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MSc thesis:

"Exploring the job profile for future platoon truck drivers"

by

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Where innovation starts

Preface

This Master thesis project is the final chapter in concluding my Master studies in Operations Management and Logistics at the Eindhoven University of Technology. The last two years have shown me that I can achieve a lot, as long as I am prepared to work hard for my goals. This is a lesson that I will carry with me in my future career.

In this Master thesis project I have cooperated with drs. Caroline Blom-de Ruiter, as my company mentor, and Leander Hepp from Transport en Logistiek Nederland (TLN). I would like to thank drs. Caroline Blom-de Ruiter for all her support and feedback along the way and for providing me the opportunity to come into contact with interesting people and to give presentations at meetings of the MBO Raad and of the Samenwerkingsorganisatie Beroepsonderwijs Bedrijfsleven (SBB). Also, I would like to thank Leander Hepp for occasionally providing me with some feedback, mainly aimed at the technological aspects of the study.

I would like to thank the Assessment Committee of the university, consisting out of dr. Pascale Le Blanc (1st supervisor), prof. dr. Albert Veenstra (2nd supervisor) and dr. Josette Gevers (3rd assessor) for being involved in this research. I would like to thank dr. Pascale Le Blanc and prof. dr. Albert Veenstra for their enthusiasm and inspiring discussions about this research in the early phase of my study. Their support helped me enormously in designing this study. Also, I would like to express my gratitude towards dr. Pascale Le Blanc and prof. dr. Albert Veenstra for providing me with fair and constructive feedback during the graduation process.

Further, I would sincerely like to thank all the respondents of this study for their willingness to support this research by participating in the interviews. They have provided me with an excellent overview of the current situation of Truck Platooning, of their opinions on the subject and of their expectations about the future of Truck Platooning.

I want to thank Dirk-Jan de Bruijn too, who invited me for the workgroup 'Chauffeur van de Toekomst', of which I already attended two meetings and of which the third meeting is scheduled in the near future. This workgroup aims to create a clear image of the characteristics of the future truck driver. This study hopefully provides all workgroup members with useful insights to reach that goal. Furthermore, Dirk-Jan de Bruijn invited me for the LEF session, a very interesting meeting organized by Rijkswaterstaat, in which the requirements for the Truck Platooning test week (i.e. on public roads) have been further clarified.

Special gratitude goes to friend and colleague student Patrick Langeveld, with whom I have had numerous constructive discussions about both our, totally different, theses. This was of tremendous help.

Last but not least, I would like to thank my family, friends and people who are not specifically mentioned here for supporting me during the graduation process.

Thank you all,
Joost Vos Eindhoven, August 2018

Management summary

This study has aimed to identify the implications that Truck Platooning will have for the profession of future truck drivers. Truck Platooning is defined as the act of, figuratively speaking, coupling multiple trucks together in a convoy of which only the leading truck has to be driven manually and in which the following trucks are 'attached' electronically to each other so that they can respond almost instantly to each other's movements. Therefore, the distance between those trucks can be shortened so that fuel can be saved.

Truck Platooning is a topic about which a solid amount of literature became available the last few years. Most of this literature focuses on the technological aspects of Truck Platooning. There is far less literature available about the involvement of humans, especially about the truck drivers, in the implementation process of Truck Platooning. In order to fill this gap in the literature, the focus of this study is on the expected implications of Truck Platooning for truck drivers' jobs. The main research question was *"How will the implementation of Truck Platooning influence the profession of truck drivers?"*. In order to be able to answer this question, several sub-questions have been formulated.

This thesis reports on a qualitative study in which face-to-face interviews with several stakeholder groups have been conducted to create a clear image of the opinions and expectations of the most important stakeholder groups involved in the Truck Platooning implementation process. The interviews were semi-structured and based on an interviewing scheme that was constructed beforehand by the interviewer so that every respondent was asked exactly the same questions. Interviews were conducted with 23 respondents from several stakeholder groups. These stakeholder groups consisted of 1) truck drivers, 2) employees of logistic services providers, 3) the ministry of Infrastructure and Waterways, 4) Rijkswaterstaat, 5) the BOVAG, 6) the CBR, 7) the Sector Institute Transportation and Logistics (STL), 8) truck manufacturers, 9) the RDW, 10) an insurance firm, and 11) labor unions. The interviews were conducted at the respondents' working locations, they were tape-recorded and the average duration of an interview was 1:18 hours. The interviews have been fully, but non-verbatim transcribed. Consequently, several criteria were developed to enable the deletion of irrelevant sections within the transcripts. After deleting the irrelevant sections, the initial coding scheme was made by labeling each (relevant) fragment, which was the unit of analysis in the coding process. The labels, or codes, in the initial coding scheme were restructured so that a new coding scheme was created that was usable for the data analysis. Since all fragments were eventually placed under labels corresponding with the different sub-questions, the data analysis could be conducted in a structured way and each sub-question was answered separately before formulating an answer to the main research question.

The main finding of this study is that the profession of a platooning truck driver will require the truck driver to possess more skills and knowledge than the current truck driver. Examples of skills and knowledge that future platooning truck drivers require are that they should be able to work with the platooning systems, for which they require knowledge about these systems, that their anticipation skills should improve, and that the truck drivers should be capable to quickly switch from passive driving (i.e. platooning) to manual driving. Some of

these skills and knowledge are also required for contemporary truck drivers, but these will become more important for the future platooning truck drivers. No skills or knowledge will become obsolete, even though the platooning truck driver will be less involved with the main driving task. These higher requirements are likely to lead to an upgrade of (the image of) the truck driver's profession, for which the educational level is also likely to increase from mbo-2 to mbo-3/4. Also, adaptations to the mindsets of truck drivers are found to be required for a successful Truck Platooning implementation process. Platooning truck drivers ideally have a mindset that is open to innovative concepts, they should be willing to cooperate (also with truck drivers from competing companies) and they should be able to trust the platooning systems.

The expectations about when Truck Platooning could be commercially implemented varied more between truck drivers themselves than between respondents in the other stakeholder groups, while was expected that it would be the other way around due to the significantly larger sample size of the latter group (19 versus 4 respondents in the other stakeholder groups and the truck drivers group, respectively). Another interesting finding was that although truck drivers unanimously expect that their jobs' contents will significantly change due to Truck Platooning, the other stakeholders did not agree upon this stance. Several respondents expect no, or only minor, consequences of Truck Platooning for the jobs of the truck drivers, while other foresee an upgrade of (the image of) the truck driver's job due to the additionally required skills and knowledge for platooning truck drivers. There was, however, a debate between truck drivers whether or not the mental workload of their jobs is likely to increase. Another interesting finding is that most respondents agree that truck drivers cannot perform alternative tasks while platooning, and that this would only be feasible if, and only if, the platooning systems are extremely safe so that the truck driver does not have to monitor the systems continuously or does not have to be ready to intervene. Contrary to the expectations, none of the truck drivers feared for leasing his/her job in the foreseeable future and they expected that all contemporary truck drivers will be capable to successfully become platooning truck drivers. Finally, it was unforeseen that some respondents would plea for abolishing the Code95 requirement of following 35 hours of refreshment courses every 5 years. The rationale underlying this opinion is that truck drivers and their employers should be sensible enough to engage in refreshment courses whenever required (e.g. when one anticipates that the truck driver's job will change and skills and knowledge should thus be refreshed). The required adaptations in the current truck driver's job profile identified by this study have been summarized in a job profile for future truck drivers, which is displayed schematically below. An elaborate description of how this job profile was created can be found in Paragraph 5.5.

Job profile future truck driver

Educational demands/ educational level	mbo-2, driving license C, additional certificates (i.e. LZV and/or Truck Platooning) Future truck driver should possess more skills and knowledge Therefore, level mbo 3/4 will be required
Avoidance opportunities	Is a chance-creating occupation

Legend

Increases	Remains equal	Decreases	Is new

	Tasks	Job-related knowledge, skills and mindsets
Executing tasks	Checking the status of the vehicle and equipment, establishing the connection	Knows the instructions and regulations, checks vehicle for damage, system indicators and fuel
		Connects the trailer
		Attaching vehicle signaling
		Ability to safely merge in a platoon
		Ability to safely split from a platoon
		Inputting the platooning systems' parameters
	Picking up and delivering cargo	Uses a tachograph
		Checks quantities, type of cargo and for visual damages, draws up (damage) reports
	Driving the truck manually	Adapts driving style to cargo that is transported
		Maneuvers the truck in complex traffic situations
		Possessing knowledge about ADAS systems
		Anticipating on complex traffic situations
		Driving efficiently
		Knows (inter-)national regulations
	Driving in platooning mode (as leader)	Adapts driving style to platoon length
		Trusting the platooning systems
		Possessing knowledge about platooning systems
		Anticipating on complex traffic situations
		Driving efficiently
		Knows (inter-)national platooning regulations
	Monitoring the platooning process (as follower)	Trusting the platooning systems
		Interpreting platooning systems
		Anticipating on errors in platooning systems
		Resolving errors in platooning systems
		Being able to quickly take over vehicle control
		Resistance to stress
	Organizing and checking the process of loading cargo into the vehicle or loading and unloading him-/herself (with the use of tools)	Knows loading and carrying techniques and stacks, stows, unstacks, and anchors the load according to instructions and weight distribution
		Knows modalities of loading and unloading and works according to the loading plan, the route planning and rules for loading safely
		Estimates the load, knows and applies ergonomic lifting and raising techniques
	Registering follow-up and activity information	Uses on-board computer and communication devices
		Keeps up with information about the execution and, if applicable, reports deviations to responsible supervisor
	Checking packing list together with customer	Aiming at the needs and expectations of the customer
	Communicating with customers	Aligning with customer during loading and unloading
		Possessing social skills
		Speaking multiple languages (among which English)

Figure 1 – Future truck driver's job profile

Job profile future truck driver (continued)

Legend

Increases	Remains equal	Decreases	Is new

	Tasks	Job-related knowledge, skills and mindsets
Regulating tasks	Communicating with internal and external services (e.g. roadside assistance and emergency services)	Asks for help in case of problems
		Possessing social skills
		Speaking multiple languages (among which English)
		Thinking along with planners about ideal moment and locations for platoon formations
		Knowledge about communicating platoon behavior with other platoon members
	Executing urgency measures in the event of an accident	Knows prescriptions and regulation, estimates the kind and scale of the breakdown, accident or other emergency situation
Supporting tasks	Determining the route according to the characteristics of the vehicle, the load and the delivery priorities	Uses navigation material (route planner, GPS, road maps, city maps)
		Executing a route check (traffic jams, accidents, roadworks)
	Checking the presence and validity of boarding and transportation documents	Knows customs formalities and reports problem concerning boarding and transportation documents to responsible supervisor
	Executing basic maintenance	
	Cleaning the vehicle	
	Maintaining and strengthening job-related knowledge	Attends trainings and courses in the context of Code95
Additive tasks	Executing alternative job tasks while platooning	Being able to execute alternative tasks
	Warning the services involved in case of an emergency situation	Know prescriptions and regulation, reports the problem to the qualified institution and the responsible supervisor
	Guarantees the safety of the cargo	Is aware of the value of the cargo and takes preventive measures against theft

Figure 1 – Future truck driver's job profile (continued)

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1. Introduction

While Europe is rapidly recovering from the economic crisis that started roughly a decade ago, the congestion of the European highway network and the emission of greenhouse gasses are also increasing again. Closer to home the effects of the prospering economic climate can also be observed, for example by the swift increase in the amount of trucks and passenger cars on our local road networks. The economic prosperity has led to recent technological innovations in the automotive sector. With the fast adoption of Advanced Driving-Aid Systems (ADAS) (Hoeger, et al., 2008) in contemporary vehicles, drivers have to perform less actions manually when driving such a vehicle, as these systems take over some of the driving functions to a certain extent (i.e. called Levels Of Autonomy). This adoption of ADAS paves the way for a successful implementation of Truck Platooning, which basically is the act of, figuratively speaking, coupling multiple trucks together in a convoy of which only the first truck has to be driven manually. The following trucks are 'attached' electronically to each other and respond almost instantly on actions of other 'platoon members' by using Vehicle-to-vehicle communication (V2V) systems (i.e. Wi-Fi), a Global Positioning System (GPS), radars and cameras. With the European initiative called ENSEMBLE, the V2V communication systems are aligned so that multi-brand Truck Platooning (e.g. DAF, Volvo and Scania trucks can operate within the same platoon) is enabled, which makes Truck Platooning more practically feasible (Hoedemaeker, 2018).

Platooning can be seen as a stepping stone towards completely autonomous mobility, which is expected to drastically change the ways in which people and goods will be transported in the future. The main advantages of Truck Platooning are 1) that trucks can drive closer to one another (an inter-truck distance of only 0.3 seconds is already technologically possible), thereby alleviating the congestion issues and decreasing fuel consumption (and thus also decreasing pollution) due to a slip-stream effect, and 2) that the number of traffic accidents is expected to decline. The roads will become safer, since the driver can be relieved from stressful driving conditions (i.e. heavy traffic and bad weather conditions), in which more accidents tend to happen (Chang, Chu, Lin, & Lui, 2012; Treat, et al., 1979). Besides solely presenting the advantages of Truck Platooning, it must be noted that the implementation process of an automation effort like Truck Platooning is very likely to result in challenges for the human operators (i.e. truck drivers) in unintended and unexpected ways (Parasuraman & Riley, 1997). Also, the tasks of transport planners (i.e. letting the trucks travel from their origin to their destination as efficiently as possible) will rapidly become more complex as the number of platooning-capable trucks increases. This is because the length of the platoon positively relates with the efficiency in terms of (overall) fuel consumption. However, if this implies that some trucks have to wait for a long time before being able to attach to a platoon, this reduces the efficiency in terms of time. Therefore, transport planners will have to search continuously for the most optimal solutions of platoon formations so that the platoon length is maximized while minimizing the amount of time that trucks have to wait in order to become part of a platoon. Finally, there are some legislation issues surrounding Truck Platooning, of which the most prevalent is the issue of whether or not truck drivers are actually 'driving' the truck and thus have to adhere to the current legislation about driving and resting times.

Aiming to be ahead of the technological developments, Transport en Logistiek Nederland (TLN) recently has filed an amendment with the World Road Transport Organization (IRU; International Road Transport Union) that aims to loosen the driving and resting times legislation, so that the technological developments do not become restricted by such legislation. If this amendment gets accepted, the truck can continue driving without the requirement to stop to let the driver rest, which can lead to strong efficiency benefits of Truck Platooning (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017).

