position. Thus, the high rivalry between road transport organizations leads to low profitability for the entire industry in both the short and long terms (Grinerud et al., 2020). This low profitability can make it difficult for these organizations to prioritize safety work within their organizations. Indeed, small road transport organizations are particularly susceptible to this risk, given their limited resources (Nævestad, Elvebakk, et al., 2018). Without enough resources (e.g., skilled and motivated drivers, competitive equipment, assets), it could be difficult for these organizations to invest in building a better safety culture.

Reason and Hobbs (2003) state that a good safety culture drives an organization toward safety goals regardless of commercial pressure and that management has a strong influence on prioritizing safety. However, inadequate resources can have a significant impact on this prioritization. Specifically, when many workers work outside the physical boundaries of road transport organizations, safety management is much more challenging because the cost of technology to monitor workers' behavior in such "remote contexts" is rather high. As a result, many organizations do not invest in safety but instead focus on productivity and efficiency (Zohar & Luria, 2005).

By choosing differentiation as its long-term leadership strategy, an organization seeks to excel in the industry in which it operates (Porter, 1992). The organization seeks to gain a competitive advantage by incorporating highly desirable and sought-after attributes into its product or service. Such attributes can involve the level of service the organization provides, its delivery systems, and so forth. While the means for differentiation are distinct for each industry, the strategic logic underlying the differentiation strategy demands that organizations differentiate themselves on attributes their competitors overlook or ignore.

Today, the pressure for organizations to incorporate sustainability principles and objectives into their policies and activities is mounting (Aarseth et al., 2017); road transport organizations are increasingly concerned with this matter. Using more environmentally friendly equipment and vehicles (e.g., electric HGVs and cargo bicycles) is an example of a strategic differentiation decision in the road transport industry. However, in order to succeed with such a differentiation strategy, the costs of delivering unique attributes must not exceed the differentiation costs, and customers must perceive the organization's offering as being something truly unique. Otherwise, the organization will not be able to charge more for the product or service than their competitors (Porter, 1992). For example, focus on safety could be a differentiator that makes an organization excel in the industry.

The last generic strategy is focus. By choosing focus as its long-term leadership strategy, an organization seeks to compete in a small area (Porter, 1992). The organization

chooses a small segment or a group of customers within an industry and aligns its strategy toward this segment or group. Transporting dangerous goods is one example of this strategy in the road transport industry. Road transport organizations that carry dangerous goods must have special equipment, vehicles, and competence to do so, and they direct their resources toward this segment (i.e., dangerous goods). They thus compete in a smaller market than competitors that do not have a focus strategy, increasing their likelihood of achieving higher profitability and having more resources available for investing in safety. The focus strategy has two variants: road transport organizations can choose to seek cost-related benefits or differentiatonal benefits within their specific segments or groups. Most industries have different segments, and some segments have special demands, like transporting dangerous goods. These demands provide opportunities for choosing a focus strategy (Porter, 1992).

Porter (1992) emphasized that an organization must choose between these three strategies. They are inconsistent with each other and cannot be combined. Organizations that engage in all three (or even two) strategies will not succeed in becoming profitable and will consequently have fewer resources to invest in safety and safety work. They will not gain a competitive advantage, as they will fail to compete with organizations that have implemented just one of these strategies (Porter, 1992).

However, there are some counterarguments regarding the inconsistency of these three strategies. For example, Reitsperger et al. (1993) state that none of the firms in their study used a single-focus strategy in alignment with Porter's model. Similarly, Hill (1988) states that pursuing differentiation could be a way to achieve a low-cost position in an industry. Furthermore, some industries do not have one unique low-cost position, so it is possible to pursue both low-cost and differentiation strategies and still be profitable. The views of Reitsberger et al. (1993) and Hill (1988) can be seen in road transport organizations, as some organizations do not focus on one single strategy. Instead, they carry out different types of transport assignments and build different types of expertise within their organizations, leading them to be profitable.

Regardless of the chosen strategy, organizational size could play a role in the development of safety. On one hand, it could be argued that it is easier for larger organizations to prioritize safety, as they are more competitive and have more resources to invest in safety (Nævestad et al., 2015). However, this claim presupposes managers' and employees' commitment to safety, which earlier research suggests is a prerequisite for organizations' safety work to succeed (Li & Itoh, 2014; Newnam & Oxley, 2016; Nævestad, Elvebakk, et al., 2018; Reason, 1998). On the other hand, it could be argued that smaller companies have an easier time connecting with their employees and thus have more success implementing safety work, even though these organizations often have fewer resources available (Newnam et al., 2012; Nævestad et al., 2015).

2.4. Research problem – Research gap

An extensive literature review has identified numerous studies focusing on taking a systems perspective when exploring work-related driving with HGVs and safety concerns. These studies often focus on a specific level of the system that surrounds work-related driving with HGVs – most commonly, the organizational level within road transport organizations. However, decisions are made within the system of road transport on different levels, and all these decisions could influence road safety (Kuran et al., 2022; Li & Itoh, 2014; Luke & Heyns, 2014; Mooren, Williamson, et al., 2014; Newnam & Oxley, 2016; Nævestad et al., 2020; Nævestad, Elvebakk, et al., 2018; Rasmussen, 1997).

This thesis expands the view of possible parties that could affect road traffic safety for work-related driving with HGVs, by taking a holistic system approach to road traffic safety and look closer to specific parties at the lower levels of the system.

Previous studies also emphasizing a systems approach which include parties on different levels when explaining road traffic safety of work-related driving with HGVs. For example, Nævestad et al. (2015) mention regulators of traffic safety as an important party, and Newnam and Goode (2015) map parties on different levels, such as governmental institutions and NGOs. However, this thesis contributes to the extensive

literature regarding road traffic safety for work-related driving with HGVs in several ways.

First, it focuses on the relationship between parties on different levels in the system and investigates how this relationship could influence road traffic safety for work-related driving with HGVs. The emphasis is mainly on the relationship between parties on the lower levels of the system (Figure 4) – the relationship between road transport organizations, their drivers, and buyers of road transport services. Even though newer research puts more emphasis on a system approach and considers the role of actors on different levels (Kuran et al., 2022), previous research often focused on relationships within an organization – for example, the relationship between management and drivers (Grytnes et al., 2016; Newnam, Warmerdam, et al., 2017). This thesis emphasizes a system approach that investigates the relationship between parties at the lower levels in the system in depth.

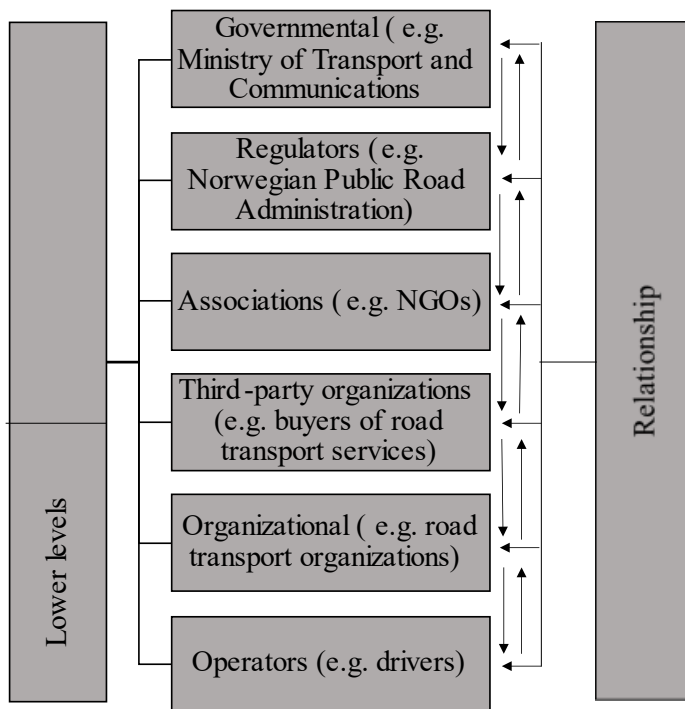


Figure 4. The system surrounding road traffic safety for work-related driving with HGVs

Second, this thesis focuses especially on buyers of road transport services as an important party in managing road traffic safety for work-related driving with HGVs. This party has significant potential for influence but is rarely mentioned in existing studies. This thesis investigates the relationship between the road transport organization (include the drivers) and the buyer of road transport services from a management perspective, seeing it in relation to other parties on different levels in the system (Figure 5) By taking the perspective of the buyers, there is a potential to suggest new measures directed towards the HGV industry in order to enhance road traffic safety for work-related driving with HGVs.

Third, by focusing on the relationship between parties on different levels in the system, especially between buyers of road transport services and road transport organizations, the thesis highlights important factors that should be present in the relationship in and between these parties – for example, cultural development within organizations, organizational interaction, and how they make decisions. A model has been developed to illustrate the complexity in road traffic safety for work-related driving with HGVs: the holistic complexity model. The model shows the complex relationship between the parties on different levels in the system and illustrates how management decisions could affect road traffic safety for work-related driving with HGVs. In addition to identifying parties, illustrate relationship and the effect of management decisions, the holistic complexity model (HCM) explains how different factors influence parties on different levels in the system.

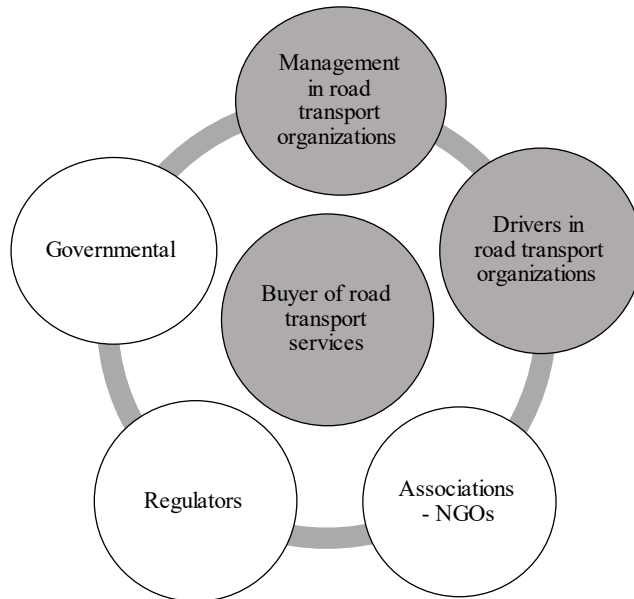


Figure 5. Buyer of road transport services as a key party in the system of road traffic safety for work-related driving with HGVs

Based on this research gap, the following overarching research question was developed:

How can the relationship between parties and organizational factors influence the management of road traffic safety for work-related driving with heavy goods vehicles?

In this thesis, “relationship” refers to the relationship between parties on different and same levels in the system surrounding work-related driving with HGVs. “Organizational factors” refer to factors that influence or are present within and outside organizations, as organizational theory is one of two lenses that is used to study the phenomena in this thesis. Furthermore, “heavy goods vehicles” are limited to trucks with and without trailers, with a minimum loading capacity on at least 7,500 kilograms. Four research questions were formulated to answer the overarching question, which are presented in section 1.2 in more detail.

2.5. Preliminary conceptual model

Based on the theory presented above, managements choice of strategy has an impact on factors like culture development, interaction, social relations and networks. Further, these factors have an impact on road safety for work-related driving with HGVs. Hence, a preliminary conceptual model was developed based on the theoretical framework (Figure 6) and the model shows the relationships of the theoretical framework that underlies this thesis.

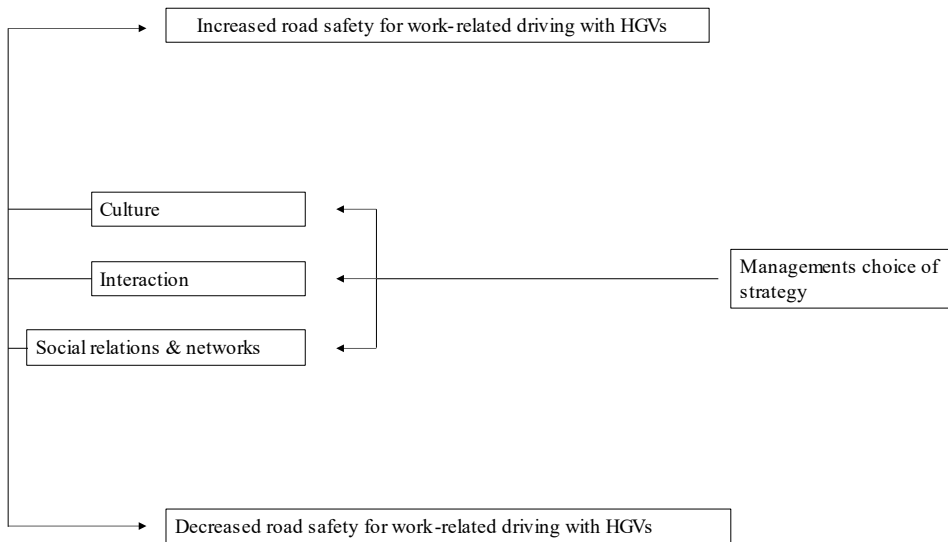


Figure 6. Preliminary conceptual model

A final model is presented in chapter 5.4, the holistic complexity model (HCM).

3. Methodology

3.0 Methodology
3.1 Philosophical perspective and paradigms
3.2 Research design
3.3 Sampling and participant strategy
3.4 Data collection
3.5 Data analysis
3.6 Methodology – Each Aarticle
3.7 Reliability and validity
3.8 Ethical considerations

This chapter provides a detailed overview of the methodology used in this thesis. First, it gives a detail explanation of the philosophical perspective and paradigms. Then, it presents a general description of research design, sampling strategy, data collection, and analysis. It also discusses the different methodological choices that could be made, in order to make a reflective choice. The chapter then presents a specific description for each article. The chapter ends with a discussion about the reliability and validity of the thesis and a discussion of ethical considerations.

3.1. Philosophical perspective and paradigms

Theory of science answers questions about ontology, epistemology, and methodology – questions about “how the world really is,” “what knowledge is,” and “in what way can we acquire knowledge about the world” (Moses & Knutsen, 2019). How a researcher answers these questions will affect what the researcher is looking for to ascertain “what reality actually looks like” and how, and to what extent, the researcher considers it possible to acquire “knowledge about reality.” Researchers from different research paradigms will, to a large extent, have different approaches to answering such questions (Kuhn, 1970). Researchers within the same paradigm can and will also have different

approaches in many cases. Thus, ontology, epistemology, and methodology will influence what the researcher considers as challenges, what the solutions are, and what data really are (Jacobsen, 2005). Moreover, a paradigm is about the general notions that create the frame of reference for research and theory development. It is about general ideas within the same science and how research challenges are to be solved within this science (Sohlberg & Sohlberg, 2008).

Traffic safety theory and organizational theory are theoretical approaches that can be said to belong to two different traditions or paradigms. Organizational theory has traditionally been objectivistic (Bryman, 2016), but it has moved closer to an idealistic direction in modern times, where the search for understanding and meaning has become more prominent (Sohlberg & Sohlberg, 2008). Research in the field of traffic safety theory has been, and still is, strongly characterized by causal explanation, often involving quantitative research projects where the goal is to find cause and effect for various effect studies (Hughes et al., 2015).

Within organizational theory, classical studies of organizations and cultures have mainly had an objectivistic view (Bryman, 2016), related to a paradigm where a mechanical approach was preferable (Sohlberg & Sohlberg, 2008). The mechanical approach is closely linked to the natural sciences and the scientific theoretical orientation of positivism, which claims that society consists of laws and that general laws can also be applied in social systems consisting of humans (Jacobsen, 2005; Langdrige & Hagger-Johnson, 2009). A researcher who belongs to this school of thought believes that a truth exists, and that this truth is best revealed through objective investigations and measurements: the world is objective and can be studied in an objective way through sensory data. The researcher is thus outside what is being researched and develops hypotheses that are tested through sensory data such as sight, sound, and feel (Jacobsen, 2005). Reality is not considered to be influenced by the researcher (Postholm & Jacobsen, 2018), and the researcher tries to verify or falsify the hypotheses in order to be able to generalize findings and establish legalities. The findings can thus be generated to also apply in other situations and to phenomena other than what is explicitly studied (Bryman, 2016). In this tradition, finding causal relationships is essential.

In recent times, the approach to research on organizations and cultures has changed. Instead, an idealistic approach (Sohlberg & Sohlberg, 2008) has become more prominent. Within this orientation, the researcher seeks understanding and meaning rather than cause and effect connections. This approach is more closely linked to the theoretical orientation of constructivism (Postholm & Jacobsen, 2018), which argues that, in the study of human beings, one cannot claim that general laws exist when human beings act and develop on the basis of experience and knowledge. In other words, opinions and perceptions will change over time. The main criticism is that it is not possible to study people in the same way as studying science – how a person acts and thinks cannot be said to be an objective reality, a social reality is the same for everyone (Bryman, 2016; Jacobsen, 2005). A researcher who belongs to the idealistic orientation has a conviction that there are different truths and realities. Furthermore, these truths cannot be generated to also apply to phenomena other than what is being studied, though they can explain comparable phenomena to some extent (Bryman, 2016) and are made probable. There are different understandings of reality, and this understanding can only be obtained by the researcher getting to know how they are being interpreted and explaining “their” reality. The researcher must therefore capture human thoughts, feelings, and abilities. This approach recognizes that organizations and cultures are constantly changing, and that reality is influenced by the context and people associated with it. In other words, within an constructivist orientation, the researcher tries to present a specific version of reality within an organization, rather than a reality that is absolute (Bryman, 2016).

Within traffic safety theory, in the same way as in organizational theory, various paradigms apply. Previous research in road safety often used skill models to explain the causes of accidents. In the 1970s and 1980s, this changed to also include motivation and risk models –that accidents can also be explained by the motives behind the driver’s decision-making processes (Fuller, 2005; Näätänen & Summala, 1976; Van der Molen & Bötticher, 1988; Wilde, 1982).

The paradigm shift that has had the greatest impact on road safety research is the development of a hierarchical framework that explains driving at strategic, tactical, and

operational levels (Ranney, 1994). The hierarchical model explains that decisions made by a driver are implemented at all three levels, and decisions made at the strategic level influence decisions made at the tactical and operational levels. For example, it may be the case that in a transport organization, decisions are made at an overall level that have consequences for the truck driver's own decisions at the strategic level. If a driving instructor at the transport organization agrees to take on an assignment without taking into account the driver's needs and statutory requirements for rest, the driver may choose to drive the transport without being suitable for it at that time. Thus, such a decision by the management of the transport organization will affect the driver's strategic choice to drive or not drive the transport. Such decisions will have a major impact on road safety for work-related driving with HGVs.

Although road traffic safety research has changed over time, it is still strongly linked to the ideals of science, where causal explanations are the dominant approach. Kuhn (1970), belonging to the natural science research tradition, argued that there could only be one paradigm that was valid at any one time. In the natural sciences, it is difficult to imagine that different paradigms can work side by side, as they seek objective truths. In physics, for example, it is challenging at the present time to imagine that theories other than the theory of relativity can describe gravity. This is because this theory is considered "normal science" in the field and is well regarded by researchers. However, this has not always been the case; the science in this area has changed through various paradigm shifts over the years.

Within the social sciences, however, it is different. Here, various paradigms have existed side by side for a long time (Thurén, 1993). In this context, Feyerabend criticized Kuhn and claimed that science needs several paradigms that compete with each other (Grimen, 2001). This competition leads to different theories and traditions opening up new perspectives, and new challenges and solutions emerge. This would not have been possible if only one paradigm was valid at a time. Postholm and Jacobsen (2018), for example, point out three different paradigms, or overarching theories, that have ruled within the pedagogical field: cognitivism, constructionism, and positivism. Within this field, there are thus different paradigms that are valid at all times. The same can be said

for this current research project, as it is an interdisciplinary social science project with a combination of organizational theory and road traffic safety theory, where different paradigms co-exist.

In this research project, it is natural that reality will be influenced by the context and the people associated with it; all participants are affected by their surroundings. The participants will, for example, be affected by new regulations implemented by the authorities, changed requirements from road transport buyers, and changed financial frameworks. Reality “as it actually is” will thus change over time. This links the project’s approach closely to a constructivist paradigm. Previous guidelines related to road traffic safety work largely aimed to develop better road standards and safer vehicles, while road traffic safety work today aims just as much at interactions between the various actors in the system of road transport and the individual driver’s behavior and attitude. Road traffic safety research is in the process of recognizing research related to a constructivist paradigm, where finding the underlying causes of human behavior in road traffic is as important as finding the effect of various measures implemented. Gaining in-depth knowledge of how people experience and understand the road traffic system is just as important as knowledge of the costs and benefits of traffic safety measures. By taking a constructivist perspective in this research, it is acknowledged that the participants have different experiences and, through these experiences, different views on what is truth and reality. Thus, it is possible to gain knowledge about their different understandings of reality.

3.2. Research design

The research design explains how a study is conducted to answer the research question (Bryman, 2016). There are mainly two approaches to research design: quantitative and qualitative. A quantitative approach is a systematic investigation that gathers quantifiable data, involving methods that deal with numbers and what is measurable. Common quantitative methods are counting, measuring, and calculating, which often result in statistics with various variables. A quantitative research approach is used when causal explanations are investigated (Bryman, 2016). In contrast, a qualitative approach generates knowledge by examining what meaning events and experiences have for those

who experience them and how they can be interpreted or understood by others. Qualitative methods are concerned with words rather than with numbers (Bryman, 2016; Jacobsen, 2005; Postholm & Jacobsen, 2018). There are different qualitative methods that can be used in research, such as ethnography/participant observation, interviews, focus groups, action research, language-based approaches like conversation analysis, and collection and analysis of texts and documents.

Since the key objective of this research project is to study the relationship between parties in the system surrounding road traffic safety for work-related driving with HGVs and understand how different organizational factors affect this relationship and, as a consequence, influence road traffic safety, it takes a qualitative approach.

For work-related driving with HGVs, advanced actions are typically carried out without them being formulated, reflected upon, and theorized (Åsvoll, 2009). The knowledge and experience that many actors in the system have can therefore be characterized as tacit knowledge (Polanyi & Sen, 2009); traditionally, such knowledge has been developed through sharing each other's knowledge and experience (Polanyi & Sen, 2009; Åsvoll, 2009). On the basis of these traditions, it was argued that deeper knowledge about the actors' meanings, experiences, and opinions was best accessible by talking to the participants (Langdridge & Hagger-Johnson, 2009). Therefore, this study has taken a qualitative approach that uses interview, focus group, and document analysis methods to collect data. These methods are explained in more detail in section 3.4.

3.3. Sampling and participant strategy

There are different ways to choose a study sample. Within qualitative sampling strategy, there are mainly three ways: convenience sampling, purposive sampling, and snowball sampling (Bryman, 2016). A convenience sample is simply available by chance to the researchers. Purposive sampling is when researchers choose participants who are relevant to the research question. A snowball sample is when participants who were involved in the study recommend new participants the researchers should include because of their expertise regarding the research question (Bryman, 2016).

In this study, participants were recruited through a combination of these sampling methods. In total, the sample was 21 participants (Table 6) recruited to individual interviews. Nine participants were recruited through a member organization for owners of road transport organizations. The researchers got access to possible participants through the representative of this organization – *convenience sampling*. These nine participants were selected according to explicit inclusion criteria: 1) that they were managers of road transport organizations that carried goods with vehicles with a total weight capacity above 7,500 kilograms, 2) that they had at least one driver as an employee. All of the participants lived and worked in the middle part of Norway. This geographic selection was made because of the road environment in the middle of Norway, where there are 4–6 lane freeways, challenging rural roads near the coast and in the mountains, city centers, and complex intersections. By using participants from this area, the results may be generalized to other geographical areas because of the variety in road environment.

Furthermore, six participants were chosen because of their relevance to the research question, as experts in the field – *purposive sampling*, and based on recommendations from already existing participants in the study – *snowball sampling*. These participants were employees in the Norwegian Public Road Administration (NPRA), the Norwegian Police, organizations with high credibility in the transport sector, and researchers/authors of literature regarding road transport. These participants were geographically located in the middle, western, and southern parts of Norway. The reasoning for this geographical sample was strictly due to the location of the participants' workplaces.

In addition, six participants were recruited because of their manager role in organizations that buy transport services. All were employed in positions of responsibility for ordering road transport for their products, so they are experts in their field – *purposive sampling*. The size of the organizations varies. One organization has approximately 500 transport assignments per day and a turnover of approximately one billion per year. The organization owns approximately 200 trolleys and containers themselves and have contracts with hired carriers. The organization does not have its

own cars; all transport is purchased externally. Another organization needs transport of approximately 6,000 trailer loads per year, as well as a lot of ad hoc domestic transportation. The organization also has significant exports of its products abroad. A third organization represent a municipality where the need for transport services is due to plowing/spreading, asphalt driving, summer operation on municipal and county roads, and transport for closed facilities. A fourth organization has just started production for sale and thus has a small need for transport at present. They order transport by a freight forwarder approximately once a month; party loads are then ordered (some pallets on a car). These organizations mainly produce salmon, groceries, and mineral water for sale. The fifth and sixth organizations are similar to those described above. These buyers of road transport services are located in the middle and southern parts of Norway. This ensures that knowledge and experience from differently located buyers of road transport services are taken into account.

Finally, eight participants were recruited for a group interview. These participants were mainly recruited due to their expertise regarding the research question: police officers who execute controls of HGVs on the roads, with expertise on what is needed to improve road safety; employees at the NPRA who conduct controls of HGVs on the roads and controls at the physical workplace (road transport organizations); employees in municipalities and counties who are experts in road safety; and a representative for the Norwegian member organization for owners of road transport organizations. All participants in the group interview were located in the middle part of Norway, but they had close collaboration and communication with representatives in similar positions in other part of the country. Therefore, the participants had knowledge and experience about conditions elsewhere in the country, so the results are not only related to the middle part of Norway.

All participation was voluntary, and all the participants agreed on participating after being told about the project and that they were able to withdraw at any time. The study was approved by the Norwegian Centre for Research Data (now named Sikt).

Table 6. Participants

	Position	Gender	Numbers of drivers employed	Expertise
Participant A	Leader	Male	<10	Leaders of road transport organizations
Participant B	Leader	Male	<10	
Participant C	Leader	Male	>60	
Participant D	Leader	Female	30	
Participant E	Leader	Male	35	
Participant F	Leader	Male	<30	
Participant G	Leader	Male	15	
Participant H	Leader	Male	>90	
Participant I	Leader	Male	>100	
Participant J	Leader in an NGO	Male	No drivers	Transport regulations
Participant K	Department leader	Male	No drivers	Crime in transportation
Participant L	Author	Male	No drivers	Transport
Participant M	Senior advisor	Male	No drivers	Transport regulations
Participant N	Police officer	Male	No drivers	Laws, regulations in transportation
Participant O	Police officer	Male	No drivers	Laws, regulations in transportation
Participant P	Buyer of road transport services	Male	No drivers	Ordering transport assignments
Participant Q	Buyer of road transport services	Male	No drivers	Ordering transport assignments
Participant R	Buyer of road transport services	Male	No drivers	Ordering transport assignments
Participant S	Buyer of road transport services	Male	No drivers	Ordering transport assignments
Participant T	Buyer of road transport services	Female	No drivers	Ordering transport assignments
Participant U	Buyer of road transport services	Male	No drivers	Ordering transport assignments
Participant V	Municipality employee	Male	No drivers	Ordering transport assignments

Participant W	Senior advisor	Male	No drivers	Road traffic safety
Participant X	Leader in an NGO	Male	No drivers	Transport regulations
Participant XX	Politician	Female	No drivers	Laws, regulations, decision making
Participant Y	Police officer	Male	No drivers	Laws, regulations in transportation
Participant YY	County employee	Male	No drivers	Road traffic safety and regulations
Participant Z	Leader in an NGO	Male	No drivers	Labor regulations, communication
Participant ZZ	Senior advisor	Male	No drivers	Road traffic safety

3.4. Data collection

There are two approaches to collecting data: deductive or inductive. In the deductive approach, the researcher first creates some expectations about what reality looks like and then goes out and collects empirical data to see if the expectations correspond to reality (Jacobsen, 2005) – going from theory to the empirical. The researcher’s expectations are formed on the basis of previous empirical findings and theories. In contrast, in an inductive approach, the researcher gathers information with an open mind, without predetermined expectations. After the information has been collected, the researcher systematizes the data and thus forms the theories – going from the empirical to theory. The goal is that nothing should limit what information the researcher collects (Jacobsen, 2005). This research takes an inductive approach, with data collected through a literature review, interviews, and a group interview.

3.4.1. Literature review

This study involves two types of literature review: a traditional review and a more systematic literature review. A traditional review aims to gain a broad understanding and description of the field, to get an overview of the “big picture.” The review does not follow a defined path but instead allows the researcher to be creative and explorative in

the search for literature. The search for literature is probing, moving from one study to another and following up on leads. Also, the studies are selected in a purposive way (Jesson et al., 2011). A more systematic literature review has a tightly specified aim and objectives with a specific review question. The scope is narrow. The review process should be transparent and documented, and a rigorous and comprehensive search for all studies should be conducted. Predetermined criteria should be made for including and excluding studies (Jesson et al., 2011). The type of literature review one needs to do depends on the research objective and question (Hart, 1998).

In this study, the traditional review was conducted to get an overview of literature regarding the research topic; it was made early in the research process. A more systematic literature review was conducted for Article 1. The rationale behind these choices is that one review should provide state-of-the-art knowledge on the field, so a traditional review was chosen. However, the literature review for Article 1 should provide knowledge connected to one specific research objective; therefore, a more systematic literature review was chosen. The literature review was conducted according to the method described in Arksey and O'Malley (2005). The method differs slightly from a systematic literature review because it allows broader topics where many different study designs might be applicable. Additionally, the method does not address very specific research questions, nor does it assess the quality of the studies included.

The stages of the literature review were as follows: (1) identifying the research question, (2) finding relevant studies, (3) selecting the studies, (4) charting and collating the data, and (5) summarizing and reporting the results.

The first phase was conducted in October–December 2019, and the second phase was conducted in October–December 2021. In the first phase, an extensive search was made of eight different databases, and a total of 787 references were found. The inclusion criteria (Table 7) were that the articles had been published between 2014 and 2019, were online, peer-reviewed, and written in English. The keywords used in the search were “risk management, safety culture, transport or/and road transport.” The initial search included studies of all transport modes, such as road, train, air, and sea. Based on titles, studies that involved transport modes other than road transport and duplications were

excluded. After this initial exclusion, the remaining number of references was 75. A specification of the inclusion/exclusion criteria are presented in table 7.

Table 7. Inclusion and exclusion criteria

	Included	Excluded
Databases	ABI/Inform, Google Scholar, Oria, ProQuest, Sage, Science Direct, Springer Link, Taylor & Francis, Web of Science	Other
Timeframe	2014–2021	Articles published before 2014
Publication type	Peer-reviewed articles available online	Books and book chapters, “grey literature” (e.g., reports), other
Focus	Studies focusing on road safety concerns with HGVs	Studies focusing on other transport modes (train, air, sea)
Language	English	Other

The second literature search phase was made on the basis of literature the researcher was familiar with and perceived as relevant to the study objective. The search also included new research published in the years 2019–2021. This second phase resulted in a total of 32 relevant articles. In total, 22 articles met the criteria and were included in the review. A full-text reading of all articles was conducted.

3.4.2. Interviews

Spradley (2016) compared interviews with friendly conversations, suggesting that it is through informal conversations that the researcher is most likely to receive information. That is, the researcher must make sure that the informant feels relaxed and does not experience the interview as an “interrogation” (Langdridge & Hagger-Johnson, 2009). In this research project, where part of the goal is to obtain the tacit knowledge that the participants possess, it was important to create this relaxed atmosphere in the interview so that the participants felt safe in the setting and could speak freely. Interviews are mainly about two things: first and foremost, establishing contact and creating a mutual

relationship of trust, and second, obtaining information (Bryman, 2016; Kvale, 1996). There are four stages to creating the relationship of trust between participant and researcher (Spradley, 2016). The first and second stages refer especially to the first meetings between participant and researcher. In this phase, the participant may feel restlessness or unrealistic expectations towards the researcher, and he/she may be in doubt as to whether he/she trusts the researcher. The participant may, for example, be uncertain about the interview setting, what the researcher really wants, and whether he/she is the right person to ask in such an interview. Furthermore, the informant may be unsure of what the researcher wants with the interview – i.e., what the purpose behind the interview is. In this study, the first and second stages were made as short as possible. Clear signals were given to the participant that he/she was the “right person for the job,” and conversations with the participant about topics that were not necessarily the focus later in the interview were held. It was stated that nothing that is said will be wrong or uninteresting. Through these phases, a good relationship of trust with the participant was created.

Spradley (2016) described the subsequent phases as collaboration and participation, in which data are generated from the questions the researcher asks. Spradley (2016) stated that the researcher should focus on descriptive questions here, meaning that the questions are asked in such a way that answers provide a thicker description of their own practice. This was the focus in this current study. Questions like “I have never been an apprentice in a transport company. Can you tell me a little about how you experienced the first days at work?” was asked, rather than “What kind of training did you get when you started here?” There are two upsides to asking the question like this. First, it takes longer to ask the first question, and this suggests to the participant that it is okay to talk for a long time in his/her answer. Second, it will often mean that the participant also talks about other things than the training, and the researcher can get a broader picture and more information out of each question.

When conducting the interviews in this current study, significant emphasis was put on these four phases. Semi-structured interviews were thus chosen as the data collection method, as they emphasize the good relationship and trust between the participant and

the researcher (Bryman, 2016). An interview guide was developed to keep the conversation within the boundaries of the topic. This guide was not very detailed but was used as an overview of main themes, so the researchers were able to cover similar themes across the participants. The individual interviews were mainly carried out by two or three researchers in a face-to-face setting. Each interview lasted for 45–60 minutes, and all the interviews were recorded and transcribed.

The attributes described above could also be said to apply for focus group interviews. Good relations and trust between the researcher and the participant group are critical, especially for collaboration and participation. A good focus group has several characteristics. The participants must be carefully recruited, the conduct of the focus group interview must take place in a comfortable environment, a skillful moderator must lead the interview, and a systematic analysis and reporting must follow the interview (Krueger & Casey, 2002). In the current study, the participants in the focus group interview were familiar with each other before the interview took place, as two meetings were held before the actual focus group interview in order to present the research problem and research question. Consequently, a good relationship of trust was established among the participants and between the participants and the moderator (researcher) before the focus group interview took place. Originally, the focus group interview was supposed to be conducted as a physical meeting. However, due to COVID-19, the meeting had to be held digitally using Teams. Because of the established relationship and trust between all actors in the focus group, there was no hassle in conducting the interview over Teams. It is assumed that it would be more challenging to conduct the interview on Teams if such a relationship was not established beforehand; it is more challenging to establish new relationships and trust through Teams meetings, especially if there were no meetings before the actual focus group interview.

3.5. Data analysis

In this thesis, data analysis was conducted in accordance with the thematic analysis approach of Braun and Clarke (2006), who stated that thematic analysis should be the first analysis method a researcher learns. Such an analysis provides core skills that will be suitable in several different analysis methods later on. One of the benefits of thematic

analysis is its flexibility; it is compatible with different paradigms. This theoretical freedom makes thematic analysis a flexible and effective research tool. The main aim when using thematic analysis is to identify, analyze, and report patterns within a data set. It gives rich details when describing the data (Braun & Clarke, 2006).

The analysis is conducted in several phases. The first phase involves becoming familiar with the data set – reading it several times. The second phase involves generating initial codes that identify features of the data that appeared interesting and could be assessed in a meaningful way in relation to the phenomena (Braun & Clarke, 2006). In this phase, the researchers continuously look for patterns to organize the data set in order to answer the research question. For example, in Article 2 in this thesis, the researchers highlighted when the participants talked about their relationship with customers and then sorted these instances into one category (i.e., one code).