1.1. Objective and research questions

The main aim of this Master thesis is to provide an answer to the question what the implications will be when Truck Platooning will be utilized on a large scale in commercial contexts. These implications can be categorized as implications for road usage, implications for (inter-)national economies and implications for the humans involved in the trucking business. Because of the existence of a 'gap' in the literature focusing on the consequences of Truck Platooning for truck drivers, this Master thesis focusses on this last category in order to fill this gap. Therefore, the research aim of this study is formulated as:

"Extending the scientific research on the implications for truck drivers of Truck Platooning implementations in order to identify the skills, knowledge and occupational mindsets required for the future profession of truck driver."

The corresponding research question of this study is formulated as:

"How will the implementation of Truck Platooning influence the profession of truck drivers?"

The answer to this overall question will be sought by looking for answers on the following sub-questions:

1. *"How do truck drivers perceive the innovation of Truck Platooning?"*
2. *"How do other stakeholders perceive the innovation of Truck Platooning?"*
3. *"What factors are likely to facilitate or to speed up the Truck Platooning implementation process?"*
4. *"What factors are likely to block or to slow down the Truck Platooning implementation process?"*
5. *"What are the implications of Truck Platooning for truck drivers' job resources while driving?"*
6. *"What are the implications of Truck Platooning for truck drivers' job demands while driving?"*
7. *"What are (safe) options for alternative job tasks for truck drivers while driving in a platoon?"*
8. *"What skillsets should a truck driver possess in order to successfully operate a platooning truck?"*
9. *"What knowledge should a truck driver possess in order to successfully operate a platooning truck?"*
10. *"What occupational mindsets should a truck driver possess in order to successfully operate a platooning truck?"*
11. *"What changes should be made in the education process of new truck drivers so that they are properly trained to operate a platooning truck?"*

These questions are formulated based on either discussions with experts in the field of road logistics or on the earlier conducted literature study (Vos, 2018a) about the current status of Truck Platooning. By finding answers on the above sub-questions, a sound answer to this research's main question can be formulated.

The current study also aims for a specific deliverable in the form of providing indications for a job profile by applying the Function Profile Methodology by Oeij et al. (2017) to the job of future truck drivers (see Paragraph 5.5.) who - with certainty - will be confronted with (semi-)autonomous trucks that will engage in platooning solutions. In order to be able to compose a well-designed job profile, it is of utmost importance that it is perfectly clear what skills, knowledge and occupational mindsets (i.e. attitudes) are required of the applicants in order to qualify for this job, which will be significantly different from the current job of a truck driver (see Appendix 1 – Example of visual representation job profile according to FPM). Having determined the required skills, knowledge and occupational mindsets for future truck drivers, this research also aims at providing recommendations to several stakeholder groups in the Truck Platooning implementation process.

1.2. Platooning scenarios

The scenario that is most practically feasible in the near future, because little infrastructural investments will be required, is that platoons form while already driving on the highway (i.e. ad-hoc platoon formation or 'on-the-fly platooning'), meaning that the driver will remain in the cabin of the truck, although transferring the operational controls to the platooning systems. The presence of the driver enables him/her to intervene in case the systems exhibit errors, thereby not requiring a one-hundred percent safe system. Another realistic infrastructural scenario is that platoons form and split at (dis)connection bays (i.e. special parking lots for platoon formation and splitting) alongside highways or at important distribution locations, so that in between those (dis)connection bays only the first truck (i.e. the leader) has to be manually driven while the rest can automatically follow. This scenario will require more infrastructural investments (i.e. building those (dis)connection bays) than the 'ad-hoc' scenario. The most realistic and short-term oriented scenario utilizing those (dis)connection bays is that the driver remains in the truck's cabin while platooning between those (dis)connection bays. This is mainly due to the legislation that somebody has to be available to take over the controls in case of an error (i.e. in a follower position). This implies that the truck driver is not allowed to rest while driving in a platoon. The next level within platooning scenarios also requires the abovementioned infrastructural investments, but can only be realized after the legislation is loosened so that there does not need to be a driver in the truck's cabin anymore. In this case, when the platoon arrives at the disconnection bay, there are truck drivers waiting to drive the last mile towards the truck's destination. In this scenario there thus is only one truck driver required to move the whole platoon (with a length of X trucks) from the connection bay to the disconnection bay. Due to the short-term feasibility of the first scenario (i.e. the ad-hoc platoon forming scenario), the remainder of this chapter will mainly focus on this type of Truck Platooning.

The activity of platooning can be split in the following three actions or levels (Hallé & Chaib-draa, 2004; Hobert, 2012):

1. Longitudinal control (adjusting speed to the preceding vehicle(s));
2. Lateral control (keeping the vehicle in its lane and enabling it to make sideway movements); and
3. Maneuver coordination (formation and splitting of platoons and the merging of the platoon with other traffic flows).

With regard to the coordination of platoon maneuvers, several coordination strategies are defined by Hobert (2012) (i.e. the ad-hoc coordination strategy) and Hallé & Chaib-draa (2004) (i.e. the 1) hard-centralized, 2) centralized, 3) decentralized and 4) teamwork coordination strategies; for a visualization see Figure 4). These coordination strategies will be explained in more detail in Paragraph 2.2. The 'teamwork model' was proposed by Hallé & Chaib-draa (2004) as a new platooning coordination strategy, since it can fulfill the task of a split or a merge in less time than the hard-centralized, centralized and decentralized coordination strategies, while only requiring a number of messages between trucks that is the average of the other three coordination strategies.

Topics related to platoon maneuvers are that of the allocation of roles for platoon members (i.e. which truck performs which action at what moment?), the allocation of driving functions (i.e. which tasks are performed by the driver and which by the platooning systems?) and the processes of transitioning control between the human operator and the platooning systems. These topics will be addressed more in-depth in Chapter 2.

1.3. Human involvement and safety aspects in Truck Platooning

Several researchers (Endsley & Kaber, 1999; Save & Feuerberg, 2012; Sheridan & Verplank, 1978) have distinguished level of autonomy taxonomies, of which in the literature study preceding this master thesis (Vos, 2018a) is determined that Save and Feuerberg's (2012) Level Of Autonomy Taxonomy (LOAT) is the most suitable automation taxonomy for studying Truck Platooning (see Appendix 2 – The Level of Autonomy Taxonomy (LOAT)). In the LOAT, the phases of 'information acquisition', 'information analysis', 'decision and action selection' and 'action implementation' are distinguished. Systems can be classified regarding the level of automation of every phase. Truck Platooning, which uses a combination of ADAS, is classified in the medium to high automation levels within the LOAT. In other words, the capabilities of the ADAS used in a platooning activity determine where the activity of Truck Platooning can be placed within the LOAT. Although the LOAT was originally developed for the aviation industry, the parallels with Truck Platooning are clearly visible (e.g. by the fact that all LOAT phases are relevant in Truck Platooning applications as well). In this thesis, the LOAT phases are used as preliminary guidelines in formulating interview questions.

Driver functions that can be taken over by ADAS are accelerating and braking (i.e. by (Coordinated) Adaptive Cruise Control ((C)ACC)), lane switching (i.e. by a 'lane assist' system) and remaining in the predefined section of a lane (i.e. by a 'lane tracking' system). This predefined section of the lane is not always the exact middle of the lane. Sometimes it is beneficial to let some trucks in a platoon drive a few centimeters left or right from the exact

middle in order to relieve the pressure on the road surface. Besides that, truck drivers have to be trained to work with the new equipment in their trucks, whereas other road users will need some time to get used to the behaviors of platooning trucks. Therefore, it is logical to implement Truck Platooning gradually.

Obviously, it is of utmost importance that the systems mentioned before are extremely safe. Both absolute and perceived safety play an important role in the Truck Platooning implementation process. Since an accident cannot always be prevented by technology, ethical decision-making is of great importance in the process of programming the accident-prevention (or damage-minimization) algorithms that guide the ADAS. The reasoning behind the trolley problem, a famous dilemma in ethics literature, is an example in which the decision has to be made whether some individuals should be sacrificed in order to save some other individuals, and if so, which individuals should be sacrificed and who should be spared (Lin, 2016; Nyholm & Smids, 2016). In this dilemma, a trolley train is uncontrollably driving a train track in the direction of multiple persons on the tracks, who will certainly be killed in case of a collision. In this issue, one person has the possibility to pull a switch that redirects the trolley train to a side-track, a situation in which less persons will be killed by the collision. The ethical question here is whether somebody may and should make such decisions over life and death. In the Truck Platooning scenario, the programmers of the platooning software have to decide on these ethical dilemmas.

Although being actively engaged in the driving tasks is the best, and quickest, way to detect system errors (Endsley & Kiris, 1995), critics of automation technology have found that people having experience with manually operating the systems, in this case manually driving a truck, perform significantly better in detecting whether an intervention is needed than operators who only have experience with the automated system (i.e. trucks that engage in platooning activities) (Kessel & Wickens, 1982). Kessel and Wickens' (1982) explanation for the superiority of operators who have experience in manually operating the systems is that those operators know, by their hands-on experience, on which visual cues they should focus, thereby enabling them to detect system malfunctions earlier and more accurately. Another critical view comes from Wilde's (1988; 1998) Risk Homeostasis Theory (RHT), which states that people adapt their behaviors to maintain a static target risk level. In the act of driving a truck this means that the driver performs riskier behavior when the (perceived) safety of the systems increases, thereby mitigating the increased safety effect of the automation systems. Safety, however, does not only mean accident-prevention or damage-minimization, but the safety of the platooning systems should be seen multi-dimensionally, so that a distinction can be made between 'absolute safety', concerning the risks of traffic accidents, and 'digital safety', concerning the difficulty to hack into the platooning software. Digital safety is important in Truck Platooning, because the ability to take over a truck while it is platooning can provide malicious parties with an extremely hazardous weapon. Therefore, it is very important that the platooning software is continuously improved as an attempt to block out hackers (Garfinkel, 2017).

As the preceding sections clarified, Truck Platooning will have major influences on the way in which truck drivers will be performing their jobs when they have to engage in Truck

Platooning activities. The tasks for truck drivers will change significantly, which potentially will lead to a whole new set of human factor issues (Merat & Jamson, 2009; Parasuraman, Sheridan, & Wickens, 2000). Research has argued that the main areas in which human performance consequences will manifest themselves are the fields of mental workload, driving skills, situational awareness (SA) and trust in automation systems (Millewski & Lewis, 1999; Moray, Inagaki, & Itoh, 2000; Parasuraman, Sheridan, & Wickens, 2000; Stanton & Marsden, 1996; Woods, Johannesen, Cook, & Sarter, 1994). These categories of human performance aspects will form the key concepts in this study for retrieving data from the respondents.

1.4. Report outline

The next chapter discusses the theoretical framework used in this study. Several categories of literature that has been incorporated have been created. These categories are 1) the occupational implications for truck drivers, 2) the communication in Truck Platooning, 3) the allocation of functions between man and machine, 4) the transitions of control (TOC), 5) the way in which man and machine interact with each other, 6) safety-related issues, 7) ethics-related issues, and 8) human performance consequences. Within the category of human performance consequences, this study focused on the changes in mental workload, on the implications for truck drivers' driving skills, on the ability for truck drivers to remain aware of their surroundings (i.e. situational awareness) and on the trust one has in automation systems. Consequently, Chapter 3 discusses all methodological decisions that have been made. First, the rationale behind selecting the research elements for this study will be explained in Paragraph 3.1., followed by a roadmap of the creation of the interviewing schemes in Paragraph 3.2. Paragraph 3.3. explains the decisions surrounding the analysis of the data. Chapter 4 reports on the application of the methodology described in Paragraph 3.2. (i.e. the creation of the interviewing schemes that were used for the data collection). Chapter 5 focusses on the analysis of the interview data and describes in Paragraph 5.1. how the data was prepared, and in Paragraph 5.2. how it was coded. Paragraph 5.3. describes how the initial coding scheme was transformed into the final coding scheme that was used to elicit answers on the research questions. These answers are presented in Paragraph 5.4. Paragraph 5.5. discusses the job profile for the future platooning truck driver that is constructed out of this study's results by using the FPM methodology. Also, this chapter discusses the discrepancies with the former truck driver job profile, which can be found in Appendix 1 – Example of visual representation job profile according to FPM. In Chapter 6, conclusions are drawn, the main research question is answered, and the shortcomings of this study, suggestions for further research and recommendations are discussed.

2. Theoretical Framework

In this chapter, the findings of the preliminary literature review are summarized in order to provide a theoretical framework that forms the foundation for this study (Vos, 2018a). First, in Paragraph 2.1., the occupational implications of Truck Platooning and the Function Job Profile by Oeij et al. (2017) are discussed, while the remainder of the chapter indicates issues related to Truck Platooning that will have, each in their own way, consequences for the occupation of truck drivers. Paragraph 2.2. discusses the communication that is needed in platooning activities, since communication is needed when the platoon is formed or split, when specific functions are being transitioned between the driver and the truck itself, but also to communicate deviations from normal situations (e.g. a traffic deviation) to the following vehicles. Furthermore, paragraph 2.2. briefly discusses coordination strategies. The topic of deciding which functions have to be fulfilled either by the driver or by the platooning systems is discussed in Paragraph 2.3. The way in which control is being transitioned between driver and the platooning systems is the topic of Paragraph 2.4. In Paragraph 2.5., the interaction between human operators and automated systems is explored, and several automation taxonomies are presented before deciding which one is most applicable for Truck Platooning. The topic of Paragraph 2.6. is the safety issues around Truck Platooning and Paragraph 2.7. discusses the ethical issues. This chapter is concluded by Paragraph 2.8., which explores the consequences of automation efforts for humans, focusing on mental workload, the skills levels, situational awareness and trust in automated systems.

2.1. Occupational implications for truck drivers

Although the implementation of Truck Platooning will have consequences for several jobs, not only in the logistics sector, but also in other sectors (e.g. driving aid system programmers, traffic regulators, customs officers, police officers and insurance employees), this study focuses on the implications for truck drivers, since they will be the ones operating the platooning trucks. Because there are many differences between truck drivers, mainly coming from the type of goods they are hauling, for the sake of feasibility this study will mainly focus on the characteristics that are common for all types of truck drivers. The current job profile of a truck driver is made explicit in a competence document (Sectorkamer mobiliteit, transport, logistiek en maritiem, 2017) that contains descriptions of the tasks that somebody in a particular job should perform and indications of the knowledge required for doing so (Oeij, van der Torre, van de Ven, Sanders, & van der Zee, 2017). Since the job contents for a platooning truck driver will change significantly, adaptations in the job profile's skills and knowledge requirements are required so that logistic services providers can effectively search for competent future truck drivers.

Oeij et al. (2017) have developed a Function Profile Methodology (FPM) that leads to a job profile with the inclusion of expected changes in the tasks and the workload for specific tasks within the job. The FPM approach is built on the sociotechnical perspective, which distinguishes four types of tasks; 1) executing tasks, 2) regulating tasks, 3) supportive tasks and 4) additive tasks (Oeij, van der Torre, van de Ven, Sanders, & van der Zee, 2017; Vaas, Dhondt, Peeters, & Middendorp, 1995). *Executing* tasks are the core tasks of the occupation

and these are generally mentioned in the job title (Oeij et al., 2017). The executing tasks are typically directly related to the production of the product or the delivery of the service for which the person is responsible. For truck drivers, examples of these tasks are checking the truck for defects, (un)loading the goods and driving the truck. Among the *regulating* tasks are the tasks that have to be fulfilled in order to solve the problems that unexpectedly occur (Oeij et al., 2017). This type of tasks is generally not formally described, but encompasses the control options one has within the function. Those control options can be job autonomy, contacting possibilities and organizational tasks. Choosing an alternative route towards the destination in the event of a traffic accident is a typical example of a regulating task for a truck driver. Another example indicating that the truck driver has relatively high autonomy on regulating tasks is the situation in which the truck driver is allowed to decide in what order to make the deliveries. As the name suggests, *supportive* tasks directly support the actual work. They can be divided into preparatory tasks and tasks that make sure that the core tasks can be executed properly and without disturbances (Oeij et al., 2017). Examples of preparatory tasks are the identification of the order of (sub-)tasks, determining the way in which the task should be executed, acquiring the required goods and (pre-)programming the equipment. Tasks that are needed to enable proper execution of core tasks without disturbances are, for example, carrying out maintenance on machinery, administrative tasks, quality control and the training of new personnel. In the occupation of a truck driver, occasionally cleaning the truck and checking the transportation documents are examples of supportive tasks. *Additive* tasks are the tasks that are not explicitly part of the job, but are implicitly supporting the job. These are not necessary for the job itself, but might be beneficial for the functioning of the team, the department or organization as a whole (Oeij et al., 2017). Among those tasks are cooperating in innovation efforts, monitoring competitors and voluntarily visiting job-related conferences or training sessions. Employers often do not explicitly describe those tasks as needed, but they might be among the desirable competences. Examples of such tasks for truck drivers are warning rescue services when (s)he sees an accident happening, going to special trucker community events and participating in (platooning) truck testing (either on the road or in a simulator). Within the FPM, a colored scheme is used to indicate which job components are likely to increase or decrease in intensity, which components stay the same and which components are new (Oeij et al., 2017). A job profile constructed according to the FPM consists of the following three parts: 1) an elaborate description of the job with information on general, technological and job market developments (that can lead to indications about how a recruiter can establish a match between an employer and an applicant), 2) a visual representation of the job components (see, for an example, Appendix 1 – Example of visual representation job profile according to FPM), and 3) a general additive description of the function itself in which often the social and behavioral desired competences are described. Examples of these social and behavioral competences are the ability to socialize with customers and other truck drivers, and the attitude to report issues observed while driving (e.g. a traffic accident on a main road leading towards the company's distribution center) immediately to the employer. Oeij et al. (2017) suggest to always validate the newly constructed job profile with leading organizations and branch organizations in order to make sure that the expectations about the future requirements are accurate.

2.2. Communication in Truck Platooning

In organizing the forming and splitting of platoons, a lot of information sharing is needed. Information between trucks (e.g. about their exact positions or about the actions they are about to undertake), between trucks and the infrastructure (i.e. Vehicle-to-infrastructure (V2I)), and, in case the formation of platoons is planned by an external party, between the trucks and the platoon planners. The Dutch research institute TNO has identified that the process of planned match-making for trucks is a complex endeavor that is still being developed (Janssen, 2017). The main difficulty arises from the fact that the transportation schedules are very tight in general. Ad-hoc (i.e. on-the-fly) formation would be easier to realize if all trucks would be slightly modified by installing communication devices and location tracking devices (Janssen, 2017). As this is an easy to realize modification, the on-the-fly platooning scenario is deemed most feasible in this study and therefore, the remainder of this study will focus on this type of platooning.

Hallé and Chaib-draa (2004) provided an overview of the data connections within a platooning action (see Figure 2), independent from whether it is a formation or a split action. It is important to note that these authors assume that platoons form while the individual trucks are already driving on the highway, instead of forming at (dis)connection hubs.

In the Guidance layer, the state of the vehicle and its surroundings are sensed and the actuators are activated that take care of longitudinal and lateral movements (Hallé & Chaib-draa, 2004). More specifically, the sub-layer Intelligent Sensing receives input data from several types of sensors and sends this data, accompanied by the vehicle status, to the Management layer, which consequently sends back the desired state to the Guidance layer. The Vehicle Control sub-layer then activates the longitudinal and lateral controllers.

The task of the Management layer is to coordinate all the platoon members' movements, for which it uses data from the Guidance layer, from the Traffic Control layer and for which it has to assess whether the locations of the trucks are safe when they either stay in their current lane (i.e. intra-platoon coordination) or if they change lanes (i.e. inter-platoon coordination) (Hallé & Chaib-draa, 2004). The Coordination sub-layer controls both the inter-platoon movements (handled by the Linking module) and the intra-platoon movements (handled by the Networking module). The Linking module receives suggestions or actions to perform from the Traffic Control layer, it reasons about the place of the truck on the highway and coordinates the lane change with other vehicles, thereby performing inter-platoon coordination (Hallé & Chaib-draa, 2004). If a truck wants to merge with a platoon or wants to split, the Networking module takes care of the platoon's stability, since this module is responsible for intra-platoon coordination (Hallé & Chaib-draa, 2004).

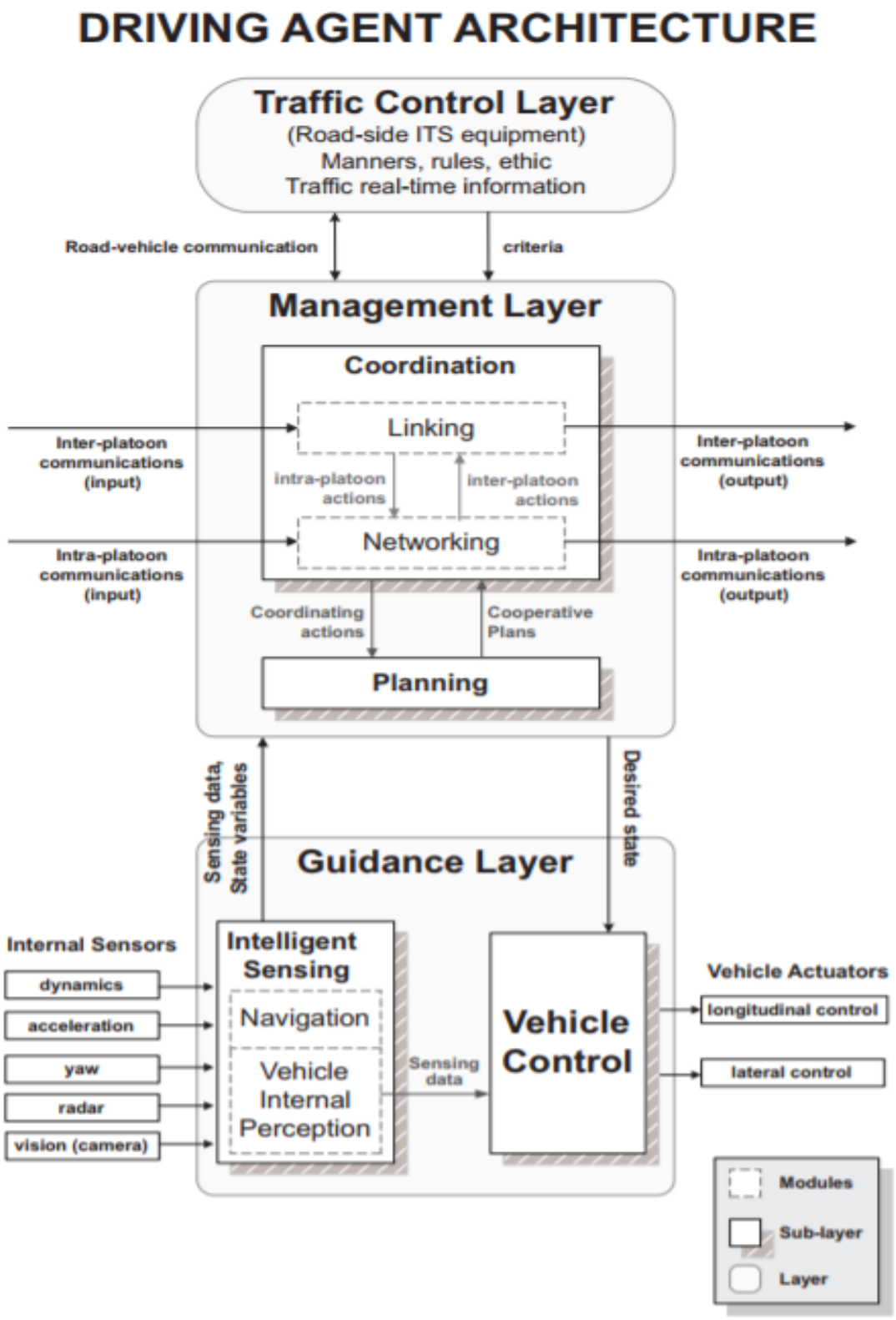

Figure 2 – Hierarchical driving architecture[1]

[1] Source: Hallé & Chaib-draa, 2004, p. 5

Figure 3 shows how a merge and a split are performed. When a vehicle (L2) wants to enter a platoon, it has to drive next to or behind the existing platoon. The entering vehicle then has to send a formation request to the leading vehicle (L1). If L1 accepts this request, L1 first arranges that a safe space is created between the following vehicles before communicating back to L2 that it is allowed to enter and where the safe space is exactly. L2 then has to alter its speed so that it is next to the empty spot before initiating the lateral movement. When L2 sends a signal back to L1 that it has entered the platoon, L1 signals all other following vehicles that the distance in between the vehicles can be reduced to the normal platooning distance. If a following vehicle has to leave a platoon, the steps above occur in the opposite direction (see the right column in Figure 3). All the communication steps described above are transmitted through the Networking module. The Planning sub-layer is used to plan a series of merging and splitting activities.

The Traffic Control layer is a road-side systems consisting of traffic signals, sign boards, Vehicle-to-infrastructure (V2I), or actually the other way around, communications, but also social laws, social rules, guidelines about how to respond to specific (bad) weather situations and other types of ethics (Hallé & Chaib-draa, 2004).

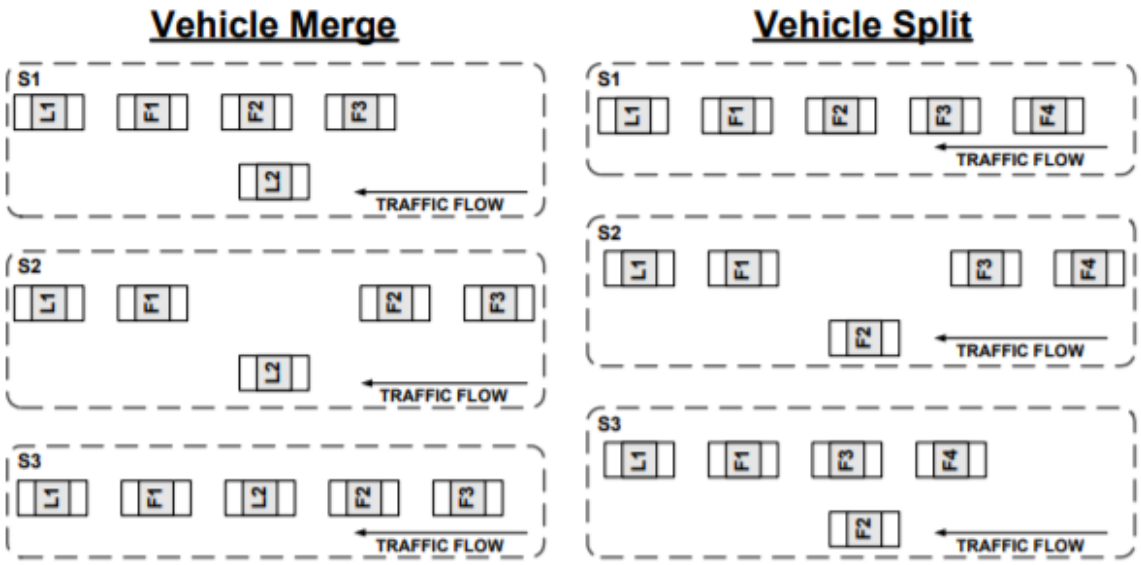

Figure 3 – Three-stage models of merging (formation) and splitting[2]

The ways in which platoons form and split are arranged by coordination strategies, of which the most basic version is that trucks randomly encounter each other on the highway and form a platoon together. This is called the ad-hoc coordination strategy (Hobert, 2012). If all communication goes through the platoon leading truck, it is called the centralized coordination model and if only the trucks that need to perform an action communicate with each other, thereby minimizing the amount of messages being sent, it is called the decentralized coordination model (Hallé & Chaib-draa, 2004). Within the centralized model, a distinction can be made between 'hard-centralized' (i.e. the merging vehicle is standardly

[2] Source: Hallé & Chaib-draa, 2004, p. 4

asked to 'attach' at the platoons rear end) and 'centralized' (i.e. the optimal location in the platoon for the merging vehicle is sought). Hallé and Chaib-draa (2004) have proposed a new platoon coordination strategy, called the 'teamwork model', in which predefined roles are allocated to all platoon members (Hallé & Chaib-draa, 2004). This coordination strategy is called the teamwork model because most platoon members are involved in tasks and they communicate whenever this is required by the specific task(s), which can be seen in Figure 4. The teamwork model has resulted in split maneuvers to be completed approximately 3 seconds faster (on a 34-37 seconds activity duration), while requiring the average amount of messages when compared to the three other coordination models (Hallé & Chaib-draa, 2004). Figure 4 summarizes the message flows for the split and merge tasks under the four models.