The third phase is conducted after finalizing the initial coding. This phase involves sorting the different codes into potential themes and collating all the relevant coded data within the themes. The goal is to group codes into themes so that they capture something important in relation to the research question (Braun and Clarke, 2006). For example, in Article 2, quotes regarding road transport organizations' relationships with customers were categorized into sub-themes like “customers recruited by offering the lowest price” and “customers recruited by offering a specialized form of transport.” These themes were identified in a theoretical (inductive) way, meaning that the analysis was driven by the motivation to gain knowledge about the organizations' possible leadership strategies and how these strategies affect safety and safety culture within the organizations. Furthermore, the themes were identified on a latent (or interpretive) level, meaning that the researchers sought to identify the underlying ideas and assumptions of the data. Thus, for latent thematic analysis, themes are developed through interpretation (Braun and Clarke, 2006). Finally, the fourth phase involves refining the themes, which entailed aggregating several sub-themes into main themes. An example of the analysis process from Article 2 is illustrated in Table 8.

Table 8. Overview of the analysis process

<i>Main themes</i>	<i>Sub-themes</i>	<i>Codes (examples)</i>
Strategies for road transport assignments	Recruit customers by offering the lowest price Recruit customers by specializing and being innovative	Good communication with customers Long-term contracts Few/many customers
Strategies for personnel	Education and training Safety management system	Education is looked at as a cost Education is looked at as an asset Seldom provide systematic education and training Management does (not) follow up on driver behavior
Strategies for equipment selection	Vehicles Customized equipment for cargo	New/old vehicles
Strategies for legality	Following laws and regulations Perceptions about control systems (e.g., governmental systems)	Willingness to take chances

As Table 9 shows, the analysis resulted in the following main themes: (1) strategies for road transport assignment, (2) strategies for personnel, (3) strategies for equipment selection, and 4) strategies for legality. The same procedure has been used in Articles 1, 4, and 5. In Article 3, a model was used as the basis for analysis. A detailed description for data analysis is presented in each article.

3.6. Research design, sampling strategy, data collection, and analysis for each article

Table 9 presents an overview of the methods used in each article.

Table 9. Overview of methods

	Article 1	Article 2	Article 3	Article 4	Article 5
Article title	Work-related driving of HGV: Factors that influence road safety and the development of a framework for safety training	Leadership strategies, management decisions and safety culture in road transport organizations	Road transport safety in Northern Norway: How buyers of road transport services can contribute to a road transport with fewer accidents and near-misses	Buyers of road transport services: Sustainability and safety responsibility	A systems view on road traffic safety of work-related driving of HGVs
Type of article	Journal article	Journal article	Journal article	Conference article	Journal article
Research design	Qualitative	Qualitative	Qualitative	Qualitative	Qualitative
Sampling	Documents and literature	15 individual interviews	6 individual interviews	15 individual interviews	9 individual interviews 8 participants in focus group interview
Data collection	Literature Review	Interview	Interview	Interview	Interview
Data analysis	Thematic analysis	Thematic analysis	Model used as basis for analysis	Thematic analysis	Thematic analysis

3.6.1. Participating industries in each article

In Articles 2, 4, and 5, participants from road transport organizations contributed to the data. These road transport organizations were all geographically located in the middle part of Norway. The size of the organizations ranged from organizations where there were only two employees (a leader and one driver) to organizations with 600 employees,

of which approximately 300 are drivers. The type of transport these organizations provide are varied. One organization transports lumber mainly on local roads, while two organizations mainly conduct long distance thermo-transport. Another two mainly transport steel both locally and long distance. Three organizations have specialized on driving dangerous goods, also both long distance and local. The last organization is mainly doing snowplowing during the winter and asphalt driving during the summer. Almost every organization transport general cargo (party goods) some trips during the year.

In Article 3, participants from organizations that buy road transport services contributed to the data. These organizations were geographically located across Norway – three in the middle part, one in the eastern part, one in the southern part, and one in the northern part. The need for transport assignments varies from one assignment every month to 500 assignments a day. Also, one of the buyers was a Norwegian county, which ordered transport like snowplowing, asphalt driving, and summer maintenance. Other transport assignments were linked to the transport of salmon, general goods, and thermo-goods.

In Articles 2 and 5, participants who are considered to be experts in their field contributed to the data. Three were NPRA employees and had expertise in road traffic controls alongside the road and controls with road transport organizations fulfilling mandatory demands and regulations. Three were police employees and had expertise in mandatory traffic regulations for HGV organizations and drivers. One was employed in an NGO that works closely with the interest of HGV organizations. One was an author of literature regarding road transport and logistics. The rest of the experts were politicians and employees in municipalities and counties, all working closely with road traffic safety and especially road traffic safety involving HGVs. All articles are included at the end of this thesis. More information about the specific research methods used are thoroughly explained in each article.

3.7. Reliability and validity

3.7.1. Reliability

In qualitative studies, reliability is about whether theories work, fit, are recognizable, and are relevant to those studied (Richardson, 1996) – how credible the findings and conclusions are, whether we can trust them. Jacobsen (2005) refers to various factors that can weaken credibility. One is whether the interview design affects those who are interviewed – that is, unwanted effects. The second is inaccuracy in the registration and analysis of data. In this study, it has been important to be aware of these factors. For example, when registering data, registrations were reviewed several times and the participants were given the opportunity to read the transcribed interviews to make sure the researchers had captured their meanings correctly. This applies in particular to the interview data. Of course, despite these reviews, error detection cannot be ruled out. In preparing and conducting the interviews, it was important to be aware of several factors to avoid unwanted effects, for example, not asking leading questions.

3.7.2. Validity

In every qualitative study, a discussion about validity is important (Yardley, 2000). It is crucial to be critical of the findings and conclusions, and critically discussing validity means being critical of the quality of the data collection. It is common to distinguish between internal validity and external validity. Internal validity is about whether the results are perceived as “correct.” External validity is about whether the results can be generalized. This means whether the results are true and whether they are transferable to other phenomena and situations (Jacobsen, 2005).

3.7.2.1. Internal validity

There are many ways to check whether the results are perceived as “correct” – how good the findings and conclusions are. Among others, methods such as validation through testing against others, validation through critical review of sources and information from the sources, validation through critical discussion of categorization, and validation of contexts (Bryman, 2016; Jacobsen, 2005) deal with how the researcher can check the data with other professionals, theory, and empirical data. The validation also deals with

how the researcher can check both whether the sources provide the correct information and how the information is obtained. The connections and categorization from the data analysis are also factors that should be validated. Additionally, Yardley (2000) emphasizes the importance of rigor, which refers to the resulting completeness of the data collection and analysis. In this study, interviews were conducted with managers of road transport organizations, experts in the field, and buyers of road transport services. Validity in this study has been controlled by discussing the data with several researchers and by matching the pattern in the data set. Also, the researchers' interpretations of the interviews have been controlled by sending the transcribed interviews to some of the participants. By doing this, researchers make sure that the participants recognize the outcome of the interview (Richardson, 1996).

3.7.2.2. External validity

The extent to which the results are generalizable has to do with whether the results are transferable and applicable to other phenomena, samples, periods, or settings (Jacobsen, 2005). While qualitative studies do not aim to determine the extent of a phenomenon, there are still two possible forms of generalization. The strength of qualitative methods is theoretical generalization – that is, to go from empirics to theory. The second form of generalization, from sample to population, is more difficult with a qualitative approach. Jacobsen (2005) nevertheless describes certain factors that may affect the possibility of such a generalization. He refers to how the units are extracted and to the use of theory and other investigations. With this as a background, it has been important to be critical in using the findings in this study to generalize. The choices of data collection methods have limited the ability to go from sample to population. Nevertheless, it could be possible to say something about general phenomena. Examples of this are various conditions to which several of the study's participants have responded. That being said, if there are possibilities of generalizing this study's findings, they would be concentrated on theoretical generalization. Transparency is also an important factor for generalization in qualitative research (Yardley, 2000). In this study, transparency has been shown by giving a detailed explanation of the research methods.

3.8. Ethical considerations

In all research, and especially in the phase where information is obtained from participants through interviews and observation, the research ethics are essential. This involves consideration for the people in the study (Fangen, 2010).

The Norwegian National Research Ethics Committees (2019) prepared four principles and general guidelines that all research must follow. The first principle is respect: everyone involved in a research project must be treated with respect. It is important to create a safe arena for the participants. The researcher must see them for what they are and recognize their voluntary participation in the project. The second principle is good consequences: researchers must strive for the activities to have good consequences and ensure that possible unfortunate consequences are acceptable. The current project could have unfortunate consequences if it were possible to identify the participating road transport organizations. If, for example, it emerges that an organization has a particularly deficient focus on safety and learning, this could affect their credibility in the industry. Thus, it is not possible to identify this study's participants. The third principle is justice: all research projects must be fairly designed and executed. To take care of this principle, it was important to conduct approximately the same interviews and look for the same things during the observation of everyone involved, as well as to ensure that the project had a good written description that everyone involved received before they signed up for the project. Through this description, a written consent forming the basis for the research was included, which stated that it was possible to withdraw this consent if the informant no longer wishes to participate in the project. The last principle is integrity: the duty to follow recognized norms and act responsibly, openly, and honestly with colleagues and the public. This means that the researcher should describe methodological choices as thoroughly as possible so that other researchers can carry out almost the same study and come to roughly the same conclusions.

There will be ethical considerations for all research projects, but there are fewer ethical dilemmas in the current research project because the research does not affect the individuals directly but rather the system the individuals are part of. The goal was not

to obtain the participants' experiences on a private, personal level, but rather to bring out experiences related to their work situation.

3.8.1. Researcher's background

As an author of this thesis, a special emphasis has been put on being a neutral researcher, as the author's background are within the road transport sector. The author has been a driving instructor for driving license candidates to classes C and D – coaches and trucks – for approximately 10 years, following seven years of employment in the NPRA supervising driver instructors as a main work task. The pitfall is that empirical findings could be interpreted and evaluated in a biased way, meaning that the researcher's background could influence the results. Significant emphasis has been put on this matter, and it is acknowledged that this could be a challenge in this study. However, by being aware of this pitfall, the author has been very careful to not assume or interpret data on the basis of own experience and knowledge. Instead, the participants' meanings, explanations, and narratives are what ground the data in this thesis. However, literature states that even when the researcher and the participants in the study seem to be speaking the same language, their words may have completely different cultural meanings (Qu & Dumay, 2011). In this thesis, the transcribed interviews were sent to the participants for review to make sure that they agree with the author's reproduction of their meanings, explanations, and narratives.

4. Findings and summary of articles

4.0 Findings and summary of articles
4.1 Findings of Article 1
4.2 Findings of Article 2
4.3 Findings of Article 3
4.4 Findings of Article 4
4.5 Findings of Article 5

This chapter gives a summary of the articles included in this thesis. First, it presents a short description of the aim of the article, followed by a short description of the methodological choices. Then, it presents the findings and a short summary of the discussion and conclusion. The full text of all the articles is attached in Part 2 of this thesis.

4.1. Article 1

Article 1 had two aims. First, the study sought to identify what the participants perceive as important factors in managing road traffic safety for work-related driving with HGVs. Second, it aimed to propose an overall framework for how safety training could be executed and its overall content. The first question was answered by using literature review as a method to identify important factors to enhance road safety for work-related driving of HGVs.

The study's second question was answered by using the results from the literature review, as well as a small-scale case study (Tight, 2017) of practical driving in the periodic training of professional drivers (Elvebakk et al., 2020). Driver performance results were collected for periodic training arranged by a Norwegian training center. In addition, an interview with the teacher responsible for these courses was conducted.

The literature review shows some important factors for the management of road traffic safety for work-related driving of HGVs at an organizational level. In particular, there

was a need for a systems approach and the implementation of safety management systems (SMSs). The SMS should include such elements as following up on driver behavior, training programs for both management and drivers, and awareness about route planning, stress, and fatigue. Important factors that stood out for the management of road traffic safety for work-related driving with HGVs at a driver level include having proper safety training and education in terms of driving behavior and following up regularly on this behavior. When it came to factors for the management of road traffic safety for work-related driving with HGVs at a third party and regulatory body level, it was especially important that organizations, governmental bodies, and regulatory bodies increased their collaboration, so that the different actors were familiar with the challenges at different levels.

The main finding was that challenges in managing road traffic safety occur when communication and collaboration between different actors fail. For road traffic safety work in this system, it was essential that every actor was familiar with its own, and each other's, challenges and possibilities.

This study's second aim was to propose a framework for a safety training program for work-related driving of HGVs. A measure/intervention to increase knowledge between actors at different levels could be joint safety training and education. Several studies have highlighted safety training, education, and competence as being crucial to safety management (Elvebakk et al., 2020; Grinerud, 2021; Newnam & Oxley, 2016).

The current study suggests a safety training framework directed towards decision makers and actors in the road safety system for work-related driving of HGVs (Figure 7). The safety training was divided, with one training program directed towards decision makers and actors at the higher levels of the system, and one training program directed towards drivers. By developing safety training directed towards governmental/regulatory bodies, third parties, and road organizations and customizing the content towards these actors, the challenges and opportunities would be made known for every actor. The challenges and opportunities experienced by each actor were well-documented in the literature; the safety training content should be based on this. Most

importantly, each actor was made aware of other actors' challenges and opportunities, and collaboration and cooperation were presented as an important tool to increase road safety for HGV businesses and drivers.

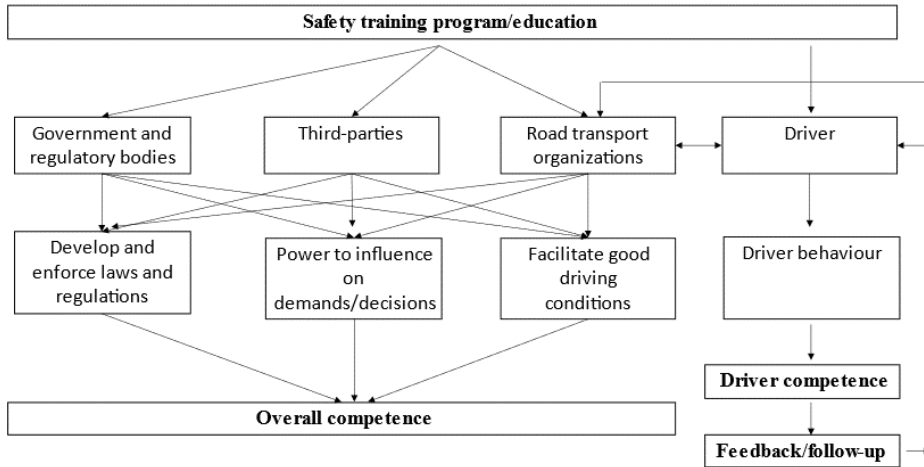


Figure 7. Safety training program (Grinerud, 2022)

For drivers, the literature states that follow-up on driver behavior was of great importance to managing road safety for work-related driving of HGVs (Grinerud et al., 2021; Luke & Heyns, 2014; Nævestad, Elvebakk, et al., 2018). By prioritizing follow-up on driver behavior, management could demonstrate their commitment to safety. The management also acknowledged company influence on and responsibility for speed and driving style (Nævestad, Elvebakk, et al., 2018). This current study proposes a framework and content for a safety training program for HGV drivers, based on module 5, “safe behavior on the road,” collected from periodic training for professional drivers (Elvebakk et al., 2020) and from the literature (Table 10). The aim of this framework and content was to increase each driver’s knowledge and competence, which would increase their opportunities to drive optimally, defensively, and safely by making correct decisions while driving. Follow-up on driver behavior was stated to be an important measure to increase road safety for HGVs. Periodic training every five years was too

seldom for follow-up, and research showed that many transport organizations do not follow up on driver behavior themselves (Grinerud, 2021).

Table 10. Safety training program for HGV drivers (Grinerud, 2022)

Time	Topic
Approximately 30 minutes	Theoretical discussion about optimal, defensive, and safe driving
30 minutes	Driving round 1: Driving with a professional instructor – the instructor does not interfere with the driving but solely observes the driving
Approximately 15 minutes	Conversation between instructor and driver about the first round of driving – which practice was optimal, defensive, and safe driving, and what are the potential areas for improvement?
30 minutes	Driving round 2: Exactly the same route is driven one more time, but this time the instructor gives the driver feedback, clues, and advice directed at how to drive optimally, defensively, and safely
Approximately 15 minutes	<p>Conversation between instructor and driver about the second round of driving – were there improvements? Measures used to detect improvements could be:</p> <ul style="list-style-type: none"> • Effectiveness (time spent on round 2 compared to round 1) • How many times the driver had to stop (due to lack of planning for situations or intersections) • Fuel consumption • Distance to others • Comfortable driving

Main findings of Article 1:

The findings showed that important factors for the management of road safety could be arranged at different levels: governmental level, third-party level, organizational level, and driver level. Most importantly, a systematic approach to road safety for HGVs was essential. Every actor was jointly responsible for road traffic safety, and actors must communicate and work together to increase road traffic safety for work-related driving with HGVs. By developing a safety training program for all actors in the system, the study proposed a method for increased communication, collaboration, and cooperation between the actors.

4.2. Article 2

This article's aim was to explore existing road transport organizations' strategies. By investigating how management prioritization and choice of strategies could affect profitability and safety in road transport, it addressed how management decisions could affect road transport organizations' ability to develop a good safety culture.

Data were collected through semi-structured interviews with participants from both road transport organizations and the government. Since the aim was to explore how different strategy choices influenced road transport organizations' ability to build a safety culture, Porter's (1992) definition of strategy was used as a theoretical lens. The empirical findings showed that there were some main factors that could support and/or constrain the development of a good safety culture in road transport organizations. These factors were influenced by the choices management makes for different decisions – that is, their strategic choices.

Specifically, the empirical findings showed that there were different ways road transport organizations got their transport assignments: 1) by recruiting customers to transport their goods for a lower price than other road transport organizations, 2) by specializing

in certain types of road transport, or 3) by focusing on certain niche markets in the industry.

Road transport organizations that operated in markets in which competition revolved around offering the lowest price tend to struggle to be profitable. Porter (1992) emphasized that only one organization could be the lowest-cost provider in a market. However, in the road transport industry, several organizations compete against each other to win assignments by providing the lowest price/bid. This competition often leads to high rivalry between organizations, thus threatening the profitability of the entire industry. Indeed, such rivalry had arisen in certain markets in the road transport industry (e.g., long-distance driving, asphalt paving, snow plowing). These were markets where the competition is high. There were many providers, both domestic and international road transport organizations, competing for the same assignments.

As a consequence of not being profitable, it seemed challenging to develop a good safety culture within the organization because the struggle of being profitable competed with safety goals (Newnam et al., 2017). Instead of having resources available to invest in developing a good safety culture, resources must be spent on getting new assignments. Low profitability was likely to capture a road transport organization in a negative spiral regarding developing a good safety culture. An example of such a spiral is shown in Figure 8.



Figure 8. Negative spiral for road transport organizations with low profitability (Grinerud et al., 2021)

Road transport organizations that deliberately tried to differentiate themselves to gain a special position in their market were more likely to be profitable and hence had resources to invest towards developing a good safety culture, such as those that specialize in certain types of road transport or focus on certain niche markets in the industry. In this study, the participants that claimed they had a unique market position tended to choose their road transport assignments and customers wisely. Instead of competing with a low-cost strategy, they focused on different niche markets in the industry, including transport assignments that required special equipment and competence (e.g., the transportation of dangerous goods, heavy steel for special operations, timber, cranes). The participants explained that even though this kind of transportation demanded greater investments in equipment and drivers, the organizations that took on such investments were typically more profitable.

Another reason that road transport organizations with differentiation and focus strategies were more profitable could be their customers' attitude. This study's participants noted that customers of organizations that implemented these strategies tended to demand safety in the transportation of their goods. Therefore, they were willing to pay more to have their goods safely transported by educated drivers and suitable equipment. In this sense, a profitable road transport organization often created a positive spiral regarding developing a good safety culture (Figure 9).

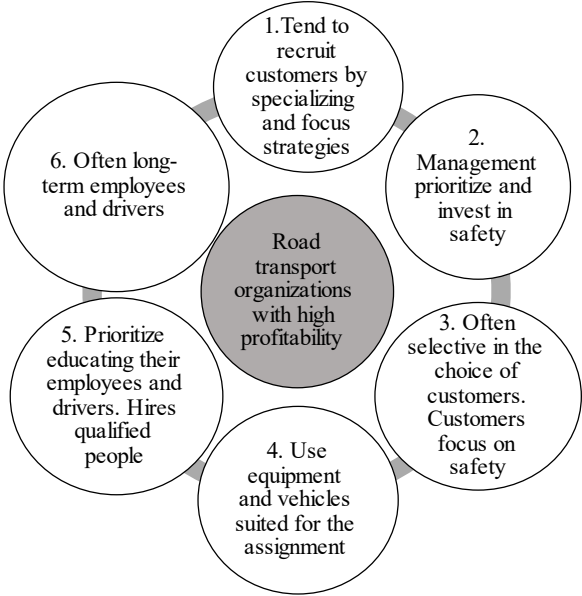


Figure 9. Positive spiral for road transport organizations with high profitability (Grinerud et al., 2021)

In addition to the leadership strategies that road transport organization chose to recruit customers, this study highlighted the importance of leadership strategies regarding personnel; the prioritization or lack thereof of training and education could affect safety and safety culture within the organization.

Main findings of Article 2:

The findings suggested that road transport organizations that chose a low-cost leadership strategy struggled to be profitable. Moreover, such strategies led to high rivalry between organizations. Such rivalry made it difficult to be profitable, so there were fewer resources available to invest in building a good safety culture. In contrast, road transport organizations that chose a differentiation or focus leadership strategy were more likely to be profitable. As a consequence, they had more resources to invest in building a safety culture by investing in equipment and employees.

4.3. Article 3

This article expands the view of possible actors that could affect safe road transport and thus takes a more holistic view into the matter of road transport safety. This study takes the perspective of the parties that are purchasing road transport assignments – that is, the buyers of road transport services. The aim of this study was to explore how buyers of road transport services could contribute to safe road transport of goods in Northern Norway and, through that, become important actors in reducing fatal traffic accidents.

A qualitative approach was selected for this study, and six semi-structured individual interviews were conducted with six different buyers of road transport services. Participants were recruited due to their relevance in the road transport sector. All were employed in positions of responsibility for ordering road transport for their products.

A modified version of the Pentagon model, originally developed by Schiefloe (Rolstadås et al., 2014), was used as an assessment tool and theoretical lens to analyze five different features of six different buyers of road transport services. In this article, the Pentagon model was modified to narrow down this research project; it was adjusted so it could be used to determine the important aspects that buyers of road transport services should take into consideration before signing a transport contract with a road transport organization. From the original aspect, *structure*, we constructed the factor *formal*

contracts. This concerns how the buyers of road transport services formalized their business relationship with the transport organization. *Technologies* was also included in the modified version. This factor covers whether there were formal criteria for the vehicle and equipment that the transport organization had to provide in order to acquire transport contracts with the buyers. The third aspect, *culture*, was modified into *decision criteria* – what criteria are of greatest importance for the buyers of road transport services when deciding on which transport organization they want to hire. *Interaction* was modified to *communication*, a factor that involves how the buyers of the road transport services perceived the importance of communication with the road transport organizations and governmental institutions. The last original aspect was *social relations and network*, and from this the factor of *knowledge/trust* was developed. It investigates whether knowledge and trust were important attributes when deciding on which road transport organization they wanted to contract with.

This modified version of the Pentagon model analysis was used to determine what kind of organizational characteristics must be in place in order to achieve the qualities that were essential for buyers of road transport services who wished to contribute to safer road transport.

The following characteristics and qualities were identified (Figure 10):

- The importance of entering a formal contract with their provider of road transport
- Being aware of the possibilities and use of new technologies
- Understanding that their decision criteria for order transport can influence road traffic safety
- Seeing the importance of good and even communication with both the transport organization and the authorities
- Recognizing that knowledge and trust with the transport organization are important but could also affect judgement regarding revisions and control

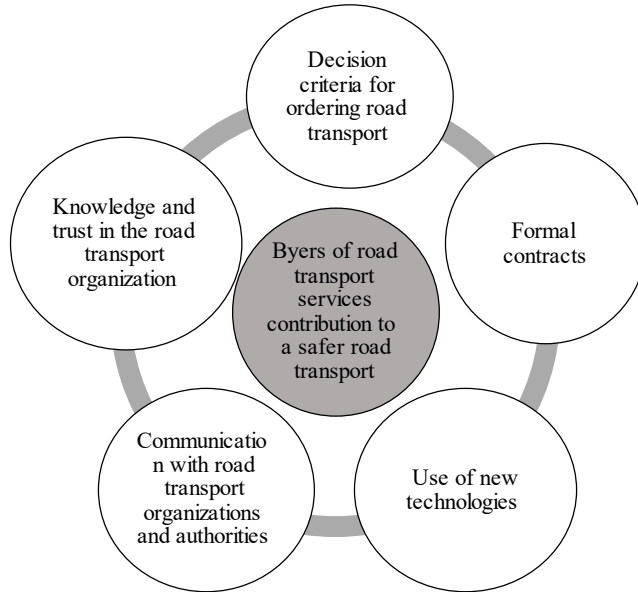


Figure 10. The contribution of buyers of road transport services to safer road transport (Grinerud, 2021)

Decision criteria: The road transport industry was stated as a low-earning industry, and the average financial result for a transport organization was 2–5 % (Grinerud et al., 2020). This led to a stringent prioritization of assets. By constantly pushing prices down, the buyers of road transport services influenced the ability of road transport organizations to prioritize safety work such as safety/driver training.

Formal contracts: Before road transport organizations could carry out the transport, it was essential that a formal contract was established between the buyer and provider. In this study, all interviewees stated that formal contracts were generally in place before the transport was carried out. However, these contracts seemed to be concerned about topics such as following laws and regulations, using modern vehicles, and the consequences if the transport is delayed. There were seldom demands directed towards issues such as the mandatory use of new technologies, specific driver competence, and the use of management systems to monitor driving behavior and driving/resting times.

To increase road safety, buyers of road transport services could consider crafting more detailed contracts with their transport organizations that state that the transport organization should follow laws and regulations.

Use of new technology: Another way to make the contracts more detailed was to insist on the specific use of new technologies. By including such demands, it would be easier to track and monitor driver behavior, driving-resting time, and loading-unloading time. Measures could thus be put in place to avoid certain situations and create safer transport routes. The use of new technologies was also stated to be one of the most important factors for achieving the Vision Zero goal (Ministry of Transport and Communications, 2017).

Communication with road transport organizations and authorities: For buyers of road transport services, good communication with road transport organizations will likely contribute to road transport safety. The interviewees in this study highlighted the importance of day-to-day communication with their transport providers. If any deviation in the transport route occurs, good communication and a strong relationship allowed for any misunderstandings to be resolved.

Knowledge and trust in the road transport organization: Most of the interviewees in this study emphasized the importance of choosing a road transport organization they were familiar with, and that this business relationship was built on knowledge and trust. On the one hand, this reasoning could be important for safer road transport because it might facilitate communication and lead to a relationship where challenges and deviations could be quickly resolved. On the other hand, choosing transport organizations based on knowledge and trust could lead to a situation where contracts are not important and regular revisions and controls are absent.

Main findings of Article 3:

Buyers of road transport services could contribute to safe road transport by prioritizing the following characteristics and qualities: 1) the importance of developing a detailed formal contract with the provider of road transport; 2) being aware of the possibilities of new technologies; 3) understanding that the decision criteria for ordering transport can influence road transport safety; 4) seeing the importance of good communication with both the transport organization and the authorities; and 5) recognizing that knowledge of and trust in a transport organization is important but could also affect judgement regarding revisions and controls.

4.4. Article 4

This article is a conference article that was further developed into a journal article (Article 3). This study contributed to the topic of road traffic safety by discussing how buyers of road transport services could contribute to sustainability and safety in the chain of transport and to the Vision Zero ideology.

This study used a qualitative approach. Data collection was therefore conducted through semi-structured interviews. A total of 16 interviews were mainly carried out by two or three researchers in a face-to-face setting. The empirics showed that there were some main factors (themes) that affect the way buyers of transport services could contribute to sustainability and safety in the chain of transport (Table 11): setting demands for the transport they order, willingness to pay market price for transport, and delivery demands.

Table 11. Factors related to the way buyers of transport services could contribute to sustainability and safety (Grinerud et al., 2020)

Themes	Explanation
1 Setting demands for the transport they order	<i>Buyers of road transport services must make demands to the transport organization regarding driver competence, following laws and regulations, and using approved vehicles and equipment.</i>
2 Willingness to pay market price for transport	<i>Buyers of road transport services must pay for quality in transport and avoid using disreputable sub-contractors who push prices to the minimum.</i>
3 Delivery demands	<i>Buyers of road transport services must be understanding about factors that can delay transport.</i>

The study suggested that buyers of road transport services could contribute to a more sustainable and safe transport by focusing on the above-mentioned factors. By doing so, one consequence was assumed to be fewer near misses and accidents with heavy duty vehicles, thereby taking our society a step closer to the aim of the Vision Zero ideology.

Main findings of Article 4:

Findings indicate that buyers of road transport services had impact on both sustainability and safety in the chain of road transport through pricing and delivery demands.

4.5. Article 5

Article 5 is more of an overview article aiming to identify the actors in the complex sociotechnical system of road transport for work-related HGV transport and illustrate how these actors could influence safer road transport.

A qualitative approach was chosen in order to acquire new in-depth knowledge about this topic. Data were collected through semi-structured interviews with nine participants and a focus group interview with eight participants. The participants identified several

actors (Table 12) that they perceived as important for managing road traffic safety for work-related driving with HGVs.

Table 12. Identified actors

Level	Actors		
Government	Supranational institutions (e.g., the EU) National institutions (e.g., Ministry of Transport, Ministry of Labour and Social Affairs)		
Regulators and associations	National institutions (e.g., NPRA, NLIA) NGOs (e.g., the Norwegian Truck Owner Association)		
Company	Buyers of road transport services	Road transport organizations	Car manufacturers
Management	Top and middle management	Top and middle management	Top and middle management
Staff/work	Employees ordering the transport/ operators	Drivers/ operators	Mechanics/ operators

Furthermore, the empirics showed that the actors had the possibility of influencing road traffic safety for work-related driving by focusing on the following factors: communication, competence, control sanctions, and economy.

Communication:

Everyday communication both inside and outside of the actors’ organizations is crucial for building competence and thereby enhancing HGV road safety. Therefore, communication is stressed as an important tool for safer work-related road transport. This includes communication between decision makers, NGOs, road transport organizations, and buyers of road transport services.

Competence:

There is consensus among the interviewees that competence is an important factor in enhancing HGV transport safety. According to the participants in the group interview, education and training are factors that affect road transport safety because education and training influence the level of competence of each actor in the HGV transport system.

The participants expressed that it is crucial for each actor in the system to possess the appropriate expertise in order to make a contribution to safer HGV transport.

Control sanctions:

All participants emphasized the need for concise demands and regulations. One participant said, “people don’t have to do something before they have to,” meaning that people do not feel obliged to do something unless there is a mandate requiring them to do it. The participants also claimed that regulations alone are insufficient; it is crucial that the control system works.

Some organizations assume that it is not profitable to follow regulations and guidelines. This attitude and the assumption itself do not serve the goal of cementing safety values in the organization. Moreover, this attitude may be perpetuated if there is a lack of consequences. Participants stated that the control system is not efficient enough to detect organizations that have no safety values. In addition to external control systems, participants also highlighted the importance of having internal control systems and follow-ups. Organizations that use external personnel to conduct internal controls (e.g., checking driving times) maintain that this is very positive for both management and drivers.

Economy:

The participants stated that, in general, resources are low in the HGV transport sector. One participant said, “we have to calculate the absolute lowest price possible to win bids for transport assignments.” In this regard, the buyers of the road transport service do not consider whether the road transport organization has invested in new equipment or is concerned with safety. In many cases, the buyers are concerned only about the price of transporting their goods, which leaves road transport organizations with few resources to invest in safety factors such as new technological equipment, new vehicles, education, and training.

Main findings of Article 5:

Communication and competence were essential for all actors, especially across or between levels and actors. Control sanctions are also important for when communication and competence fail. Prevention and motivation work better than punishment and control when behavior is to be influenced.

The next chapter discusses the main findings in light of theory and previous research.

5. Discussion

5.0 Discussion
5.1 Important parties for managing road traffic safety for work-related driving with HGVs
5.2 The influence of organizational factors
5.3 Parties' contribution towards road traffic safety for work-related driving with HGVs
5.4 The holistic complexity model (HCM)

The key objective of this thesis was to study the relationship between parties in the system surrounding road traffic safety for work-related driving with HGVs and understand how different factors affect this relationship and, as a consequence, influence road traffic safety. The main research question was how the relationship between parties and organizational factors can influence the management of road traffic safety for work-related driving with heavy goods vehicles. In order to answer this overarching question, four sub-questions were developed. First, who are important parties in the system of work-related driving of HGVs? Second, what do parties in the system of road transport perceive as important factors for managing road safety for work-related driving of HGVs? Third, how can parties on an organizational level and an operational level contribute to increased road safety for work-related driving of HGVs? Fourth, how can the complexity surrounding road transport safety for work-related driving with HGVs be illustrated and managed?

These questions were approached from different angles in the five articles. The first article was a literature review, and the other four articles were based on empirical research. In the following section, sub-questions 1–4 will be discussed in light of empirical findings and previous research.

5.1. Important parties for managing road traffic safety for work-related driving with HGVs

Previous research has identified important parties who have the possibility of affecting road traffic safety for work-related driving with HGVs. Newnam, Goode, et al. (2017) used the AcciMap technique of Rasmussen (1997) to understand crash causation in Australia. This technique is underpinned by the idea that there are several parties within a system that all have the potential to influence an incident. Newnam et al. (2017) identified several parties that have this potential. At the higher levels in the system, they identified local and state governments and heavy vehicles regulators. These findings are similar to the empirical findings in articles referenced in this dissertation (Grinerud, 2022). The participants highlighted supranational institutions like the EU; national institutions like the Ministry of Transport, the Ministry of Labour and Social Affairs, the Norwegian Public Road Administration, and the Norwegian Labour Inspection Authority; and NGOs like the Norwegian Truck Owner Association (NTOA). The NTOA is not classified as a local or state government, nor a heavy vehicles regulator, but it has a big impact through its lobbying such institutions. Aside from the NTOA, these parties have the potential to affect road traffic safety by deciding and implementing laws and regulations. Since legal aspects is not covered in this dissertation, emphasis is not put on these parties but instead on parties at the lower levels in the system. Nevertheless, it is important to understand that these parties are crucial when it comes to deciding and implementing laws and regulations that are functional with a regular working day for the road transport of goods. It is also important to keep in mind that some challenges faced by parties at the lower levels could be due to constraints placed on them by regulators/government bodies.

At the lower levels of the system, Newnam, Goode, et al. (2017) identified parties like road transport clients, heavy vehicle companies, drivers (and other actors at the scene of the incident), equipment, environment, and meteorological conditions. Road transport organizations (or heavy vehicle companies) and their drivers are expected to be very important when it comes to influencing road traffic safety for work-related driving with HGVs. Nævestad et al. (2022) highlight engagement and involvement from the

management in road transport organizations in order to increase road safety, hereby, to develop a good safety culture within the organization. Drivers cannot be expected to be concerned with safety if it is not a priority at the company they belong to. Also, road transport organizations and their drivers are obviously important for road traffic safety, as they operate on the sharp end of the system.

In the study from Newnam, Goode, et al. (2017), transport clients are given relatively little attention as a party that could affect road safety for work-related driving with HGVs. This is contrary to the studies from Grinerud (Grinerud 2021; Grinerud et al., 2020), where clients are seen as a very important party in this matter as they can dictate how the transport is to be carried out with regard to safety.

According to Rasmussen (1997), one first needs to identify the parties in the system in order to control safety within a system. The parties presented above have been identified both by previous research and by empirical findings in the current study. The following discussion mainly emphasizes the buyers of road transport services, road transport organizations, and their drivers – the parties on the sharp end of the system.

Furthermore, Rasmussen (1997) states that parties in the system must be familiar with own strengths and weaknesses and those of the others. Therefore, different parties in the system must function together. It is the relationship within and between the parties that is important for controlling safety. This relationship is affected by different organizational factors.

5.2. The influence of organizational factors

As presented in the theoretical chapter (Chapter 2) and in Grinerud (2021), the Pentagon model is an assessment tool that can analyze why unwanted incidents occur from a systems level perspective and can be used to prevent them. A Pentagon model analysis can also be used for planning and organizational development – for example, by determining what kind of organizational characteristics must be in place to achieve certain qualities (Kongsvik et al., 2018; Rolstadås et al., 2014). In this context, relevant qualities include road transport without accidents or near-misses.

Both Newnam and Goode (2015), Newnam & Muir (2021) and Nævestad et al. (2022) highlight the importance of OSM and SMS in road transport organizations. OSM measures seem to provide an approach to reducing the number of killed and severely injured, with a share up to 51% in accidents involving HGVs in Norway (Nævestad et al., 2022). One of the main arguments for the importance of OSM/SMS is that when road transport organizations invest in such management systems, it is as a result of the management's focus on safety – safety is prioritized within the organization. Such an investment and prioritization also affects the employees' attitude and motivation for safety (Nævestad, Elvebakk, et al., 2018).

One of the five aspects the Pentagon model analyzes is culture (Kongsvik et al., 2018). OSM/SMS is especially important when it comes to building a culture where safety is prioritized. A road transport organization's culture is built up of elements like values and attitudes, norms, competence, knowledge, habits, and established way of working. A challenge in the road transport industry is that in Norway, 85% of the trucking companies employ five or fewer persons (Nævestad et al., 2022). Smaller organizations have fewer resources and hence fewer resources to invest in OSM/SMS. However, it could be the management's choice of strategy that affects how an organization prioritizes these above-mentioned elements, and one of the most important choices is on which ground the road transport organization recruits customers. Grinerud et al. (2021) state that road transport organizations that recruit customers on the basis of the lowest bid – offering road transport as cheaply as possible – have challenges with being profitable, so there are fewer resources to invest in building a culture that focuses on safety. If road transport organizations instead recruit customers by doing something different than their competitors – specializing in concrete road transport assignments or offering something unique – they have a better possibility of being profitable (Grinerud et al., 2021). Also, the choice of how an organization recruits customers has an impact on how they perceive education and training their drivers, which is important factors for building a good safety culture. While road transport organizations that recruit customers by the lowest bid tend to neglect the importance of education and training, road transport organizations that specialize in specific transport assignments tend to assess education and training as being very important elements for safe road transport. The reasoning

behind this argument is that road transport organizations that recruit customers by the lowest bid also tend to struggle with profitability. Hence, there is little resources available to focus on safety factors like education and training as these demand for resources. For example, road transport organizations specializing in transporting dangerous goods have a 75% lower risk of accidents than other road transport organizations (Nævestad et al., 2021) because these organizations work more systematically with SMS and safety. Thus, having the resources to invest in both OSM and SMS is important to develop a good safety culture within the road transport organization, and a good safety culture is an important factor for the safe road transport of goods (Grinerud et al., 2021). Hence, road transport organizations which struggle with resources often experience larger competition between production- and safety goals, whereas production goals tend to be prioritized because it brings economical resources to the organization on short term.

Another aspect analyzed by the Pentagon model is interaction (Kongsvik et al., 2018), which covers factors like communication, cooperation, coordination, leadership, decision making, and learning. These factors are important within each organization but even more important in the relationship between the different parties in the system surrounding work-related driving with HGVs. Rasmussen (1997) states that it is important that the different parties know each other's strengths and weaknesses in order to manage safety – especially buyers of road transport services, road transport organizations, and their drivers, as they are all a part of the sharp end of the system. The interaction between these parties needs to be extremely good. Buyers of road transport services have the possibility to set demands for the road transport they order – for example, that the transportation of their goods is done with competent drivers, adjusted equipment, and set delivery time (Grinerud, 2021; Grinerud et al., 2020). However, in order to make the “right” demands, the interaction with the road transport organization and their drivers is very important. The interaction between the management of road transport organizations – e.g. route planners – and their drivers is also important, as the management must be familiar with the risks that drivers meet in their daily work. Reason and Hobbs (2017) label this information sharing as an “informed culture,” which is an important factor in regard to increase safety. They also highlight that the workplace must

have a “reporting culture,” meaning that it should be natural for all employees at the workplace to notify about situations that cause risk of accidents. The information shared should be something the organization learns from and thus increase safety. Hence, interaction both between and within each party is important for increasing road safety for HGVs.

The Pentagon model also analyzes the element of social relations and networks (Kongsvik et al., 2018). This element consists of factors like friendship, informal alliances, trust, power, influence, competition, and conflicts; it is important for the relationship between parties in the system. An important factor to highlight is trust between buyers of road transport services and road transport organizations. According to Grinerud (2021), most buyers of road transport services highlight the importance of choosing a road transport organization they trust. They emphasize being familiar with the road transport organization and prefer that their business relationship is built on knowledge and trust with the transport provider. Knowledge and trust in the transport provider facilitate communication and lead to a relationship where challenges and deviations can be quickly resolved, so conflicts are rare and handled quickly if they do appear. However, when the business relationship between buyers of road transport services and road transport organizations is based primarily on knowledge and trust, it can affect their professional relationship, leading to situations where contracts are not important and regular revisions and controls by the buyers of road transport services with the transport provider are absent. Consequently, building a business relationship based on primarily knowledge and trust could result in less safety focus as situations are handled ad hoc. This is aligned with system thinking principle where improving communication both upwards and downwards in the system is essential for safety within the system. In a system thinking approach the goal is to eliminate, mitigate, or control hazards to avoid accidents and losses (Leveson, 2021). In order to achieve such goals, commitment and whether the parties are committed to safety and whether they are aware of safety constraints are of importance (Rasmussen, 1997). Hence, when focusing on increasing road traffic safety for work-related driving with HGVs, it is important for buyers of road transport services and road transport organizations to be aware of the

pitfalls when engaging in road transport assignments on the basis of knowledge and trust between the buyer and the provider.

A huge challenge in the work towards a safer road transport is the competing goals of production and safety. In a world where commercial success often benefits from operating close to safety boundaries, decisions will be affected by the competing goals of production and safety (Sætren et al., 2019). Demands for safety and pressures for efficiency and production are difficult to manage. An example from the findings in this thesis supports this argument: regarding the road transport of Norwegian salmon from the fish slaughterers to the airport where the salmon is exported out of Norway, participants spoke of the importance of getting the salmon to the airport in due time and how this could be a challenge on curvy Norwegian winter roads. How this challenge was managed was very much affected by the road transport organization's internal culture and safety focus but also by how the buyers perceived their responsibility for safe road transportation of their goods.

The following section discusses how these parties can contribute to safer road transport.

5.3. Parties' contribution towards road traffic safety for work-related driving with HGVs

The third sub-question in this thesis was how parties can, on an organizational level and an operational level, contribute to increased road safety for work-related driving of HGVs. In contrast to the findings in Newnam, Goode, et al. (2017), buyers of road transport services were highlighted as an important party in managing road safety for work-related driving with HGVs in Grinerud (2021); Grinerud et al. (2020). The main rationale behind this was the fact that buyers of road transport services can set demands towards the transport provider. When highlighting one party as important in managing road traffic safety for work-related driving with HGVs, it could be argued that a reductionist view is taken instead of seeing the system as a whole. This thesis argues that, in order to take a systems approach towards road traffic safety one should also consider the contribution from each party. Therefore, in addition to considering the interaction between all the parties within the system, one should also consider how each

party prioritize safety. This is due to the premise that the system can be influenced by the environment it operates in (Salmon et al., 2012). Also, each party contribute to a functional system with their input and the system is usually path dependent. Meaning that their past behavior influences their present behavior (Salmon et al., 2012). With this argument in mind this thesis argues that it is important to highlight what each party can contribute with into the system in order to maintain road safety for work related driving with HGVs.

In Grinerud et.al. (2020), participants agreed about the importance of buyers of road transport services setting demands on the road transport organizations they hire, especially driver competence, following laws and regulations, and using appropriate vehicles and equipment. Driver competence is highlighted because it is important that drivers have the competence and skills to execute safe transport. Some of the participants mentioned that the challenge with hiring foreign road transport organizations for Norwegian winter roads is that the drivers lack winter driving competence. By choosing a road transport organization that prioritizes educating their drivers on the specific transport they carry out, they will increase the quality of the transport. Furthermore, the participants highlighted the importance of buyers hiring road transport organizations that follow laws and regulations, which ensures that drivers are getting the right salary and have good working conditions; this is important for safe transport. Transport organizations that fail to follow laws and regulations are a major safety concern, as they set themselves and other road users at risk by, for example, overloading their vehicles and driving too many hours. Finally, the participants highlighted the importance of buyers hiring road transport organizations that use appropriate vehicles and equipment. Vehicles and equipment must be adjusted to the kind of transport they carry in order for the transport to be safe. Examples that were given included challenges with securing the cargo if the vehicle or equipment are not fitted to transport the cargo, or with driving on icy roads without proper winter tires.

However, in order for the road transport buyers to set such demands, they must experience a sustainability and safety demand from general society. Organizations operating in a high-risk environment experience such a demand – e.g., organizations in

the oil and gas industry experience relatively few accidents and near-misses (Weick & Sutcliffe, 2001) because of their high prioritization of safety. Road transport organizations that execute transport assignments for such organizations must comply with many safety demands, and these organizations are seldom involved in road traffic accidents (Nævestad et al., 2022). This shows that if buyers of road transport services include the transportation of their goods in their own OSM/SMS, it is likely that road transport accidents involving work-related driving with HGVs will decrease. The situation today seems to be that those who buy road transport services have well-documented and implemented OSM and SMS from when the goods are produced until collection by the road transport organization, but as soon as the goods are loaded on the trailers, it seems like the buyers let go of whatever sustainability and safety responsibility they have. Hence, buyers can contribute to a safer road transport by ensuring that their OSM and SMS also apply for the road transport organizations they hire and set demands on them (Grinerud, 2021; Grinerud et al., 2020).

Road transport organizations, on their part, could contribute to safer work-related driving with HGVs by making sure they prioritize OSM and SMS, and especially by using competent drivers and equipment. However, in order for road transport organizations to have the resources to prioritize this, they must be profitable. Hence, they must choose their customers wisely and recruit customers not by having the cheapest price (Grinerud et al., 2021). Most importantly, buyers of road transport services and road transport organizations must interact with each other and get to know each other's strengths, weaknesses, and challenges.

With the findings and results for sub-questions 1–3 as the grounding material, a model that illustrates the complexity surrounding road transport safety for work-related driving with HGVs was developed. The model is presented in the next section.

5.4. The holistic complexity model (HCM)

Work-related driving with HGVs is underpinned by a complex system, and this complexity needs to be managed in order to increase road traffic safety. When taking a systems perspective, several failures could be the triggering factor that leads to accidents

involving work-related driving with HGVs (Newnam & Goode, 2015). Reason (1990) distinguishes between active and latent failures; active failures could be the result of latent failures. In the system surrounding work-related driving with HGVs, latent failures could occur because of actions and decisions made by management with the road transport organizations or with the buyers of road transport services. Examples of failures include scheduling less driving time than the route actually needs or providing drivers with insufficient equipment and trailers. Active failures are those that are instantly visible – e.g., a driver falling asleep while driving or cargo falling off the trailer during transport – and result in accidents (Grinerud et al., 2020).

Increasing road transport safety for work-related driving with HGVs requires focusing on latent failures because there are numerous parties making decisions that affect the driver and his/her working day. This contrasts with driving for pleasure, where the driver can often make most decisions himself/herself. For the professional driver, there is an external environment of parties making decisions that affect the driver's working day – governmental and regulatory bodies, NGOs, and bodies that enforce laws and regulations. Governmental and regulatory bodies decide on laws and regulations that apply to the drivers – for instance, laws and regulations that regulate driving and resting time per day/week, driver qualifications, and other regulations directed towards the actual conduct of transport assignments. These laws and regulations need to be functional with a driver's daily work in order to decrease possible latent failures. Meanwhile, NGOs lobby the government and regulators. NGOs often work with the driver's best interest in mind, making sure that the laws and regulations are functional and pushing for changes when functionality is lacking.

Additionally, there are those who enforce laws and regulations. The consequences of not applying laws and regulations are often directed towards the driver; some would argue that this is quite unfair, as this even applies when the road transport organization did not make it possible for the driver to follow the laws and regulations. In order to increase road traffic safety for work-related driving with HGVs and reduce the possibility of latent failures, it is important that road transport organizations facilitate their drivers following laws and regulations. The road transport organizations must

possess certain qualities for this, like an internal culture that prioritizes safety (Newnam & Muir, 2021; Nævestad et al., 2022) and a good relationship with their buyers (Grinerud, 2021). The management's choice of strategy affects how the organizations prioritize safety work – OSM and SMS including making sure that their drivers are competent for road transport assignments. The choice of strategy also affects the choice of customers and how they interact and develop relationships with their buyers.

The same applies for the buyers of road transport services. It is their choice of strategy – how they choose their road transport provider and how they set demands towards the actual conduct of the road transport assignments – that affects how safe the road transport will be. It is important that buyers of road transport services take safety responsibility for the road transport of their goods as well; their OSM and SMS must also apply for the road transport (Grinerud et al., 2020).

However, an important premise is that both the road transport organization and the buyer of road transport services are profitable organizations. Without resources, it is less likely that the organizations work systematically with safety concerns (Nævestad, Elvebakk, et al., 2018).

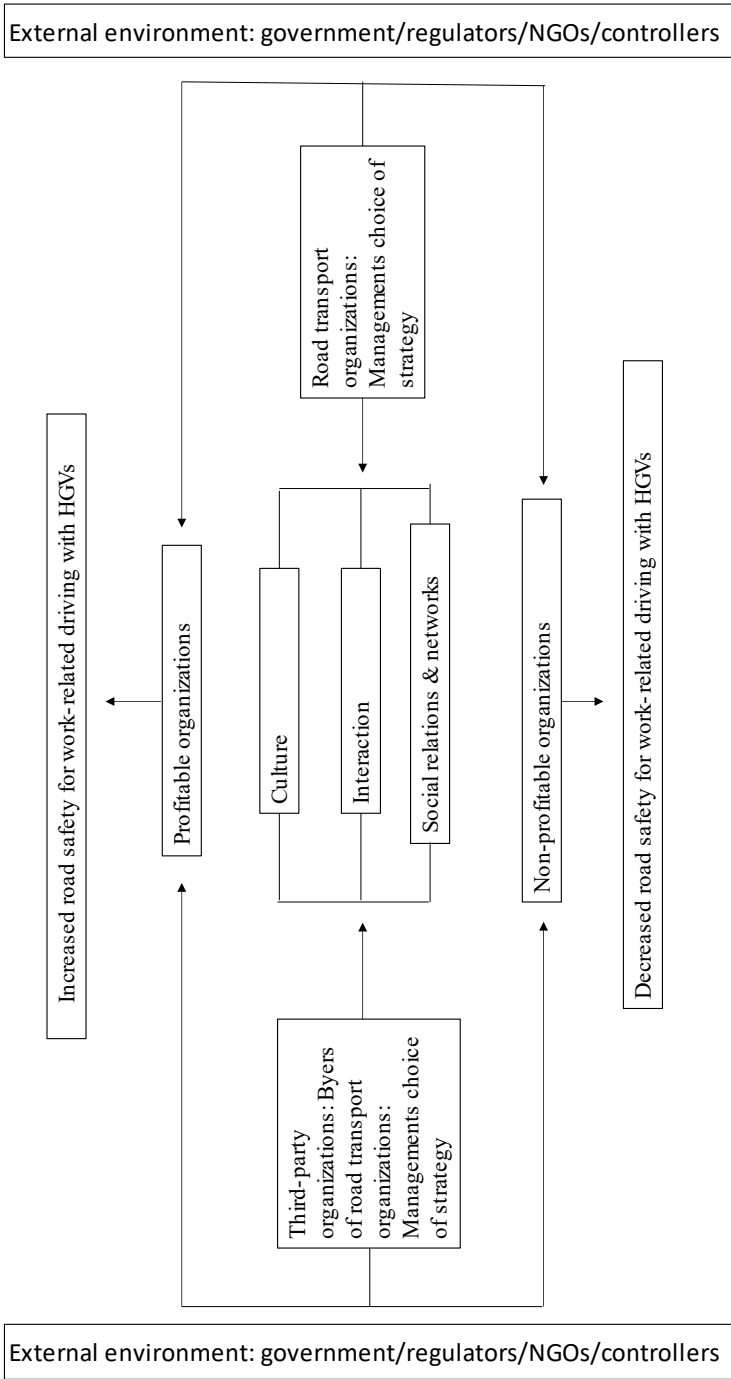


Figure 11. The holistic complexity model

The holistic complexity model shows the complexity of the system surrounding work related driving with HGVs. In the external environment, there are parties with great influence on the system. There is, on the higher levels, supranational and national institutions which place constraints on the operational parties and NGOs lobbying towards these decisionmakers. There are controllers on different levels. Hereby, controllers which is directed against several actors on the sharp end of the system. This could be roadside controls of vehicles and drivers, controls at the workplace where the road transport organization is situated, controls at the workplace where the buyer of road transport services are situated, etc. Also, there are car manufactories, chassis builders that decide how vehicle and equipment should be made and put to use. Despite that these abovementioned parties have not been a focus in this thesis, it is acknowledged that these have a big influence on parties at the sharp end of the system (Grinerud, 2022; Newnam, Goode, et al., 2017).

However, despite the fact that parties at the lower levels of the system is influenced by the parties at the higher levels of the system, this thesis argues that parties at the sharp end of the system have the possibility to take responsibility for safe road transport themselves. Road transport organizations and buyers of road transport services choice of strategy is in HCM key factors to increase road safety for work-related driving with HGVs.

Road transport organizations choice of strategy affects their internal culture (culture in HCM model above). This could be how they prioritize building a safe culture and invest in OSM/SMS. Nævestad et al. (2022) states that by implementing OSM in road transport organizations, there could be a decrease in killed and severe injured by 51%. Further, road transport organizations choice of strategy also affect how they interact and how they establish relationship and network both within own organization but also with other parties in the system (social relations & network in HCM model above). Rasmussen (1997) states that sharing information, both top-down and bottom-up is a prerequisite for controlling safety. Hence, how the road transport organization prioritize interaction, hereby, communication, collaboration and cooperation is of essence (interaction in HCM model above) (Grinerud, 2022).

The same arguments as described above about road transport organizations can also be used regarding the buyers of road transport services. There is a need for those parties to take more responsibility about how their goods are transported. In a recent study by Grinerud (2021) it is stated that this responsibility must exceed also outside of the buyers work place. Meaning that buyers of road transport services must demand for safe road transport for their goods. A prerequisite for this to happen is that buyers of road transport services are invested in safety and prioritizing a safe culture within their organization. Hence, the management choice of strategy will affect this.

However, it is stated that resources are needed in order to prioritize safety and invest in a safe culture (Grinerud et al., 2021; Nævestad et al., 2022). Otherwise production goals are prioritized over safety goals as it is the production that brings economical resources into the organization on a short term. Grimsrud's (2021) study suggest that road transport organizations where the management chose a strategy that revolves around offering the lowest price to get transport assignments tend to struggle to be profitable. Hence, instead of having resources available to invest in developing a good safety culture, resources must be spent on getting new assignments. On contrary, road transport organizations that deliberately chose a strategy which tries to differentiate themselves to gain a special position in their market were more likely to be profitable and hence had resources to invest towards developing a good safety culture, such as those that specialize in certain types of road transport or focus on certain niche markets in the industry (Grinerud et al., 2021).

Consequently, HCM illustrate that the managements choice of strategy in the end affect the organizations possibility to be profitable and have resources to invest in safety and develop a good safety culture. It is widely acknowledged that investment in safety and good internal safety culture is of importance for road safety for work-related driving with HGVs (Newnam & Goode, 2015; Newnam, Goode, et al., 2017; Newnam & Muir, 2021; Nævestad et al., 2020; Nævestad, Elvebakk, et al., 2018; Nævestad et al., 2022). Hence, management decisions will in the end affect whether road safety for work-related driving with HGVs increase or decrease.

6. Conclusion

6.0 Conclusion

6.1 Implications and further research

The overarching question for this thesis was how the relationship between parties and organizational factors can influence the management of road traffic safety for work-related driving with heavy goods vehicles. The main focus was on the parties buyers of road transport services, the road transport organizations, and their drivers. Parties like local and state governments and heavy vehicles regulators were also identified in this study, but the focus was not on these parties, as the legal aspect was not covered in this thesis. However, it is acknowledged that these have a big influence on parties at the sharp end of the system

The relationship between buyers of road transport services and road transport organizations is important, as they both are on the sharp end of the system of work-related driving with HGVs. Organizational factors like culture, interaction, and social relations and networks are important for increasing road traffic safety. Most crucial is the internal culture in each organization. In order to prioritize safety work, the organization must have an internal culture that emphasizes safety. It starts with the top management, which must prioritize and invest in safety if employees should also be invested in carrying out their jobs with regard to safety. An important finding was that the management's choice of strategy – how they recruit customers and employees – had a solid impact on the organization's profitability, and profitability had an important impact on how each organization prioritized safety.

Also, the level of interaction and social relationship between and within each party was essential. It is essential that every party must be familiar with each other's strengths, weaknesses, and challenges in order to make the system surrounding road safety for work-related driving with HGVs functional. Although parties at the sharp end of the system could experience challenges due to constraints placed on them by

regulators/government bodies, this thesis argues that these parties have the possibility to take greater responsibility regarding road traffic safety for work-related driving with HGVs (Grinerud, 2021, 2022; Grinerud et al., 2020; Grinerud et al., 2021)

The buyers of road transport services could be seen as a very important party in regards of safe road transport, do to their possibilities to set demands towards the road transport organization. The HCM model was developed to explain the complexity in the system and how this complexity could be managed.

6.1. Implications and further research

Road traffic safety is a field that is still developing. It is a multidisciplinary field where different literature and theories could be used to explain a phenomenon. The findings from this thesis contribute to road traffic safety using organizational theory as a lens. On a theoretical level, this thesis contributes to road traffic safety theory by exploring the relationship between different parties in the system surrounding work-related driving with HGVs. While previous research has focused on the relationship between actors within the same level or organization, this thesis focused more on the relationship between levels or organizations and investigate some parties in depth. Hence, most emphasis is put on the relationship between organizations at the lower levels of the system. Elements from organizational theory and general safety theory were used to highlight factors that are crucial for this relationship and for enhancing road traffic safety. The results from this thesis compliments system thinking by showing how each of the parties in the system has a responsibility for the system to work.

The greatest contribution of this thesis is to the practical field. Practical implications of the constraints in the system is assumed to be that the driver is being seen as responsible for road traffic safety. This in contrary to the findings from this thesis which shows that a number of parties and their strategies have an effect on road traffic accidents.

This thesis could especially impact management in road transport organizations and buyers of road transport services. First, the thesis provides essential suggestions that will be important when the management of road transport organizations decides on their

business strategy – what to focus on when offering their services and signing new employees. If road transport organizations think it would be profitable to take on every transport assignment without setting demands towards safety and employ every driver who wants to work, this thesis would be different. This thesis explores how different strategic choices and organizational factors could influence profitability and hence road traffic safety for work-related driving with HGVs.

On the other hand, the thesis presents buyers of road transport services as an important party in road traffic safety work. By setting demands towards those that transport their goods, this party could contribute to a better work environment for drivers, correctly equipped vehicles, and better profitability for the industry; ultimately, their demands will contribute to safer road transport.

The road transport industry must take more responsibility towards road safety and sustainable road transport. Hence, this thesis presents the holistic complexity model, which shows the relationship between the parties and the factors that affect this relationship. For management in road transport organizations and for buyers of road transport services, this model presents the importance of relationships and organizational factors that can be known and managed within each organization. Further research should be conducted on this matter, and the model should be developed further in order to increase road transport safety for work-related driving with HGVs. Short and precise education and training programs should be established and conducted for management, drivers, and buyers of road transport services in order to make each other's strengths, weaknesses, and challenges known to every party in the system and to provide the competence that is required. Future research should be conducted in relation to such education and training.

An overall limitation in this thesis is the large number of parties that operate in the system surrounding work-related driving with HGVs which was not captured in this research. Main emphasis has been put on parties on the lower levels of the system. Hereby, buyers of road transport services, road transport organizations and their drivers.

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Part two

Full text og articles 1-5

Review

Work-Related Driving of Heavy Goods Vehicles: Factors That Influence Road Safety and the Development of a Framework for Safety Training

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Abstract: Road traffic accidents are a major health concern all over the world. Each year, 1.3 million people die in fatal road traffic accidents. Fatal and serious heavy goods vehicle (HGV) crashes are over-represented in many countries. This paper is a contribution to the road safety literature and has two aims. First, the study seeks to identify important factors in managing road safety for work-related driving of HGVs. Second, the study proposes an overall framework for how safety training could be executed and its overall content. Methods used were a literature review and a case study. The results show that important factors for management of road safety could be arranged at different levels: governmental level, third-party level, organizational level and driver level. Most important is that a systematic approach to road traffic safety for HGVs is essential. Every party is jointly responsible for road traffic safety, and parties must communicate and work together to increase road traffic safety for work-related driving of HGVs. By developing a safety training program for all parties in the system, the study proposes a method for increased communication, collaboration and cooperation between parties.

Keywords: road traffic safety; heavy goods vehicles; driver training; system approach



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1. Introduction

Road traffic accidents are a major health concern all over the world. Each year, 1.3 million people die in fatal road traffic accidents [1]. Another 20–30 million people sustain non-fatal injuries annually [2]. Fatal and serious heavy goods vehicle (HGV) crashes are over-represented in many countries [3]. Due to HGVs' great size and weight, accidents involving these vehicles are often fatal. In Norway, road transport organizations employ a large number of professionals whose main work is on the roads. HGV drivers account for the largest proportion (40%) of drivers in work who are involved in accidents and sustain injuries [4]. In Norway, specific interventions and measures directed particularly at work-related driving of HGVs are implemented. If new interventions and measures are not put in place, however, reducing HGV accidents and consequently achieving Norway's road safety target presents a challenge [5].

Even though there is a large body of research on the causes of HGV crashes, there is little research to evaluate the strategies that might be effective for preventing these crashes [3]. As a consequence, new research focuses increasingly on a systematic approach to reducing accidents involving HGVs. This means that accidents that do occur are not solely the driver's responsibility [5]. A crash caused by fatigue, for example, might not solely be the driver's fault, but could also be due to the supervisor's lack of involvement in route planning, or the type of compensation method used to align performance objectives with drivers' payment. Supervisors' level of involvement may also be restricted due to their own workload, company policies or pressure from higher up in the organization [6]. Recent research highlights stress- and fatigue-management policies and interventions in order to reduce work-related accidents with HGVs [7]. Hence, several small decisions from the top level down to the driver level may have triggered the actual accident.

This paper is a contribution to the road safety literature and has two aims. First, the study seeks to identify the important factors in managing road traffic safety for work-related driving of HGVs. By conducting a literature review, an overview of what the research literature deems to be important factors will be presented. The literature review has a focus on the management perspective and does not cover legal nor other perspectives.

Safety training and education are highlighted as important factors in managing road safety for work-related driving of HGVs [3,8,9]. In a recent study by Llamazares, J., S. A. Useche, L. Montoro and F. Alonso [10], similarities between commuting crashes and the work environment of professional drivers are suggested. It is stated that time pressure and fatigue are potential enhancers of commuting accidents the same way these factors are enhancers of accidents involving professional drivers. An important finding in their study is that 44% of the commuting crashes involved drivers with less than ten years of tenure. The study therefore concludes with the importance of job experience and training as protective factors.

Even though safety training and education are highlighted as important factors, there is little research into how such training could be executed and the potential content of such training and/or education. This study's second aim is therefore to propose an overall framework for how safety training could be executed and its overall content. Safety training would thereby be directed towards all parties in the system of work-related driving of HGVs. However, most attention will be given to safety training directed at drivers, and detailed safety training is illustrated by a Norwegian case study. This leaves the study with the following two research questions: (I) What are important factors to manage road traffic safety for work-related driving of HGVs? (II) How can an overall safety training framework be arranged to enhance road safety for work-related driving of HGVs?

A presentation of the methodology and results is provided below. Thereafter, results are discussed in regards to previous literature. Finally, a conclusion is proposed.

2. Methods

2.1. Literature Review

This study's first question is answered by using literature review as a method. The purpose of this literature review is to identify important factors to enhance road safety for work-related driving of HGVs. The literature review was conducted according to the method described in [11]. The method differs from a systematic literature review because the method allows broader topics where many different study designs might be applicable. Additionally, the method does not address very specific research questions, nor does it assess the quality of the studies included. The main aim of the method is to map relevant literature regarding important factors to manage road safety for work-related driving of HGVs. The stages of the literature review are as follows:

(1) Identifying the research question, (2) finding relevant studies, (3) selecting the studies, (4) charting and collating the data and (5) summarizing and reporting the results.

Step 1: Identifying the research question

As stated in the Introduction, this paper seeks to identify research literatures which present important factors that affect the management of road traffic safety for work-related driving of HGVs. Appendix A, Table A1, provides an overview of the studies included in the review, as well as a summary of the aim of the study, main findings and which factors have been identified.

Step 2: Finding relevant studies

The review was carried out according to the method described by Hart, C. [12]. The literature search was conducted in two phases. The first phase was conducted in October–December 2019 and the second phase was conducted in October–December 2021. In the first phase (October–December 2019), an extensive search was performed of eight different databases. The databases providing the most references were Google Scholar, Oria, Proquest, Science Direct, and Taylor and Francis. In addition, a second literature search phase was conducted (October–December 2021). This search was performed based on

literature the researcher was familiar with and perceived as relevant to the study objective. Moreover, the search also included new research published from the years 2019–2021. The keywords used in the search were ‘risk management, safety culture, transport and/or road transport’.

Step 3: Selecting the studies

The initial search included studies of all transport modes, such as road, train, air and sea. Based on titles, studies that involved transport modes other than road transport and duplications were excluded. The remaining road transport studies had to present factors that could influence the management of road traffic safety for work-related driving of HGVs. Hereby, studies that take a management perspective. Other inclusion criteria (Table 1) were that the articles had been published between 2014 and 2021, were online, peer-reviewed and written in English.

Table 1. Inclusion and exclusion criteria.

	Included	Excluded
Databases	ABI/Inform, Google Scholar, Oria, Proquest, Sage, Science Direct, Springer Link, Taylor and Francis (London, UK), Web of Science	Other
Timeframe	2014–2021	Articles published before 2014
Publication type	Peer-reviewed articles available online	Books and book chapters, ‘grey literature’ (reports, governmental reports, etc.), Other
Focus	Studies focusing on road safety concerns with HGVs	Studies focusing on other transport modes (train, air, sea)
Language	English	Other

Step 4: Charting and collating the data

Articles were then critically reviewed according to the method described by Hart, C. [12]. The following statistics were registered for each article: the study’s origin, authors, year of publication, method used, aim of study, main result and HGV road safety factors identified (Appendix A).

Step 5: Summarizing and reporting the results

Main findings from all included studies were organized on a chart, compared and summarized. In addition, a descriptive text about specific HGV road safety factors linked to each study was produced (Appendix A).

2.2. Case Study

This study’s second question, concerning how an overall framework for safety training could be arranged to enhance road safety for work-related driving of HGVs, was answered by using the results from the literature review, as well as a small-scale case study [13].

A case study affords the researchers an in-depth understanding of the phenomena that is being studied. There are mainly three types of case studies: intrinsic, instrumental and collective case studies [14]. In this study, an instrumental case study has been used, meaning that the case study uses a particular case to study the phenomena [14]. The study was conducted according to the description in [14].

Step 1: Defining the case

The case that was studied was the practical driving in periodic training of professional drivers (a more detailed description of mandatory periodic training in relation to the case study will be provided in Section 4.3) [15]. The research question that was to be answered was how an overall framework for safety training could be arranged to enhance road safety for work-related driving of HGVs.

Step 2: Selecting the case

The reasoning behind the selection of the case was that the practical driving part of the periodic training of professional drivers could be an illustrative case, to develop a

framework for safety training that is not too resource-demanding. Implementation of such a framework could be assumed to be easier for road transport organizations.

In addition, the case was chosen because of its accessibility for the researchers. Researchers were given access to instructors, professional drivers who attended the course, vehicles and locations.

Step 3: Collection of the data

Data were collected through observation of the course at a Norwegian training center and an interview with one instructor. In addition, driver performance results were collected for the practical driving. Results extracted from these data are presented in Section 4.3.

Step 4: Analyzing, interpreting and reporting the data

The data that were collected through observation and the interview were analyzed and interpreted with the research question in mind. Observation and interview notes were read and re-read to be familiar with the data. After this phase, the researchers identified important factors that could be used as a basis for the framework for safety training for work-related driving of HGVs. In addition, driver performance results were used to show improvement in driver behavior.

3. Results

In the following sections, the results from the literature review and the case study will be presented.

3.1. Literature Review

3.1.1. Search Results

A total of 805 studies were identified by the keywords used in the literature search and the additional manual search. However, after assessing the studies according to the inclusion criteria and removing duplicates, 93 studies were potentially relevant. The abstracts of these 93 studies were then reviewed. After this, 22 studies were included in the review (Table 2).

Table 2. Search results.

	Search Terms	Results	Potentially Relevant	Included in Review	Excluded due to Non-Relevance or Duplication
Google Scholar	Risk management + Safety culture + Road transport	205	42	1	204
Oria	Risk management + Safety culture + Transport	420	31	8	412
ABI/Inform	Risk management + Safety culture + Road transport	6			6
Proquest	Risk management + Safety culture + Road transport	13	2		13
Sage	Risk management + Safety culture + Transport	31			31
Science Direct	Risk management + Safety culture + Transport	31			31
Taylor and Francis	Risk management + Safety culture + Transport	76			76
Web of Science	Risk management + Safety culture + Transport	5			5
Manual search by reviewing reference list, etc.		32	18	13	5
Total		805	93	22	783

3.1.2. Descriptive Presentation—Outcome

The analysis of the 22 included articles was conducted with the following research question in mind: What are important factors to manage road traffic safety for work-related driving of HGVs? Analysis of the articles showed that they could be categorized into three distinct groupings: articles with factors contributing to road traffic safety on an (I) organizational level, (II) driver level and (III) third-party organizations and regulatory bodies level. In the following sections, a presentation of the factors at each level is provided.

3.1.3. Organizational Level

There is a need for management of road transport organizations to implement a system-thinking approach and safety management systems (SMS) in road transport organizations [3,4,16–19]. Accidents involving HGVs are likely to be a result of systems issues involving a network of interlinked contributory factors [19]. A reductionist perspective of finding the cause of an accident will not inform effective interventions or policy development [19]. Instead, the focus will be on identifying unsafe driver behavior, implying that the driver is solely to blame for the accident [7]. A collectivistic perspective is required in order to improve knowledge sharing and situational safety practices in transport [8]. Moreover, it must be acknowledged that the transport system has characteristics of a complex sociotechnical system, whereby all parties should be taken into consideration when an accident occurs [7]. A systematic approach to workplace road safety would acknowledge that responsibility for road traffic safety is shared across the system and that resources allocated to plan and manage workplace road traffic safety should be focused across all levels of the system, and not solely on the behavior and practice of the individual driver [1].