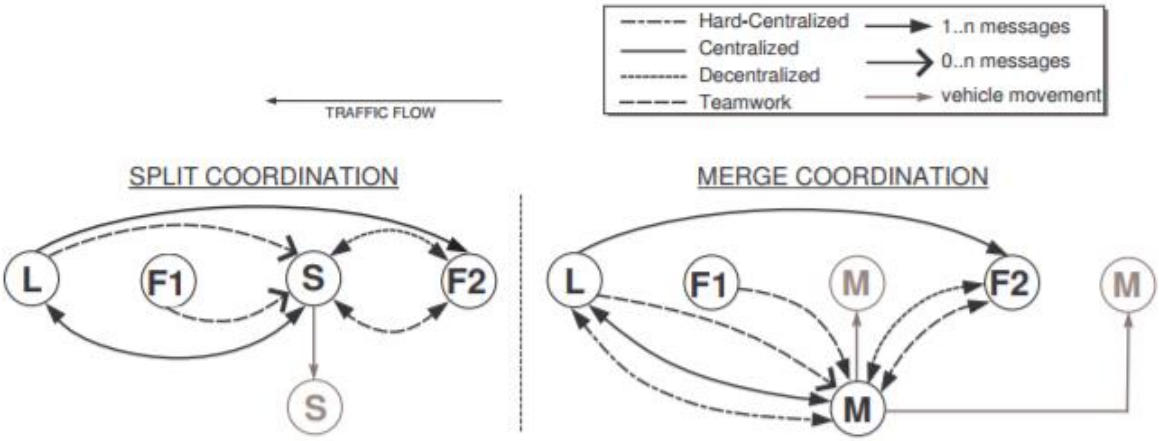

Figure 4 – Four coordination models of the merge and split tasks[3]

2.3. Function allocation

From the literature it becomes clear (see Figure 5) that it is important to have a clear separation of driving functions before being able to allocate functions to either the driver or the automated systems (Singleton, 1989; Stanton & Marsden, 1996). As was identified in the preliminary literature study (Vos, 2018a), Marsden's (1991) Hypothetical-Deductive Model (HDM) is the most preferable function allocation model, consisting out of the following five steps:

1) Specification (system requirements are specified);
2) Identification (system functions are identified and defined in terms of their (desired) inputs and outputs);
3) Hypothesize solutions (specialist teams advance hypothetical design solutions);
4) Testing and evaluation (experiments are conducted and data is gathered to check whether the function design is usable); and
5) Optimization and design (errors are corrected by iterations).

[3] Source: Hallé & Chaib-draa, 2004, p. 7

Besides the seven driver functions distinguished by Webster et al. (1990) (i.e. 1 = signalling, 2 = steering, 3 = accelerating, 4 = waiting, 5 = yielding (i.e. giving way to other road users), 6 = stopping, 7 = calculating), it is argued in the literature study that operating and monitoring the satellite navigation system should be added to this set of driver functions (Vos, 2018a).

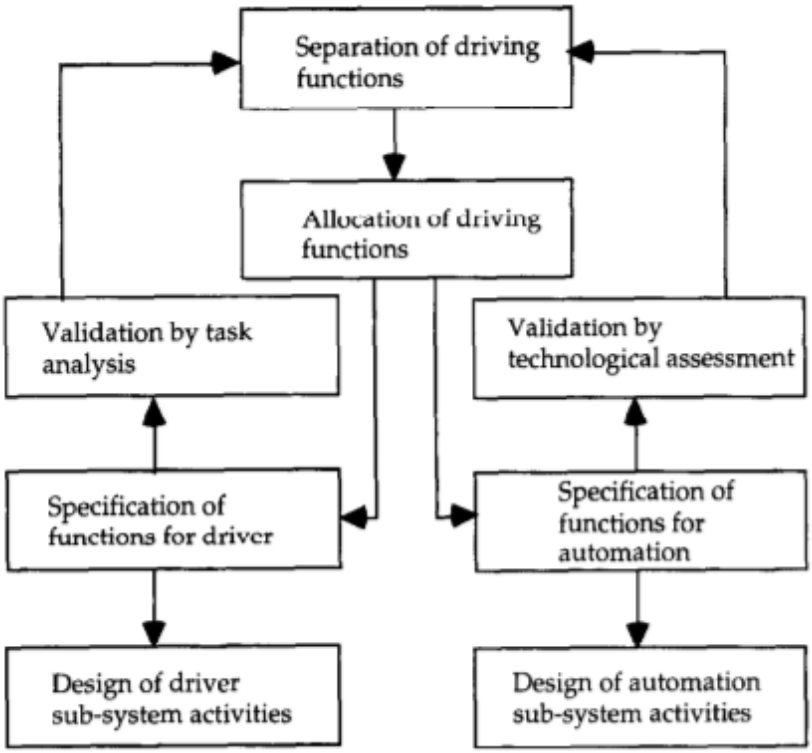

Figure 5 – Summary of function allocation process[4]

2.4. Transitions of control (TOC)

Research has found that drivers' reaction times increase when they are driving in autonomous mode when compared to driving the same distance manually (Merat & Jamson, 2009; Willemsen, Stuiver, & Hogema, 2014). This finding suggests that relying on the drivers themselves to intervene in a potential hazardous situation is not realistic. A recent study by TNO (i.e. a renown Dutch research institute) concluded that the role of the driver will change from being in full control towards a role in which only temporary control is required, which implies that the driver cannot be taken out of the loop in the foreseeable future (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017). Merat and Jamson (2009) conclude that autonomous vehicle systems should be developed in such a way that the driver is able to regain control very quickly, to limit the driver's reaction time. In an ideal situation, the driver does not even have to intervene because the autonomous vehicle can handle all contingencies by itself, but this situation is still relatively far from reality (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017). It is interesting to see that right after drivers have regained control, the number of steering movements (and/or intensity of those movements)

[4] Source: Stanton & Marsden, 1996, p. 45; adapted from Singleton, 1989

is higher than necessary. Willemsen, Stuiver and Hogema (2014) hypothesized that this is either the result of the driver having lost some feeling for the vehicle's dynamics or of them trying to test whether they have actually regained control over their vehicle (Willemsen, Stuiver, & Hogema, 2014). Drivers can take over control by pressing the brake or throttle pedals over a pre-specified threshold pressure, by turning the steering wheel more than a pre-specified turning angle or by commanding control retrieval by pressing a button or by a voice command. The systems must return control to the driver only after it is assessed to be safe (i.e. based on vehicle and environmental statuses) to do so, which could mean that the transition of control is not immediate (California, US Patent No. US 9,342,074 B2, 2016). TNO has concluded that, since not all drivers are equal in terms of their required response times and because the different tasks they are executing require different transition periods (i.e. a driver who is texting can more easily take back control than a driver who is sleeping), that a uniform solution is sub-optimal (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017). Therefore, TNO has developed the Driver Readiness Estimator (DRE), which "*assesses the time for a truck driver to be able to take over control at the end of a period of automated driving*" (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017, p. 9), enabling the platooning systems to individualize the take-over actions (i.e. Transitions Of Control; TOC). This individualization means that the DRE can determine when the driver should be notified that (s)he has to take over control soon, depending on both the driver's state and the environmental state, and in what ways the systems should keep assisting the driver. TNO's study found, which is logical, that there was a significant difference in the response times of truck drivers who were ready and those who were not ready. More interesting is the finding that there is no significant difference between a truck driver who is simply doing something else or a truck driver who has his/her eyes closed. Another interesting finding by TNO (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017) is that the time that a truck driver needs to regain control over the systems (i.e. TOC) is independent of the duration of automated driving before the situation in which it is required to regain control. This was concluded in TNO's study because no significant differences in the take-over times were found after being out of the loop for 5 and 20 minutes. This finding suggests, and thereby contradicts former studies' outcomes (Merat & Jamson, 2009; Willemsen, Stuiver, & Hogema, 2014), that Truck Platooning can be used for both short and long transport acts.

2.5. Human-machine interaction

In Truck Platooning, the truck driver has to work with the systems that enable the truck to engage in platooning activities. Therefore, the human operator has to interact with machines in a way that is dependent on the decisions made in the function allocation process. In every situation where a systems takes over the tasks of sensing, detecting, information-processing, decision-making or monitoring, one can speak about automation (Moray, Inagaki, & Itoh, 2000; Parasuraman & Riley, 1997; Parasuraman, Sheridan, & Wickens, 2000). In general, researchers and practitioners try to automate many industrial processes to arrive at a situation in which industry is less prone to human error and the human cognitive process can be freed up for higher cognitive functions (Wiener, 1988). Some authors, however, have another view on automation, of which the most extreme view is that the human is being degraded to merely being a 'button-pusher' (Wiener, 1988). In Truck Platooning, it is highly

unlikely that the truck driver will become obsolete in the near future, since automation is gradual and it therefore will take a long time until a state of 'full automation' will be reached (Bainbridge, 1983; Parasuraman, Sheridan, & Wickens, 2000). On the other hand, the truck driver's job will change significantly. The consequences for the job of truck drivers are discussed in Paragraph 2.8.

Scientific studies have resulted in several taxonomies (i.e. the Sheridan-Verplank taxonomy (Sheridan & Verplank, 1978), Endsley and Kaber's automation taxonomy (Endsley & Kaber, 1999) and Save and Feuerberg's Level Of Autonomy Taxonomy (LOAT) (Save & Feuerberg, 2012)) that scale levels of autonomy in an uniform way, so that ambiguities in the terminology can be altered. Save and Feuerberg's (2012) Level Of Autonomy Taxonomy (LOAT) is explained in Appendix 2 – The Level of Autonomy Taxonomy (LOAT). Although originally designed for the aviation industry, the LOAT is also applicable to the Truck Platooning domain because its functions (i.e. *information acquisition, information analysis, decision and action selection,* and *action implementation*) are also present in Truck Platooning applications and because the automation levels can be easily translated into terms of Truck Platooning. Platooning trucks *acquire information* mainly via a set of sensors, cameras and V2V communication systems, or the driver can provide data based on his experience with, for example, anticipating on the traffic flow. In Truck Platooning applications, the function of *information analysis* is (almost) entirely done by the platooning systems. With regard to the *decision and action* selection function, the platooning systems are also on a high autonomy level, since the systems are able to decide themselves whether the action they want to take can be safely selected or not. Finally, platooning trucks basically drive autonomously when the systems are engaged, so platooning trucks are exhibiting high levels of autonomy as well with regard to the *action implementation* function. Next to the LOAT, recently an automation taxonomy was specifically designed for automated vehicles, consisting out of 6 SAE (i.e. Society of Automotive Engineers) levels (i.e. SAE levels 0-5) (Reese, 2016). This taxonomy is graphically displayed in Figure 6 and elaborated into more details in the preliminary literature study (Vos, 2018a).

The way in which human drivers react to autonomous vehicles and the other way around can be described as a human-vehicle compatibility issue, which can be subdivided into two categories: 1) forward compatibility and 2) backward compatibility (van Loon & Martens, 2015). Forward compatibility refers to the interactions of human drivers with, and expectations of the behavior of, automated vehicles. Nowadays, most motorists do not (yet) have much experience with autonomous driving. Their current attitudes are therefore more based on 'gut feelings' than on real ratio. It is likely that when motorists become more used to autonomous vehicles on the roads, they can easier cope with them because road users then will be better able to predict the automated vehicles' behaviors (i.e. movements). Van Loon and Martens (2015) concluded that automated vehicles perhaps should exhibit sub-optimal driving behaviors so that other motorists can interpret these (more natural) behaviors more easily. This, however, will diminish some of the fuel efficiency and safety advantages of autonomous driving. Backward compatibility is the ability by which autonomous vehicles are able to anticipate on the behavior of other (unequipped) vehicles. The automation systems thus must be aligned with the expectancies of other road users, they

should be perceived as safe enough, and the driving behavior of such systems should be smooth enough in order for society, i.e. mainly other road users, to accept autonomous driving (i.e. Truck Platooning) as an innovation.

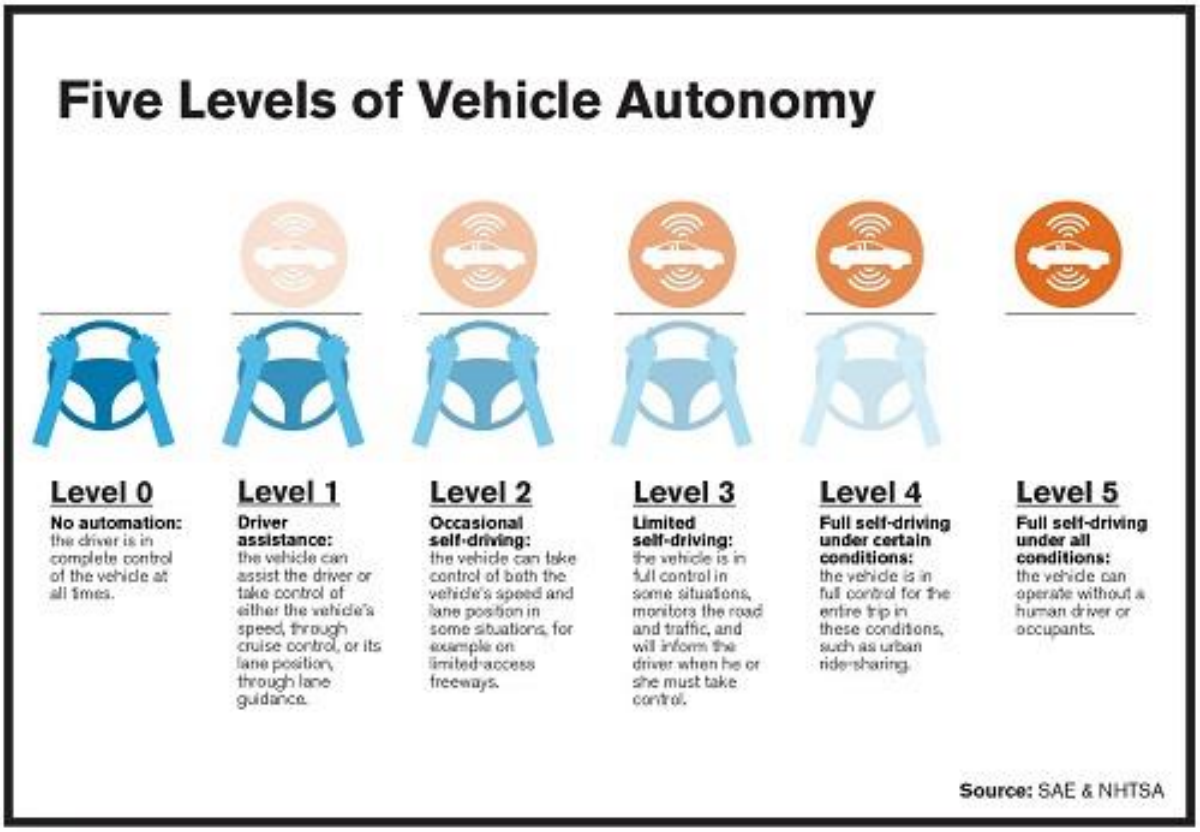

Figure 6 – Automation taxonomy for automated vehicles[5]

2.6. Safety issues

Traffic accidents are in most cases the result of human factors such as tiredness, intoxication and distraction (Treat, et al., 1979). Also, trucks are involved in a relatively high proportion of the traffic accidents and those accidents generally are more disastrous as well (Cantor, Corsi, Grimm, & Özpolat, 2010; Charlton & Bastin, 2000). Studies have identified that the relatively unhealthy lifestyle of truck drivers, discussed into more detail in the preliminary literature study (Vos, 2018a), is related to the proportionally high accident rate (Stoohs, Guilleminault, Itoli, & Dement, 1994). Truck Platooning can thus help in decreasing the number and severity of traffic accidents by taking away a great deal of driver-made errors. Although platooning generally can be considered very safe, the coexistence with vehicles that are not equipped with V2V systems heavily complicates everyday driving situations (van Loon & Martens, 2015). More specifically, if there are many vehicles on the road that cannot communicate with the platooning trucks (i.e. unequipped vehicles), the platooning systems should be designed in a way so that they can anticipate on the behavior of these unequipped vehicles (i.e. backward compatibility).