It is stated that transport organizations have little focus on organizational safety management (OSM), and thereby also little focus on SMS [4]. This is a particular challenge for small transport companies with limited resources. Consequently, an OSM strategy for small transport companies was developed in one of the studies [4]. To develop this OSM strategy, Nævestad et al. identified a set of evidence-based organizational safety measures that fulfilled five criteria. They had to: (1) address risk factors found in previous research, (2) have an effect on safety outcomes in previous research, (3) be attainable at a relatively low cost, (4) not be too complex, content-dependent or comprehensive and (5) be complementized to existing safety management standards. The measures identified on the basis of these five criteria were then arranged on a ladder, whereby the organizations start at the lowest level, before proceeding to: level (1) safety commitment of managers and employees, level (2) follow-up of driver speed, driving style and seat belt use, level (3) focus on work-related factors' influence on traffic safety (e.g., organization of transport) and level (4) safety management system (e.g., ISO 39001). It is argued that the safety culture increases at each level of the ladder, while the accident risk decreases [2].

It is stated that driver behavior is affected, among other factors, by the perceived level of stress. How transport schedule planning is conducted influences this perception (e.g., fatigue risk due to long working hours, as drivers get paid for actual production). Route planners must be aware of this risk when scheduling transport routes. The implementation of training programs for managers is highlighted as important [20–23].

The review of the literature showed some factors that stand out as important for the management of road safety for work-related driving of HGVs at an organizational level. In particular, there is a need for a systems approach and the implementation of safety management systems (SMS). It is crucial that the SMS include such elements as follow-up on driver behavior, training programs for both management and drivers and awareness about route planning, stress and fatigue. An overview of the literature is presented in Table 3.

Table 3. Organizational level.

Source	Findings
Newnam et al. [19]	There is a need for systems-thinking for management of transport companies.
Li and Itoh [16] Mooren et al. [3] Moreen et al. [17] Nævestad et al. [18] Phillips et al. [22] Warmerdam et al. [24] Nævestad et al. [4] Nævestad et al. [2] Grinerud et al. [25]	There is a need for the implementation of a safety management system (SMS) in road transport and for systematic safety management work. Effective workplace management programs must also include the drivers, who should be seen as the companies' responsibility. Implement training programs for managers of drivers.
Li and Itoh [16] Newnam et al. [26] Nævestad et al. [27]	Focus on building a good safety culture/climate in transportation companies.
Dawson et al. [20] Phillips et al. [22]	Fatigue amongst drivers must be addressed by implementing fatigue management systems.
Thompson et al. [23]	How drivers are paid affects the safety level. Payment systems should be 'flat-range' wage systems.
Li and Itoh [16] Grytnes et al. [8] Grinerud et al. [25]	Increase communication between drivers and management and their willingness for teamwork.

3.1.4. Driver Level

At the individual driver level, several studies highlight the importance of driver/safety training and monitoring of driver behavior. This is argued to be the management of road transport organizations' responsibility: to provide their drivers with the right competence to execute their work. It is highlighted that safety training is closely linked to safety outcomes [3,4]. It is stated that such safety training could be arranged differently in terms of both informal courses/coaching/knowledge sharing, and formal training/education. The management of road transport organizations must provide an opportunity to identify and reduce the frequency of unsafe driving behavior by implementing corrective measures, such as coaching. The authors of [9] highlight the importance of a collectivist practice among drivers that can be utilized to improve knowledge sharing and situational safety practices. Li, Y. and K. Itoh [16] suggest more formal training, whereby they highlight proper safety training to give drivers more realistic views of stress/workload effects on their performance at work. Furthermore, in 2009, mandatory periodic freight transport training was implemented in Europe [15]. It is stated that after completing this periodic training, the driver/student will: (I) drive optimally and safely, (II) demonstrate professionalism in the execution of the profession and (III) protect their own and others' safety at work when the vehicle is stationary. Elvebakk, B., T.-O. Nævestad and L. C. Lahn [15] state that the periodic training is a success in many ways. This conclusion is based on Norwegian students' self-reporting that they have acquired new knowledge and changed their driving practices after completing 35 h of mandatory periodic training (a more detailed description of mandatory periodic training will be provided in relation to the case study in Section 4.3).

However, even though proper safety training is likely to have a positive outcome for road safety, few road transport organizations systematically provide non-mandatory safety training for their drivers [25]. The reasons for the lack of such programs is cost, a lack of information about efficient training programs, logistics and a lack of senior management support [26]. Nonetheless, there are also findings that suggest that by providing regulatory driver/safety training, road transport organizations have an advantage when recruiting new drivers, as many drivers perceive driver/safety training as important [25]. In addition to driver/safety training, studies also highlight the importance of follow-up on driver

behavior (e.g., [4]). It is stated that technology and organizational follow-up on driver behavior are important for managing road safety with work-related driving of HGVs.

After reviewing the literature, some factors stand out as important for the management of road safety for work-related driving of HGVs at a driver level. They particularly include that drivers should have proper safety training and education in terms of driving behavior and that this behavior should be regularly followed up. An overview of the literature is presented in Table 4.

Table 4. Driver level.

Source	Findings
Luke and Heyns [28] Mooren et al. [17] Nævestad et al. [4]	Monitor driving performance and behavior and implement measures (i.e., coaching).
Li and Itoh [16] Mooren et al. [3] Grytnes et al. [8] Warmerdam et al. [24] Grinerud et al. [25] Elvebakk et al. [15]	Implement safety training for drivers. Improve driver competence and communication between drivers. Implement safety rules.

3.1.5. Third-Party Organizations and Regulatory Bodies

Different studies highlight third-party organizations and regulatory bodies as important parties that can influence safe road transport using HGVs. In this study, third-party organizations are limited to focus on buyers of road transport services. Nævestad, T.-O., R. O. Phillips and B. Elvebakk [18] state that time pressure is a critical problem in the transport industry. It is said that, for example, transport buyers and forwarding agents are likely to put pressure on/stress drivers. This means that drivers take greater risks while driving due to tight time margins for assignments [5,9,18]. Transport buyers and forwarding agents can also influence safe road transport through the requirements they set. These requirements include that drivers must have winter driving proficiency before transporting their goods on winter roads [9]. It is stated that a lack of skills to drive on Norwegian winter roads is a road safety challenge [29]. The management of road transport organizations' choice of strategy is influencing what kind of customers they acquire. Hereby, customers that enhance or decrease road traffic safety for work-related driving of HGVs [25].

Governmental and regulatory bodies are important for the management of road safety for work-related driving of heavy goods vehicles. In this study, governmental bodies are limited to be those who approve legal acts, while regulatory bodies are limited to those who enforce laws and regulations. They play a key role in maintaining safety at all levels through their regulations and policies [7]. For example, if regulatory bodies' inspections fail to detect deficiencies in road transport organizations' maintenance procedures, this may result in HGVs with non-functional brakes being allowed on the road. Further, if governmental and regulatory bodies approve and enforce laws and regulations that are not in line with actual day-to-day transportation, challenges for drivers and road transport organizations in applying these regulations will occur. To prevent these challenges, frequent communication and collaboration between parties is highlighted as important.

After reviewing the literature, some factors stand out as important for the management of road safety for work-related driving of heavy goods vehicles at a third-party organizational and regulatory body level. It is particularly important that third-party organizations and governmental and regulatory bodies increase their collaboration, so that the different parties are familiar with the challenges at different levels. An overview of the literature is presented in Table 5.

Table 5. Third-party organizations and regulatory bodies.

Source	Findings
Newnam et al. [6] Newnam et al. [19] Nævestad et al. [18] Nævestad et al. [29] Grinerud et al. [5] Grinerud [9] Grinerud [25]	Increase collaboration with other stakeholders (i.e., governmental and regulatory bodies, NGOs, transport buyers and researchers).

3.2. Case Study

In the following, results collected from (1) interviewing an instructor and (2) observing actual driver training in module 5 in periodic training for professional drivers are reported.

The actual training in module 5 was conducted as shown in Table 6.

Table 6. Actual driver training module 5.

What	Who
Introductory conversation between instructor and driver	Instructor and driver in dialogue
60 min of driving	Driver active, instructor is a passive observer
Feedback conversation	Instructor and driver in dialogue
60 min of driving	Driver active, instructor active with clues and feedback on driving behavior
Feedback conversation	Instructor and driver in dialogue

The driving rounds of 60 min are exactly the same for both rounds. The driver is measured by explicit factors in both rounds, so that improvement can be registered. These factors are fuel consumption, speed, number of stops and time consumption. The overall aim is to drive optimally, defensively and safely, and it is proposed that these factors can serve to illustrate whether this aim is achieved or not. For example, if fuel consumption is lower in round two, this is most probably because the driving is better planned, and hence safer. Less stops in round two also indicate better planned driving and thereby more optimal and safe driving. Full stops with HGVs are time-consuming because it takes time to stop and accelerate heavy weight. Unnecessary stops increase time and slow down the overall speed. In addition, the professional instructors use their experience to assess whether the driving is optimal, defensive and safe. This includes whether speed is adjusted to the circumstances, distance to others and positioning on the road in general and in particular towards intersections or other similar situations. The results for 17 drivers (Table 7) showed a better score for almost every factor from round 1 to round 2.

An example could be Driver 17, who reduced their fuel consumption by 0.37 L, increased the average speed by 6 km/h, reduced the number of stops from 7 to 2 and reduced time consumption by 11 min. In addition, the professional instructor stated that the driving in round 2 was more optimal, defensive and safe due to the driver's improved planning of driving behavior.

Table 7. Results for safe driving training module 5.

Driver	Fuel Consumption (liters)			Average Speed (km/hr)			Number of Stops			Time Used (minutes)		
	Round 1	Round 2	Dif.	Round 1	Round 2	Dif.	Round 1	Round 2	Dif.	Round 1	Round 2	Dif.
1	1.17	1.12	0.05	46	49	3	7	3	4	63	58	5
2	2.1	2.0	0.1	45	45	0	4	2	2	63	62.5	0.5
3	3.54	3.62	0.08	44	45	1	1	1	0	66	64	2
4	1.33	1.29	0.04	47	48	1	5	1	4	63	62	1
5	2.2	2.1	0.1	43	45	2	1	1	0	66	64	2
6	4.24	4.19	0.05	45	48	3	3	2	1	64	62	2
7	1.09	1.07	0.02	46	48	2	2	2	0	61	58	3
8	2.3	2.1	0.2	45	45	0	8	3	5	63	62.5	0.5
9	1.35	1.35	0	50	51	1	6	1	5	60	58	2
10	4.03	3.77	0.26	46	46	0	3	1	2	62	62	0
11	3.81	3.68	0.13	41	44	3	4	3	1	68	64	4
12	3.54	3.31	0.23	43.6	44.6	1	7	0	7	65	64	1
13	3.53	3.0	0.53	36	43	7	9	5	4	75	63	12
14	1.28	1.26	0.02	42	49	7	6	0	6	70	60	10
15	1.15	1.05	0.1	41	48	7	10	2	8	70	61	9
16	3.34	3.14	0.2	37.8	43.2	5.4	5	2	3	76	66	10
17	3.85	3.48	0.37	37	43	6	7	2	5	74	63	11

4. Discussion

This study's first aim was to identify important factors to manage road traffic safety for work-related driving of HGVs. These factors were categorized into three groups: how management of road transport organizations' decisions could affect road traffic safety for work-related driving of HGVs on an organizational, driver and third-party level.

4.1. Important Factors to Manage Road Safety for Work-Related Driving of HGVs

The majority of the studies in the review see road traffic safety for work-related driving of HGVs as a complex phenomenon. This means that the driver is not solely to blame when a road accident involving an HGV occurs. A systematic approach to road safety for HGVs is essential. It is stated that third-parties such as governmental and regulatory bodies must develop and enforce laws and regulations in line with road transport organizations and driver challenges [6]. Other third parties such as buyers of road transport services must be made aware of their power to influence road safety and to set requirements that do not reduce safety levels [5,9]. The road transport organizations by which the drivers are contracted must facilitate good conditions for drivers. Pay and working hours must be acceptable, and it must be possible to implement routes without drivers having to break the law in terms of driving and resting times, etc. [18,27]. At the driver level, it is stated that accidents that can be related directly to unsafe driver practices are often a result of speeding, following too closely, frequent or rapid lane changes, unsafe braking and acceleration, driver distraction or inattention and failing to wear a seat belt [4,28].

The aforementioned factors should be easy to handle at each level. This means that when governments and regulators develop laws and regulations, these laws and regulations should make sense for those developing them. Road transport organizations should not face any challenges in terms of facilitating good conditions for drivers, since after all they are the ones hiring the drivers. However, a challenge for management of safety in this system is a lack of communication and collaboration between different parties in the system [1,9,27]. There is a need for parties to be aware of the challenges experienced by other parties at different levels of the system. Governments and regulators must develop laws and regulations that make sense for those who will be affected by these laws and regulations, namely road transport organizations, drivers, etc. Moreover, road transport organizations must facilitate good conditions for drivers, and the drivers must decide what good driving conditions are. As a consequence, all factors must be viewed in context, in order to manage road traffic safety for work-related driving of HGVs. Latent failure can only be detected if knowledge, competence and experience are shared between all parties in the system. Latent failures in this context refer to errors that may occur due to actions

and decisions made by management or others who are removed from the direct control interface. Such latent errors could, in the next step, lead to active failures. That is where the consequences are instantly visible, and where there is a clear relationship between cause and effect [30], for example when an HGV driver is involved in a road accident [31].

Based on the results of the literature review, empirical findings in the case study and previous research, this study proposes a framework for a safety training program for work-related driving with HGVs. In addition to improve driver skills, the framework also aims to increase communication and collaboration between different parties in the system of work-related driving with HGVs.

4.2. Safety Training

This study’s second aim was to propose a framework for a safety training program for work-related driving of HGVs.

A measure of/intervention to increase knowledge between parties at different levels could be joint safety training and education. Safety training, education and/or competence are highlighted as crucial to safety management in several studies, e.g., [3,9,15,16,32]. This could be seen as a surprising finding in this current literature review as previous research conclusions often highlight that driver education and training have little or no effect on road traffic safety [33,34].

Even though safety training and education are highlighted as important interventions in this literature review, there is little research to be found on the content of such safety training and education. Nævestad, Elvebakk and Phillips [4] come closest to suggesting content through their safety ladder, but this study is not specific concerning the content of safety training and education for parties in the system of road transport for work-related driving of HGVs. However, a very important statement in their study is about the complexity of the safety training. They highlight the importance of not making these programs too complex and resource-demanding. The reasoning behind this is the fact that the road transport industry is a low-earning industry, and there are few resources. Hence, complex safety programs will not be implemented due to the competition between safety and production goals.

An example of a complex safety program is the international standard ISO 39001: 2012 Road traffic safety (RTS) management systems—requirements with guidance for use. This standard is complex and demands numerous resources to implement. It is demanding for all road transport organizations to implement, in particular for small road transport organizations since they often have fewer resources to invest in safety programs.

The current study suggests a safety training framework directed towards decision makers and parties in the road transport system for work-related driving of HGVs (Figure 1). There is an aim that the safety training framework should also be possible to implement for smaller road transport organizations. Hence, it is constructed to be simple, effective and easy to implement with few resources. Consequently, the framework is not in competition with ISO 39001: 2012 Road traffic safety (RTS) management systems, but instead it aims to be a substitute targeting both small and large road transport organizations.

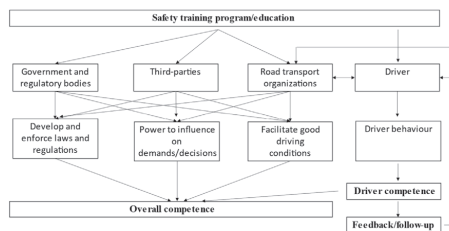


Figure 1. Safety training program.

The suggested safety training program is divided into two parts. One training program directed towards decision makers and parties at the higher levels of the system, and one training program directed towards drivers. The reasoning between this division is based on findings in the literature review. It is stated that communication between all parties in the system is important, to ensure familiarity with each other's challenges and opportunities [30,35]. Consequently, communication is a key component of the management of road traffic safety for work-related driving of HGVs. One intervention to increase communication could be joint safety training for every party in the system.

By developing a safety training program directed towards governmental/regulatory bodies, third-parties and road transport organizations, and customizing the content towards these parties, challenges and opportunities will be made known for every party. The challenges and opportunities experienced by each party are well-documented in the research literature, and the safety training content should be based on this. Most important is that each party is made aware of other parties' challenges and opportunities, and that collaboration and cooperation are presented as an important tool to increase road traffic safety for HGV businesses and drivers.

It is suggested that an arena where governmental/regulatory bodies, third-party organizations and road transport organizations can discuss with each other is established (Figure 1). In this arena, the different parties can present their area of responsibility as well as their challenges, e.g., regulatory bodies such as the NPRA present their concern(s) about what they detect during road traffic controls of HGVs. Road transport organizations (which own the HGVs) are given the opportunity to explain their concerns towards the same road traffic controls. By communicating to, and not against, each other, joint solutions for the challenges can be established. Furthermore, when the management of road transport organizations and buyers of road transport services communicate with each other to find solutions on time pressure, route planning, loading capacity, etc., it is assumed that challenges can be solved. By establishing such an arena for these parties, competence for each party will increase individually and as a group. Together, they will contribute to enhance the overall competence.

Finally, the actual transportation on the roads must be completed by competent drivers to minimize the possibilities of road accidents. Therefore, a safety training program aiming towards increasing the drivers' competence is of importance. In the following, a suggestion for such a training program is proposed.

4.3. Safety Training Program for HGV Drivers

4.3.1. Introduction

As a part of the European Union's road traffic safety work, a new directive related to basic and periodic training for professional drivers was implemented in all EU member states in 2008/2009 (EU directive 2003/59/EC). The directive concerns compulsory basic training of 280/140 h and periodic training of 35 h every 5 years [15]. The training consists of 5 modules. Modules 1–4 are mostly theoretical, with some practical tasks such as securing cargo, first aid, correct use of tire chains and correct use of fire extinguishers. Module 5 concerns the topic of 'safe behavior on the road' and consists of both theoretical classroom teaching and practical driving (EU directive 2003/59/EC). In the periodic training, most training centers spend an average of 28 h on modules 1–4 and 7 h on module 5, with around 2 h as practical driving with a professional instructor, where the aim is to drive optimally, defensively and safely [15].

A significant proportion (26.2%) of respondents in Elvebakk et al.'s study [16] completely agreed that they had improved their defensive driving skills after completing module 5. The current study therefore proposes a safety training program for HGV drivers based on two data sources:

- Post-training studies
- Results collected from actual driving training in module 5 as periodic training for professional drivers

4.3.2. Outcome

According to the research literature, follow-up on driver behavior is of great importance to managing road safety for work-related driving of HGVs [2,4,28,31]. By prioritizing follow-up on driver behavior, management can demonstrate their commitment to safety. The management also acknowledges company influence on and responsibility for speed and driving style [4]. When the research literature uses the phrase ‘follow-up’ concerning driver behavior, this mostly refers to such measures as self-monitoring facilitated by technology (e.g., on-board monitoring systems) and management monitoring and support. However, it should also be possible to suggest that driver behavior could be followed up more practically and more regularly than through periodic training every five years. The research literature therefore also highlights driver training as an important measure to increase road safety [3,15].

The current study proposes a framework for and the content of a safety training program for HGV drivers, based on module 5 ‘safe behavior on the road’ collected from periodic training for professional drivers and from the research literature (Table 8). The aim of this framework and content is to increase each driver’s knowledge and competence. This will increase the drivers’ opportunities to drive optimally, defensively and safely by making correct decisions while driving. Follow-up on driver behavior is stated to be an important measure to increase road safety for HGVs. Consequently, periodic training every five years will be too seldom to function as a follow-up on driver behavior. In addition, research shows that many transport organizations do not perform frequent follow-ups on driver behavior themselves [25].

Table 8. Safety training program for HGV drivers.

Time	Topic
Approximately 30 min	Theoretical discussion about optimal, defensive and safe driving
30 min	Driving round 1: Driving with a professional instructor. The instructor does not interfere with the driving. He/she solely observes the driving.
Approximately 15 min	Conversation between instructor and driver about the first round of driving. Which practice was optimal, defensive and safe driving and what are the potential areas for improvement?
30 min	Driving round 2: Exactly the same route is driven one more time. However, this time, the instructor gives the driver feedback, clues and advice directed at how to drive optimally, defensively and safely.
Approximately 15 min	Conversation between instructor and driver about the second round of driving. Were there improvements? Measures used to detect improvements could be: <ul style="list-style-type: none"> • Effectiveness (time spent on round 2 compared to round 1) • How many times the driver had to stop (due to lack of planning for situations or intersections) • Fuel consumption • Distance to others • Comfortable driving

The current study’s proposed safety training program for HGV drivers is proposed to be executed between the periodic training programs every five years. Once every 6–12 months is suggested, which makes it important that the safety training program is not too time-consuming. Consequently, the framework and content suggested could be executed over two hours. It is assumed that when the training is not too time-consuming,

more frequent execution of the program within each road transport organization will be possible. In between the execution of the safety training programs, it is proposed that drivers be followed up through on-board systems and dialogue with supervisors. The practical safety training program is proposed to be organized as outlined in Table 8.

For this safety training program to work, each road transport organization must educate supervisors/professional instructors. These individuals plan and schedule execution together with each driver. In this way, the program could be executed while the drivers are at work performing their regular jobs. Consequently, the resources needed to execute the program would be kept at a minimal level.

4.3.3. Limitations

This study does present some limitations. First, the number of articles included in the literature review was relatively low ($n = 22$). However, the articles included tended to describe similar challenges. It is therefore assumed that the literature review reveals the overall picture. The study was limited to factors that affect the management of road traffic safety on an organizational, third-party and driver level. Consequently, technical and mechanical factors have not been identified. Moreover, factors such as roadway geometric design and specific traffic control measures were not emphasized in this study. The reasoning behind this limitation is that the focus of the study has been on the management and their decisions at the above-mentioned levels. Second, the framework and content of the proposed safety training program were not empirically tested. It is proposed that the program should be empirically tested in future studies.

4.3.4. Implications and Further Research

It is assumed that the proposed safety training program will increase communication and collaboration between all parties and thereby enhance road traffic safety for work-related driving of HGVs. As a consequence of safer road transport, it is also assumed that minor damage to vehicles and equipment will decrease. Consequently, implementation of the proposed training program will reduce road transport organizations' costs related to accidents and minor damages and the safety training program could provide a financial gain for the organization. However, more research should be conducted. It is suggested that a practical study of how the program functions within a road transport organization should be conducted.

5. Conclusions

This study's research questions were: (I) What are important factors to manage road traffic safety for work-related driving of HGVs? (II) How can an overall framework for safety training be arranged to enhance road traffic safety for work-related driving of HGVs? By using literature review as a method, important factors to manage road traffic safety for work-related driving of HGVs were identified. These factors were categorized at different levels in the system of road transport safety. This revealed the important factors for management of road traffic safety at the governmental level, third-party level, organizational level and driver level.

Developing and enforcing laws and regulations in line with road transport organizations and driver challenges was categorized as the most important factor at the governmental and regulatory levels. At the third-party level, the factor highlighted as important was these parties' power/opportunity to influence safety and set requirements. An important factor highlighted at the organizational level was the facilitation of good conditions for drivers. Lastly, at the driver level, skilled and experienced drivers were highlighted as important to manage road traffic safety. Most important, however, is that a systematic approach to road traffic safety for HGVs is essential. This means that every party is jointly responsible, and parties must communicate and work together to increase road traffic safety for work-related driving of HGVs.

By developing a safety training program for all parties in the system, the current study proposed a method for increased communication, collaboration and cooperation between the parties. A safety training program directed towards parties at the higher levels of the system, as well as a safety training program directed towards HGV drivers, were proposed. It is assumed that by executing a joint safety training program for parties at the higher levels of the system, parties will gain more knowledge and insight into each other's challenges and opportunities. When such knowledge is held, it is assumed that each party will be more capable of viewing things from another perspective, consequently becoming more solution-oriented. The safety training program for HGV drivers was developed with the aim of increasing HGV drivers' knowledge and competence. This will enhance the drivers' opportunities to drive optimally, defensively and safely by making correct decisions while driving.

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Appendix A

Table A1. Studies included in the review.

Study (Country)	Sample/Method	Aim of Study	Main Result	HGV Road Safety Factors
Grytnes et al. (2016) Denmark, [8]	Participant observation Semi-structured interviews	Analysis of heavy goods vehicle (HGV) drivers' and managers' differentiated understandings of risk and safety and management within an organizational context.	Drivers have individual attitudes towards safety, although they frequently share knowledge with other drivers. The companies' structure shapes this individual thinking towards safety. Risk-taking is prevalent among HGV drivers, and the management of such risk is one's own responsibility.	Increase communication between drivers and between drivers and management. Implement safety rules with a collectivistic approach.
Nævestad et al. (2018) Norway, [4]	Systematic literature review	Develop an organizational safety management (OSM) strategy for small road transport companies.	Identified a set of evidence-based organizational safety measures that fulfill five criteria. The measures have been arranged on a 'safety ladder'. The companies start at the bottom before proceeding to the next step.	Work systematically with management of safety. Follow-up on drivers' speed, driving style and seat belt use. Focus on work-related factors' influence on traffic safety.
Li and Itoh (2014) Japan, [16]	Questionnaire survey	Develop a safety climate scale for the trucking industry.	Significant correlations with safety outcome measures were identified for several safety climate factors. A good safety climate contributes positively to safety performance.	Continuous assessment of safety climate. Increase willingness to engage in teamwork. Implement safety management system (SMS), including safety training.
Mooren et al. (2014) Australia, [3]	Questionnaire survey	Identify differences in management characteristics between companies with good and poor safety records, using vehicle insurance claim.	Low-claiming companies (good performing) were smaller, did more safety-related checking, checked accident history at recruitment, paid drivers for all time worked and monitored driver work and workload. High-claiming companies conducted more safety training and had more safety policies.	Monitoring drivers instead of safety training. Implement safety management system (SMS) that is suitable for the company's size.
Thompson et al. (2015) Australia, [23]	Simulated transport system (STS) using the NetLogo ABM platform (Wilensky, 2013)	Determine whether agent-based modelling may be usefully applied to explore the effect of driver payment methods on driver fatigue and crash risk.	Drivers operating under 'per-km' and 'per-trip' piece rate incentive systems were significantly more likely to drive while fatigued, with the subsequent occurrence of all associated issues (loss of license, increased crash risk, increased fines), than those paid under 'flat-rate' wage conditions.	Implement 'flat-rate' payment for drivers.

Table A1. Cont.

Study (Country)	Sample/Method	Aim of Study	Main Result	HGV Road Safety Factors
Newnam and Oxley (2016) Australia, [32]	Case study	Describes a new and innovative conceptual framework for a program designed to improve work-related driver safety. The focus of this program is on developing the skills of supervisors in identifying situations in which their drivers may be at risk on the road (e.g., drivers are tired, stressed, or under pressure to meet deadlines) and in managing these situations through effective safety leadership.	The program develops the key, yet largely unrecognized, safety management skills of supervisors using developmental techniques, including 360-degree feedback, behavioral self-monitoring, leadership coaching and communities of practice.	Implement training program for managers of the drivers.
Nævestad et al. (2015) Norway, [18]	Mixed methods—Document analysis and interview	This report outlines the results of a study of severe road traffic accidents in Norway, triggered by drivers at work. The aim has been to examine whether and to what extent risk factors of these types triggering drivers and their vehicles can be traced back to work-related factors.	The quantitative analysis of AAG data shows that excessively high speeds for the circumstances, failure to use a seat belt and insufficient information gathering were the most important risk factors in fatal accidents triggered by drivers at work. The qualitative analysis of reports from AIBN and expert interviews uncovered the following work-related factors considered central for traffic safety: follow-up of drivers' speed, driving style and use of seat belt, pay systems, safety culture, risk assessments, procedures/ work descriptions and training. The AIBN reports and the interviews indicate that the following framework conditions influence traffic safety: time pressure, competition, type of transport and accident investigations/inspections. Most of the interviewees held that work-related factors with potential implications for traffic safety are insufficiently monitored in controls and inspections.	See the drivers as the company's responsibility. Implement safety management system (SMS).
Warmerdam et al. (2017) Australia, [24]	Semi-structured interviews	Use a benchmarking tool developed by the National Road Safety Partnership Program to assess industry maturity in relation to risk management practices.	Overall, the results demonstrated varying levels of maturity of risk management practices across organizations, highlighting the need to build accountability within organizations, improve communication practices, improve journey management, reduce vehicle-related risk, improve driver competences through an effective workplace road safety management program and review organizational incident and infringement management.	Implement risk management practice.
Newnam et al. (2017) Australia, [19]	Document analysis	Efforts to understand crash causation should be focused beyond the driver and identify contributing factors at other levels within the road freight system.	There was a lack of evidence to suggest an understanding of system-based reform based on the identification of reductionist-focused recommendations. It is concluded that researchers and practitioners (i.e., government and industry) need to work together to develop prevention efforts focused on system reforms. Systems-thinking-based data collection and analysis frameworks are urgently required to help develop this understanding in road freight transportation.	Implement systems-thinking in the organization. Collaborating with others (i.e., transport buyers, regulatory bodies).

Table A1. Cont.

Study (Country)	Sample/Method	Aim of Study	Main Result	HGV Road Safety Factors
Newnam et al. (2017) Australia, [26]	Interviews	Explore the role of high-performance workplace systems (HPWS) in influencing safe driver behavior.	HPWS practices are not designed or implemented with consideration of the safety of drivers. Organizations with employees that need to drive for work should integrate driver safety within the broader Occupational Health and Safety (OHS) System.	Build organizational culture with both a top-down and bottom-up approach.
Dawson et al. (2014) Australia, [20]	Literature review	Critically review currently available and emerging fatigue technologies.	Fatigue detection technology has the potential to improve management of fatigue in transportation companies. However, the effectiveness must be documented through studies providing converging evidence. This is not the case at the current time.	Implement fatigue management system (levels 1–5).
Phillips et al. (2017) Norway, [22]	Literature review	Review fatigue-related risk and exposure factors and control measures for operators of land- and sea-based transport forms.	Review 13 types of measures identified for the monitoring or control of fatigue risks, and two systematic measures needed to anchor risk mitigation in safety management systems (SMS), organizational learning and training.	Implement fatigue management system in the companies' SMS.
Nævestad et al. (2018) Norway, [27]	Literature review	Map interventions that can be used to develop good safety culture in transport companies and assess expected effects of interventions on safety culture and safety outcomes, and identify factors influencing safety culture change.	Safety culture interventions seem to be effective, but they are often comprehensive and resource-demanding.	Focus on developing a good safety culture.
Mooren et al. (2014), [17]	Literature review	Collate the evidence concerning safety management characteristics or practices that produce demonstrable differences in injury rates and other safety improvement indicators and reveal which characteristics or practices these effects have.	Found limited research that provides the beginning of an evidence base for a set of safety management characteristics that have been associated with improved safety outcomes. However, some characteristics have evidence from many studies supporting their preliminary inclusion in a safety management system (SMS) suitable for heavy vehicle transport operations (management commitment, safety training, scheduling and journey planning).	Implement safety management system. Safety training.
Luke and Heynes (2014) South Africa, [28]	Literature review and case study	Identify the riskiest driver behaviors in commercial fleets in South Africa. Determine the business impact of such behavior and establish a framework for the management of such behavior.	Risky incidents were significantly reduced on implementing a driver risk management system (DRMS).	Monitor driver performance and behavior. Analyze risky driving events. Implement measures (i.e., coaching).
Newnam and Goode (2015) Australia, [6]	Rasmussen's accimap technique is applied to the analysis of road freight transportation crashes. Thematic analysis used to identify factors and relationships	Capture the complex system of factors influencing road transport crashes by applying Rasmussen's risk management framework and associated accimap technique.	System approach can increase knowledge. A reductionist view of crash causation does not tell the whole story.	Increase collaboration between the transport company and others (i.e., transport buyers and regulatory bodies).
Grinerud (2021) Norway, [9]	Interviews	Explore how buyers of road transport services can contribute to safe road transport of goods in northern Norway and through this become important parties in reducing fatal traffic accidents.	Buyers of road transport services can contribute to safer road transport by emphasizing 5 factors: (1) develop detailed formal contracts with road transport organizations, (2) use new technology, (3) evaluate their decision criteria for ordering road transport, (4) good communication and (5) be aware of how knowledge and trust in a transport organization could affect judgement regarding revisions and controls.	Put more responsibility for safe road transport on buyers of road transport services. Increase collaboration between buyers of road transport services and road transport organizations.

Table A1. Cont.

Study (Country)	Sample/Method	Aim of Study	Main Result	HGV Road Safety Factors
Grinerud, Aarseth and Robertsen (2021) Norway, [25]	Interviews	Investigate how management decisions can affect road transport organizations' ability to develop a good safety culture.	Road transport organizations that choose a low-cost strategy struggle to be profitable. Moreover, such strategies lead to high rivalry between organizations. Such rivalry makes it difficult to be profitable, so there are fewer resources available to invest in building a good safety culture. In contrast, road transport organizations that choose a differentiation or focused leadership strategy are more likely to be profitable. As a consequence, they have more resources to invest in building a safety culture.	Management commitment and resources must be available to develop a good safety culture in road transport organizations.
Nævestad, Phillips, Levin and Hovi (2017) Norway, [29]	Analysis of personal injury accident data and survey	Examine the safety outcomes of increasing internationalization in Norwegian road transport of goods and discuss the importance of potential risk factors related to increasing proportions of foreign HGVs on Norwegian roads.	Foreign HGVs have a three times greater risk of single-vehicle accidents and twice the risk of head-on collisions. They are also more likely to trigger fatal accidents. Two risk factors are highlighted as important: experience with Norwegian roads and winter driving.	Foreign drivers need more experience and education in driving on Norwegian roads (especially winter driving). Buyers of road transport services need to take more responsibility for hiring competent drivers.
Elvebakk, Nævestad and Lahn (2020) Norway, [15]	Document analysis, case studies and survey	Evaluation of the mandatory periodic training of professional drivers in Norway.	In many ways, the periodic training is a success. Considerable numbers of students report that they have acquired new knowledge and changed their driving practice.	Education and training as a tool for safer road transport.
Nævestad, Blom and Phillips (2020) Norway, [2]	Interviews and survey	Validate the safety ladder approach [4] in empirical research by comparing safety structure, safety culture and accident risk for trucking companies. The study has four aims: (1) to map the safety structure at the different levels of the safety ladder, (2) examine whether safety culture is improved with increased structural measures at each safety ladder level, (3) examine whether the accident risk decreases at each safety ladder level and (4) discuss practical implications.	Based on interview results, increasing structural safety measures for the companies at each level of the safety ladder are registered. Survey results indicate increasing safety culture scores at each level of the safety ladder, while the accident risk decreases. The study concludes by suggesting the concrete management practice related to each level as good practice, as these seem to be related to the increases in safety culture and decreases in accident risk.	Safety commitment of managers and employees. Follow-up on driver behavior. Focus on work-related factors' influence on traffic safety. Safety management system.
Grinerud, Sætren and Aarseth (2020) Norway, [5]	Interviews	Discuss how buyers of road transport services can contribute to sustainability and safety in the chain of transport and to the Vision-Zero Ideology.	Findings indicate that buyers of road transport services have an impact on both sustainability and safety in the chain of road transport, by exerting influence through pricing and delivery demands.	Transport buyers must set requirements for the road transport they order, be willing to pay for safe road transport and be aware of how their delivery demands have an impact on driver behavior.

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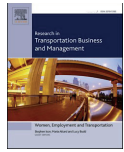
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Leadership strategies, management decisions and safety culture in road transport organizations

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ABSTRACT

In Norway, approximately 688 people are injured each year in traffic accidents involving heavy goods vehicles (HGVs), and for every third road fatality there is an HGV involved. Norway has approximately 35% more fatalities per inhabitant resulting from accidents involving HGVs compared to the rest of Europe. These numbers suggest that interventions are needed to reduce road accidents involving HGVs in Norway. This paper contributes to the field of road transportation research by identifying how strategic management decisions can affect road transport organizations' ability to develop a good safety culture. Semi-structured interviews with 16 participants were conducted. The findings suggest that road transport organizations that choose a low-cost leadership strategy struggle to be profitable. Moreover, such strategies lead to high rivalry between organizations. Such rivalry makes it difficult to be profitable, hence there are fewer resources available to invest in building a good safety culture. In contrast, road transport organizations that choose a differentiation or focus leadership strategy are more likely to be profitable. As a consequence, they have more resources to invest in building a safety culture.

1. Introduction

Road traffic accidents rank as the eighth leading cause of death worldwide, accounting for 2.2% of all deaths globally. Every year, 1.35 million people are killed in traffic accidents, with an average of more than 3000 traffic deaths a day worldwide. In addition, 20 to 50 million people are injured or disabled in traffic accidents (World Health Organization, 2018). In Norway, a country with approximately six million people, several years of systematic work on road safety has led to a decrease in road accidents involving fatalities and severe injuries. In 1970, there were 570 fatalities and 4552 severe injuries caused by road traffic accidents. These numbers have decreased to 108 fatalities and 565 severe injuries in 2018 (Statistics Norway, 2020). However, compared to the rest of Europe, Norway has approximately 35% more fatalities per inhabitant from accidents involving heavy goods vehicles (HGVs) (Langeland & Phillips, 2016). On average, approximately 688 people are injured in traffic accidents involving HGVs each year, and for every third road fatality, there is an HGV involved (Langeland & Phillips, 2016). These numbers suggest that interventions are urgently needed to reduce road accidents involving HGVs in Norway (Ministry of Transport and Communications, 2017).

One challenge for managing the safety of HGVs is the increasing amount of domestic and international road transport in Norway. The national transport performance (million tons-km driven) by domestic road transport organizations has increased from 16,979.4 million tons-km in 2012 to 19,389.4 million tons-km in 2019 (Statistics Norway, 2021a). In addition, national transport performance by foreign road transport organizations has increased from 6984.9 million tons-km in 2021 to 8787.7 million tons-km in 2019 (Statistics Norway, 2021b).

The mere presence of HGVs in the road environment increases the potential for accidents with severe injuries. However, it is not to say that HGV drivers are solely to blame for these accidents. The scattered location of businesses and strong economic growth have contributed to the increased use of HGVs on roads, many of which have numerous bends and can be characterized as typical countryside roads - namely, narrow roads without separate driving lanes that are poorly suited for frequent HGV road transport (Langeland & Phillips, 2016). This can make safely transporting goods on roads challenging.

However, research has established that a good workplace safety culture in road transport organizations has the potential to reduce road crashes (Grytnes, Shibuya, Dyreborg, Grøn, & Cleal, 2016; Mooren, Grzebieta, Williamson, Olivier, & Friswell, 2014; Nævestad, Bjørnskau,

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Hovi, & Phillips, 2014; Nævestad, Elvebakk, & Phillips, 2018; Nævestad, Hesjevoll, & Phillips, 2018; Nævestad, Phillips, & Elvebakk, 2015; Newnam, Warmerdam, Sheppard, Griffin, & Stevenson, 2017; Njå & Fjelltnun, 2010). That notwithstanding, more focus is needed on the significance of safety culture for transport safety (Nævestad, Blom, & Phillips, 2020).

While previous research has highlighted the different types of leadership strategies organizations can implement to gain competitive advantages (Porter, 1992; Porter & Kramer, 2006; Reitsperger, Daniel, Tallman, & Chismar, 1993), as well as the different attributes they need to consider when developing a safety culture (Reason, 1998; Reason & Hobbs, 2017), no one has specifically addressed how leadership strategies support and/or constrain safety culture in road transport organizations. Thus, this paper aims to fill this knowledge gap by exploring existing road transport organizations' strategies. This paper contributes to the field of road transportation research by investigating how management prioritization and choice of strategies can affect profitability and safety in road transport, thereby addressing how management decisions can affect road transport organizations' ability to develop a good safety culture. Thus, the research question for this article is as follows: *Which leadership strategies support and/or constrain safety culture in road transport organizations?*

In the following paragraphs, an overview of the term *safety culture*, followed by a short presentation of *leadership* and *general strategy*, is given. Thereafter, a detailed explanation of *competitive strategies* and the different approaches that road transport organizations can implement to increase their competitive advantages are presented, followed by a presentation of the methods used in this paper, the results and a discussion. Finally, a conclusion is provided prior to a complete listing of all references.

1.1. Safety culture

Safety culture is a term used by many researchers, authors, and experts in different fields, with different definitions having been applied. Essentially, safety culture describes the underlying nature of an organization's approach to safety (Hughes, Newstead, Anund, Shu, & Falkner, 2015), which is shaped by people within and outside the organization through organizational structures and social relationships (Şimşekoglu & Nordfjærn, 2017). Safety culture is a shared safety-relevant way of thinking and acting that is (re)created through the joint negotiation of people in social settings (Nævestad, Hesjevoll, & Phillips, 2018). As such, a safety culture is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behavior that determine an organization's commitment to health and safety management and the style and proficiency of that management (Safety of Nuclear Installations in Li & Itoh, 2014).

In organizational safety culture a distinction is often made between functionalist (top-down) and interpretive (bottom-up) approaches (Glendon & Stanton, 2000; Grytnes et al., 2016). A functionalist approach assumes that organizational culture exists as an ideal to which organizations could aspire (Glendon & Stanton, 2000). Functionalist scholars tend to focus on formal aspects of organizational safety, namely structures, practices, controls and policies (Nævestad, Hesjevoll, & Phillips, 2018). An interpretive approach assumes that organizational culture is a complex phenomenon of social groupings with shared beliefs and values (Grytnes et al., 2016) comprising the beliefs, attitudes and values of the organization's employees regarding safety focus (Nævestad, Hesjevoll, & Phillips, 2018). In road transport organizations there is a need to consider both approaches to safety culture.

In the road transport industry, there are some challenges affecting the organizations' ability to develop a good safety culture, such as the framework conditions and fierce competition in the industry (Nævestad, Hesjevoll, & Phillips, 2018). Road transport organizations consist of several employees (drivers) working outside the physical boundaries of the workplace (Newnam & Goode, 2015). This limits the possibility of a

solely functionalist (top-down) approach because direct employer or supervisory control is limited (Huang et al., 2013). However, the drivers are often seen as individualists who are taking responsibility for their own work and are free to make own decisions (Grytnes et al., 2016). As a result, the drivers develop knowledge and skills that affect their possibility to influence the general safety work within the organization. In this sense, to develop a safety culture throughout all positions in the organization, all workers need to be aligned with the rest of the organization. This involves taking an interpretive approach (bottom-up) to building a good safety culture. Reason and Hobbs (2017) state that safety culture can only be improved if all members in the organization are included in the process and dedicated to improving safety.

In order to develop a good safety culture within an organization, the importance of the management's prioritization of safety is important, and this is well documented in the literature. Mooren, Grzebieta, et al. (2014) state that the management's commitment to safety can affect all levels of incident and injury risks. Newnam et al. (2017) highlight that effective safety leadership has a positive influence on supporting safe road transport. In a recent study (Nævestad, Elvebakk, & Phillips, 2018), management's commitment to safety is highlighted as a prerequisite for a road transport organization's safety work to succeed. Management must support the safety measures adopted by the organization and communicate that they are important to their employees. Otherwise, it is unlikely that the employees will turn the measures into everyday practices. In other words, if management's commitment to safety is low, employees are less likely to consider safety work important, thereby decreasing the organization's ability to improve safety as a whole.

A challenge for management to prioritize safety is seen when safety goals conflict with other organizational imperatives such as profitability (Newnam et al., 2017). In businesses where resources are low, as in the road transport industry, safety goals and profitability goals make competing demands (Rasmussen, 1997). Although building a good safety culture is resource demanding, so is ignoring it. An Australian study states that drivers of HGVs have one of the highest rates of serious occupational injury (Mooren et al., 2014). Seen together with the numbers from Norway, that for every third road fatality there is an HGV involved (Langeland & Phillips, 2016), it is clear that accidents are resource demanding for road transport organizations in terms of drivers being injured and unable to do their job, HGVs needing repairs, higher insurance claims, etc. A good safety culture within an organization is assumed to decrease such incidents and thereby increase road safety in general (Nævestad et al., 2020).

To develop a good safety culture, there are certain attributes an organization needs to consider. In particular, Reason and Hobbs (2017) emphasize that members of an organization must be aware of the hazards in their workplace and expect that people and equipment can fail. They must have collective mindfulness of the things that can go wrong. Such mindfulness could be a challenge when most of an organization's employees work outside the physical boundaries of the workplace. Research has shown that in order to create a safety culture, the culture must have five attributes: informed culture, just culture, reporting culture, flexible culture, and learning culture (Reason & Hobbs, 2017). *Informed culture* means that management and employees must have knowledge about the risk factors across the entire system. In the safety context, human, technical, organizational, and environmental factors can create a risk for safety. In road transport organizations, this means that management and employees must be aware of risk factors, not only within the boundaries of the workplace but also on the road and at loading/unloading sites. *Just culture* means that it is acceptable to experience failure yet crucial to report errors and near mistakes so that the organization can learn from them. *Reporting culture* refers to the need to report errors and near mistakes. Indeed, since most of road transport organizations' work is done outside the physical boundaries of the workplace, organizational members must trust each other to report errors and near mistakes in order to manage the risk factors. When organizations are aware of why, where, and when risk factors occur, they can

change routines/guidelines and possibly avoid those areas/times where and when risks occur. Finally, a safety culture consists of a *flexible culture*, which refers to learning from errors and near mistakes so that the whole system can be improved instead of focusing on standalone fixes. It is essential that every member of the organization learn from such errors and mistakes – *learning culture* (Reason & Hobbs, 2017).

1.2. Leadership and general strategy

Leadership and strategy are key factors that influence an organization's ability to compete in a market. To execute leadership, at least three social conditions must exist: (1) there must be a group of two or more people; (2) the group must work on a common task; and (3) group members must have differentiated responsibilities (i.e., members must have different duties) (Stogdill, 1950). All of these conditions are present in road transport organizations (and in all other organizations), and the leader is the person who is differentiated from other organizational members by his or her influence over goal setting and goal achievement for the organization (Stogdill, 1950). Therefore, leadership can be defined as “the process of influencing an organization in its efforts towards achieving an aim or goal” (Johnson, Whittington, Scholes, Angwin, & Regné, 2011).

However, in the road transport industry, workers' performance is often difficult to see because drivers work outside the physical boundaries of their organizations. This limited visibility makes executing leadership challenging in these organizations (Zohar & Luria, 2005) because management must lead workers and implement any needed changes from afar.

Nevertheless, the leaders of such organizations must make decisions regarding the direction they want to go, which affects employees working both inside and outside the physical boundaries of the workplace. For road transport organizations, such decisions could include how they recruit their customers, how they educate their drivers, how they prioritize safety work, and so forth. Together, these decisions shape an organization's overall strategy.

Strategy has been defined in several ways throughout the years. One definition describes strategy as “the long-term direction of an organization” (Johnson et al., 2011), and another describes it as “the determination of the long-run goals and objectives of an enterprise and the adoption of courses of action and the allocation of resource necessary for carrying out these goals” (A. Chandler in Johnson et al., 2011). In this paper, these definitions can be seen as the general definition of strategy, but a more precise definition of competitive strategy (as presented in the next section) is useful for answering this paper's specific research question.

1.3. Competitive strategy approaches

In this study, where the aim is to explore how different strategy choices influence road transport organizations' ability to build a safety culture, Porter's definition of strategy is relevant. Porter claims that business decisions are only strategic if they involve doing something different than one's competitors: “Competitive strategy is about being different. It means deliberately choosing a different set of activities to deliver a unique mix of value” (M. Porter in Johnson et al., 2011).

Porter (1992) emphasizes that organizations' strategic choices play an important role in their ability to be competitive in markets—that is, to be profitable. Organizations can be competitive in markets (i.e., develop a competitive advantage) by taking one of two main approaches: a low-cost strategy or a differentiation strategy. For the low-cost approach, organizations recruit customers by delivering a product or service at the lowest possible cost, whereas for the differentiation approach, they offer a product or service with especially high quality (Reitsperger et al., 1993). These two approaches to developing a competitive advantage leads to three different generic strategies to achieve above-average results in an industry: low-cost leadership,

differentiation leadership, and focus leadership (Porter, 1992) (Table 1).

When a road transport organization chooses low-cost leadership as a long-term strategy, the organization focuses on achieving the lowest production costs in its industry (Porter, 1992). An example of achieving this in the road transport industry is using equipment and vehicles over a longer period of time and/or carrying out the road transport of goods for the lowest price. If the organization succeeds in achieving and maintaining the lowest costs, it will receive above-average results and be the cost leader in the industry. However, the pitfall is whether the organization's customers perceive its service or product as comparable with those of other organizations. If not, the organization may have to lower its price well below average to win customers. The strategic logic underlying low-cost leadership usually means that only one organization can be the cost leader in an industry. In the road transport industry, several organizations compete to obtain this position. Thus, the high rivalry between road transport organizations leads to low profitability for the entire industry in both the short and long term (Porter, 1992). This low profitability can make it difficult for these organizations to prioritize safety work within their organizations. Indeed, small road transport organizations are particularly susceptible to this risk given their limited resources (Nævestad, Elvebakk, & Phillips, 2018) Without enough resources (e.g., skilled and motivated drivers, competitive equipment, assets, etc.), it could be difficult for these organizations to invest in building a better safety culture.

Reason and Hobbs (2017) state that a good safety culture drives an organization toward safety goals regardless of commercial pressure and that management has a strong influence on prioritizing safety. However, inadequate resources can have a significant impact on this prioritization. Specifically, when many workers work outside the physical boundaries of road transport organizations, safety management is much more challenging because the cost of technology to monitor workers' behavior in such “remote contexts” is rather high. As a result, many organizations do not invest in safety but instead focus on productivity and efficiency (Zohar & Luria, 2005).

By choosing differentiation as its long-term leadership strategy, an organization seeks to excel in the industry in which it operates (Porter, 1992). The organization seeks to gain a competitive advantage by incorporating highly desirable and sought-after attributes into its product or service. Such attributes can involve the level of service the organization provides, its delivery systems, and so forth. While the means for differentiation are distinct for each industry, the strategic logic underlying the differentiation strategy demands that organizations differentiate themselves on attributes their competitors overlook or ignore.

Today, the pressure for organizations to incorporate sustainability principles and objectives into their policies and activities is mounting (Aarseth, Ahola, Aaltonen, Økland, & Andersen, 2017), and increasingly more road transport organizations are concerned with this matter. Using more environmentally friendly equipment and vehicles (e.g., electric HGVs and cargo bicycles) is an example of a strategic differentiation decision in the road transport industry. However, in order to succeed with such a differentiation strategy, the costs of delivering unique attributes must not exceed the differentiation costs, and customers must perceive the organization's offering as something truly unique. Otherwise, the organization will not be able to charge more for the product or

Table 1
Approaches and generic strategies.

Approaches	Generic Strategies	Competitive advantage
Low-cost Strategy	Low-cost leadership	Compete in the market by delivering a product or a service at the lowest possible cost
Differentiation Strategy	Differentiation leadership	Compete in the market by offering something unique/special
	Focus leadership	Compete in the market by focusing and specializing on a certain aspect

service than competitors (Porter, 1992). As an example, focus on safety could be a differentiator that makes an organization excel in the industry.

The last generic strategy is focus. By choosing focus as its long-term leadership strategy, an organization seeks to compete in a small area (Porter, 1992). The organization chooses a small segment or a group of customers within an industry and aligns its strategy toward this segment or group. Transporting dangerous goods is one example of this strategy in the road transport industry. Road transport organizations that carry dangerous goods must have special equipment, vehicles, and competence to do so, and they direct their resources toward this segment (i.e., dangerous goods). By doing so, they compete in a smaller market than those competitors that do not have a focus strategy, thus increasing their likelihood of achieving higher profitability and having more resources available for investing in safety. The focus strategy has two variants such that road transport organizations can choose to seek cost-related benefits or differentiability benefits within their specific segments or groups. Most industries have different segments, and some segments have special demands, like transporting dangerous goods. These demands provide opportunities for choosing a focus strategy (Porter, 1992).

Porter (1992) emphasizes that an organization must choose between these three strategies. They are inconsistent with each other and cannot be combined. Organizations that engage in all three (or even two) strategies will not succeed in becoming profitable and will consequently have fewer resources to invest in safety and safety work. Hence they will not gain a competitive advantage as they will fail to compete with organizations that have implemented just one of these strategies (Porter, 1992).

However, there are some counterarguments to Porter's (1992) argument about these three strategies being inconsistent with each other. For example, Reitsperger et al. (1993) state that none of the firms in their study used a single-focus strategy aligning with Porter's model. Similarly, Hill (1988) states that pursuing differentiation could be a way to achieve a low-cost position in an industry. Further, some industries do not have one unique low-cost position, so it is possible to pursue both low-cost and differentiation and still be profitable. Both Reitsperger et al.'s (1993) and Hill's (1988) view can be recognized in some road transport organizations as some organizations do not focus on one single strategy. Instead, they carry out different types of transport assignments and build different types of expertise within their organizations, leading them to be profitable.

Regardless of the strategy used, organizational size could play a role in the development of a safety culture. On one hand, it could be argued that it is easier for larger organizations to prioritize safety as they are more competitive and have more resources to invest in safety (Nævestad et al., 2015). However, this claim presupposes managers' and employees' commitment to safety, which earlier research suggests is a prerequisite for organizations' safety work to succeed (Li & Itoh, 2014; Nævestad, Elvebakk, & Phillips, 2018; Newnam & Oxley, 2016; Reason, 1998). On the other hand, it could be argued that smaller companies have an easier time connecting with their employees and thus have more success implementing safety work even though these organizations often have fewer resources available (Nævestad et al., 2015; Newnam, Lewis, & Watson, 2012).

2. Method

The following section describes the research design, research participants, data collection, and data analysis method used in this paper.

2.1. Design

This study is qualitative and takes a constructivistic approach as its ontological position. Research has shown that the reality of a phenomenon under study is affected by the context and the people connected to this reality (Jacobsen, 2005; Postholm & Jacobsen, 2018). For this

study, this means that management and employees in the road transport industry are affected by their circumstances and that their reality is in constant change, for example, from new government regulations, changing demands from their customers, and shifting economic status. In other words, "reality as it actually is" changes and develops over time (Bryman, 2016). Therefore, the findings from this study present an image of the reality in this industry seems at this moment in time, but they do not try to explain this reality as absolute (Bryman, 2016).

This study takes a hermeneutic epistemological approach. This approach was chosen because the aim of the study was to gain insight into participants' own experiences and meanings of the phenomena and because the researchers described and interpreted these experiences and meanings in the context of the phenomena (Fejes & Thornberg, 2009).

Data was collected through semi-structured interviews with participants from both road transport organizations and the government. This data-collection method was chosen because the study seeks to get in-depth knowledge about how leadership strategies affect safety and safety culture in road transport organizations. To obtain such knowledge, it is essential to gain insights into the experiences and meanings of people who are familiar with the phenomena (Langdridge & Hagger-Johnson, 2009).

2.2. Study participants and recruitment

Participants were recruited through a combination of convenience sampling, purposive sampling, and snowball sampling (Bryman, 2016). A *convenience sample* is simply available by chance to researchers. In this study, several participants were recruited through a member organization for owners of road transport organizations. Thereafter, *purposive sampling* was conducted by choosing participants who were relevant to the research question. Participants were chosen based on two explicit inclusion criteria: to be chosen, the individual (1) had to be a leader of a road transport organizations that carried goods with vehicles with a total weight capacity above 7500 kg and (2) had to have at least one driver as an employee. Finally, participants were selected through *snowball sampling*. Participants who were involved in the study recommended new participants who were included because of their expertise regarding the research question (Bryman, 2016). These individuals included employees of the Norwegian Public Road Administration (NPRA), Norwegian Police, and organizations with high credibility in the road transport industry as well as researchers/authors in the road transport field. Employees of NPRA were included as participants in this study because of their extensive knowledge of laws and regulations regulating the road transport industry. Also, NPRA employees, as well as police officers, meet numerous of HGV drivers and road transport organizations through their supervisor and control tasks e.g., in traffic controls along the road and in controls of road transport organizations. This gives these participants knowledge and experience of the road transport industry that were of value for this study.

In total, the sample included 16 participants (Table 2), of whom nine were leaders of road transport organizations and seven were experts in the field. All participation was voluntary, and all the interviewees agreed to participate after being told about the project and reminded that they were able to withdraw at any time. The study was approved by the Norwegian Centre for Research Data (NSD).

2.3. Procedure and data collection

The study is limited to interviewing participants in road transport organizations situated in the middle part of Norway. This group of participants was chosen due to the high number of road transport organizations in this area and travel-related challenges for the research team. By geographically narrowing the research area, it was possible to conduct the interviews in four months. In addition to the interviewees from the road transport organizations, interviews with experts in the field were conducted. Most of these expert interviews were conducted

Table 2
Participants.

Participants	Position	Gender	Numbers of drivers employed	Expertise
Participant A	Leader	Male	< 10	
Participant B	Leader	Male	< 10	
Participant C	Leader	Male	> 60	
Participant D	Leader	Female	30	
Participant E	Leader	Male	35	
Participant F	Leader	Male	< 30	
Participant G	Leader	Male	15	
Participant H	Leader	Male	> 90	
Participant I	Leader	Male	> 100	
Participant J	COO	Male		Transport regulations
Participant K	Governmental department leader	Male		Crime in transportation
Participant L	Author	Male		Transport regulations
Participant M	Senior advisor governmental position	Male		Transport regulations
Participant N	Police officer	Male		Transport laws and regulations
Participant O	Police officer	Male		Transport laws and regulations

outside the mentioned geographical boundaries because these individuals' workplaces were in other locations.

The interviews were mainly carried out by two or three researchers in face-to-face settings. Each interview lasted for 45–60 min, and each was recorded and transcribed. A semi-structured interview guide was used, so it was possible to cover similar themes across the different interviewees. The semi-structured interview guide included different topics, but in this study, only topics dealing with the companies' leadership strategies are included. After interviewing 13 participants, little new information connected to the study's research question was obtained. However, three more interviews were conducted to ensure that assumption was correct.

2.4. Measures

A semi-structured interview guide consisting of open questions was developed prior to the interviews. Questions were primarily formulated to answer the study's research question—*What leadership strategies support and/or constrain a safety culture in road transport organizations?* However, the first questions were about making the interviewees comfortable in the interview setting (Jacobsen, 2005) by allowing them to talk freely about their organizations and their interest in the topic. During the entire interview, the researchers concentrated on allowing the interviewees to talk, only interrupting if there were follow-up questions. An example of the interview questions is presented in Table 3.

2.5. Analysis

Data analysis was conducted in accordance with Braun and Clarke (2006) thematic analysis. The analysis was conducted in several phases. The first phase involved becoming familiar with the dataset, while the second phase included generating initial codes. These codes identified features of the data that appeared interesting and could be assessed in a

Table 3
Example interview questions.

Open question	Follow-up question
Can you tell us about your organization?	What type of customers do you have? What type of transport do you carry out? What are the factors that constrain and/or support your safety work?
Which factors affect your workdays?	How do regulations/laws/systems affect your workdays?
How do you perceive the safety culture in your organization?	How can you work to create a better safety culture?
How do you maintain your drivers' competence and skills?	Do you provide your drivers with more education than what is mandatory?

meaningful way in relation to the phenomena (Braun & Clarke, 2006). In this phase, the researchers continuously looked for patterns to organize the dataset in order to answer the research question. For example, the researchers highlighted when the participants talked about their relationships with customers and then sorted these instances into one category (i.e., one code). The third phase was conducted after finalizing the initial coding. This phase involved sorting the different codes into potential themes and collating all the relevant coded data within the themes. The goal was to group codes into themes such that the themes captured something important in relation to the research question (Braun & Clarke, 2006). For example, quotes regarding road transport organizations' relationships with customers was categorized into sub-themes like "customers recruited by offering the lowest price" and "customers recruited by offering a specialized form of transport." These themes were identified in a theoretical (deductive) way, meaning that the analysis was driven by the motivation to gain knowledge about the organizations' possible leadership strategies and how these strategies affect safety and safety culture within the organizations. Further, the themes were identified on a latent (or interpretive) level, meaning that the researchers sought to identify the underlying ideas and assumptions of the data. Thus, for latent thematic analysis, themes are developed through interpretation (Braun & Clarke, 2006). The fourth phase involved refining the themes, which entailed aggregating several sub-themes into four main themes.

An example of the analysis process is illustrated in Table 4. The list of codes is not exhaustive.

The analysis resulted in the following main themes: (1) Strategies for road transport assignment, (2) strategies for personnel, (3) strategies for equipment selection, and 4) strategies for legality. A complete

Table 4
Overview of the analysis process.

Main themes	Sub-themes	Codes (examples)
Strategies for road transport assignments	Recruit customers by offering the lowest price	Good communication with customers
	Recruit customers by specializing and being innovative	Long-term contracts Few/many customers
Strategies for personnel	Education and training	Education is looked at as a cost
	Safety management system	Education looked at as an asset Seldom provide systematic education and training Management does (not) follow up on driver behavior New/old vehicles
Strategies for equipment selection	Vehicles Customized equipment for cargo	
Strategies for legality	Following laws and regulations	Willingness to take chances
	Perceptions about control systems (e.g., governmental systems)	

presentation of the results is provided in Section 3.0.

3. Results

The empirics shows that there are some main factors that can support and/or constrain the development of a good safety culture in road transport organizations. These factors are influenced by choices the management makes for different decisions—that is, their strategic choices. In the following, the interview data is presented. The statements presented solely sum up the meanings of the participants of this study. An overview of the main- and sub themes are presented in Table 5.

3.1. Strategies for road transport assignments

The participants in this study highlighted that to work toward a better safety culture within road transport organizations, resources (e.g., skilled and motivated drivers, assets to invest in courses/education, up-to-date vehicles and equipment, etc.) must be available. It was stated that these resources are only available if organizations are profitable. The participants agreed upon that the type of road transport assignment an organization has is important in this regard. It is stated that there are two main ways of recruiting customers to get road transport assignments: 1) by offering the lowest price and 2) by specializing and being innovative.

3.1.1. Recruiting customers by offering the lowest price

Several of the participants explained that they recruit customers by offering the lowest price. Most of these road transport organizations are in competition with other road transport organizations to get transport assignments—namely, driving tenders. The organization that offers to execute an assignment for less money, wins the tender. As one interviewee noted, “If you don’t calculate the absolute lowest cost you can, you will not get the tender, and you are out of business” (Interviewee B).

The empirics show that organizations that compete for such tenders are typically involved in long-distance road transport, asphalt paving, or snow plowing. Some of the participants highlighted that industry newcomers need customers and that competing in such tenders often provides them with customers to start their business. These newcomers often have few HGVs and less equipment, which means they can offer a low price to execute transport assignments. It was stated that this practice could make it difficult for existing road transport organizations to win such tenders.

All participants involved in long-distance road transport highlighted the challenge of competing with foreign road transport organizations to get transport assignments. Foreign road transport organizations often offer lower prices to get assignments, and Norwegian road transport organizations must match these offers.

Regarding transport assignments like asphalt paving or snow plowing, the participants again stated that organizations that offer the lowest price generally get assignments. The entities that order such assignments are often price-sensitive county councils or municipalities. As one of the interviewees put it, “The state, county council, or municipality is often the principal, and they chase their expenses. They do that independently

even if it affects safety” (Interviewee C). The participants, especially the experts, also stated that there are plenty of road transport organizations that are willing to take assignments even if doing so brings low earnings, so this action is rather stable.

Another challenge the participants mentioned is that organizations that compete for driving tenders are often the last link in a road transport chain. This means that for each transport assignment, there is a principal that has a contract with a customer but hires sub-contractors to carry out the actual transport. It was stated that this practice leads to very low profitability for the sub-contractors as they are the last ones in the road transport chain. For example, one participant stated, “There have been some challenges when we have driven for transport centrals. The central takes a provision of the assignment and doesn’t care if we earn money or not on the transport” (Interviewee B).

3.1.2. Recruiting customers by specializing and being innovative

Some of the participants are very selective in which customers they want in their portfolio. They highlighted the importance of customers who are willing to pay for safety and quality and acknowledge their drivers. For example, one interviewee explained, “We have decided to not execute some specific road transport assignments, for example, the transport of salmon. That kind of transport puts too much pressure on our drivers” (Interviewee H). It was stated that transporting salmon in Norway often requires long-distance driving and time pressure as the transport must make it to the airport by a certain time to load the salmon on board an aircraft for export. It was also highlighted that by not carrying out such road transport assignments, the organizations avoid competition with foreign road transport organizations, which most of the interviewees stated is a major cause of low earnings in the industry.

The interviewees stated that instead of competing to get assignments by offering the lowest bid, they compete on other criteria, such as specialization, innovative solutions, and high-quality driving and delivery. They prioritize carrying out specific types of road transport assignments. An example provided by the participants are organizations that are specialized in only transporting dangerous goods. Such transport demands special HGVs, equipment, and competence, which these road transport organizations provide. By specializing within this field, organizations have a limited number of customers (e.g., customers in the oil business). It was stated that these types of customers are generally very concerned with safety and have a good safety culture within their own organizations. Therefore, they also tend to apply their safety focus when their goods are being transported. It was specifically highlighted that such customers put demands on how road transport organizations carry out transport assignments. As one of the experts noted, “We seldom find errors in the transport of dangerous goods. This is because the big oil and gas firms demand quality from the ones who execute the transport” (Interviewee M).

Other road transport organizations recruit customers with innovative thinking and solutions. For instance, some of the participants are testing electric HGVs and bicycles. These participants highlighted their concerns about environmental issues and wanted to contribute to more environmentally friendly road transport. Also, some participants highlighted the importance of specializing in different transport assignments in order to have work throughout the year. For example, one interviewee said, “We carry out transport of fuel (dangerous goods), food, and different kinds of waste” (Interviewee H).

It was highlighted that, because their organization carry out different types of road transport assignments, drivers can switch between different transport assignments. The participants highlighted this ability to switch assignments as a big advantage because drivers do not become bored and seldom quit their jobs. This was assumed to make it easier to build a safety culture within the organization because there are seldom new drivers to train.

Further, the participants that were recruiting customers by specializing and being innovative highlighted the importance of customer relationships, especially having an open dialog with customers outlining

Table 5
Overview of main- and sub themes.

Main Theme	Sub theme
1) Strategies for road transport assignments	Recruiting customers by offering the lowest price Recruiting customers by specializing and being innovative
2) Strategies for personnel	Education and training Safety management systems
3) Strategies for equipment selection	
4) Strategies for legality	

that deliveries and travel/work times must maintain safety. The participants particularly emphasized strong communication and trust with customers. For example, one participant explained, "We have transported our clients' goods for 25–60 years. Our contracts are good, and we have trustful relationships with our clients" (Interviewee D).

Overall, a common factor amongst participants that were representing road transport organizations that recruit customers by specialization and innovative solutions is that they can turn down assignments that are not profitable.

3.2. Strategies for personnel

The importance of stable employees on long-term contracts were stated as essential for building a safety culture within road transport organizations. Related to this strategic decision, some of the participants highlighted the importance of education and training and following up with driver behavior as crucial factors in this matter.

3.2.1. Education and training

It is stated by some of the participants that road transport organizations that experience time pressure and low earnings often experience challenges with offering systematic education and training above what is mandated by regulations.¹ With regard to mandatory training every 5 years it was highlighted that this was not enough. That additional and more frequent personnel meetings being internal, or external, and containing theoretical or practical courses should also be provided. Since the content of such meetings were suggested to be both theoretical and or practical, both regulatory issues and culture development knowledge could be combined. By regulatory issues the participants refer to gaining knowledge about new laws and regulations, internal guidelines on loading and unloading routines or but not least customer management. By culture development participants refer to developing a uniform understanding of the organization, challenges and internal practices. All of which were mentioned to develop a good safety culture.

Education and training were often viewed as expensive and time consuming, thus many road transport organizations do not prioritize these activities given their lack of resources. For instance, one interviewee explained, "I don't have any system for education and training. I take it little at a time. Maybe not so good at this. I see that I could have done things differently, but we haven't had any accidents in many years, only small things" (Interviewee G).

Some interviewees stated that the mandatory education every driver must receive every five years is enough to maintain competence. However, other interviewees stated that systematic and frequent education is not only important for safety; it also motivates employees and leads to closer relationships between employees. In such cases, the barrier for employees to reach out to each other for advice and help is lowered. One interviewee said it like this: "It has to do with attitude. The seriousness in what we are working with. I always say, without education and training, everything will stop" (Interviewee I).

Some participants also mentioned that by prioritizing education and training, organizations will get the best drivers, and the best drivers know how to solve difficult challenges and when to stop driving if circumstances demands for it. It was highlighted that such behavior tends to lead to fewer near misses and accidents, and that organizations that prioritize educating their drivers regularly experience lower costs for repairs and maintenance on vehicles and equipment. As one interviewee

put it, "The driver is the boss. If he/she says that the transport cannot be executed according to plan, we listen" (Interviewee I).

Several participants stated the importance of giving the drivers responsibility and trusting that they are competent to make the right decisions. However, it was also stated that in order to have such trust, management must be sure drivers have the competence and skills required.

3.2.2. Safety management systems

Several of this study's participants stated that road transport organizations that are concerned about safety in road transport are also generally concerned about becoming more systematic and certified. They find it important to certify their organizations according to industry standards. For instance, one interviewee said, "We are ISO certified according to four standards: quality, environment, work-place safety, and traffic safety. It is a lot of work to stay certified, but it is not more than we have to" (Interviewee I).

Participants in smaller road transport organizations stated that it can be too resource demanding to become certified according to ISO standards. However, they are still aware of the importance of using systems to monitor their performance, and they find monitoring driver behavior to be helpful in their safety work. One interviewee explained his organization's approach: "We use Dynafleet and Scaniafleet active. We follow up on driver behavior and organize regular meetings with the drivers to discuss the results from the fleet system. This is seen as a positive thing by the drivers" (Interviewee D). In addition to fleet systems, there was also widespread use of systems that register deviations in driving, loading, and unloading routines.

3.3. Strategies for equipment selection

As stated above, personnel strategy is of importance when it comes to recruiting and keeping employees. In addition, the participants emphasized that the choice of equipment also influences the attractiveness of organizations. In a road transport market that lacks drivers, it is difficult to find competent drivers. The interviewees stated that in addition to providing education and training, road transport organizations must provide drivers with the best equipment. As one participant put it, "By letting the drivers choose their favorite vehicle, get new tires every autumn, and get the right equipment to do the job, I get satisfied drivers who take care of it all like it was their own" (Interviewee A). The participants further explained that providing new vehicles and customized equipment contributes to motivating drivers and that motivated drivers tend to stay with the organization.