[5] Source: http://ghsp.vermont.gov/content/autonomous-vehicles-vermont

A collective name for systems that can aid the driver while driving is Advanced Driving-Aid Systems (ADAS) (Hoeger, et al., 2008). Examples of the ADAS that are prerequisites for Truck Platooning are Cooperative Adaptive Cruise Control (CACC), an Automated Highway System (AHS) or an Intelligent Vehicle Highway System (IVHS), a lane tracking system, a lane changing system and wireless vehicle communication systems (Hobert, 2012; Ioannou, 1997).

Besides only looking at 'absolute' safety (i.e. traffic accidents) in Truck Platooning applications, 'digital' safety (i.e. with how much certainty can attempts to hack into the systems be blocked) is also important to take into account when developing the platooning systems. It is likely that one-hundred percent (digitally) safe systems are infeasible at the moment of implementation (Garfinkel, 2017). Therefore, it is of utmost importance to let software developers continuously assess and improve the platooning software (Garfinkel, 2017). This importance is underlined even more by the likelihood that malicious people would like to hack autonomous trucks more than autonomous passenger cars due to the bigger disruption effects that hi-jacked trucks can cause.

Critics on the enhanced safety effects of Truck Platooning indicate that training of new truck drivers and maintaining their experience with manually driving the truck could become more difficult (Hancock & Parasuraman, 1992). They argue that if a truck driver has less experience with manual driving, (s)he will perform significantly worse in the situations in which a high level of vehicle control is especially important, namely at a moment when the truck driver has to intervene. Furthermore, Kessel and Wickens (1982) have found that operators who have experience with the manual system perform significantly better in detecting whether manual intervention is needed than operators who have only worked with the automated version of the system. Another critical stance comes from Wilde's (1988; 1998) Risk Homeostasis Theory (RHT) reasoning, which reasons that drivers will always adapt their risk taking behaviors towards a static predefined risk level. Stanton & Marsden (1996) underline the RHT by arguing that people maintain a target level of risk to which they adapt their behaviors so that the discrepancy with this target level is being minimized. This target risk level is defined as "*the risk level one deems acceptable and is the risk level at which the individual believes to maximize the overall utility of his or her action*" (Wilde, 1989). If the risk coming from the environment is becoming higher, for example because of bad road conditions, drivers will drive more safely, while driving riskier when the environmental conditions become less risky again. The determinants for the target risk level are 1) the costs and 2) the benefits of cautious behavior and 3) the costs and 4) the benefits of relative dangerous behaviors (Hoyes, Stanton, & Taylor, 1996; Wilde, 1998).

2.7. Ethical issues

Since accidents cannot be prevented at all times due to the dependence on external factors, accident-prevention (or damage-minimization) algorithms should be programmed for the platooning systems. In the process of deciding how these algorithms should be programmed, one comes across some ethical issues (Goodall, 2014; Lin, 2016; Nyholm & Smids, 2016). Philosophers frequently refer to the trolley problem, which basically is the ethical dilemma of whether or not somebody may and should make decisions over life or death. In the classical trolley problem somebody has the power to sacrifice Y people in order to save X people

(where holds that X > Y) through operating a lever, thereby determining which track a trolley (having no brakes) should follow. If the lever is not pulled, this will result in a collision with X people, while the result will be a collision with Y people when the lever is pulled and the other track is chosen (see Figure 7).

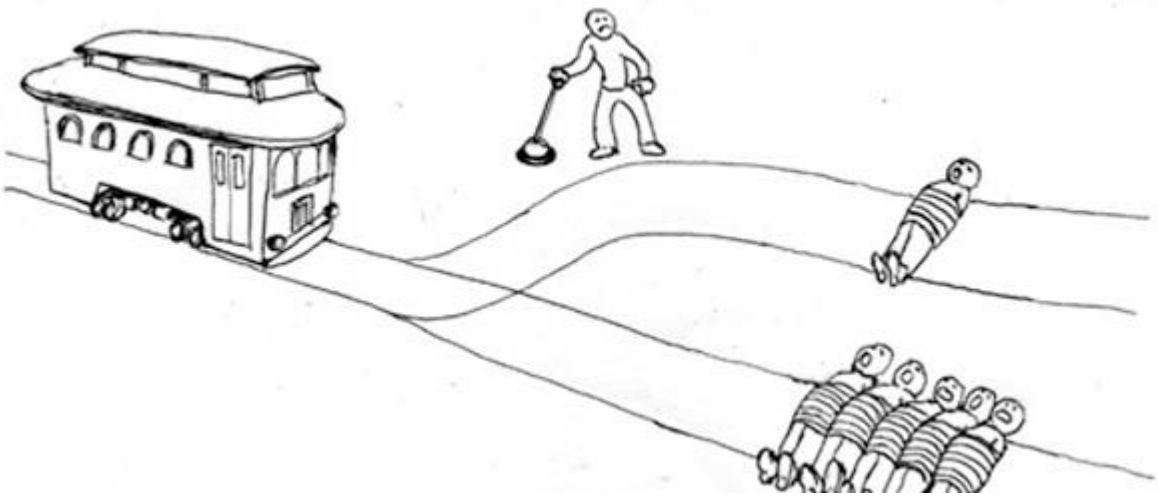

Figure 7 – Visualization of the trolley dilemma

Relating this ethical dilemma with Truck Platooning, the programmers of the platooning software should incorporate in their algorithms how the systems should respond to dangerous situations. In situations where casualties are inevitable, choices must be made whether the systems should either minimize the number of casualties or whether the truck driver should be protected as much as possible.

Unlike real-life situations, in which there is a lot of natural uncertainty, in the trolley problem one knows the exact outcome of each decision possibility beforehand. Another difference with reality is that a driver has to make these considerations in a split second, while programmers can think longer about how the systems should respond in a particular situation (Nyholm & Smids, 2016). Moreover, a diversity of stakeholders (e.g. lawyers, risk-assessment experts, engineers and ordinary citizens) can be involved in the algorithm-programming process (Nyholm & Smids, 2016). Also, Wood (2011) argues that the trolley case is too far removed from real life because the trolley problem neglects the moral and legal responsibilities that are important in real life traffic. Finally, who (or what institution) should be held responsible in the rare case that an accident with a platooning truck occurs, is a topic that is part of the field of ethics and will therefore not be discussed in this study.

2.8. Human performance consequences

The consequences of automation efforts will result in several human performance related issues (Merat & Jamson, 2009; Parasuraman, Sheridan, & Wickens, 2000). The most important human factor issues identified up to today are sudden changes in the driver's workload (which can result in unwelcome 'automation surprises') (Parasuraman, Sheridan, & Wickens, 2000; Woods, Johannesen, Cook, & Sarter, 1994), the decay of driving skills (Parasuraman, Sheridan, & Wickens, 2000; Stanton & Marsden, 1996), the loss of situational awareness (Millewski & Lewis, 1999; Parasuraman, Sheridan, & Wickens, 2000) and too little or too much trust (i.e.

‘undertrust’ and ‘overtrust’, respectively) in the systems (Moray, Inagaki, & Itoh, 2000; Parasuraman, Sheridan, & Wickens, 2000). Automation efforts should be designed in such a way that all the costs of these human factor issues will be minimized (Parasuraman, Sheridan, & Wickens, 2000).

2.8.1. Mental workload changes

Some researchers have argued that automation efforts in driving results in a higher workload for the driver due to the increased number of systems that have to be monitored (Hancock & Parasuraman, 1992). Furthermore, Parasuraman and Riley (1997) also observed an increase in drivers’ mental workload when the activation and monitoring of the systems is considered a highly cognitive task. There are, however, also researchers who claim that the mental workload decreases when automation efforts increase. These researchers (Vicente & Rasmussen, 1992; Wiener, 1988) mainly base their reasoning on the fact that automation systems take over the task of data integration (i.e. interpretation) and presents the interpreted data (i.e. on displays within the vehicle), relieving the driver from this highly cognitive duty of data interpretation. Furthermore, these studies have concluded that the operators’ hazard detection performance increased by implementing such design principles (Vicente & Rasmussen, 1992; Wiener, 1988). Because of the opposite views in the field of mental workload, it can be concluded that literature is inconclusive on this matter.

2.8.2. Driving skills implications

There is substantial evidence that driving skills decay rapidly when they are not used frequently (Parasuraman, Sheridan, & Wickens, 2000; Rose, 1989). Since hazard detection is one of the driving skills that degrades when not utilized often, this potentially has a negative influence on the safety of Truck Platooning, as detecting dangerous situations will become one of the main tasks of a truck driver in a platooning truck. Although taking the driver ‘out of the loop’ can provide new opportunities for fulfilling non-driving related job tasks, it could simultaneously adversely affect the ability to intervene manually when needed (Hancock & Parasuraman, 1992) due to unfamiliarity with the manual driving tasks. An interesting finding by Endsley and Kiris (1995) was that drivers’ confidence increased with the increase of automation levels. Also, the drivers did not perceive to have lost their skills. Moreover, it seemed their skills to determine the best solution to the occurring problem did not decrease, since all respondents (i.e. regardless of the automation condition they were in) chose the best solution. All these findings are the exact opposite of what was expected by Endsley and Kiris (1995), but they are also contradicting other studies (Parasuraman, Sheridan, & Wickens, 2000; Rose, 1989). Therefore, literature currently still is inconclusive about whether or not skills degrade when they are only rarely used.

2.8.3. Situational Awareness (SA)

Endsley (1995, p. 287) defined situational awareness (SA) as “*having a constantly evolving picture of the state of the environment*” and distinguishes between three SA levels. The first level (Level 1 SA) is about the awareness of specific key elements in the situation. Level 2 SA is about being able to comprehend and integrate the information in the light of the operational goals and in Level 3 SA one is able to project future states of the systems

accurately. Automation might result in a situation where the operators pay less attention to that information that the systems show to the operator and to the work environment, because they know that the automated systems are carrying out the tasks (Parasuraman, Sheridan, & Wickens, 2000). If the systems just respond to environmental inputs, without informing the driver, this leads to decreased SA, simply because the driver is not actively involved in the driving task. Systems can also provide the driver with an information overload, which also leads to decreased SA (Endsley & Kiris, 1995). The literature study (Vos, 2018a) elaborates more on the Error Taxonomy, developed by Endsley (1995), that parallels the SA levels. His study, however, concluded that experience in the job is negatively related to the amount of SA errors being made. Endsley (1995) argues that SA is a prerequisite for effective decision-making and for human performance in dynamic systems, because SA is an important input for the decision-making process. Moreover, Endsley (1993) concluded that there is an independence between work load and SA, meaning that a reduction in work load does not automatically lead to more SA. Automation efforts can also lead to positive effects in terms of one's SA, for example by integrating and visualizing the data in an easily interpretable form (Parasuraman, Sheridan, & Wickens, 2000). Also, the systems can detect situations in which human intervention might be needed, only alerting the driver when strictly required. Endsley and Kiris (1995) have found in their study that intermediate levels of automation result in better SA than full automation (Endsley & Kiris, 1995). Thereby, it can be argued that aiming at full automation might not be the best solution in all cases. Endsley and Kaber (1999), however, did not find such results in their study, but they found that automation was most meaningful in physical implementation assistance (e.g. steering, accelerating and braking), while automation sometimes hindered higher cognitive processes (e.g. decision-making). Future research should aim at finding out what level of autonomy suits Truck Platooning best.

2.8.4. Trust in automation systems

The final human performance issue related to Truck Platooning is the trust that a human operator has in the automation systems. Both 'overtrust' (i.e. complacency) and 'undertrust' can occur, each resulting in their own set of issues. Overtrust occurs mostly when the human operator has multiple tasks, of which one is monitoring the automation systems (Parasuraman, Molloy, & Singh, 1993). This could lead to situations in which the systems perform wrong actions, that the human operator wrongly interprets the data displayed by the systems as correct or that the human operator's attention is distracted from a certain important area (Parasuraman, Sheridan, & Wickens, 2000). If the human operator underutilizes the systems, this will likely lead to a situation in which (s)he will start using the systems less, which could lead to negative situations due to, for example, decreases in road safety (Parasuraman, Sheridan, & Wickens, 2000; Save & Feuerberg, 2012). Undertrust is often the result of the systems alerting the driver of hazardous situations when the driver does not perceive these situations as dangerous. It is crucial for automation system designers to maximize the chances that the systems triggers an alarm when there truly is an alarming situation, while minimizing the amount of false alarms (Parasuraman, Sheridan, & Wickens, 2000).

TNO (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017) conducted a survey among the truck drivers who participated in their study. They did both a pretest and a posttest, which prevailed an interesting finding regarding the growth of trust as somebody has had more experience with the systems. In the pretest the respondents indicated that they had far less trust in those systems for driving on public roads than for driving in a simulated environment, while indicating no difference at all in the posttest between their general trust in those systems and their trust in the systems for driving on public roads. Moreover, the score for trust in the systems for driving on public roads increased with 19.1% point between the pretest and the posttest and is determined significantly different ($z = -3.780$, $p < .001$) (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017, p. 48).