Some interviewees stated that serious buyers of road transport services set demands on what kind of equipment road transport organizations must provide. For instance, some customers set demands that all vehicles must be equipped with systems that do not allow the driver to start the vehicle if he/she has been drinking alcohol. Further, some require that all vehicles have cruise control, anti-lock brakes, lane-keeping assistance, and so forth, while others also set demands on how much a vehicle can pollute. Some participants stated that all of these demands often are mandatory, and if a road transport organization does not fulfill these demands, it will not get transport assignments from these customers.

3.4. Strategies for legality

The participants agree that the road transport industry generally has low profitability. It is stated that, to survive as an organization in this pressed market, some are willing to "bend" rules and regulations set by the government. One interviewee said it like this, "On average, long-distance road transport has a net income result around 3–5%. So, if they can come up with some smart things to do to save some money and get a competitive advantage over their competitors, some will do that. For example, work longer hours or overload the vehicle" (Interviewee

¹ Directive 2003/59/EC of the European Parliament and of the Council of 15 July 2003 on the initial qualification and periodic training of drivers of certain road vehicles for the carriage of goods or passengers, demands that drivers must undergo 35 h of training every fifth year. The content of the training are both theoretical and practical. Hereby, amongst other, training in driving time and rest period, loading/unloading of cargo, accident preparedness and safe/optimal driving.

K). According to some of the experts, the chance of being caught breaking the rules is small, especially if the road transport assignment is mainly local driving. One interviewee mentioned timber transport as an example. Often such transport is carried out locally on small roads with a weight limit. Organizations that overload their vehicles on these roads can carry more each trip and consequently make more money than those that adhere to the load limit.

Few interviewees from the road transport organizations were willing to talk about their own practice in this matter. However, all the experts in the field commented on this practice and spoke about it as a big challenge for safety.

4. Discussion

This study’s aim was to examine which leadership strategies support and/or constrain safety culture in road transport organizations. After analyzing the data using thematic analysis (Braun & Clarke, 2006), four final themes were uncovered: 1) strategies for road transport assignments, 2) strategies for personnel, 3) strategies for equipment selection, and 4) strategies for legality.

The empirics in this study shows that there are different ways road transport organizations get their transport assignments: I) by recruiting customers to transport their goods for a lower price than other road transport organizations, II) by specializing in certain types of road transport or III) by focusing on certain niche markets in the industry.

Road transport organizations that operate in markets in which competition revolves around offering the lowest price tend to struggle to be profitable. Porter (1992) emphasizes that only one organization can be the lowest-cost provider in a market. However, in the road transport industry, several organizations compete against each other to win assignments by providing the lowest price/bid. This competition often leads to high rivalry between organizations, thus threatening the profitability of the entire industry. Indeed, such rivalry has arisen in certain markets in the road transport industry (e.g., in long-distance driving, asphalt paving, and snow plowing). These are markets where the competition is high. There are many providers, both domestic and international road transport organizations, competing on the same assignments.

As a consequence of not being profitable, it seems challenging to develop a good safety culture within the organization. This is because the struggle of being profitable competes with safety goals (Newnam et al., 2017). Instead of having resources available to invest in developing a good safety culture, resources must be spent on getting new assignments. This could constrain developing a good safety culture as building one demands that resources are invested, both in the short and long term. For example, having a clear and concise strategy regarding investments in equipment is difficult when resources are low. Hence, equipment and vehicles are used for a longer period of time, resulting in road transportation without sufficient equipment/vehicles. Moreover, low profitability tempts road transport organizations and their drivers to take chances regarding legality, for example, by overloading their

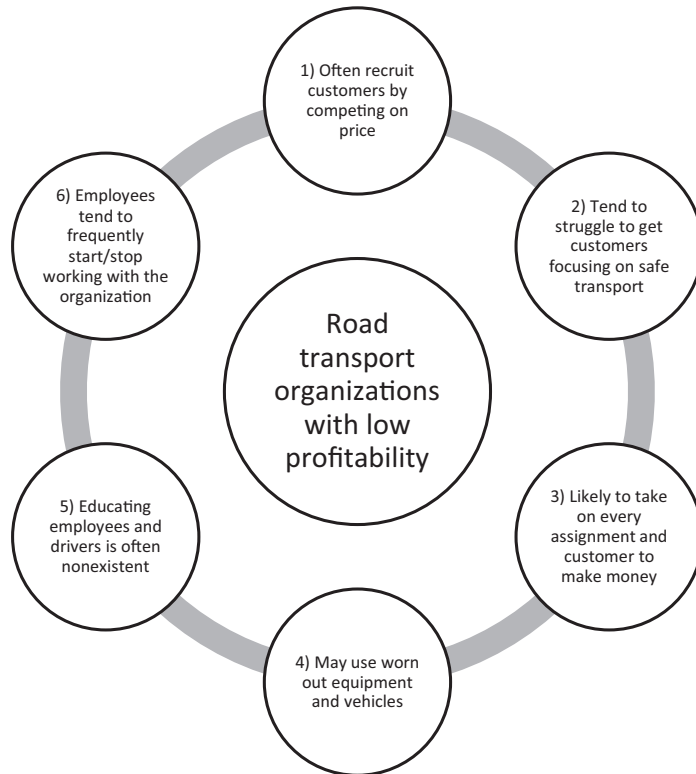


Fig. 1. Negative spiral for road transport organizations with low profitability.

vehicles and driving too many hours in order to make more profit. In this sense, low profitability is likely to capture a road transport organization in a negative spiral regarding developing a good safety culture. An example of such spiral is shown in Fig. 1.

Road transport organizations that deliberately try to differentiate themselves to gain a special position in their market are more likely to be profitable and hence have resources to invest toward developing a good safety culture, such as those that specialize in certain types of road transport or focus on certain niche markets in the industry. In this study, the participants that claim they have a unique market position tend to choose their road transport assignments and customers wisely. Instead of competing with a low-cost strategy, they focus on different niche markets in the industry, including transport assignments that require special equipment and competence (e.g., the transportation of dangerous goods, heavy steel for special operations, timber, cranes, etc.). The participants explained that even though this kind of transportation demands greater investments in equipment and drivers, the organizations who take on such investments are typically more profitable. Porter (1992) emphasizes that for an organization to succeed with a differentiation strategy, it must differentiate itself on attributes its competitors ignore or neglect. Such differentiation may seem like a challenge in road transport, as the aim is to simply move something from one place to another. However, one way an organization can differentiate itself in the transportation industry is by becoming an expert in a special type of road transport. Another way is to invest in innovative solutions and offer customers something unique, such as transport with

electric vehicles or bicycles in urban areas. This type of differentiation is likely to be even more important in the future when more organizations incorporate sustainable principles and objectives into their practices (Aarseth et al., 2017).

Another reason road transport organizations with differentiation and focus strategies are more profitable could be their customers' attitude. This study's participants noted that customers of organizations that implement these strategies tend to demand safety in the transportation of their goods. Therefore, they are willing to pay more to have their goods safely transported by drivers who are educated and equipment that is suitable. This is in accordance with a recent study, stating that buyers of road transport services are an important actor for safer and more sustainable road transport (Grinerud, Sætren, & Aarseth, 2020). In this sense, a profitable road transport organization often creates a positive spiral regarding developing a good safety culture. An example of such spiral is shown in Fig. 2.

In addition to which leadership strategies road transport organization chose to recruit customers, this study highlights the importance of leadership strategies regarding personnel. In a recent study by Nævestad et al. (2020) it is stated that the work to develop a good safety culture starts immediately when people are hired. It is essential to communicate the norms that apply in the organization and involve employees in the process of building a good safety culture. This is in accordance with several of the participants in this current study. They highlight the importance of investing in the employees, both in terms of organized and un-organized communication, education, and training. As for

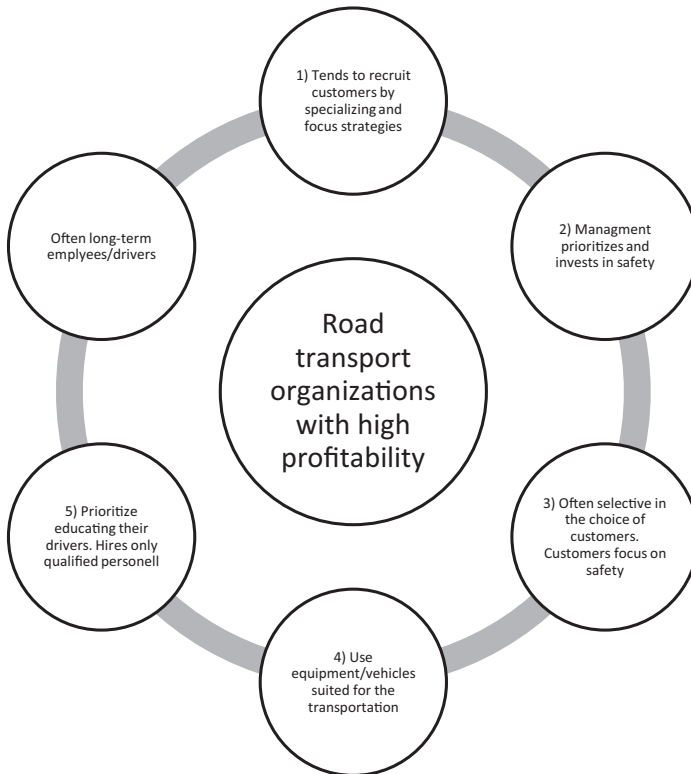


Fig. 2. Positive spiral for road transport organizations with high profitability.

organized communication, safety management systems are highlighted as an example. Safety management systems are seen as important because it allows management (and the driver) to gain insight into driver behavior and provides possibilities to implement the right measures in the right place. This could contribute to developing a learning culture, which Reason and Hobbs (2017) emphasize as a key attribute of a good safety culture. As for organized education and training, regular frequent meetings/courses (both theoretical and practical) are viewed as a motivating factor to keep employees (drivers) employed. It is highlighted as important to have long-term employees in order to develop a good safety culture in the organization. Frequent education/training are also considered attractive to recruit new employees. Joint discussions about risk awareness between management and employees are also considered important. In general, the management's commitment to safety is critical to developing a good safety culture (Newnam et al., 2017). This current study's participants highlight the importance of applying both a top-down and bottom-up approach to developing safety culture; it is just as crucial that the management has knowledge about the employees' (drivers) everyday challenges as it is for employees (drivers) to know about managements' everyday challenges. Reason and Hobbs (2017) emphasize that such discussions create an informed culture, another key attribute of a good safety culture.

4.1. Limitations

While this study provides insights into how strategic choices affect safety culture in road transport organizations, it also has some limitations. The study's participants are mainly from the middle part of Norway. We chose these participants because of the high number of road transport organizations in this area and their willingness to contribute to the study. We acknowledge that the results could have been different if the participants were from other areas of Norway or from another country. However, the road transport industry throughout Norway is experiencing the same challenges, so we decided to concentrate on participants from the middle part of Norway.

This study's results mostly focus on processes that are in road transport organizations' external environment (e.g., how the management recruit customers and employees) while the theoretical framing of strategy and safety culture mainly emphasizes intra-organizational processes. It could be a limitation of the study that the theoretical framework does not focus more on the processes in the organization's external environment. However, it is the assumption that intra-organizational processes (e.g., management's decisions) are affected by the organizations' external environment that lies behind this rationale.

It can also be a limitation of the study that only management level and experts in the field are participants. It could be the case that some arguments would be different if drivers were included as participants. However, the aim of the study was to discover which leadership strategies support and/or constrain safety culture in road transport organizations. Therefore, the focus has been on the management level and experts in the field: the management level because they make the choices and decide on organizations strategy, and experts in the field because they could shed light on the management's decisions.

5. Conclusion

The aim of this study is to answer the following research question: *Which leadership strategies support and/or constrain safety culture in road transport organizations?*

After analyzing the empirics, four main categories were uncovered. These categories entail how road transport organizations recruit their customers and get transport assignments, choose their personnel, select equipment, and perceive laws and regulations. These categories ultimately reveal how road transport organizations prioritize and make decisions—that is, how they *set their strategies*.

By choosing a low-cost leadership strategy (Porter, 1992) - in this context, recruiting customers by offering the lowest price - road transport organizations struggle to be profitable. More specifically, this strategy leads to high rivalry between organizations, which makes it difficult to be profitable and hence have resources available to invest in developing a good safety culture. Indeed, any available resources are likely to be used to get new assignments, not to develop a good safety culture. As such, it is reasonable to argue that in the road transport industry, a low-cost leadership strategy constrains organizations' ability to develop a good safety culture.

Road transport organizations that implement a differentiation or focus leadership strategy (Porter, 1992) compete in their market by specializing in specific transport assignments or by being innovative and offering something unique to their customers. They do not compete on the lowest bid, and therefore earn more profit that can be directed toward safety (e.g., investing in their employees). Their customers also set demands, including safety demands, that they must fulfill to get assignments. These factors lead these organizations to prioritize buying new equipment, educate their drivers, and meet customer demands. Hence, by choosing one of these strategies, organizations have the potential to become profitable and can thus focus more on developing a good safety culture.

It may seem like customers can push for road transport organizations to develop a good safety culture. Customers that include road transport in their own product chains are more likely to believe that safe road transport costs money. That is, by starting to include the actual transport of their goods in their production chains, customers are likely to begin choosing their transport organizations with more concern. Indeed, while there will always be both serious and unserious road transport organizations, to decrease the number of unserious organizations, customers must be aware of their social responsibility in safe road transport. Thus, further research should focus on road transport customers' responsibility in this matter.

Author agreement

First author, Katrine Grinerud, state, on behalf of all authors, that all authors have seen and approved the final version of the manuscript being submitted. Grinerud warrant that the article is the authors' original work, hasn't received prior publication and isn't under consideration for publication elsewhere.

Declaration of interest

None.

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Road Transport Safety in Northern Norway: How Buyers of Road Transport Services Can Contribute to a Road Transport with fewer Accidents and Near-misses*

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Abstract. This paper contributes to filling a knowledge gap by presenting new research within the practical field of road transport. It takes the buyers of road transport services as its point of entry and seeks to answer the follow question: How can buyers of road transport services contribute to safe road transport in northern Norway? A qualitative approach was selected for this study, and semi-structured interviews were conducted with six different buyers of road transport services. By using a modified version of The Pentagon Model, different aspects were analyzed in order to identify organizational characteristics and qualities that will improve the possibility for buyers of road transport to contribute to a safer road transport in Northern Norway and thereby contribute to fewer accidents and near-misses. The following characteristics and qualities were identified: 1) the importance of developing a detailed formal contract with the provider of road transport; 2) being aware of the possibilities with new technologies; 3) understanding that the decision criteria for ordering transport can influence road transport safety; 4) seeing the importance of good communication with both the transport organization and the authorities; 5) recognizing that knowledge of and trust in a transport organization is important but could also affect judgement regarding revisions and controls. This study suggests that buyers of road transport services can contribute to a safer road transport in northern Norway by emphasizing these five characteristics and qualities.

Keywords: *heavy goods vehicles, road transport safety, buyers of road transport services.*

Introduction

In January 2019, in the northern part of Norway, a young man died in a traffic accident involving an HGV (Heavy goods vehicle). The weather conditions were variable, with wind and precipitation in the form of snow. The young man was on his way back to school in a passenger car after celebrating Christmas with his family. Driving in the opposite direction was a Lithuanian HGV. The HGV was travelling at a speed of 88 km/h at the time of impact. The tires on the trailer were considered unsuitable for driving on snow and ice-covered roads, and the driver had not fitted the tires with snow chains at the time of the accident. The driver lost control of his trailer, which strayed into oncoming traffic. Approximately two and a half months after the accident, the young man died as a result of the injuries he sustained in the collision¹.

This chronicle is one of several severe accidents that occur between foreign HGVs and passenger cars in the northern part of Norway. The above-mentioned accident has, however, been of considerable importance in drawing attention to this predicament.

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¹ Accident Investigation Board Norway. Thematic report on serious accidents involving heavy goods vehicles: Framework conditions for ordering goods transport by road. AIBN report 2020/02. URL: <https://havarikommissjonen.no/Vei/Avgitte-rapporter/2020-02-eng> (accessed 25 August 2020).

Research shows that foreign drivers only account for 6 % of the average domestic transport in Norway, but they account for 11% of the HGVs involved in personal injury accidents. Furthermore, foreign HGVs are three times more likely to cause single vehicle accidents and twice as likely to be involved in head-on collisions. In addition, they seem to be more likely to trigger fatal accidents [1, Nævestad T.-O., Phillips R.O. et al. pp. 16–19]. In the years 2014–2018, HGVs were involved in 140 accidents with casualties in Norway. 34 (24%) of the accidents involved foreign HGV drivers, and these drivers were the triggering party in 10 (7%) of the accidents. Moreover, in 2010–2013, foreign HGV drivers were the triggering part in 58% of the accidents with casualties ². These numbers indicate that there has been a decrease in accidents where foreign drivers have been the triggering part; however, to achieve further decline, new interventions and measures must be put into place.

For new interventions and measures to apply foreign road transport organizations and drivers, it must be possible for Norwegian authorities to control and monitor them. This in order to ensure that foreign road transport organizations and their drivers meet Norwegian demands and standards for road transport with HGVs. Relatively new research in this field shows that: 1) management's commitment to safety is of importance regarding the organization's accidents rate [2, Mooren L., Grzebieta R. et al., pp. 86–88, 3, Newnam S., Warmerdam A. et al.]; 2) safety/driver training is associated with a reduced crash and accident risk [2, Mooren et. al.]; and 3) pay systems may negatively influence safety outcomes [3, Newnam et. al.; 1, Nævestad et.al., pp. 16–19]. These findings are important to address with interventions and measures, but regarding foreign drivers and organizations, it is unlikely that the Norwegian authorities can regularly control and monitor such factors, in particular, that concerning safety and driver training.

It is difficult to predict the future, but the amount of domestic and foreign road transport is unlikely to decrease in the years to come. It is therefore essential to put new interventions and measures into place. Forecasts for the years 2015–2030 indicate a 25% growth in traffic along Norwegian roads. Moreover, it is expected that the growth of HGVs will be significantly higher than for passenger cars. If new interventions are not implemented, there could be an increase of 175 people involved in deaths and severe injuries in 2030 compared to 2015 ³ To counteract this presumed development, The Ministry of Transport and Communications has highlighted concrete measures directed towards HGVs and their organizations. Research supports that new measures should be directed towards the HGV industry and emphasizes that there is a need to look deeper into the underlying causes of accidents involving HGVs [4, Newnam S. and Goode N., 5, Njå O. and

² Ministry of Transport and Communications. Veitrafikkulykker med tunge kjøretøy involvert [Roadtraffic Accidents involving Heavy Vehicles]. Report 2019. URL: <https://www.regjeringen.no/contentassets/ec3cbab7ecef413bbe00888f3ba8f8cf/veitrafikkulykker-med-tunge-kjoretoy-involvert.pdf> (accessed 27 August 2020).

³ Meld. St. 33 (2016-2017) (2017). National Transport Plan 2018–2029. Oslo: Ministry of Transport and Communications. URL: <https://www.regjeringen.no/en/dokumenter/meld.-st.-33-20162017/id2546287/> (accessed 27 August 2020).

Fjelltun S.H., 6, Nævestad T.-O., Phillips R.O. et al., 7, Grytnes R., Shibuya H. et al., 8, Nævestad T.-O., Elvebakk B. et al., 9, Nævestad T.-O., Hesjevoll I.S. et al.]. Traditionally, interventions intended to decrease accidents involving HGVs have often been directed at the individual level (driver-level). However, newer research emphasizes the importance of taking a more holistic and systematic approach to this matter [4, Newnam S. and Goode N., 10, Larsson P., Dekker S.W.A. et al.].

Therefore, in order to contribute to the research field of transportation safety, this study expands the view of possible actors that could affect safe road transport and through this takes a more holistic view of road transport safety. This study will accordingly take the perspective of those actors that purchase road transport assignments — that is, the buyers of road transport services. This study will explore how buyers of road transport services can contribute to safe road transport of goods in northern Norway and through this become important actors in reducing fatal traffic accidents. More specifically, knowing that foreign drivers might lack experience driving in severe weather conditions, which often appear in northern Norway, and drive vehicles not suited for that environment [1, Nævestad T.-O., Phillips R.O., 11, Langeland P.A. and Phillips R.O.], this study focuses on those who hire foreign road transport organizations to transport their goods to/from northern Norway. There has so far been little research that takes this approach, thus this study aims to contribute by filling this knowledge gap.

Road transport in Northern Norway

In the Northern part of Norway, there is, amongst others, two challenges that could especially affect the safety of road transportation: the scattered locations of businesses and the road environment [11, Langeland P.A. and Phillips R.O.]. The road environment consists of conditions such as challenging topography, vast mountain areas, deep fjords and adverse climatic conditions [12, Bardal K.G., p. 49]. In the years 2015–2019, 28 individuals were killed and 213 were injured in accidents involving HGVs in the northern part of Norway⁴.

There are many businesses in need of road transport in northern Norway. As an example, salmon farming is one of the largest industries in this region, and it has considerable road transport needs. One of this study's interviewees, who represents a large salmon farm, stated that their need for transport was approximately 6000 HGVs each year. The amount of salmon slaughtered in 2018 illustrates this need for road transport. In 2018, 551,000 tons of salmon were slaughtered. This accounts for 43 percent of the Norwegian volume of salmon and approximately 20 percent of total world production⁵. The road transport of salmon is mainly and mostly carried out by foreign road transport organizations and their drivers, according to this study's interviewees. Research indicates that there is a specific challenge associated with foreign road users who

⁴ Statistics Norway. Trafikkulykker med personskaade [Traffic Accidents with human injuries]. (2020). URL: <https://www.ssb.no/transport-og-reiseliv/statistikker/vtu> (accessed 28 August 2020).

⁵ Nordland Research Institute. Nord-Norge er en "supermakt" for oppdrett av laks [Northern Norway is a "Superpower" for Salmon Farming]. (2019). URL: <https://www.kbnn.no/artikkel/nord-norge-er-en-supermakt-for-oppdrett-av-laks> (accessed 28 September 2020).

lack experience in navigating narrow roads with high gradients/many curves and winter driving conditions [1, Nævestad et al., p. 4] yet it is just these circumstances that characterize the road environment in northern Norway in general, and even more specifically the road environment surrounding Salmon farms as they are mostly scattered across rural areas.

This notwithstanding, instead of exploring interventions and measures directed towards these foreign road transport organizations and their drivers, this study focuses on the buyers of road transport services in Norway. By setting demands on the foreign road transport organizations and their drivers, it is assumed that the buyers of road transport services in northern Norway could play an important role in positively affecting safe road transport [1, Nævestad T.-O., Phillips R.O., 13, Grinerud K., Sætren G.B. et al.]. Norwegian laws and regulations do, to some extent, impose responsibility on buyers of road transport services in this matter.

Regulations directed towards buyers of road transport services

There are currently some regulations that are directed towards buyers of road transport services and their responsibility when placing an order. These regulations are at best unclear and difficult to determine, especially for new actors in the industry. They are not to be found in paragraphs that are typically directed towards road transport. Rather, they are to be found in more general laws and regulations. This means that, in order to become familiar with these provisions, you must learn through experience.

The first regulation that is of interest here is stated in the Norwegian Penal Code. This is the law that regulates all criminal actions in Norway, and one paragraph has a provision about general complicit responsibility. It is stated that a penal provision also applies to any person who contributes to the violation, unless otherwise provided⁶. The interpretation of this provision is that it will come into force for buyers of road transport services if the transport organization they have hired violates current laws and regulations. Examples of this include overloading their vehicles, not obeying regulated driving hours or not paying their drivers the minimum regulated salary. It is the Norwegian Public Road Administration and the Norwegian Labor Inspection Authority that follow up on such cases, but a challenge is proving that the buyer of road transport services has not done their utmost to prevent the situation.

In addition to the provision about general complicit responsibility, there are provisions about information and duty of control. These provisions are provided for in regulations on information, duty of control and right of access⁷, which regulate the responsibility of the transport organizations to inform buyers of road transport services about the salary and working conditions of their drivers. This is information that the buyers of road transport services must have before they decide to enter a collaboration with the transport organization.

⁶ Penal Code (2005) The Norwegian Penal Code. URL: <https://lovdata.no/NLE/lov/2005-05-20-28> (accessed 30 June 2020).

⁷ Regulations on Generalizations (2008) Information-, duty of care and right of access code. URL: <https://lovdata.no/LTI/forskrift/2008-02-22-166> (accessed 30 July 2020).

Further, there is also a provision about duty of control. The buyers of road transport services must ensure that the information they receive from the transport organization about their drivers' salary and working conditions is accurate. Moreover, they have the right to demand documents, etc., that confirm the information they received [1, Accident Investigation Board Norway]. These provisions are made to ensure that the drivers are working under good conditions.

This paper outlines important aspects that buyers of road transport services in Northern Norway should take into consideration when ordering road transport from foreign road transport organizations. It takes the buyers of road transport services as its point of entry and seeks to answer the follow question: *How can buyers of road transport services contribute to safe road transport in northern Norway?* In addition, the paper outlines some practical implications for buyers of road transport services and Norwegian authorities.

Further, a presentation of the theoretical framework will be given before the method and results are presented. This will be followed by a discussion linking the findings and related theoretical framework, and lastly, a conclusion.

Theoretical framework

In this study, a modified version of the Pentagon Model, originally developed by Schiefloe [14, Rolstadås A., Tommelein I. et al.] is used as an assessment tool to analyze five different features of six different buyers of road transport services.

In this section, a detailed explanation of the Pentagon Model [14, Rolstadås A., Tommelein I. et al., 15, Kongsvik T., Albrehtesen E. et al., pp. 68–72], and our modified version, will be given to explain its use in the analysis.

Pentagon Model

When an unwanted incident occurs, it is of vital importance its cause be found to prevent it from happening again. It is possible to investigate an incident on an individual or system level. Traditionally, traffic accidents have been investigated on an individual level, holding the driver responsible [4, Newnam S. and Goode N., pp. 141–142, 10, Larsson P., Dekker S.W.A. et al.]. When investigating on an individual level, the aim is to understand why humans act like they do. When investigating on a system level, the aim is to investigate the whole organization in order to identify its ability to avoid unwanted incidents [15, Kongsvik T., Albrehtesen E. et al.].

The Pentagon Model is an assessment tool that can analyze why unwanted incidents occur from a systems level perspective and can also be used to prevent them. Moreover, a Pentagon Model analysis can be used for planning and organizational development, for example by determining what kind of organizational characteristics must be in place in order to achieve certain qualities [15, Kongsvik T., Albrehtesen E. et al., pp. 68–72].

A Pentagon Model analysis combines a system-oriented approach and social constructivist theoretical approach to understand the working situation for the different actors involved. The

model places special emphasis on keywords like interpretation, sense-making, and interests and takes both formal and informal aspects into account [14, Rolstadås A., Tommelein I. et al.]. The model analyzes five different aspects: structure, technologies, culture, interaction and social relations and network. These are the most important variables that characterize an organization [15, Kongsvik T., Albrehtesen E. et al.]. *Structure* covers how the organization has defined roles, responsibility and authority. *Technologies* refers to tools, equipment, IT-systems and infrastructure that are essential to the activities of the organization. *Culture* consists of attitudes, values, norms and knowledge and establishes expectations for how "work is done here". *Interaction* involves communication and cooperation, while *Social relations and network* refers to important factors in all kinds of work, such as trust, friendship and access to knowledge [14, Rolstadås A., Tommelein I. et al., 15, Kongsvik T., Albrehtesen E. et al.].

In this paper, the Pentagon model has been modified to fit this research project. The model is adjusted so it can be used to determine the important aspects that buyers of road transport services should take into consideration before deciding which road transport organization should transport their goods. From the original aspect, *structure*, we have constructed the factor *formal contracts*. This concerns how the buyers of road transport services formalize their business relationship with the transport organization. *Technologies* is also included in the modified version. This factor covers whether there are formal criteria for the vehicle and equipment the transport organization must provide in order to acquire transport contracts with the buyers. The third aspect, *culture*, has been modified into *decision criteria*. Underlying this factor is what criteria are of greatest importance for the buyers of road transport services when deciding on which transport organization they want to hire. *Interaction* has been modified to *communication*, a factor that involves how the buyers of the road transport services perceive the importance of communication with the road transport organizations and governmental institutions. The last original aspect is *social relations and network* and from this the factor of *knowledge/trust* has been developed. It investigates whether knowledge and trust are important attributes when deciding on which road transport organization they want to contract with.

This modified version of the Pentagon Model analysis has been used to determine what kind of organizational characteristics must be in place in order to achieve certain qualities, qualities that are essential for buyers of road transport services who wish to contribute to safer road transport in Northern Norway.

Method

In the following section, a description of the research design, research participants, data collection and analysis method used in this paper will be provided. A qualitative approach was selected for this study, which seeks to gain in-depth knowledge about how buyers of road transport services can contribute to safe road transport in Northern Norway. To achieve such knowledge, it is essential to acquire the participants' experience and opinions about the topic [16, Langdridge D.

and Hagger-Johnson G.]. Data collection was therefore conducted through semi-structured interviews.

Research Participants and recruitment

Six interviews were conducted with six different buyers of road transport services. The interviewees were recruited due to their relevance in the road transport sector [17, Kvale S.]. All were employed in positions of responsibility for ordering road transport for their products. Participation was voluntary, and all the interviewees agreed to participate after being informed about the project and that they were able to withdraw at any time. The study was approved by the Norwegian Centre for Research Data (NSD).

The interviews were mainly carried out by two or three researchers in a face-to-face setting. The interviews were not recorded, but validity was ensured by sending all interview transcripts back to the informants for feedback. Each interview lasted approximately 45 minutes.

Data Collection and Analysis

A semi-structured interview guide [17, Kvale] was used to ensure the researchers were able to cover similar themes across the interviewees. The semi-structured interview guide included different topics.

First, the interviewees were asked to talk about their organization's formal structure.

Second, they were asked to discuss the criteria they use to determine from whom they order transport. Third, they were asked how they made sure the transport they ordered was safe and carried out according to laws and regulations. Finally, they were asked to add any additional information relevant for the study. During the entire interview, the researchers concentrated on allowing the interviewees talk and only interrupted if there were follow-up questions.

As an analysis tool, the Pentagon Model [14, Rolstadås A., Tommelein I. et al., 15, Kongsvik T., Albrehtesen E. et al., pp. 68–72] has been modified and applied to determine what kind of organizational characteristics must be in place in order to achieve certain qualities, qualities that are important for buyers of road transport services to have in order to contribute to safer road transport. The results are presented in the next section.

Results

By using the modified Pentagon Model, the following aspects have been analyzed for six different buyers of road transport services in order to identify the organizational characteristics and qualities that will improve their ability to contribute to a safer road transport with fewer accidents and near-misses: *formal contracts, technologies, decision criteria, communication and knowledge/trust*. First, an overall summary of the results will be presented for each aspect. Second, an overview of the results for each organization will be outlined (Table 1).

Formal contracts: All the interviewees stated that formal contracts were signed with the road transport organizations that transported their goods. Any demands directed towards the transport organization were detailed in the contracts, such as insisting that it must follow laws and regulations and use appropriate equipment and vehicles. However, in busy times, transport assignments were also carried out by transport organizations with whom they did not have a formal contract. Several interviewees stated that: *We create formal contracts with our main providers of transport, but we also use transport organizations ad-hoc in busy times* (Interviewee A, B, F). As maintaining a driver's license and CPC (Driver Certificate of Professional Competence) was an obvious requirement, only one interviewee stated that extra driver competence, education and courses were imposed. *The driver must participate in a course on customer service and optimal driving in order to be able to transport our goods* (Interviewee F). One of the interviewees also set demands in their contracts regarding the use of a driver computer, driver behavior, monitoring, etc.

Technologies: Five out of six interviewees stated that only new and modern vehicles could be used when transporting their goods. *The vehicle must be suited for Norwegian conditions, meet environmental demands, have at least a Euro 6 engine* (Interviewee A, B, D, F). One interviewee stated that in addition to this, the vehicles must also be fitted with alco measure (making the vehicle impossible to start if the driver has been drinking alcohol). One of the interviewees also demanded the use of driver behavior monitoring.

Decision criteria: All of the interviewees stated that the cost of the transport was of considerable importance when deciding with whom they should sign a transport contract. *We are concerned with cheap transport and use only foreign transport organizations when exporting our goods out of Norway* (Interviewee C). Another stated that *our biggest clients are in low-cost chains, so big volume is of great importance for us to be profitable. Therefore, transport prices are important when we make our decision to order transport* (Interviewee A). Some of the interviewees also stated that quality and flexibility in transport assignments were of importance, but in the end it all came down to the price.

Communication: Five out of six interviewees highlighted good informal communication with the road transport organization as very important. *We discuss delivery times, etc., openly and come to an agreement if there are any challenges* (Interviewee A). A day-to-day communication to clarify deviations in delivery or loading/unloading times was highly appreciated. Formal revisions of contracts and follow-up on the transport organization's compliance with laws and regulations were mostly absent. *We see it as other authorities' responsibility to control and follow up road transport organizations regarding laws and regulations* (Interviewee D). Most of the interviewees pointed out that communication with authorities about their responsibility when ordering road transport services is lacking. *How can we do things right when no one provides us with this important information?* (Interviewee E). More information about this matter is thus required.

Knowledge/trust: Five out of six interviewees chose a transport organization based on former knowledge of the organization, and the relationship is often based on trust. Because of their knowledge of and trust in their transport organization, follow-up concerning demands in contracts, etc., are often absent. *We trust our main contractors to carry out their job in line with the written contract, therefore we don't do follow-ups* (Interviewee D).

Table 1

Overview of the results — Buyers of road transport services

	Formal / informal contracts	Technologies	decision criteria	communication	knowledge/trust
Organization A	Large organization that orders approximately 500 road transport assignments each day. Creates formal contracts with their main providers of transport, but they also use transport organizations ad-hoc in busy times. The contracts set demands that the transport organization must follow laws and regulations, use appropriate equipment and vehicles, etc. However, the contracts do not set demands directed towards the competence of the driver except that the driver has a driving license and CPC (Driver Certificate of Professional Competence).	Set demands for their transport organizations that they must use appropriate vehicles and equipment. The vehicle must be suited for Norwegian conditions, meet environmental demands (at least Euro 6 engine). However, they do not set any demands regarding a driver computer, driver behavior monitoring, etc.	Concerned with environmental concerns. Transport organizations that transport their goods must use HVO fuel during the summertime and seek the possibility of using electric vehicles. Further, they only allow transport organizations that are considered "serious" and "lawfully" to carry their goods.	Close interaction with their transport organizations. They follow up with revisions each year where they control that the laws and regulations are followed. On a day-to-day basis they can discuss delivery times, etc., openly and come to an agreement if there are any challenges. Good communication is highlighted.	Highlighting the importance of using transport organizations they are familiar with. The relationship is based on trust.
Organization B	Large organization that orders approximately 6000 road transport assignments each year. Significant export need. Uses mostly foreign road transport organizations for this purpose. Creates formal con-	Set demands for their transport organizations insisting they must use appropriate vehicles and equipment. The vehicle must be suited for Norwegian condi-	Concerned with fast, cheap and punctual transport. They perceive the transport of their goods as a part of their value chain and only allow transport organizations that are consider "seri-	Follow up their transport organizations with ad-hoc controls of tires and chains during the wintertime. However, a lack of communication between those who order the transport and the management is mentioned	Strives to have a close interaction with their transport organizations, but numerous transport assignments in the ad-hoc market are compromising this.

	<p>tracts with their main providers of transport, but also use transport organizations ad-hoc in busy times. The contracts set demands e.g. the transport organization must follow laws and regulations, use appropriate equipment and vehicles, etc. However, the contracts do not set demands directed towards the competence of the driver except that the driver has driving license and CPC (Driver Certificate of Professional Competence).</p>	<p>tions, meet environmental demands (at least Euro 6 engine). However, they do not set demands regarding a driver computer, driver behavior monitoring, etc.</p>	<p>ous" and that "lawfully" to carry their goods.</p>	<p>as a challenge.</p>	
Organization C	<p>Mid-size organization that orders approximately 140-240 road transport assignments each day. They create formal contracts with their main providers of transport. The contracts set demands e.g. that the transport organization must follow laws and regulations, use appropriate equipment and vehicles, etc. However, the contracts do not set demands directed towards the competence of the driver except that the driver has driving license and CPC (Driver Certificate of Professional Competence).</p>	<p>Set demands for their transport organizations by insisting that they must use appropriate vehicles and equipment. The vehicle must be suited for Norwegian conditions. However, they do not set any demands regarding a driver computer, driver behavior monitoring, etc.</p>	<p>Concerned with cheap transport and use only foreign transport organizations when exporting their goods out of Norway. They acknowledge that transport is a part of their value chain but do not execute revisions or controls when their main contractors use sub-contractors.</p>	<p>Emphasizes good communication with their main contractors regarding deviations. For example, regarding loading/unloading times, delivery times, etc. They do not follow up with regular revisions in order to make sure laws and regulations are being followed</p>	<p>Considers the relationship with governmental institutions of great importance. They find laws and regulations regarding their transport buyer responsibility as unclear. They request more information and better cooperation between the government, road transport organizations and buyers of road transport services</p>
Organization	Concerns a munic-	Set demands	Concerned with	They see it as other	Trust their main

<p>D</p>	<p>ipality. They order transport like snow plowing and asphalt paving. They have formal contracts with their main providers of transport. The contracts set demands e.g. that the transport organization must follow laws and regulations, use appropriate equipment and vehicles, etc. However, the contracts do not set demands directed towards the competence of the driver except that the driver has driving license and CPC (Driver Certificate of Professional Competence).</p>	<p>for their transport organizations e.g. that they must use appropriate vehicles and equipment. The vehicle must be suited for Norwegian conditions, meet environmental demands (at least Euro 6 engine). However, they do not set any demands regarding a driver computer, driver behavior monitoring, etc.</p>	<p>cheap transport. They do not demand extra education of the driver, as long as the formal licenses are obtained. They have the possibility to set more demands in their contracts but have chosen not to do this.</p>	<p>authorities' responsibility to control and follow up on road transport organizations regarding laws and regulations. Day-to-day communication with main contractors are absent. There are meetings regularly.</p>	<p>contractors to carry out their job in line with the written contract. Do not follow-ups.</p>
<p>Organization E</p>	<p>Small start-up business with a limited road transport buyer need. It is expected that the need for transport will increase in the years to come. They have a contract with one large road transport organization. They have not set any demands in this contract. Instead, it is the transport organization that has designed the contract.</p>	<p>Has not set any demands regarding the vehicles and equipment the road transport organization uses when transporting their goods.</p>	<p>States that price is the most important factor when they order transport. Second in importance is flexibility.</p>	<p>Has little to no communication with the road transport organization and governmental institutions. They were not aware of their responsibility as a buyer of road transport services and call for more information in this matter.</p>	<p>Did not have any relation to the road transport organization before they hired them to transport their goods.</p>
<p>Organization F</p>	<p>Large organization that has contracts with 15 main contractors. They have formal contracts with their main providers of transport, but</p>	<p>Set demands for their transport organizations e.g. that they must use appropriate vehicles and equipment. The</p>	<p>Concerned with quality in road transport. The transport must be safe. Further, they have environmental concerns and aim to</p>	<p>Value close interaction with their transport organizations. They follow up with revisions each year where they control that laws and regula-</p>	<p>Highlight the importance of using transport organizations they are familiar with. They tend to use small and middle-sized transport organi-</p>

	they also use transport organizations ad-hoc in busy times. The contracts set demands e.g. that the transport organization must follow laws and regulations, use appropriate equipment and vehicles, etc. In addition, the contracts set demands directed towards the competence of the driver. Their drivers must participate in optimal driving course	vehicle must be suited for Norwegian conditions, meet environmental demands (at least Euro 6 engine). Also, they set demands regarding a driver computer, driver behavior monitoring, etc.	be a market leader in environmentally friendly transport. Finally, they are concerned with transport prices. They find it very important that all drivers have taken a course in optimal driving in order to decrease the number of accidents.	tions are followed. On a day-to-day basis they can discuss delivery times, etc., openly and come to an agreement if there are any challenges. Good communication is highlighted.	zations because trust and easy to access and communication is highly valued.
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Discussion

Previous research shows that buyers of road transport services have the possibility to influence safe road transport by setting demands directed towards road transport organizations [1, Nævestad T.-O., Phillips R.O. et al., 13, Grinerud K., Sætren G.B. et al.]. However, to set such demands, the buyers must possess some organizational characteristics and qualities. By using the modified version of The Pentagon Model as an assessment tool, some of these characteristics and qualities have been identified:

- Understand that their decision criteria for order transport can influence road safety
- The importance of entering a formal contract with their provider of road transport
- Being aware of the possibilities and use of new technologies
- See the importance of good and even communication with both the transport organization and the authorities
- Recognize that knowledge and trust with the transport organization is important but could also affect judgement regarding revisions and control

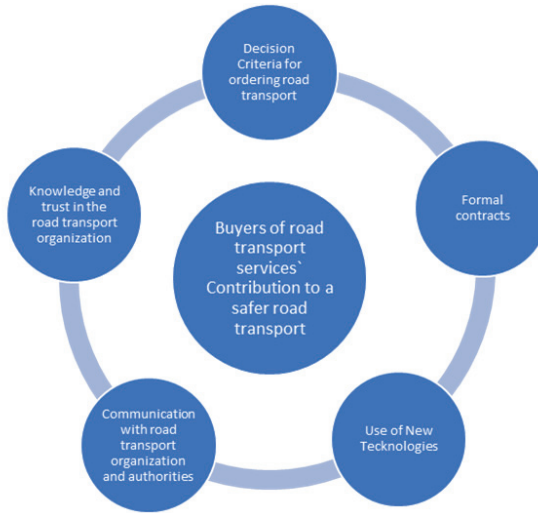


Fig. 1. Buyers of road transport services` contribution to a safer road transport

Decision criteria

The road transport industry is a low-earning industry, and the average financial result for a transport organization is between 2–5 % [13, Grinerud K., Sætren G.B. et al.]. This leads to a stringent prioritization of assets. By constantly pushing prices down, the buyers of road transport services influence the ability of the transport organizations to prioritize safety work, such as safety/driver training. In our interviews, most participants stated that they did not demand additional safety/driver training, and consequently, they were unwilling to pay extra to provide this. Some interviewees even said that additional safety/driver training was not taken into consideration at all when deciding on a transport assignment, this despite the fact that additional safety/driver training is associated with a reduced crash and accident risk [2, Mooren L., Grzebieta R. et al., p. 79].

Buyers of road transport services should be concerned with this fact, especially when ordering road transport to/from northern Norway from foreign road transport organizations during wintertime. It is stated that local knowledge about weather and driving conditions is of importance [12, Bardal K.G., p. 50] to ensure road transport is carried out in a safe manner. It is likely that foreign drivers who lack winter driving skills would improve their driving competence if those who purchase their services would demand additional knowledge and safety/driver training. This would in turn imply that road transport organizations must offer such training in order to gain transport assignments.

However, for the road transport organization to follow through with this, there must be assets available to fund such training. The responsibility for this matter should lie on both the road transport organization and the buyer of the road transport service. Consequently, the decision criteria applied by buyers of road transport services cannot be restricted to choosing the cheapest

provider. In this sense, the grounds on which the buyers of road transport services make their decision could influence how they contribute to safer road transport.

Formal contracts

Before transport organizations can carry out the transport, it is essential that a formal contract between the buyer and provider is established. In this study, all interviewees state that formal contracts are generally in place before the transport is carried out. However, these contracts seem to be concerned about topics such as following laws and regulations, using modern vehicles, the consequences if the transport is delayed, etc. There are seldom demands directed towards, specific driver competence, the use of management systems to monitor driving behavior and driving/resting times, etc.

To increase road safety, buyers of road transport services could consider crafting more detailed contracts with their transport organizations. Contracts that state that the transport organization shall follow laws and regulations seem to wage in this context. Instead, the buyers of road transport services should set demands that are clear and concise, e.g. demand that the road transport organization have a safety management system like ISO 39001 or similar [8, Nævestad T.-O., Elvebakk B. et al., p. 387].

However, it is not enough to simply set detailed demands into a contract. The contract needs to be followed up with revisions and control on a regulatory basis. Several of the interviewees in this study stated that they do not follow up on the demands in the contracts, trusting instead the transport organization to carry out the transport in line with the contract. It could be assumed that depending on such trust makes it difficult to discover any deviations from the terms of the contract, as there is a complete lack of regulatory revisions and controls. In comparison, following up formal detailed contracts with regulatory revisions and control could be a factor that increases road transport safety.

Use of new technologies

The use of new technologies is stated to be one of the most important factors for reducing casualties and injuries in traffic accidents⁸. A way to make the contracts more detailed would be to insist on the specific use of new technologies, especially the technologies that new vehicles is equipped with. By including such demands, it would be easier to track and monitor driver behavior, driving-resting time and loading-unloading time. Measures can thus be put in place to avoid certain situations and create safer transport routes.

The use of new technologies such as GPS and tracking systems would be of specific help in planning transport routes. For example, if a driver experiences some challenges on one route, a

⁸ Meld. St. 33 (2016–2017) (2017). National Transport Plan 2018–2029. Oslo: Ministry of Transport and Communications. URL: <https://www.regjeringen.no/en/dokumenter/meld.-st.-33-20162017/id2546287/> (accessed 27 August 2020).

message could go out to the rest of the drivers in his/her road transport organization to inform them of this issue. For foreign drivers, this would assist in choosing another route and acquiring important local knowledge about the area without being present. The consequence could be that the drivers receive better background information on which to base their decisions.

Demanding the use of new technologies in contracts would also encourage transport organizations to integrate this into their management system and use it more consciously. An on-board safety monitoring system is a good example of how new technologies can help identify risky driving behavior [18, Luke R. and Heyns G.J.].

Communication with road transport organizations and authorities

For buyers of road transport services, good communication with road transport organizations will likely contribute to road transport safety. The interviewees in this study highlight the importance of day-to-day communication with their transport providers. If any deviation in the transport route occurs, good communication and a strong relationship allow any misunderstandings to be resolved. For example, if a road transport organization knows it will be fined by their buyer if the transport is delayed, they are more likely to carry out the transport assignment in unsuitable weather conditions, which makes them more vulnerable to accidents. On the other hand, if a road transport organization can call the buyer, explain the situation and thereby avoid a penalty, then they are more likely to stop and wait for better weather conditions.

The value of good communication can also be extended to the relationship between the buyers of road transport services and the authorities. There are several laws and regulations directed towards buyers of road transport services^{9, 10}, but these are not easily discovered, especially by new organizations and start-ups. One of the interviewees (a start-up organization) stated that, even though they scheduled a meeting with the Norwegian labor inspection directly after opening their business, no information about their responsibilities were mentioned. Other interviewees stated that they knew about them, but only vaguely.

If new and small buyers of road transport services are to set the necessary demands for their transport organizations, information regarding this matter must be a priority. There is, however, currently a lack of both information and education directed towards buyers of road transport services regarding their responsibility for a safe road transport.

Knowledge and trust in the road transport organization

Most of the interviewees in this study emphasize the importance of choosing a road transport organization they are familiar with, and this business relationship is built on knowledge and trust. On the one hand, this reasoning can be important to safer road transport because it

⁹ Penal Code (2005) The Norwegian Penal Code. URL: <https://lovdata.no/NLE/lov/2005-05-20-28> (accessed 30 July 2020).

¹⁰ Regulations on Generalizations (2008) Information-, duty of care and right of access code. URL: <https://lovdata.no/LTI/forskrift/2008-02-22-166> (accessed 30 July 2020).

might facilitate communication and lead to a relationship where challenges and deviations can be quickly resolved. On the other hand, choosing transport organizations based on knowledge and trust could lead to a situation where contracts are not important and regular revisions and controls are absent. Consequently, this can affect the buyers' possibility to set demands on their transport organizations, thereby affecting the safety of the road transport.

Practical implications

This study has shown that there are some characteristics and qualities that buyers of road transport services should take into consideration to contribute to a safer road transport in Northern Norway, that is, a road transport with fewer accidents and near misses.

First, buyers of road transport services should be aware of how their decision criteria for ordering transport can influence road safety. If their decision is made solely with respect to price, it puts the transport organization in a position where they have few resources to spend on safety work. Second, a detailed formal contract with their transport providers is essential in the sense that demands can be made to increase road transport safety. Third, demanding the use of new technologies can make road transport more transparent and put necessary measures in place. Fourth, facilitating good communication with the transport organizations can help avoid misunderstandings regarding transport delays and other unforeseen challenges. Fifth, buyers should choose transport providers they are familiar with, but must be aware of the pitfalls if their relationship is based solely on knowledge and trust.

As for the Norwegian authorities, it is important to be aware of the lack of knowledge buyers of road transport services have regarding their responsibility for a safe road transport. More education and information must be given in this matter, and directed especially towards new organizations, start-ups and small business that order road transport.

Implications, Limitations and Further Research

This study is of value to buyers of road transport services, as it can increase their awareness of how they can contribute to a safer road transport. This is especially true for those buyers of road transport services located in and scattered across rural areas in northern Norway, as the driving conditions in these areas often demand very skilled drivers with good local knowledge about the area.

Further, this study can assist the Norwegian authorities by identifying the lack of knowledge buyers have about their responsibility for safe road transport. Recommendations include developing education and courses and directing relevant information towards the group in question.

The numbers of interviewees can be a limitation in this study. However, the researchers sampled interviewees with diversity, ranging from large organizations to new start-ups. All partici-

pants were experienced and knowledgeable, and substantially information was given to the researchers. Nonetheless, more research on the topic should be conducted.

There is little research on buyers of road transport services and their role in contributing to a safer road transport. Further research should focus on the aspects mentioned above, especially with the aim of acquiring in-depth knowledge from buyers of transport services and decision makers in these organizations.

Conclusion

The research question for this study is as follows: *How can buyers of road transport services contribute to safe road transport in northern Norway?* By using a modified version of The Pentagon Model, different aspects were analyzed in order to identify organizational characteristics and qualities that will improve the possibility for buyers of road transport to contribute to a safer road transport in Northern Norway and thereby contribute to fewer accidents and near-misses.

There are two challenges in particular that affect the safety of road transportation in northern Norway: the scattered locations of businesses [11, Langeland P.A. and Phillips R.O.] and a road environment with challenging topography, vast mountain areas, deep fjords and adverse climatic conditions [1, Nævestad T.-O., Phillips R.O. et al., p. 4, Bardal K.G., p. 49]. These challenges demand that drivers have skills and knowledge about driving in such an environment with such conditions.

Consequently, buyers of road transport services need to be sure that the drivers they hire have these skills and knowledge. Therefore, buyers of road transport services should consider: 1) developing a detailed formal contract with the provider of road transport; 2) seizing the opportunities with new technologies; 3) whether their decision criteria for ordering transport could influence road transport safety; 4) the importance of good communication with both the transport organization and the authorities; 5) that knowledge of and trust in a transport organization is important but could also affect judgement regarding revisions and controls.

This study suggests that buyers of road transport services can contribute to a safer road transport in northern Norway by emphasizing these five characteristics and qualities. By doing so, it will be the buyers of road transport services that set the demands for the transport organizations as they will choose to hire only those that fulfill them. In this way, foreign, as well as domestic, road transport organizations will be forced to comply with these demands to acquire transport assignments.

Conflict of interest

The author declared no potential conflict of interests with respect to the research, authorship and/or publication of this article.

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4391 Buyers of Road Transport Services: Sustainability and Safety Responsibility?

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This study takes the buyers of road transport services as its point of entry. While the literature on sustainability has grown, the situation is different regarding literature that discusses sustainability in the context of buyers of road transport services. This study contributes to the field by discussing how buyers of road transport services can contribute to sustainability and safety in the chain of transport and to the Vision-Zero Ideology.

Thus, the research question is: *How can buyers of road transport services contribute to sustainability and safety in the chain of transport and to the "Vision Zero" – ideology?* A qualitative approach was selected for this study. The study sought to get in-depth knowledge about how buyers of road transport services could contribute to sustainability and safety in the chain of transport. Data collection was therefore conducted through 16 semi-structured interviews. Thematic analysis was used. Findings indicate that buyers of road transport services have impact on both sustainability and safety in the chain of road transport by influencing through pricing and delivery demands.

Keywords: Sustainability, safety, road transport, heavy-duty vehicles, Vision Zero ideology.

1. Introduction

Norway's road safety network is controlled by a vision that there shall be no fatalities or severe injuries on the roads – *The Vision Zero Ideology*. As a sub-goal, the government has stated that the number of fatalities and severe injuries due to road accidents, should be maximum 350 cases by the year 2030 (Ministry of Transport and Communications, 2017). To achieve this aim, it is stated that accidents involving heavy duty vehicles (HDV) must be reduced. Several researchers point out that more research on the HDV business has a high safety potential (Njå et al., 2010; Nævestad et al., 2015; Grytnes et al., 2016; Nævestad et al., 2017; Nævestad et al., 2018). However, most research on this field focuses on transport companies as the point of entry.

Differently from the above-mentioned studies, this study focuses on the buyers of road transport services. In our time, all companies are expected to take social responsibility especially for safety and environmental concerns (United Nations, 2015), and the pressure on business to incorporate sustainability principles and objectives into policies and activities is mounting (Aarseth et al.,

2017). In this study, sustainability is seen in connection with safety in road transport, and a sustainable transport is seen as transport that has not led to near misses and accidents. Further, procurement in the transport industry is also obliged to consider sustainability.

While the literature on sustainability has grown (Aarseth et al., 2017) and is relatively widely known, the situation is different regarding literature that discusses sustainability in a safety context. Especially the role of buyers of road transport services, and how these can contribute to more sustainable and safe transport in general. This study contributes to the field by discussing how buyers of road transport services can contribute to sustainability and safety in the chain of transport and to the Vision-Zero Ideology.

Thus, the research question is: *How can buyers of road transport services contribute to sustainability and safety in the chain of transport and to the "Vision Zero" – ideology?*

Further in this paper a short presentation of sustainability theory, safety in the chain of transport and a short description of the Vision Zero Ideology will be given before the method and result are presented. Thereafter there is a

discussion linking the findings and the related theoretical framework, and a conclusion.

1.1. Sustainability

The modern use of the term *sustainability* is broad, and a precise definition may be challenging. However, most definitions of the term include the relationship between humans and the resources they use (Voinov, 2007). The widely used definition of the Brundtland Commission defines sustainable development as; "Sustainable development is development that meets the need of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987). Most scholars agree that sustainable development includes the need to simultaneously balance social, environmental and economic goals (Aarseth et al., 2017).

The pressure on organizations to incorporate sustainability principles and objectives into policies and activities is mounting, and research on sustainability strategies for organizations suggest that sustainability is a salient issue that needs to be thoroughly considered (Aarseth et al., 2017). Developing sustainable supplier practices and supporting suppliers in implementing sustainability was found to be one of the main strategies for buyers of goods and services (Jaillon and Poon, 2008; Liu et al., 2010; Ross et al., 2010; Shi et al., 2012; Eriksson et al., 2013)

Sustainable development is seen in a relationship with buying road transport services. In the chain of transport, there are different stakeholders which all need to be profitable. This drive for profit may interfere with organizations' contribution to sustainable development, hereby, the role of the stakeholders in shaping sustainable practices (Aarseth et al., 2017). Therefore, sustainability also includes development of practices that reduce accidents by increasing the focus on safety by all stakeholders in the chain of transport, including the buyers of transport services. An accident is resource-demanding for society. First, in the short term at the scene of the accident by resources like paramedics, ambulance, firefighters, police, closed roads, detours, crashed vehicles, broken goods and so forth. Secondly, in longer terms with hospital and rehabilitation expenses, loss of work capacity and death, to mention some (Bezerra, 2020). Consequently, increased focus on safety can

contribute to a more sustainable transport chain because an accident can be seen as an imbalance of social, environmental and economic goals (Bezerra, 2020).

1.2 Vision zero Ideology in Norway

Norway's road safety network is controlled by a vision that there shall be no fatalities or severe injuries on the roads (Vision Zero ideology). The original Vision Zero was developed by the Swedish Road Administration to serve as an ethical foundation and a basis for road safety work in the mid-1990s (Elvebakk et al., 2009). A modified version of this vision was introduced in Norway with the National Transport Plan 2002–2011 (Ministry of Transport and Communications, 2000), and has become an important guideline for the Norwegian road safety work, and has established that it is morally and ethically unacceptable that people are killed or severely injured in road accidents. In 1970, 570 persons were killed in road accidents in Norway, and in 2015 this number was reduced to 117. This is despite the fact that road traffic has increased by approximately four times as many vehicles (Ministry of Transport and Communications, 2017).

The Vision Zero is not stated to be an absolute target, as it is difficult to imagine that it is possible not to experience a single accident where there are fatalities or severely injured persons involved. Nevertheless, as a sub-goal, the government has stated that the number of fatalities and severe injuries, due to road accidents, should be maximum 350 cases by the year 2030 (Ministry of Transport and Communications, 2017). In order to achieve this goal, the effort is concentrated on different areas, whereas one area is heavy vehicles.

Prognoses for the years 2015–2030 indicate a 25% growth in traffic along Norwegian roads. It is expected that the growth of heavy-duty vehicles will be significantly higher than for small cars. If new measures are not implemented, an increase of 175 people involved in deaths and severe injuries is calculated in 2030, compared to 2015 (Ministry of Transport and Communications, 2017). In order to counteract this presumed development, The Ministry of Transport and Communications (2017) has highlighted some concrete measures directed towards heavy-duty vehicles, but a complicating factor in Norway's traffic safety

plans is our membership in the EEA and Schengen agreement. The EEA agreement guarantees equal rights and obligations within the internal market for individuals and economic operators in the EEA. It states that there shall be free movement of goods, services, persons and capital throughout the 31 EEA States (European Free Trade Organization [EFTA]). The Schengen Agreement was signed in 1985 and led most of the European countries towards abolition of their national borders, to build a Europe without borders (Schengen Visa Info, 2018). This has resulted in a huge increase of road users with another traffic culture and traffic understanding entering Norway. A specific challenge is foreign road users who are not competent to drive on Norwegian winter roads. Road safety measures must therefore also involve the buyers of road transport services who give these organizations commissions in Norway. They are the stakeholders who set the standard for profitability and sustainability and have the opportunity to facilitate Vision Zero work.

1.2.1 "Swiss Cheese Model"

The well-known so-called "Swiss Cheese" model is used as a theoretical framework to explain accident causation (Reason, 1990). The model can also be used to identify how actions and decisions made by buyers of road transport services can influence safety in transport.

The Swiss cheese theory is illustrated by slices of cheese with holes in them where each slice is equivalent to a barrier. As no barrier is one hundred percent tight, the holes show weaknesses in the barrier layer. The holes thus represent errors or failures. An accident is therefore a result of an incident that hits all the holes in the layers of barriers, according to this theory (Reason, 1990).

In his model, Reason (1990) distinguishes between *active* and *latent failure*, where active failures might be results of latent ones. Active failures are errors where the consequences are instantly visible, and where there is a clear relationship between cause and effect (Sætren et al., 2016): for example, when an HDV-driver is involved in a road accident. Latent failures refer to errors that may occur because of actions and decisions made by management or others who are removed from the direct control interface. These actions and decisions can have been taken long

before the actual incident, and therefore be harder to identify as a latent cause of an accident. The "Swiss Cheese" model illustrates this concept by showing that latent conditions in combination with active failures could lead to a breach in the layers of defense and lead to errors and accidents (Reason, 1990).

As shown above, there is little research on the role of buyers of road transport services in general, and specifically how this group might affect safe and sustainable transport. Thus, this study will contribute to the field by setting focus on the buyers of road transport services' role in this matter.

2. Method

A qualitative approach was selected for this study. The study seeks to get in-depth knowledge about how buyers of road transport services can contribute to sustainability and safety in the chain of transport. To achieve such knowledge, it is essential to get the participants' experience and opinions about the topic (Langridge, 2004). Data collection was therefore conducted through semi-structured interviews.

The interviewees were recruited through a member organization for owners of road transport organizations in Norway. All participation was voluntary, and all the interviewees agreed on participating after being told about the project and that they were able to withdraw at any time. The study was approved by the Norwegian Centre for Research Data (NSD). Nine semi-structured interviews were conducted with leaders of road transport organizations situated in the middle part of Norway. Further, 7 semi-structured interviews were conducted with "experts in the field". These experts were mainly employed by the Norwegian government, Norwegian Police, organizations with high credibility in the road transport sector and/or as authors of literature regarding road transport. All interviewees were chosen because of their relevance to the road transport sector (Kvale, 1996).

The total of 16 interviews were mainly carried out by two or three researchers and in a face-to-face setting. All the interviews were recorded and transcribed. All interviewees agreed on interviews being recorded. Each interview lasted approximately 45 minutes. A semi-structured interview guide (Kvale, 1996) was used so the

researchers were able to cover similar themes across the interviewees. The semi-structured interview guide included different topics, but in this study only topics dealing with the contribution by buyers of road transport services to sustainability and safety were included. As an example, questions like; *"How do you experience that those who buy transport service from you set demands for how you carry out the transport?"* and *"How do you set demands to those that buy your transport services?"* were asked.

Data analysis was conducted according to Braun and Clarke's (2006) thematic analysis. Quotations that appeared in the dataset that were related in some way to the research question were coded. The different codes were sorted into potential themes. The "keyness" of the themes was whether they captured something important in relation to the research question. The themes were identified through a theoretical (deductive) way, meaning that the analysis was driven by the researcher's theoretical interest in the field: here, the interest in gaining knowledge about buyers of road transport services contributions to sustainability and safety in the chain of transport.

2.1 Validity

In every qualitative study, a discussion about validity is important. (Yardley, 2000). Yardley highlights the importance of being sensible to context. In this study, a presentation of theory was given in order to set the context and make it possible for the reader to get an understanding of the theoretical framework. Further, the theoretical framework sets a direction for what has been studied.

Further, Yardley emphasizes the importance of rigour and refers to rigour as the resulting completeness of the data collection and analysis. In this study interviews were conducted with managers of transport organizations and "experts in the field". Some of the managers also had a role as buyers of road transport services, but there is a weakness in the study that no interview was conducted with large bodies of buyers such as buyers in the salmon industry, grocery industry, building industry etc. It may be possible that the lack of interviewees in these industries have affected the results of this study because their point of view is missing.

Transparency is also an important factor for qualitative research (Yardley, 2000). In this study,

transparency has been shown by giving a detailed explanation of the data collection and analysis process.

3. Results

The research question for this study was; *How can buyers of road transport services contribute to sustainability and safety in the chain of transport and to the "Vision Zero" – ideology?*

The empirics show that there are some main factors (themes) that affect the way buyers of transport services can contribute to sustainability and safety in the chain of transport. These factors are (1) setting demands for transport they order, (2) willingness to pay market price for transport and (3) delivery demands.

Table 1. Factors related to the way buyers of transport services can contribute to sustainability and safety

Themes	Explanation
1 Setting demands for transport they order	<i>Buyers of road transport services must make demands to the transport organization. Hereby, driver competence, that they follow laws and regulations, use approved vehicles and equipment</i>
2 Willingness to pay market price for transport	<i>Buyers of road transport services must pay for quality in transport and avoid using disreputable sub-contractors who push prices to the minimum</i>
3 Delivery demands	<i>Buyers of road transport services must be understanding about factors that can delay transport.</i>

1 Setting demands for transport they order.

There is consensus amongst the interviewees about the importance that buyers of road transport

set demand to transport organizations they hire. Especially demands like (1) driver competence, (2) following laws and regulations, (3) using appropriate vehicles and equipment. **Driver competence** is highlighted because of the importance that drivers have competence and skills to execute a safe transport. Some of the interviewees mentioned the challenge with hiring foreign road transport organizations on Norwegian winter roads because of the lack of winter driving competence of the drivers. Interviewees highlighted that by choosing a transport organization that prioritizes educating their drivers on the specific transport they carry out will increase the level of quality of the transport. This can be illustrated by the following quote: *"Driver skills are important. We observe that even if the equipment and vehicles are the same, many foreign drivers are involved in accidents and near-misses because skills in winter-driving are lacking"* (Interviewee M).

Further, the interviewees highlighted the importance of buyers of road transport services hiring transport organizations that **follow laws and regulations**. This too ensures that drivers are getting the right salary and have good working conditions as this is of importance for safe transport. Transport organizations that fail to follow laws and regulation are a major safety concern. They set themselves and other road users at risk by for example overloading their vehicles and driving too many hours. Some interviewees address this as a big challenge as shown by this quote; *"Drivers are being pushed to carry out illegal transport in order to earn more money for the company. The chance of being caught is small, but the earnings are big"*. (Interviewee K).

Finally, the interviewees highlighted the importance of buyers of road transport services hiring transport organizations that **use appropriate vehicles and equipment**. It was said by the interviewees that vehicles and equipment must be adjusted to the kind of transport they carry out in order for the transport to be safe. Examples that were given was challenges with securing the cargo if the vehicle or equipment is not fitted to transport the cargo. Another example that has been given is driving on icy roads without proper winter tires.

A quote that illustrates the importance of setting demands is; *"Transport buyers can contribute to*

safer roads by demanding that transport organizations employ drivers with the right competence, that they have the right equipment and that they educate their employees" (Interviewee L).

Several interviewees highlighted the importance of *"Fair Transport"*. This is a certification for transport organizations and buyers of road transport services, which makes them solely responsible for safe road transport. It is argued that buyers of road transport services lack knowledge about this responsibility.

2 willingness to pay market price for transport.

The interviewees pointed out that the transport industry is a low-earning industry, and that the average financial result for a transport organization is between 2–5 %. This leads to hard prioritization of assets. By constantly pushing prices, the buyers of road transport services, influence the ability of the transport organizations to prioritize safety work. One quote illustrates this; *"When the margins are small, assets are not being invested in safety work"* (Interviewee K). It was argued by the interviewees that buyers of road transport services can contribute to sustainable and safe transport by paying market price for the transport they order. In this context, a challenge with several subcontractors is mentioned by the interviewees. Using many subcontractors for transport commissions will result in a smaller margin for all parties. This is illustrated by the following quote: *"Norwegian transport organizations hire subcontractors even when they understand that the price they pay is less than needed to conduct the transport according to laws and regulations"* (Interviewee K)

3 delivery demands set by the buyers of transport services.

According to the interviewees a challenge for sustainable and safe transport is delivery demands regardless of the cause of a possible delay. In many circumstances the cause of delay is outside the control of the transport organization and driver. However, the buyers of road transport services still give warnings to and/or fine the transport organization for the delayed transport. This could lead the transport organization and driver to take unnecessary risks: for example, driving when the

weather conditions are bad or bending laws and regulations for driving time. An illustrative quote was *"We have delivery demands on everything we do. If we are more than 1 hour late, we will get a fine"* (Interviewee E)

Overall, the interviewees argue that buyers of road transport services can be the tool for making all parties in the chain of transport responsible for sustainable and safe transport; meaning that leaders and decision makers within the group of buyers of road transport services must prioritize sustainability and safety when they order transport services.

4. Discussion

The aim of this study was to examine how buyers of transport services can contribute to sustainability and safety in the chain of transport and to the "Vision Zero" – ideology.

Our findings were the categories: (1) setting demands for road transport they order, (2) willingness to pay market price for transport and (3) delivery demands set by the buyers of transport services. There was agreement between interviewees on these topics and they were mentioned directly or indirectly by all.

Setting demands for transport they order was one of the three most important factors in how transport buyers can contribute to sustainability and safety. Especially hiring transport organizations which focus on educating their drivers, following laws and regulations and using appropriate vehicles and equipment were highlighted as important factors. These findings could contribute to filling in some possible holes or errors in the Swiss cheese model. Reason (1990) distinguishes between active and latent failures in his model, and the above-mentioned factors is possible latent failures, meaning that accidents and near misses can occur because these factors are not prioritized by the management of the transport organizations.

The study's findings could also contribute to implementing one of the main strategies found from the systematic literature review of sustainability (Jaillon and Poon, 2008; Liu et al., 2010; Ross et al., 2010; Shi et al., 2012; Eriksson et al., 2013, Aarseth et al., 2017;). Developing sustainable supplier practices and supporting suppliers were found to be highly important in gaining sustainable development. By setting demands for transport they order, transport buyers

can support suppliers in implementing sustainable practices which contribute directly or indirectly to safety and Vision-Zero ideology.

A second important factor is the willingness of the buyers of road transport service to pay market price for road transport. For transport organizations to work with and prioritize safety, the organizations must be profitable. A quote from one of the study's interviewees illustrate this; *"in competition with money, safety always loses"*. Meaning that if the transport organization is struggling with economic survival, they will do what it takes to be profitable: overload their vehicles, use inappropriate vehicles and equipment, drive too many hours, bend laws and regulations and so forth. Buyers of road transport services can contribute to a more profitable, and thereby a more sustainable and safe transport industry by paying market price for the service they order. By doing so, they acknowledge that safe road transport is resource-demanding and facilitate opportunities for transport organizations to prioritize safety. Consequently, buyers of road transport services contribute to a more sustainable transport by hiring transport organizations that can secure their long-term economic performance by avoiding short-term behaviors such which are socially detrimental or environmentally wasteful (Porter and Kramer, 2006).

A third important factor is delivery demands that buyers of road transport services make of transport organizations. By setting delivery demands independent of weather conditions and other conditions, they put safe transport at a risk. This might lead transport organizations and their drivers to push safety limits. In this way, buyers of road transport services will contribute to these unsafe organizational and driver decisions which could end in near misses or accidents.

A common challenge for all the above-mentioned factors is the practice that buyers of road transport services and transport organizations use subcontractors to carry out their transport commissions. This practice can make it difficult for buyers of road transport services to know who is transporting their goods. So even if the buyers are concerned that their transport should be sustainable and safe, it might not be the case. Many of these subcontractors are foreign transport organizations with different views and culture on road safety. Consequently, these organizations are involved in more near misses

and accidents than domestic organizations. In order to achieve a more sustainable and safe transport and thereby, the aim of the Vision Zero ideology, more regulation on subcontractors allowed in transport commissions is therefore necessary.

This study's findings indicate that buyers of road transport services have impact on both sustainability and safety in the chain of road transport because they influence transport through their pricing and demands. By hiring transport organizations that prioritize safety and quality it is suggested that the contribution to the Vision Zero ideology will be of importance. Also, by their pricing and delivery demands, buyers of road transport services can contribute to more sustainable and safe transport.

4.1 Implications and Further Research

This study can be useful for governments that set regulations for the transport industry. This study suggests that more responsibility must be put on buyers of transport services in order to get more sustainable and safer transport. These are both important factors in order to achieving sub-goals in the Vision Zero ideology. Further, this study could be of value for buyers of transport services by making them more aware of the possibilities they have to contribute to sustainable and safe transport.

There is little research regarding buyers of transport services' and their possibility to contribute to more sustainable and safer transport. Further research should focus on these aspects and more studies should be conducted, especially studies where the aim is to get in-depth knowledge from buyers of transport services and decision makers in these organizations. Moreover, future research should examine which criteria buyers of road transport services use when deciding on a transport order, and how these criteria can affect safety outcomes.