3. Methodology

This chapter provides a summary of the research methodology used in this study. The main research question of this study aims to enrich the literature on the implications of Truck Platooning, an innovation on which currently relatively little literature is available that emphasizes the perspective of the truck driver. Because there currently are only a few empirical studies on the implications of Truck Platooning, the current study is of an exploratory nature (Baarda, de Goede, & Teunissen, 2005). The research questions can be classified as open questions. A disproportional stratified sampling technique (i.e. samples of several stakeholder groups are taken, where the sample sizes do not necessarily represent the actual proportion of the stakeholder groups' population sizes) (Vennix, 2012) was adopted. The reason for doing so is that there are many different stakeholder groups that should be consulted, of which the sizes vary considerably (e.g. there are considerably more truck drivers than HR employees at logistics services providing organizations). All stakeholder parties are given more or less equal voices in order to find a balance between the different perspectives that might exist on Truck Platooning. Because the target group in this study is very diverse and the answers that the respondents will provide are probably even more diverse, it is beneficial to use a qualitative data gathering method. One of the reasons for doing so is that qualitative research is more flexible than quantitative research in adapting the research methodology during the execution of the study (Baarda, de Goede, & Teunissen, 2005). Adapting the research methodology could be necessary when there is unwillingness or inability of preferred respondents to be consulted for the study, which fortunately was not necessary in this study. Further, qualitative research allowed the researcher to tailor the data gathering methods to the data source (i.e. respondents in this case) by, for example, making different interview guides tailored for the categories of respondents. In this study, interviewing guides were used to collect the data needed to answer the research questions. By using this data collection method, the interview guides can be (slightly) adapted to the respondents, something that was needed due to the variety in backgrounds of the stakeholders that have been interviewed. Although surveys could probably provide reasonable answers to the research questions as well, it is likely that respondents are unwilling to fill out surveys because of survey overload (conversation C. Blom, TLN, 20-02-2018). It is often observed in practice that respondents are more willing to respond when contacted in a more personal way, instead of being sent a standardized request to fill out an online survey (conversation C. Blom, TLN, 20-02-2018). Therefore, to motivate the respondents to participate in this study, individual face-to-face interviews were conducted, and the researcher traveled to the respondents to conduct the interviews at their working environments to minimize the amount of effort a respondent had to invest. The reasoning behind the research elements selected for this study are discussed in Paragraph 3.1.1. through 3.1.11. Paragraph 3.2. elaborates on how the interviews were conducted, while Paragraph 3.3. describes how the data was analyzed, consisting out of a paragraph devoted to the preparation of the data (i.e. Paragraph 3.3.1.) and a section discussing the procedure of data codification (i.e. Paragraph 3.3.2.).

3.1. Research Elements

Research elements are defined as either the variables, the carriers of certain characteristics, or the *who's* and the *what's* to which characteristics or relationships between characteristics can be attributed (Segers, 1999). Table 1 summarizes the research elements of the current study and indicates in which paragraphs these research elements are discussed briefly.

Table 1 – Research elements

Research element name:	**Number of respondents (23) / interviews (20):**	**Discussed in paragraph:**
Truck drivers	4/4	3.1.1.
Employees of logistic services providers	6/5	3.1.2.
Ministry of Infrastructure and Waterways (I&W)	2/1	3.1.3.
Road authority (Rijkswaterstaat)	1/1	3.1.4.
BOVAG	1/1	3.1.5.
CBR	1/1	3.1.6.
Sector Institute Transportation and Logistics (STL)	1/1	3.1.7.
Truck manufacturers (and/or the platooning system manufacturers)	3/2	3.1.8.
Vehicle authority (RDW)	1/1	3.1.9.
Insurance companies	1/1	3.1.10.
Labor unions	2/2	3.1.11.

3.1.1. Truck drivers

In this study, the most important research element consists of the truck drivers. Because the research focuses on their perspectives, this study aims to 'give the truck drivers a voice'. Truck drivers, of course, have a great amount of knowledge of the daily and practical aspects of their jobs. Therefore, it can be reckoned that truck drivers are the best source to gain an overview of what the job of a truck driver currently entails. Since there are many different types of truck drivers (for example due to differences in the loads they are hauling, in their education, in their countries of origin and in personal characteristics), 4 different types of truck drivers were interviewed (i.e. a garbage truck driver, a truck driver for a big post organization, a city distribution truck driver and a truck driver who transports sea containers) in order to obtain a wide spectrum of insights.

3.1.2. Employees of logistic services providers

The employees within logistic services providers (e.g. haulers or shippers) can also be split into different subgroups of employees, of which the most important categories for this

research are the managers, the planning employees and the HR personnel, because these groups can provide meaningful insights in the daily operations of logistic services providers. Other functions than those above are beyond the scope of this study. Managers can provide data on a high cognitive level (i.e. they adopt a more strategic view on the trucking businesses than truck drivers), since they are required to have a good overview of what goes on in the organization. Therefore, they have to be up-to-date on important matters regarding several aspects of the business, enabling them to combine several sources of information into one source of useable data. Planning employees can provide insights into practical issues surrounding the task of planning the platoons, even though they probably only have experience with inter-firm planning instead of intra-firm planning, which will become much more common in platoon planning. Finally, the HR employees in logistic services providers are the ones continuously searching for new truck drivers. Therefore, they possess knowledge of which skills and knowledge currently are needed for truck drivers. Moreover, they will probably have meaningful insights into the required skillsets and knowledge for truck drivers that will engage in Truck Platooning. 6 respondents within 5 logistic services providers have been interviewed (i.e. in one interview a HR employee and a planner have been interviewed simultaneously). 2 HR managers, 1 planner, 2 managers and 1 internal educator have been interviewed.

3.1.3. Ministry of Infrastructure and Waterways (I&W)

This ministry is responsible for traffic legislation, the Dutch highway infrastructure and has close ties to the European Union (EU). Therefore, this ministry is responsible for the roads on which Truck Platooning will be used first (i.e. highways). This governmental organization, amongst other things, aims to design the highway network in such a way that congestion is minimized while optimizing traffic flows and is highly involved in Smart Mobility projects. The ministry of I&W has the authority to design and adapt regulations regarding transportation. Since legislation is an important aspect in the commercial implementation of any innovation, it is also important in the implementation process of Truck Platooning. Recently, TLN has filed an amendment with the IRU (i.e. the International Road Transport Union) requesting that technological advances will not be obstructed by legislation regarding driving and resting times (conversation C. Blom, L. Hepp & N. Krul, TLN, 20-02-2018). To gain insight in this legislative perspective, 2 representatives of the ministry of I&W were interviewed.

3.1.4. Road authority (Rijkswaterstaat)

Rijkswaterstaat is the executing organization within the ministry of I&W. Rijkswaterstaat is responsible for handling traffic accidents, determining when rush-hour lanes should be opened and for the general state of the highway network. Therefore, this organization, for example, needs to take into account the increased weight-issues at bridges, because of the increased pressure due to the decreased distance between trucks in platoons. Furthermore, Rijkswaterstaat will be confronted with Vehicle-to-Infrastructure (V2I) and Road-Work-Warnings communication issues, since a way in which platoons are able to communicate with the dynamic road-signs that are operated by Rijkswaterstaat must be found. One employee of Rijkswaterstaat was consulted in order to discuss these topics.

3.1.5. BOVAG

Because the jobs of truck drivers will change when Truck Platooning is adopted on a large scale, the way in which truck drivers are educated also has to be adapted. The Dutch branch organization for mobility, BOVAG, can provide a high-level perspective on the requirements for contemporary and future truck drivers, because a great proportion of the truck driving schools in The Netherlands is a member of BOVAG. Furthermore, being the branch organization for the whole mobility sector, BOVAG also possesses information about the perspectives of truck importers and retailers. Therefore, a spokesman of BOVAG was interviewed in this study.

3.1.6. CBR

When a novice (truck) driver has had enough driving lessons, the driving exam is conducted by an independent organization, which is called the CBR in the Netherlands. The CBR also organizes refreshment courses for all types of driving licenses. Since this organization arranges both the theoretical as the practical assessment of whether a driver is skilled enough to get his/her driving license, the CBR can share insights on the potential adaptations of the training and examination programs that are needed for future truck drivers. One employee of CBR was interviewed.

3.1.7. Sector Institute Transportation and Logistics (STL)

STL is the execution institute that is instructed by its social partners to construct documents regarding the required skills and knowledge (i.e. the jobs' competence profiles) for all kinds of jobs in the field of transportation and logistics, among which the vocational training for becoming a truck driver. A very experienced employee of STL has been interviewed to gain insights in the requirements for the current education of truck drivers and in how this institution thinks that educational programs should be adapted to anticipate for Truck Platooning. Furthermore, the representative of STL provided the current truck drivers' job competence profile document (Sectorkamer mobiliteit, transport, logistiek en maritiem, 2017) that was used in the analysis.

3.1.8. Truck manufacturers

In order to find out how the developers of Truck Platooning systems keep the truck drivers in mind, 3 respondents from 2 known truck manufacturer companies, DAF and Scania, have been interviewed.

3.1.9. Vehicle authority (RDW)

The RDW has the authority to decide whether vehicles are safe enough for being allowed onto public roads. As the preceding literature study has concluded, issues regarding safety are among the biggest hurdles to take in order to let Truck Platooning become a success (Vos, 2018a). Thus, it is necessary to acquire a thorough view on what prerequisites the RDW has determined for the safety systems of platooning trucks in order to be allowed on the road. Therefore, a senior advisor within the RDW has been interviewed.

3.1.10. Insurance companies

The literature study preceding this research has concluded that there will be some ethical issues surrounding the liabilities in the case of an accident with a platooning vehicle (Vos, 2018a). Therefore, it is important to discuss the ways in which platooning vehicles will be insured in the future. An employee of the insurance company that possesses around 90% of the market share regarding truck insurances, TVM, was interviewed.

3.1.11. Labor unions

The labor unions are institutes that are committed to lobby for the rights of employees. Because of this function, a labor union has a lot of information of how their members view certain new developments/innovations and which fears are present within these groups of employees. Two representatives of the transportation sector within the two biggest labor unions in the Netherlands (i.e. CNV and FNV) have been interviewed.

3.2. Interviewing Methodology

In order to enable a researcher to conduct good interviews, a thorough preparation is required, which consists of more than solely formulating the questions that have to be posed to the respondents (Emans, 2002). The interviews were conducted semi-structured, meaning that the most important questions were formulated up-front, while the follow-up questions were left to the interviewer to formulate ad hoc, even though some suggestions for follow-up questions were also formulated up-front (Baarda, de Goede, & Teunissen, 2005). Although Baarda et al. (2005) indicate that the ordering of the questions can be changed if the interviewer sees a reason to do so, in this research Emans' (2002) stance is adopted, in which the ordering of the questions should be well thought through before the interviews are conducted and therefore should not be adapted during the interviews. According to Emans (2002), interviewing schemes should be constructed so that it is theoretically possible that the persons who are actually conducting the interviews are different from those that constructed the interviewing schemes. A good interviewing scheme therefore includes instructions for the introduction of the interview, on how notes should be made (or whether an audio tape recording should be made), on the way the interview should be concluded, on the methods of asking follow-up questions, and on how the answers should be evaluated (Emans, 2002). Even though in this study only one person conducted the interviews, an interviewing scheme still was useful to prevent the interviewer having to improvise while conducting the interviews. The following sections will address the methodology behind constructing such an interviewing scheme, divided into 9 steps (see Figure 8). Consequently, Chapter 4 applies those steps and presents the interviewing schemes for the different stakeholders that have been interviewed in this study.

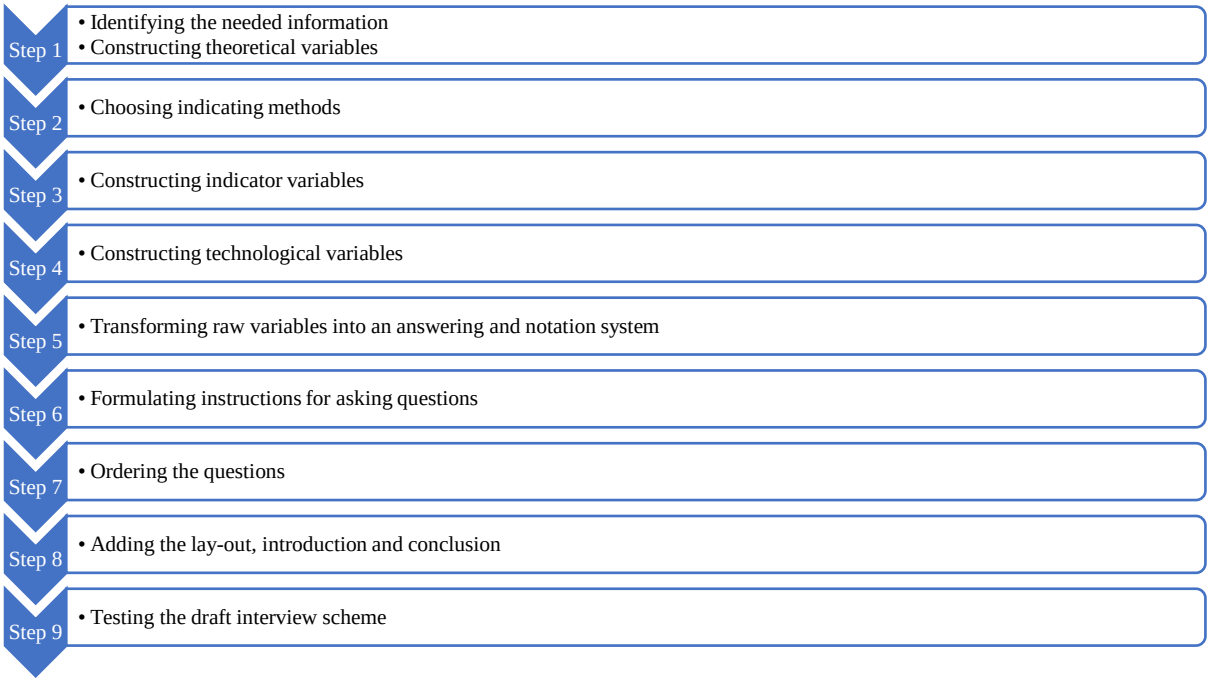

Figure 8 – Steps for constructing an interviewing scheme[6]

3.2.1. Step 1: Constructing theoretical variables

Constructing an interviewing scheme consists of multiple steps, of which the first step is to build a list of variables (Emans, 2002). A variable can be defined as "a collection B of values of which exactly one can be connected to each element of a collection A of persons or objects" (Emans, 2002, p. 120). Therefore, it is important to first identify and define the collections (A's) of objects or persons about which or whom information should be collected. Since the variables constructed in this initial step are often not usable for direct translation into interview questions, helping variables (i.e. indicators) that can be transformed into interview questions should be sought (Emans, 2002).

3.2.2. Steps 2 and 3: Choosing indicating methods and constructing indicator variables

The process of constructing these indicator variables is the next step in building an interviewing scheme (Emans, 2002). But, before being able to do so, an indicating method should be chosen (i.e. step 2) for every theoretical variable. There are multiple indicating methods, of which *self-description* is the simplest. As the name suggests, the respondent is asked to describe himself/herself in terms of the theoretical variable (Emans, 2002), of which the validity can be doubted because people are not always accurate in describing themselves. *Factual* indicators (i.e. that can be observed and therefore are non-debatable) are considered more valid, but not always available (Emans, 2002). Further, *behavioral intentions* can also be used as indicator variables. Even though Emans (2002) acknowledges that asking respondents for their intentions is related to self-descriptive indicators, he concludes that behavioral intention indicators are less prone to invalidating factors than purely self-descriptive variables

[6] Source: Emans, 2002, p. 119

(i.e. which describe one's internal conditions). *Detailing* is a special form of creating indicator variables, because in detailing one element is picked that represents the theoretical variable (Emans, 2002). Because this chosen element can be imagined by the respondents more easily than the rather abstract theoretical variable, it is more practical in interviewing situations. Since such specific situations often cannot cover the whole scope of the theoretical variable, multiple detailing variables can be used as indicators for the overarching theoretical variable (Emans, 2002). In order to translate these indicators back in terms of the theoretical variable, the researcher has to come up with a combination rule (i.e. a formula that assigns a weight to each indicator variable) (Emans, 2002). By using the indicating method(s) selected in step 2, the researcher is able to construct the list of indicator variables (i.e. step 3).

3.2.3. Step 4: Constructing technological variables

Besides indicator variables, another type of 'raw' variables is distinguished. Those variables are called 'technological' variables and they can aid the processing of the interview results (Emans, 2002). Examples of such variables are 'interview duration (in minutes)', 'interview location' and 'respondent's age'.

3.2.4. Step 5: Transforming raw variables into an answering and notation system

The raw variables (i.e. indicator variables and technological variables) are the building blocks for the interviewing schemes (Emans, 2002). The answering and notation system is the combination of decisions, per raw variable, whether the question is open or closed and which method of taking notes should be adopted. The first decisions that have to be taken are whether the questions should be open or closed and, in case they will be open, if field coding should be applied or not (Emans, 2002). Closed questions can only be used when the B-collections of a variable are small (i.e. only several answering possibilities) and enable the researcher to easily analyze the results statistically (Emans, 2002). Open questions require the respondent to think deeper, but can also have a stimulating effect, since the respondent is able to vent his/her thoughts (Emans, 2002). Further, open questions are useful in situations where there is still a lack of clarity on what kind of answers can be expected (Emans, 2002). Finally, Sudman and Bradburn (1974) have concluded that open questions are generally perceived as less threatening in case of sensitive subjects. On the other hand, other studies found that closed questions tend to make respondents more open-hearted (Schaeffer & Charng, 1991; Sudman & Bradburn, 1974). Although at first glance this seems odd, it actually is quite logical because closed questions prevent respondents evading certain topics in their answers (Emans, 2002). If one wants to adopt a technique in which a combination of open and closed questions is used, the interviewer has to *field-code* during the interview. This means that an open question is posed and the interviewer has to summarize the respondent's answer in an answering possibility, of which only the interviewer has a complete list (Emans, 2002). Therefore, the researcher has to determine per question whether it is feasible (and useful) to write down all answer possibilities. If ordinal answering categories are used, the interview designer can decide between an even or an uneven number of answering possibilities, depending on whether a neutral answer possibility should be included or not (Emans, 2002). Emans (2002) also stated that choosing a neutral category or not is independent from the decision whether or not to include an 'other' or 'no opinion' answering

possibility, since there is a clear difference between the respondents having no opinion at all and the respondents who have an opinion that really cannot be characterized within one of the answering possibilities. Including such 'no opinion' answer possibilities has the potential downside of respondents misusing this answer category to evade answering to sensitive topics (Gilljam & Granberg, 1993). Alwin (1992) has concluded that a larger number of response categories contributes to the reliability of the results because it allows the respondents to provide more nuances in their answers.

With regard to the second domain within the answering and notation systems, the researcher has to determine how respondents' answers are noted. The options are 1) ticking boxes (i.e. for closed questions and for open questions where field-coding is used), 2) writing down everything the respondent says, 3) writing down keywords to summarize the respondent's answer and 4) taking no notes at all. A decision scheme for all the decisions in constructing an answering and notation system is depicted in Figure 9.

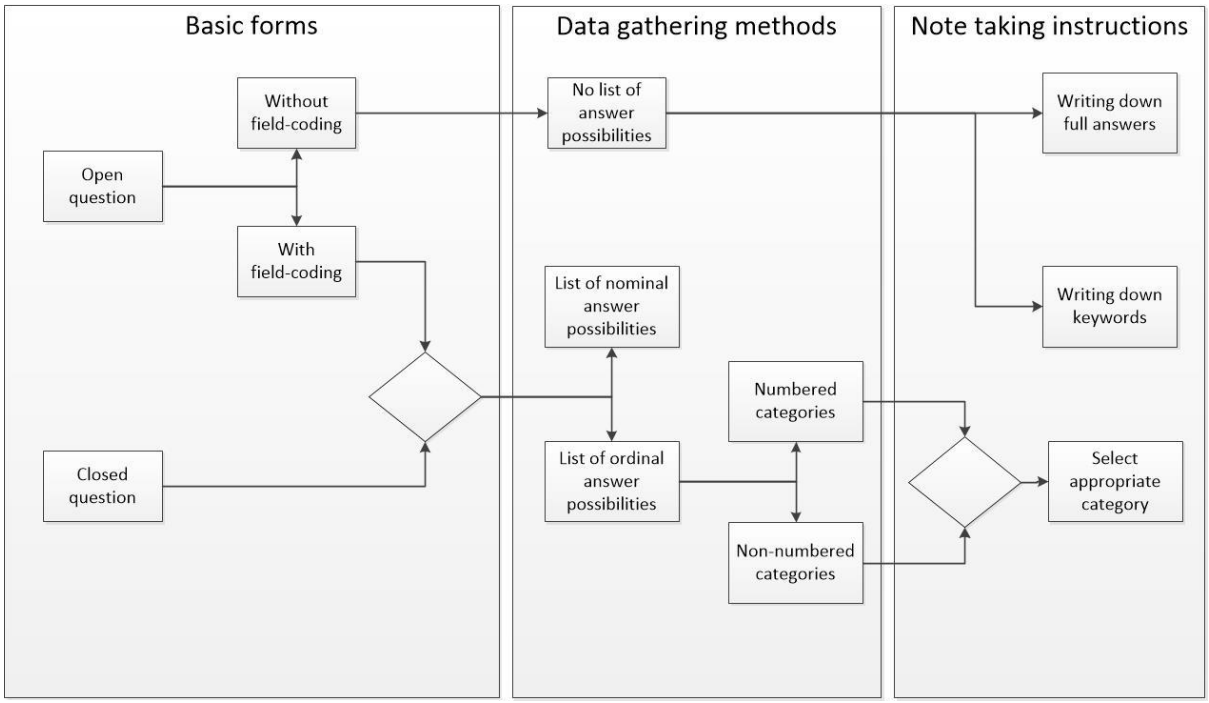

Figure 9 – Decision scheme in constructing an answering and notation system

3.2.5. Step 6: Formulating instructions for asking questions

The first decision that has to be made in order to formulate instructions for the way in which the questions are asked is the decision between a structured or unstructured interviewing scheme. In the structured version, the interviewer has to pose the questions in the exact order and wording that is written in the interview guide, while the exact order and wording can be 'improvised' by the interviewer in the unstructured variant (Emans, 2002). Independent from whether the interview is structured or unstructured, the interviewer needs to have an interviewing guide. Moreover, it is argued that it might even be more important in unstructured interviews for the interviewer to know what the exact goal of each question is, so that the interviewer can formulate the question better (Emans, 2002). Sometimes,

especially in unstructured interviews, it is beneficial to share the goal of the question with the respondent in order to motivate him/her to answer it. Also, instructions should be included in the interviewing scheme about how the interviewer should pose follow-up questions. The interviewing scheme should contain whether asking follow-up questions is allowed for specific questions and if so, on which aspects the interviewer should focus (Emans, 2002). In structured interviews, this step determines the exact wording of each questions, of which the interviewer should not deviate. An argument in favor of the structured interview is given by Sudman and Bradburn (1983), who state that the wording of questions is crucial in maximizing the validity of the obtained data.

3.2.6. Step 7: Ordering the questions

When the questions have been formulated (i.e. if the interview is (semi-)structured) or the topic list with additional guidelines (i.e. in case of an unstructured interview) is made, the questions (or topics) should be put in a logical order (Emans, 2002). First, the order of the broad subjects should be determined, before the order within those groups of questions can be decided upon. In an ideal situation, not only a logical order can be found, but even a 'psychological order', so that the successive subjects are connected to each other as perceived logically by the respondent (Baarda, de Goede, & Teunissen, 2005; Scheuch, 1973). Because usually the communication between interviewer and respondent improves as the interview advances, the interview can be seen as a learning experience for both (Emans, 2002). Difficult and sensitive questions should always be preceded by some easy to answer questions, so that the interviewer and respondent first get the chance to get acquainted to each other, to get acquainted to the topic and to gain each other's trust, which is required for the respondent to answers sensitive questions (Baarda, de Goede, & Teunissen, 2005; Emans, 2002). Ostrander (1993) even argued that this process of trust-building already starts at the moment that the respondent is contacted to participate in the study. Furthermore, people naturally aspire to be consistent in answering questions, so questions asked in the beginning of the interview can influence the way in which respondents answer questions posed later in the interview (Bridge, et al., 1977; Emans, 2002). Salience, defined as the extent to which people relate to certain topics, also plays an important role in interviewing techniques. It can, for example, happen that a respondent at the beginning of the interview only moderately relates to a particular topic, but by having discussed this topic during the interview, provides the interviewer with very extensive answers on a particular question at the end of the interview (something the respondent would not have done if that question would have been posed at the beginning of the interview (Emans, 2002)). Consistency and salience of the interview questions should be taken into account when determining the question order. Kahn and Cannell (1957) developed two ordering patterns called the 'funnel pattern' and the 'inversed funnel pattern', in which questions go from broad to specific and from specific to broad, respectively. Advantages of the funnel approach are that the consistency-mechanism does not work in a negative way, because at the beginning of the interview the focus is not put on details that can influence respondents' evaluation of a higher level construct, and that the broad questions at the beginning of the interview can function as 'filtering questions', determining whether some questions should be skipped or adapted for this respondent (Emans, 2002). On the other hand, for the funnel approach to work properly, the respondent

must have a sufficiently good view, right at the start of the interview, on the issue(s) being studied. The inversed funnel approach should be preferred when the respondents' frame of reference has to be built (or expanded) and aligned during the interview (Emans, 2002). Emans (2002) states that it could be possible for some types of studies that all the respondents have the same frame of reference when being interviewed, so that their answers can be analyzed more thoroughly. The inversed funnel approach can help in such cases by guiding the respondents' attention into a specific direction, thereby creating a situation in which all respondents' frames of reference are more or less aligned. Although this strategy is mostly used in studies gathering data via surveys, it sometimes can be beneficial to formulate a question both positively and negatively in order to test whether respondents suffer from a response bias (i.e. answering always, more or less, in the same answer category). To check this, positive and negative formulations of the same question should be separated in the interview. Finally, when the question categories are ordered, the questions within these categories can be ordered too (e.g. chronologically or by the (inversed) funnel principle) (Emans, 2002).

3.2.7. Step 8: Adding the lay-out, introduction and conclusion

The researcher needs to think about the information that the respondent should receive before the interview in order to make him/her more comfortable during the interview itself. An important issue to stress in the introduction is how it is guaranteed that the data is analyzed in a confidential way (Baarda, de Goede, & Teunissen, 2005). Furthermore, if not yet communicated up front, the interviewer should inform the respondent about the topic of the interview (in combination with the research goals) and the expected duration of the interview (Baarda, de Goede, & Teunissen, 2005; Emans, 2002). In the conclusion the respondent should be thanked for his/her time and effort and should be asked for any comments or remarks (Emans, 2002). In computer-aided interviewing, the lay-out can only be adapted to a certain extent. In this study, however, the interviews will be conducted manually. Therefore, the researcher needs to make sure that the interviewing scheme is easy to use and that the lay-out looks professional to the respondent (Emans, 2002) (i.e. graphically uniform). This can, for example, be achieved by placing the exact formulation of each question between quotation marks and by writing instructions for the interviewer in an *italic* font.

3.2.8. Step 9: Testing the draft interviewing scheme

Although the researcher has thoroughly thought through all the decisions in the process of construction the interviewing scheme, this does not guarantee that the interviewing scheme functions properly in practice (Emans, 2002). Emans (2002) has distinguished 4 methods, which can be utilized in conjunction, to test the interviewing scheme. These are 1) '*observing test interviews*', in which systematic observation takes place of an interview being conducted with the draft interviewing scheme, 2) '*asking test interviewers*', in which the test interviewers (who are in an ideal situation the same persons who will be conducting the real interview) will be asked about their experiences with conducting the test interviews, 3) '*asking test respondents*', where the test respondents in an ideal situation have characteristics equal to the real target group, and 4) '*consulting experts*', i.e. people who are experienced in interviewing, who understand both the interviewer and respondents'

perspectives, and who are consulted about improving the interviewing scheme (Emans, 2002).

3.2.9. Step 10: Constructing the final interview scheme

When a combination of tests, addressed in Paragraph 3.2.8., has been conducted, the feedback should lead to improvements in the interviewing scheme. If all feedback is processed, the researcher can either choose to re-test the interviewing scheme or to start conducting the 'real' interviews. Before conducting the real interviews, the interviewer obviously needs to study the final interviewing scheme in detail as a preparation.