5. Conclusion

The research question for this study was; *How can buyers of road transport services contribute to sustainability and safety in the chain of transport and to the "Vision Zero" – ideology?* Our findings were the categories: (1) setting demands for road transport they order, (2)

willingness to pay market price for transport and (3) delivery demands set by the buyers of transport services. This study suggest that buyers of road transport services can contribute to a more sustainable and safe transport by focusing on these three factors. By doing so, one consequence is assumed to be fewer near misses and accidents with heavy duty vehicles, thereby taking our society a step closer to the aim of the Vision Zero ideology.

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A systems view on road traffic safety of work-related driving with heavy goods vehicles

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Abstract

Road traffic accidents are seen as a leading cause of death that must be mitigated to ensure general public health. Roughly 1.24 million people die each year due to road traffic accidents, and another 20–50 million people sustain non-fatal injuries. Heavy goods vehicles are over-represented in fatal and serious road traffic accidents in many countries. Traditionally, individual road users have often been deemed solely responsible for these accidents. Unlike non-occupational driving, work-related driving, such as operation of a heavy goods vehicle is influenced by a number of systemic factors leading to potential accidents. This paper aims to contribute to the field of road transport research by identifying actors and components in the socio-technical system who have the potential to influence road transport safety. These include actors who may or may not be instrumental in ensuring safe road transport without the risk of accidents and the extent to which they can contribute. Data has been collected through semi-structured interviews and focus group interviews. The findings suggest the most important actors to be the European union, Ministry of Labour and Social Affairs, Ministry of Transport, the Norwegian Public Road Administration, the Norwegian Labour Inspection Authority, the Norwegian Police, municipalities, buyers of road transport services, car manufactories, management of road transport organizations and their drivers. It is suggested that these actors could enhance road transport safety with heavy goods vehicles by focusing on four factors. These are communication, competence, control sanctions and economy.

Keywords: Heavy goods vehicle, road traffic safety, socio-technical system

1. Introduction

Road traffic accidents are seen as a leading cause of death that must be mitigated to ensure general public health (Moonaghi, Ranjbar, Heydari, & Scurlock-Evans, 2015; Newnam & Goode, 2015; Nævestad, Hesjevoll, & Phillips, 2018). Work-related driving is an increasingly important factor in road accidents (Newnam & Oxley, 2016). Roughly 1.24 million people die each year due to traffic accidents, and another 20–50 million people sustain non-fatal injuries (Hughes, Newstead, Anund, Shu, & Falkmer, 2015; Warmerdam, Newnam, Sheppard, Griffin, & Stevenson, 2017). Heavy goods vehicles (HGVs) are over-represented in fatal and serious road accidents in many countries (Mooren, Grzebieta, Williamson, Olivier, & Friswell, 2014; Şimşekoğlu & Nordfjærn, 2017).

Traditionally, individual road users have been deemed solely responsible for road traffic accidents. This view has been perpetuated and reinforced by findings claiming that human error is the cause of approximately 95% of road crashes (Larsson, Dekker, & Tingvall, 2010). This approach is reductionist, and focuses on identifying unsafe driver behavior such as inappropriate speed, fatigue and drug use (Dawson, Searle, & Paterson, 2014; Newnam & Goode, 2015; Phillips, Kecklund, Anund, & Sallinen, 2017). While this approach may correctly identify the direct cause of a traffic accident, it does not cover the underlying causes of accidents. What is needed instead is a more holistic approach to road transport safety.

Unlike non-occupational driving, work-related driving, such as operation of a heavy goods vehicle (HGV) is influenced by a number of systemic factors leading to potential accidents. A reductionist approach to traffic accidents will be insufficient to detect potential causes of traffic accidents (P. Salmon, McClure, & Stanton, 2012). In turn, it will be difficult to put corrective measures in place. Examples of such underlying, systemic factors include payment systems rewarding production, thereby enticing drivers to take unnecessary risks, demanding working hours, illogical scheduling leading to driver fatigue and/or causing drivers to fall asleep behind the wheel (Nævestad, Elvebakk, & Phillips, 2018) and other organizational factors that influence a driver's working day and potentially leading to stressful situations (Newnam & Goode, 2015). In addition, vehicles not suitable for current road conditions and improper equipment to secure the cargo are factors that could contribute to accidents.

Instead of taking a reductionist approach, the road transport system could be seen as a complex sociotechnical system (Leveson, 2004; Rasmussen, 1997), meaning that the system contains technical, psychological, and social elements. In addition, the system is influenced by a high degree of uncertainty and independence, challenging the boundaries of safety (Newnam & Goode, 2015). This paper takes a systems approach to road transport safety for HGVs.

Several scholars within the field of road transport safety acknowledge the use of a systemic approach when studying road transport safety and traffic accidents (Goode, Salmon, Lenné, & Hillard, 2014; Hughes, Anund, & Falkmer, 2015; Larsson et al., 2010; Newnam & Goode, 2015; Nævestad, Elvebakk, et al., 2018). However, there is limited research on the actors that are a part of the "system" encompassing work-related driving with HGVs and how these actors influence road transport safety. Therefore, this paper aims to contribute to the field of road transport research by identifying actors in the socio-technical system who have the potential to influence road transport safety. These include actors who may or may not be instrumental in ensuring safe road transport without the risk of accidents and the extent to which they can contribute.

Thus, the research question for this paper is "Who are the actors/components in the complex socio-technical system of road transport for work-related HGV transport and how can they influence safer road transport?"

In the following paragraphs, a detailed explanation of a complex socio-technical system, and a justification of why road transport is a complex socio-technical system is given. Thereafter, methods used in this paper is presented, followed by results and a discussion. Finally, a conclusion is presented.

2.0 Theoretical framework: Complex socio technical system and risk management

While a common approach to analyzing road transport safety has so far been based on the view that the driver is solely responsible when accidents occur (a reductionist perspective), there is currently a shift towards the assumption that road transport safety can be enhanced by implementing systemic theories (Larsson & Tingvall, 2013; P. M. Salmon & Lenné, 2015). It is argued that if systems thinking were applied to road transport safety, it would lead to a better understanding of the reasons for road transport safety's lack of success and would result in solutions for new interventions and measures (P. Salmon et al., 2012). This argument is applicable especially for work-related driving with HGVs. Because of Norway's success in its road safety work during the past 40 years, the number of fatalities on Norwegian roads has decreased from 570 fatalities and 4,552 severe injuries in 1970 to 108 fatalities and 565 severe injuries in 2018 (Statistics Norway, 2020). The same success in decreasing road transport accidents involving HGVs has not been achieved, however. On average, 688 people are injured in traffic accidents involving HGVs each year, and for every third road fatality, there is an HGV involved (Langeland & Phillips, 2016). In a systemic view, the answer cannot be found by detecting the errors the driver made that led to these accidents. Instead, a systemic approach considers the interaction between all the actors within the system, including broader organizational, social or political interactions that might contribute to unsafe road transport leading up to an accident (Larsson & Tingvall, 2013).

It has been said that a system that includes technical, psychological and social elements is a sociotechnical system (P. Salmon et al., 2012). In addition, a *complex* socio-technical system is defined by six specific traits. Firstly, the system is open. This means that the system can be influenced by the environment in which it operates and, conversely, can influence this same environment. Secondly, the system's components are *ignorant of the system* as a whole. Thirdly, the actors/components themselves are not complex, but integrated in a system; the system itself will be complex. Fourth, there must be inputs from the actors/components at all times to maintain a

functional system. Fifth, complex systems are path-dependent. This means that their past behavior influences their present behavior. Finally, interactions within complex systems are non-linear. Input and output are not symmetric and small events can produce large results.

These six characteristics can be found in the road transport system (P. Salmon et al., 2012). Moreover, as stated by Newnam and Goode (2015), road transportation can be classified as a complex socio-technical system since it comprises technical, psychological and social elements which inform goal-directed behavior, and the system is influenced by a high degree of uncertainty and independence. Therefore, when road accidents are seen as complex phenomena, there is no longer an obvious relationship between the behavior of parts in the system and system-level outcomes. Instead, system-level behaviors emerge from the multitude of relationships and interconnections deeper inside the system (Dekker, Cilliers, & Hofmeyr, 2011).

Rasmussen (1997) developed a framework showing the complex socio-technical system that is involved in the control of safety. The idea behind the framework is that accidents are caused by the decisions and actions of all actors within the system and by multiple contributing factors (Newnam & Goode, 2015). This framework helps to identify actors who interact or have interdependencies, and any actor who can affect or is affected by the actions, decisions, policies, practices or goals within the system. In this sense, the actors have the possibility to help or harm the functioning of a system (Gibson, 2000; Aarseth, Rolstadås, & Klev, 2015).

This risk management framework has been used previously in several disciplines and domains. These include the mining industry (Donovan, Salmon, Lenné, & Horberry, 2017), food industry (Cassano-Piche, Vicente, & Jamieson, 2009), aviation (Thoroman, Goode, Salmon, & Wooley, 2019) and road traffic (Newnam & Goode, 2015).

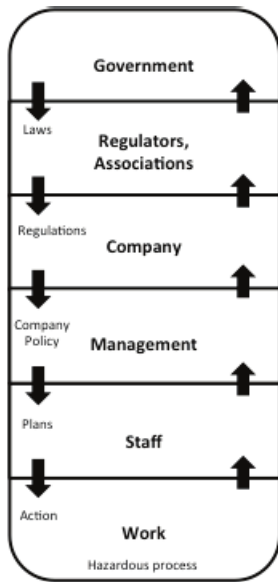


Fig. 1. Rasmussen's risk management framework (adapted from Rasmussen, 1997).

The framework identifies the actors in the system, including government, departments, regulators, CEOs, managers, supervisors and workers (figure 1). Safety is maintained through a vertical integration process, meaning that decisions made at higher levels are reflected at lower levels of the system. In addition, information and experiences realized in the lower levels of the system are communicated to the higher levels so that this information and experiences can be known at the higher levels before decisions are taken (Newnam & Goode, 2015; Rasmussen, 1997).

At the top level, governmental institutions attempt to control safety through legal systems. In road transport, for example, there are national laws. Legislators pass acts that affect different aspects of safety. In road transport these include acts pertaining to driving time, loading capacity, driver training, etc. In addition to legal regulation concerning safety, legislators and other agents (for example non-governmental organizations) are concerned with general economic health in terms of employment and trade balance. Legislation then makes explicit the priorities of conflicting goals (Rasmussen, 1997). It is common to use safety reviews and accident analyses to guide regulators in their work. At the next level, the legislation is interpreted and implemented via specific rules that control the activity in certain kinds of workplaces. Interpreters and implementers at this level are national (local) regulators, interest organizations and non-governmental organizations (NGOs). The next level – company level – is where the legislations and rules are interpreted and implemented in the context of a specific company. At the lowest levels, "hands-on" workers develop operating

procedures regarding how the work task should be carried out in practice. This includes management in the companies, supervisors and drivers when related to road transportation.

Rasmussen (1997) explains the use of the framework in order to control safety in five steps. I) The first step is about identifying the decision makers in the system. This could be done by mapping the relationships between the decision makers. II) The second step is the importance of having information about proper action targets for all actors, including both production and safety-related objectives. III) The third step is the importance of sharing information, both top-down and bottom-up in the system. It is especially important that decision makers be well acquainted with information about work processes at the lower levels. IV) The fourth step is the importance of competence and capability of the various actors. This is a matter not only of formal knowledge, but also tacit knowledge and practical skills. V) The last step concerns commitment and includes whether the actors and decision makers are committed to safety and whether they are aware of safety constraints.

The reasoning behind the system is related to the fact that it is difficult to detect when mitigation towards the boundaries for safety performance occur. Especially in complex and challenging systems.

In the domain of road transport, Newnam and Goode (2015) used this framework to analyze road freight transportation crashes in Australia. The framework has also been used to examine the problem of distracted driving from a systems theory perspective (Young & Salmon, 2015). However, in the domain of road transport there is still a need to take a more holistic approach to safety management (Newnam, Goode, Salmon, & Stevenson, 2017; Nævestad, Elvebakk, et al., 2018). This paper contributes toward meeting this need by using Rasmussen's (1997) risk management framework to identify actors and components in the complex socio-technical system of work-related driving with HGVs. The paper also seeks to reveal how these actors and components influence road transport safety.

3.0 Method

There are two different methodological approaches that can be taken in academic research – the qualitative or the quantitative approach. Quantitative research deals with numbers and statistics, while qualitative research deals with words and meanings (Jacobsen, 2005). With regard to the scarcity of extant empirical research in this area, a qualitative approach was chosen in order to acquire new in-depth knowledge about this topic. Data has been collected through semi-structured

interviews and focus group interviews. The data was transcribed and analyzed by means of thematic analysis (Braun & Clarke, 2006).

As its philosophical base, this study had a constructivist approach. This implies that the reality of a phenomenon under study is affected by the context and the people connected to this reality (Jacobsen, 2005; Postholm & Jacobsen, 2018) For this study, within the domain of road transport safety, it is assumed that road transport safety is affected by its circumstances and that its reality is in a state of constant change, transformed, for example, by new government regulations, new technologies, etc. In other words, “reality as it actually is” changes and develops over time (Bryman, 2016).

3.1 Study participants, Procedure and Data collection

Purposive sampling is the fundamental principle for selecting participants in qualitative research (Bryman, 2016). This approach was also the initial approach used for this study, and participants were recruited because of their relevance for the research topic and due to their experience and knowledge about road transport with HGVs. The interviews were carried out using two different methods – individual semi-structured interviews and focus group interview (Bryman, 2016; Kvale, 1996).

3.1.1 Individual semi-structured interviews

Nine participants were recruited through a member organization for owners of road transport organizations. The organization facilitated access to potential participants. Participants were chosen based on two explicit inclusion criteria: I) the participant had to be a leader of a road transport organization that hauled goods with vehicles having a total weight capacity above 7,500 kilograms and II) the participant had to have at least one driver as an employee.

The interviews were mainly carried out by two or three researchers in face-to-face settings. Each interview lasted for 45–60 minutes, and each was recorded and transcribed. A semi-structured interview guide was used so that similar themes were covered. The semi-structured interview guide included various topics. In this study, the topics prioritized were those involving identification of different actors in the complex socio-technical system of HGV transport and the way(s) these actors might influence safer road transport. The interview guide consisted mainly of open questions and functioned more as guidance than as a rigid protocol. Each interview started with making the participants comfortable in the interview setting (Jacobsen, 2005). Examples of questions include: Can you tell us about your background and interest in road transport? Can you tell us about the road transport organization you lead? Can you tell us about factors that affect safety in your day-to-day

work? How do you perceive your organization's focus on safety? Which organizations, etc. affect safety in your organization?

All participation was voluntary, and the interviewees gave their consent to participate after being informed about the project and being reminded that they were able to withdraw from the study at any time. The study was approved by the Norwegian Centre for Research Data (NSD).

3.1.2 Focus group interview

After interviewing nine leaders of road transport organizations, a focus group interview with eight participants was conducted. The participants represented different institutions/organizations that have a possibility to affect road transport safety by virtue of their positions. The participants represented local government, national government, NGOs and the Norwegian Police. Focus group interviews were selected because they allow the participants I) to discuss the topic in a group setting, II) to build up a view of the topic based on the interaction that takes place within the group, III) to argue and challenge each other's views (Bryman, 2016). The eight participants were familiar with one another before attending the focus group interview. The activity and contributions of all involved were high .

Because of Covid 19 restrictions, the focus group interview was held digitally via Teams. It is the researcher's perception that this way of conducting the group interview was just as good as conducting it physically. First, the facilitator gave information about the topic for the interview and explained how the interview should be conducted. The focus group interview guide was developed based on Rasmussen's (1997) risk management framework and consisted of only two questions: Who are the actors/organizations/NGOs/others that have the possibility to affect HGV transport safety? How can these actors/organizations/NGOs/others influence road transport safety? Second, every participant was given time to speak their mind in turn. There were no interruptions during this session. Third, every participant discussed the topic in plenary and in addition commented on one another's talks. Finally, the facilitator wrapped up the focus group interview by summarizing what had been said. The entire session lasted approximately two hours.

3.2 Data analysis

Data analysis was conducted in accordance with Braun and Clarke's (2006) thematic analysis. More precisely, this was a theoretical deductive thematic analysis, meaning that the analysis was driven by the researcher's theoretical interest in the road transport safety area. This form of thematic analysis seeks to provide a detailed analysis of some aspect of the data. The data is therefore coded with a focus on the research question. This thematic analysis was conducted at a latent level, meaning that

the analysis starts by examining the underlying ideas and assumptions in what the participants said. The transcribed interview material consisted of several utterances regarding the participants' perceptions of the actors they considered important contributors in the system of work-related HGV transport and how these contributors could influence safer road transport. These utterances were carefully systematized and given a code. Codes of similar meaning were grouped together and these groupings represent the themes in this analysis.

In this way, the analysis was conducted in several phases. The first phase involved reading and re-reading the dataset. The second phase included generating initial codes. In this phase, the researchers looked for patterns in which to organize the dataset so as to answer the research question. The third phase involved sorting the different codes into potential themes and collating all the relevant coded data within the themes. The goal was to group codes into themes such that the themes captured something important in relation to the research question. The fourth phase involved refining the themes, which entailed aggregating sub-themes into main themes (Braun and Clarke, 2006).

This resulted in several sub-themes and five themes, as shown in table 1. The first theme, *actors*, covers findings related to the first part of the research question, namely *“Which actors could be a part of the complex socio-technical system of road transport for work-related HGV transport?”*. Theme numbers 2–4 cover findings related to the last part of the research question, namely *“how can they (the actors) influence safer road transport?”*.

Table 1. Themes

Number	Sub-theme	Theme
1	Supranational institutions, national institutions, buyers of road transport services, road transport organizations, car manufactures	Actors
2	Information, values	Communication
3	Education, training	Competence
4	Intern and extern follow-ups	Control sanctions
5	Lack of resources, lack of finances	Economy

The sub-themes emerged out of utterances made by the participants in the study. For example, when participants were asked about who they perceived as important contributors to work-related road safety with HGVs, they mentioned, among others, supranational and national institutions like the EU and the Norwegian Public Road Administration. These utterances were then categorized in

sub-themes like “supranational institutions” and “national institutions” before naming the theme globally as “actors”. Further, when participants talked about education and training as important factors in terms of control safety, these utterances were developed as sub-themes and constituted the global theme “competence”. A more detailed presentation of the themes and associated findings is given in the following section.

4.0 Results

The research question for this paper was “*Who are the actors/components in the complex socio-technical system of road transport for work-related HGV transport and how can they influence safer road transport?*”. Five themes were identified through the analysis of the data, I) actors, II) Communication, III) Competence, IV) Control sanctions and V) Economy. Each theme is presented in the following paragraphs. Each presentation is exclusively the view of the participants in the study. In addition, some utterances are reproduced literally as the participants formulated them.

4.1. Actors

This theme captures actors in the HGV transport system who are considered important safety contributors to HGV transport by the participants in this study. The participants noted the importance of actors like the European union (EU), Ministry of Labour and Social Affairs, Ministry of Transport, the Norwegian Public Road Administration (NPRA), the Norwegian Labour Inspection Authority (NLIA), the Norwegian Police, municipalities, customers of road transport organizations, car manufacturers, management of road transport organizations and their drivers. These actors have been categorized under five different findings, I) supranational institutions, II) national institutions, III) buyers of road transport services and IV), road transport organizations and V) car manufacturers (Figure 2).

All participants in the focus group interview highlighted the European union (EU) as an important actor having the potential to affect road transport safety in Norway, especially through their regulations (*supranational institution*), including regulations regarding education and training, limited hours of driving and vehicle standards such as suitable tires for weather conditions. One participant stated that “*The EU is setting the standard with their regulations and there is nothing we can do that goes against that*”. However, another member in the group interview argued that not all EU statutes have to be implemented directly into the laws and regulations of member countries. There is still some leeway for the member countries to implement local variants. In some cases, *National institutions* like the Norwegian Public Road Administration can therefore implement locally adjusted

regulations. One participant employed in a municipality put it this way: *"Legal acts from EU could be both directives and orders. We have to implement some of these directly into our own legal system, while with others, we can make minor changes and adjustments before implementing them"*. Other organizations that were highlighted as contributors to safe HGV transport were NGOs like the Norwegian truck owners' association. It is said that they have an important role in speaking in favor of the industry's causes. This includes lobbying national government and decision makers before new regulations are put into place.

Both supranational and national institutions are underscored as important actors in affecting road transport safety because of their role as decision makers in the adoption of legislation. However, some of the national institutions have other roles, as well, whereby they have the opportunity to influence HGV transport safety. One particularly important role is that of *buyers of road transport services*. Some national institutions are major buyers of road transport services. These include asphalt transport, snowplowing, construction work, etc. It is claimed that these institutions affect HGV transport safety through demands (or lack of demands) in contracts they enter into with road transport organizations. Moreover, interviewees say that commercial businesses needing road transport services have the potential to influence safe HGV transport through their role as buyers of road transport services. These businesses have the possibility to make demands on the transporters of their goods. These demands can be embedded in written contracts, and only transport organizations that fulfill these demands would be eligible to transport goods. One interviewee said, *"Buyers of road transport services need to ensure quality. This includes quality in terms of work tasks, safety work and environmental concerns"*.

Other actors that were pointed out as contributors to HGV transport safety were *road transport organizations*, including both management and employees (e.g., drivers). It was maintained as crucial that management invest in safety and prioritize safety work within the organization. Without this commitment, employees and drivers assume that safety is not a priority in the organization. Consequently, unnecessary risks are taken at all levels of the organization. This study's participants highlight the importance of management being attentive to their employees' and drivers' experience and knowledge about day-to-day work activities. By doing this, the management will be able to ascertain the operations that involve risk and risky behavior. A leader for a road transport organization said that *"we need to listen to the drivers. If they communicate safety concerns, it is a safety concern. Management cannot overrule the drivers"*.

In addition, car manufacturers were mentioned as important actors because they design and produce HGVs and thus have an opportunity to influence HGV transport safety.

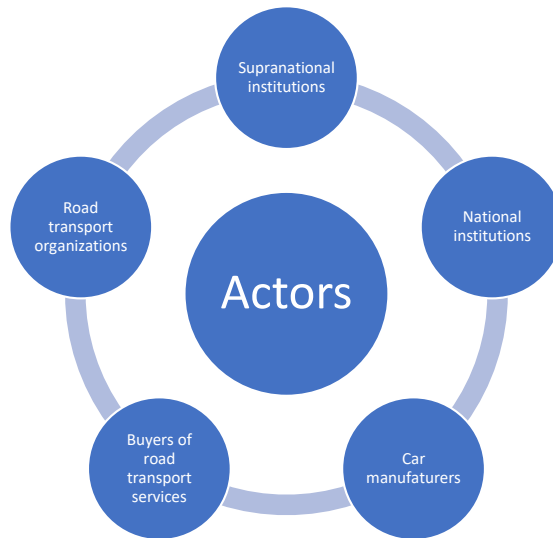


Fig. 2. Actors

4.2 How can the actors influence road safety

In the following, findings are presented that relate to how the actors can contribute to a safer work-related HGV road transport.

4.2.1 Communication

It is claimed that everyday communication both inside and outside of the actors' organizations is crucial for building competence and thereby enhancing HGV road safety. Therefore, communication is stressed as an important tool for safer work-related road transport. This includes communication between decision makers, NGOs, road transport organizations and buyers of road transport services. The participants stated that each actor must be aware of the challenges faced by other actors in order to collaborate for the greater good, namely road transport safety.

4.2.2 Competence

There is consensus among the interviewees that competence is an important factor in enhancing HGV transport safety. According to the participants in the group interview, education and training are factors that affect road transport safety. The rationale behind this is that education and training influence the level of competence each actor in the HGV transport system holds. The participants expressed that it is crucial for each actor in the system to possess the appropriate expertise in order to make a contribution to safer HGV transport. Government needs competence to make decisions

regarding implementation of effective regulations, management in road transport organizations needs employees with competence regarding organizational management, drivers need competence in driving the cargo and the buyers of road transport services need competence in their roles as "buyers". One participant put it like this: *"we need employees with specific buyer competence when we order road transport of our goods"*. It is assumed that without employees with specific expertise in each role, it is difficult to build an industry with safety values, in short, an industry that puts safety first.

4.2.3 Control sanctions – Intern/extern follow-ups

Participants, both in the focus group interview and individually, emphasized the need for concise demands and *regulations*. One participant said that *"people don't have to do something before they have to"*. Meaning that people don't feel obliged to do something unless there is a mandate requiring them to do it. It was also claimed that regulations alone are insufficient. It is crucial that the control system works. The participants point to the supranational and national institutions and their responsibility to put effective regulations in place. In addition, the participants talk about the responsibility that buyers of road transport services and road transport organizations have in regard to implementing guidelines and protocols in their own organizations. This is to ensure that management and employees alike take environmental and social responsibility. One of this study's participants said that *"honesty does not pay, because unfortunately, honesty is not profitable in this business"*. This opinion reflects the fact that fly-by-night organizations can continue without observing business ethics. Some organizations assume that it is not profitable to follow regulations and guidelines. This attitude and the assumption itself do not serve the goal of cementing safety values in the organization. Moreover, this attitude may be perpetuated to a certain extent if there is a lack of consequences. Participants state that the control system is not efficient enough to detect organizations that have no safety values. In addition to external control systems, participants also highlight the importance of having internal control systems/follow-ups. Organizations that use external personnel to conduct internal controls (e.g., checking driving times) maintain that this is very positive for both management and drivers. One participant said, *"we have a company that checks our drivers' compliance with driving time four times a year. If a driver has driven too many hours without the mandatory rest, the company follows up the driver directly. This works better than having our own management spend time on this kind of thing"*. It is stated by the participants that a control system, both internal and external controls that manages to detect cheaters will benefit the professional actors in the industry who are concerned with safety values.

4.2.4 Economy

The participants in this study stated that resources are in general low in the HGV transport sector. One participant said that *"we have to calculate the absolute lowest price possible to win bids for transport assignments"*. In this regard, the buyers of the road transport services do not consider whether the road transport organization has invested in new equipment or is concerned with safety, etc. In many cases, the buyers are concerned only about the price of transporting their goods. This leaves the road transport organizations with few resources to invest in safety factors such as new technological equipment, new vehicles, education and training.

In summary, participants in this study have highlighted several actors that they regard to be part of the complex socio-technical system of HGV road transport. These include both supranational and national actors. These actors can influence HGV road transport safety by I) building the right competence, II) conducting internal/external follow-ups and III) providing resources. In the following section, these findings are discussed in the context of literature and previous research.

5.0 Discussion

This study seeks to answer a two-part research question. First, the study seeks to identify actors that are part of the complex socio-technical system of road transport for work-related HGV transport. Secondly, the study seeks to ascertain how these actors can influence safer work-related road transport.

The actors highlighted by this study's participants were supranational institutions like the EU¹, national institutions like the Ministry of Transport, the Ministry of Labour and Social Affairs, the Norwegian Public Road Administration and the Norwegian Labour Inspection Authority, NGOs like the Norwegian Truck Owner Association, buyers of road transport services, road transport organizations and car manufacturers. These actors can be categorized in accordance with the risk management framework developed by Rasmussen (1997) (table 2). At the top level, we find supranational institutions like the EU and national ministries. These are the actors that have an impact on deciding legislation that will be applicable for the industry. At the next level, we find departments that formulate the details and content in statutes and NGOs that have an opportunity to lobby the above-mentioned institutions and departments. At the lower levels, we find

¹ Norway is not a member state of the European Union (EU). However, it is associated with the Union through its membership of the European Economic Area (EEA), signed in 1992 and established in 1994. According to Norway's Foreign Affairs from the legislative acts implemented from 1994 to 2010, 70% of EU directives and 17% of EU regulations in force in the EU in 2008 were in force in Norway in 2010 (NOU 2012:2, 2012)

organizations that carry out their day-to-day work in accordance with laws and regulations decided by the above-mentioned actors.

Table 2: Overview of actor level

Level	Actors		
Government	Supranational institutions (EU) National institutions (e.g., Ministry of Transport, Ministry of Labour and Social Affairs)		
Regulators and associations	National institutions (e.g., NPRA, NLIA) NGOs (e.g., the Norwegian Truck Owner Association)		
Company	Buyers of Road Transport Services	Road Transport Organizations	Car manufactories
Management	Top and middle management	Top and middle management	Top and middle management
Staff/work	Employees ordering the transport/ operators	Drivers/ operators	Mechanics/ operators

Rasmussen (1997) states that to control safety within a system, one first needs to identify the actors in the system; secondly, actors in the system must be familiar with one another's strengths and weaknesses. The different actors (components) in the system must function together and it is the relationship between the actors that is important in order to control safety. However, in a world where commercial success often benefits from operating close to safety boundaries, decisions will be affected by the competing goals of production and safety (Sætren, Wigum, & Bogfjellmo, 2019). The boundaries include perceived acceptable performance, unacceptable workload and economic failure. These boundaries are essential elements related to the organizations' production and safety. To prevent accidents, Rasmussen states that the focus should be on "control of behavior by making the boundaries explicit and known and giving opportunities to develop coping skills at boundaries" (Rasmussen, 1997). Thus, safety has the possibility to be maintained through an understanding of the specific work and system context (Sætren et al., 2019). According to the participants of this study four factors are crucial for actors within the complex socio-technical system of road transport for work-related HGV transport in order to manage safety. Hereby, communication (information, values), competence (education, training), control sanctions (intern/extern follow ups) and economy (resources and finances).

Communication and *competence* are two factors that may be seen as corresponding to Rasmussen's (1997) boundaries for "perceived acceptable performance". Rasmussen (1997) highlights the importance of information sharing between actors on different levels in order to control safety within the socio-technical system. It is essential that decision makers be aware of the challenges that actors face at lower levels, and vice versa. In this sense there is a need for vertical flow of information in the system, and this information needs to be communicated both top-down and bottom-up. In the absence of this information flow, it could be assumed that one is nearing the boundary marking a departure from acceptable performance. Also, if actors at the different levels lack competence in their respective areas, a mitigation towards the boundary is possible. If actors on the management level lack knowledge and competence about the challenges their drivers face, it is possible that they are planning longer driving routes than what is justifiable. This could result in drivers taking risks by working too many hours, etc., thereby drifting towards the limits of acceptable workloads. The same problem could occur if actors on the supranational and national levels lack knowledge about challenges experienced at the management level and correspondingly design legislation that compromises safety.

The participants in this study stated that competence needs to be improved at several levels of the system. Competence in organizing transport assignments was particularly cited. Participants stated that buyers of road transport services can be key actors in increasing road transport safety. The rationale for this is that they have the possibility to provide economic resources to the road transport organization, meaning that the buyers are those who determine the price of transport assignments. Moreover, they have the opportunity to set demands in contracts with the road transport providers and thereby decide the degree of focus on safety in terms of the actual transport of their goods. The study's participants point out two different groups of buyers of road transport services — governmental institutions and private businesses/organizations. In order to set more and precise demands, the employees working with transport orders need competence and knowledge about the way and the degree to which the demands will improve safety. A previous study (Grinerud, Sætren, & Aarseth, 2020) indicates that such knowledge amongst buyers of road transport services is lacking. Knowledge about applicable laws and regulations is necessary, along with the consequences for not operating in compliance with these. In addition, knowledge is needed about the challenges and practice experienced by road transport organizations. If such knowledge is in place, those who order transport assignments will have a better foundation in how to design contracts. Education and training of employees who work with transport assignments could therefore enhance work-related road transport safety.

Control sanctions are also highlighted in this study as a factor that could influence safer work-related road transport. It is claimed that control sanctions are necessary in order to control HGV road safety. The lack of regulatory control serves to ignore fly-by-night road transport organizations. However, many of today's control sanctions are directed towards the lowest level of the system – drivers/operators. These individuals are mostly merely following rules imposed by other actors at higher levels of the system. Therefore, control sanctions should be directed at higher levels of the system. Leveson (2011) argues that instead of rewarding and punishing operator error, a change in the environment or a change in the system, will likely be more efficient in ensuring safety..

As stated earlier, decisions will be affected by the competing goals of production and safety. If a road transport organization struggles to be profitable, it is likely that the organizations will move toward *economic failure*, which is the fourth factor influencing safer road transport with HGVs. Therefore, supranational and national institutions need to understand the economic pressure that road transport organizations experience when implementing statutes and control systems. Newnam et.al. (2015) states that accident analysis in Australia fails to address the economic pressure that influences decisions and actions at the higher level of the system. The present study shows that it is just as important to identify economic pressure at the lower levels in the system. According to this study's participants, economic pressure is a threat to safety. Road transport organizations that experience economic pressure tend to bend laws and regulations and put their production targets before their safety targets. Therefore, it is essential for road transport safety that laws, regulations and the control system be capable of preventing and detecting illegalities so that such practice will not be profitable.

Finally, top and middle management at every level in the system needs to be committed to safety if work-related road transport safety is to be enhanced (Nævestad, Hesjevoll, et al., 2018; Rasmussen, 1997). One important target objective is for every actor to work toward a common goal and implement values that support this goal.

Limitations

There are some limitations regarding the present study. The number of participants is relatively low. There are nine individual interviews and one group interview with eight participants. In total, 17 participants. This number of participants makes it difficult to generalize the findings in this study. However, the participants were chosen because of their extensive knowledge and experience with the road transport industry. Moreover, the participants were highly motivated to use their competence to ensure safer road transport. Therefore, it is likely that the findings indeed provide a picture of the circumstances regarding this study's research question at this moment of time.

It is likely that there are additional actors that may be relevant in the socio-technical system of road transport. However, in this study, the focus have been placed on the "big" actors and not on the details. One actor that is rarely mentioned in this study is the driver of the HGV. Clearly, this actor has a large potential to decrease/increase road transport safety by their driving behavior. However, this study's focus has been on the system level and therefore the explicit challenges occurring at the driver level has been left out. The same goes for challenges concerning the road environment, car manufacturers, etc. More research should be conducted pertaining to the influence these actors may have on general road transport safety.

6.0 Conclusion

The research question for this study was "Who are the actors/components in the complex socio-technical system of road transport for work-related HGV transport and how can they influence safer road transport?"

The most important actors have been identified by this study's participants to be the European union (EU), Ministry of Labour and Social Affairs, Ministry of Transport, the Norwegian Public Road Administration (NPRA), the Norwegian Labour Inspection Authority (NLIA), the Norwegian Police, municipalities, buyers of road transport services, car manufactories, management of road transport organizations and their drivers.

It is assumed that these actors could enhance road transport safety with HGVs by focusing on four factors. These are communication, competence, control sanctions and economy. By prioritizing these factors, one can assume that work-related road transport safety would increase and thereby avoid operation on the fringes of acceptable performance, unacceptable workloads and economic failure.

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Road Traffic Safety for Work-Related Driving with Heavy Goods Vehicles - It’s a Shared Responsibility

This PhD thesis addresses an important topic which is of concern for practitioners in the road transport industry. The thesis asks the overarching research question, how can the relationship between parties and organizational factors influence the management of road traffic safety for work-related driving with heavy goods vehicles (HGV).

In order to explore this question, the thesis uses a qualitative research approach, and consists of an introduction and five separate articles. Article 1 seeks to identify important factors in managing road safety for work-related driving of HGVs by conducting a literature review and proposes an overall framework for how safety training for parties in the system could be executed. Article 2 takes the perspective of road transport organizations and identifies how management decisions can support or constrain road traffic safety for work-related driving with HGVs. Articles 3 and 4 are following up on Article 2, but they take the perspective of the buyer of road transport services and investigate the role of this actor in supporting or constraining road traffic safety. Finally, Article 5 gives an overview of all the actors in the system surrounding road traffic safety for work-related driving with HGVs.