3.3. Data Analysis Methodology

This section elaborates on the methods used to analyze the data. First, the way in which the raw data is converted into data that can be codified is discussed in section 3.3.1. This data preparation phase consists out of three steps, which are 1) the transcription phase, 2) the activity of deleting irrelevant pieces of text out of the transcripts, and 3) the choices surrounding the unit of analysis. Section 3.3.2. explains the choice for the technique of emerging coding in this study (Blumberg, Cooper, & Schindler, 2014). Finally, the considerations that have to be made while restructuring the coding scheme are discussed.

3.3.1. Data preparation

The first step in preparing the qualitative data for analysis is transcribing the interviews (Baarda, de Goede, & Teunissen, 2005). With transcribing it is meant that everything that is being said during the interview is digitalized by means of a commonly-used text editor (e.g. MS Word). Blumberg et al. (2014) distinguish between selective and full transcription. In the first form the main part of the respondents' answers is transcribed and the apparently irrelevant sections are summarized, while in the latter form the answers are noted literally, independently from the researcher's judgement about the relevance. The second decision that has to be made is that the researcher must choose whether or not the transcriptions will be verbatim or not (Blumberg, Cooper, & Schindler, 2014). Verbatim means that the interview is transcribed word by word including all kind of repetitions. The other option (i.e. non-verbatim) is to adopt a more formal writing style, in which the interviewer converts the spoken language into easily readable sentences. The final decision that has to be made, according to Blumberg et al. (2014), is about whether only the spoken words should be transcribed or whether pauses and emotional expressions should be included as well. With respect to the same issue, Baarda et al. (2005) report that emotions, non-verbal communication and incidents should be included as much as possible, if deemed relevant according to the interviewer. The transcripts should be made as soon as possible after the interview took place, so that all the (non-verbal) details can still be remembered by the interviewer and subjectivity can therefore be prevented (Baarda, de Goede, & Teunissen, 2005).

The second data preparation step is the deletion of irrelevant sections within the transcribed texts (Baarda, de Goede, & Teunissen, 2005). Next, the unit of analysis should be determined. Baarda et al. (2005) have distinguished between four types of analysis units, namely 1) words,

2) sentences, 3) fragments, and 4) themes. If the unit of analysis is 'words', then the researcher focuses attention on the exact wording for certain phenomena. Also, differences in wording for the same phenomena are interesting in those cases. The researcher can also choose to attach labels (i.e. codes) to 'sentences' or 'fragments'. In many cases in practice, respondents express more than one stance in a sentence. Baarda et al. (2005) therefore argue that in many cases fragments should be preferred over sentences as the unit of analysis. The unit of analysis 'theme' is mainly used when the researcher is only broadly interested in certain phenomena, which often are then compared between several cases (e.g. comparing themes in annual reports of multinationals) (Baarda, de Goede, & Teunissen, 2005). The next paragraph discusses the methodology adopted while coding the data in the interview transcripts.

3.3.2. Coding

Words are more difficult to analyze than numbers, since words can have multiple meanings and are contextually dependent (Blumberg, Cooper, & Schindler, 2014). Although interpreting text in its context makes qualitative analysis generally harder than analyzing numbers (i.e. quantitative analysis), it can also lead to a richer understanding of the phenomenon under study (Blumberg, Cooper, & Schindler, 2014).

Coding is a technique that aims to structure, reduce and interpret the information that comes from extensive data sources such as field notes, interview transcripts and other written documents (Blumberg, Cooper, & Schindler, 2014). In order to attain a richer understanding of the current requirements for truck drivers, the truck driver competence profile (Sectorkamer mobiliteit, transport, logistiek en maritiem, 2017), constructed by STL, was included in the analysis next to the main data source, which are the interviews. Finally, a research report by the Dutch research institute TNO (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017) on, among other topics, the response time for truck drivers in Truck Platooning situations with different levels of attention was part of the data collection as well. The total amount of data in this study therefore comes from 23 respondents in 20 interviews and from 2 relevant documents. Although the vast majority of the data stems from the interviews, these documents add to the validity of the project due to the employment of data-triangulation (Baarda, de Goede, & Teunissen, 2005).

Coding describes how pieces of information should be labeled. Blumberg et al. (2014) distinguish between two types of coding, namely prescriptive coding and emerging coding. If a researcher uses prescriptive coding, the list of codes is constructed up-front, while in the emerging coding strategy, also referred to as 'open coding' (Aken, Berends, & Bij, 2012), the codes are derived from the material during the analysis phase. Emerging coding is open and unstructured and therefore suitable to provide new insights and knowledge while at the same time minimizing the chance of missing important aspects that are not identified beforehand. Emerging coding has a downside too, which is the fact that it is more time-consuming than prescriptive coding, since all material should be checked at least twice to ensure that all the material is scanned for all the codes that have been identified during the coding process.

The codes should be developed so that meaningful labels are attached to sections of the information in the transcripts, while simultaneously reflecting the content of that specific section of the transcript (Blumberg, Cooper, & Schindler, 2014). In the initial coding phase, it is better to have too many codes than having disregarded potentially important information. The next step is then to check if the fragments that have received the same code really express the same phenomenon or actually mean the same. If this is not the case, multiple separate codes should be made. For codes that are used very frequently, it should be checked whether they are consistently used and whether it might be sensible to split them into sub-codes that better reflect the data. For codes that are rarely used, the researcher should determine whether or not to merge them (Blumberg, Cooper, & Schindler, 2014). Paragraph 5.3. briefly explains how the initial coding scheme was transformed, following Blumberg et al.'s (2014) guidelines, into the final coding scheme that was used in analyzing the data. The next chapter, however, first discusses how the methodology described in Paragraph 3.2. was applied to construct the interviewing schemes (i.e. one version for the truck drivers and one version for all other stakeholder groups).

4. Interviewing Scheme

This chapter describes how the theory about constructing interviewing schemes, as described in Paragraph 3.2., was applied in this project. Table 2, in Paragraph 4.1., depicts the results of executing step 1 (see Paragraph 3.2.1.), which is the development of theoretical variables by means of identifying the objects/persons to which/whom values are attributed. In Paragraph 4.2., the indicating methods are chosen (i.e. step 2) in conjunction with the construction of the indicator variables (i.e. step 3). Those activities are highly intertwined and are therefore combined in one paragraph. Only a few technological variables are utilized in this study, which are discussed in Paragraph 4.3. In Paragraph 4.4., answering and notation systems are added to the raw (i.e. indicator) variables, while in Paragraph 4.5. the exact formulations of the interview questions are determined. Consequently, the order of the interview questions was adapted in Paragraph 4.6., and the interview's layout, introduction and conclusion were constructed in Paragraph 4.7. The final steps in order to arrive at the final interviewing scheme, testing the draft interviewing scheme and processing the feedback from these tests, are respectively discussed in Paragraphs 4.8. and 4.9. Finally, since this chapter focusses on the interviewing scheme for the interviews with the truck drivers, the discrepancies with the interviewing scheme that is used in the interviews with the other stakeholders are discussed in the concluding section of this chapter (i.e. Paragraph 4.10.).

4.1. Step 1: Constructing theoretical variables

The first two research sub-questions aim to find out how truck drivers and other stakeholders perceive Truck Platooning. In order to find out how the Truck Platooning implementation process is perceived, the best way is to ask all these stakeholders about their views. The A collection for the theoretical variable '*perception about Truck Platooning*' therefore consists out of all these stakeholders. The values that the stakeholders can express (i.e. collection B) can range from extremely positive to extremely negative with all intermediate values. With regard to the third and fourth research sub-question, which are constructed to, respectively, identify factors facilitating and impeding the Truck Platooning implementation, all stakeholders should be asked about their views. The A collection thus consists out of all respondents, too, for theoretical variables 2 and 3. Since it is unknown up front what answers the respondents will provide, the B collection for both variables can become all possible values. Both sub-questions 5 and 6, which try to elicit responses about potential changes in job resources and job demands, respectively, are applicable to all stakeholders (i.e. collection A again consists out of all stakeholders), even though this might not be clear at first glance. For example, although one could think that the work of Rijkswaterstaat is not directly related to the job of a truck driver, Rijkswaterstaat is responsible for the road infrastructure and thus also for the infrastructural components the platooning truck will communicate with (via Vehicle-to-Infrastructural communication methods). Therefore, Rijkswaterstaat can influence the data that a truck driver will see on his displays (e.g. about temporary speed limitations or closed lanes due to accidents or road works). Furthermore, Rijkswaterstaat has much experience with accident-handling, something that a truck driver can be confronted with occasionally as well. The reason behind asking (in research sub-question 7) all stakeholders about new options for a truck driver's job tasks is that innovative ideas can sometimes come

from other perspectives than that of the truck drivers themselves. Therefore, the A collection for theoretical variable '*options for alternative job tasks*' again is all stakeholders and the answers they can provide are unknown up-front. Although it might not be immediately clear why the A collections for the theoretical variables '*required skillsets*', '*required knowledge*' and '*required occupational mindsets*' also consist out of all stakeholders, again an example might clarify this. A truck insurance company, for example, can provide insight into frequent causes of accidents with (semi-)autonomous vehicles. Based on these insights, they might identify crucial skills, knowledge and occupational mindsets for a truck driver operating such a vehicle. In order to gain knowledge about potential changes (theoretical variable 10) for the educational programs of truck drivers, all stakeholders will be consulted, but more emphasis on these topics will be put in the interviews with the institutions related to these programs (i.e. the BOVAG, the CBR and STL).

Table 2 – Step 1: Constructing theoretical variables

Theoretical Variable #	**Theoretical variable name**	**Derived from research sub-question #**	**Collection A (persons and/or objects)**	**Collection B (values)**
1	Perception about Truck Platooning	1 + 2	All respondents	• Extremely positive • Extremely negative • All intermediate values
2	Facilitating factors	3	All respondents	• All possible values
3	Impeding factors	4	All respondents	• All possible values
4	Implications for job resources	5	All respondents	• All possible values
5	Implications for job demands	6	All respondents	• All possible values
6	Options for alternative job tasks	7	All respondents	• All possible values
7	Required skillsets	8	All respondents	• All possible values
8	Required knowledge	9	All respondents	• All possible values
9	Required occupational mindsets	10	All respondents	• All possible values
10	Changes in truck driver educational programs	11	All respondents	• All possible values

Furthermore, insurance firms can provide insights into how to train platooning truck drivers to prevent, or minimize the damage of, traffic accidents. Again it holds that the respondents' responses are not fixed and thus the B collection can take all values. Finally, the labor unions have a lot of truck drivers as their members and can therefore provide some indications of how truck drivers would like to see the educational programs being adapted.

4.2. Steps 2 and 3: Choosing indicating methods and constructing indicator variables

The way in which the stakeholders perceive Truck Platooning (i.e. theoretical variable 1) is a broad, and perhaps quite a general, question. Therefore, the *detailing* indicator method will be used and the respondents' perception of Truck Platooning will be operationalized by 1) assessing the stakeholders' knowledge about Truck Platooning, by 2) asking them (i.e. only the truck drivers) which ADAS systems are available in their trucks, by 3) asking them (i.e. again only the truck drivers) how frequently they use ADAS, by 4) asking about their opinions about ADAS, by 5) assessing their trust in ADAS, and by determining how they perceive 6) job changes and 7) job security. Therefore, the corresponding indicator variables are 'knowledge about Truck Platooning', 'availability of ADAS', 'frequency of ADAS usage', 'attitude towards ADAS', 'trust in ADAS', 'perception of job changes' and 'perception of job security' (see Table 3).

Table 3 – Steps 2 and 3: selecting indicating methods and translating theoretical variables into indicator variables

Theoretical variable	**Indicator variable(s)**	**Indicating method**
Perception about Truck Platooning (#1)	1.1. Knowledge about Truck Platooning 1.2. Availability of ADAS 1.3. Frequency of ADAS usage 1.4. Attitude towards ADAS 1.5. Trust in ADAS 1.6. Perception of job changes 1.7. Perception of job security	Detailing (Self-)description/detailing (Self-)description/detailing (Self-)description/detailing (Self-)description/detailing (Self-)description/detailing (Self-)description/detailing
Facilitating factors (#2)	2.1. Facilitating factors	Description
Impeding factors (#3)	3.1. Slowing down factors 3.2. Blocking factors	Description Description
Implications for job resources (#4)	4.1. Implications for job resources	Description
Implications for job demands (#5)	5.1. Implications for job demands	Description
Options for alternative job tasks (#6)	6.1. Currently unable but preferable truck driver job tasks	Description

Required skillsets (#7)	7.1.	Current skillset of a truck driver	(Self-)description
	7.2.	Required skillsets of a truck driver	Description
	7.3.	Discrepancies between current and required skillsets	Description
Required knowledge (#8)	8.1.	Current knowledge of a truck driver	(Self-)description
	8.2.	Required knowledge of a truck driver	Description
	8.3.	Discrepancies between current and required knowledge	Description
Required occupational mindsets (#9)	9.1.	Current occupational mindsets of a truck driver	(Self-)description
	9.2.	Required occupational mindsets of a truck driver	Description
	9.3.	Discrepancies between current and required occupational mindsets	Description
Changes in truck driver educational programs (#10)	10.1.	Components of current truck driver educational programs	(Self-)description
	10.2.	Required components of future truck driver educational programs	Description
	10.3.	Required focus areas during examination	Description
	10.4.	Required interval for refreshment courses	Description
	10.5.	Required components of future truck driver refreshment courses	Description

Most indicator variables have been translated into open interview questions. Therefore, the indicating methods distinguished by Emans (2002) in Paragraph 3.2.2., *self-descriptive*, *factual*, *intentional behavior* or *detailing* indicators, cannot be applied properly in most cases. Indicator variables 1.2. through 1.7., 7.1., 8.1., 9.1. and 10.1. are exceptions that do not require an adaptation of the indicating method *self-description*, since in most cases something else than the respondent's own characteristics (i.e. their opinions about some matters) is being studied. This adapted indicating method is therefore called "*description*" instead of "*self-description*".

In case of theoretical variable 2 (i.e. facilitating factors), the theoretical and indicator variable are equal. Theoretical variable 3 can be operationalized by subdividing the impeding factors into factors that slow down the implementation process of Truck Platooning (i.e. indicator variable 3.1.) and into factors that completely block this implementation process (i.e. indicator variable 3.2.). The implications for truck drivers' job resources (i.e. the options that truck drivers have), theoretical variable 4, and the implications for truck drivers' job demands (i.e. the tasks for which the truck drivers are responsible), theoretical variable 5, again have only one indicator variable, which therefore are equal to their theoretical counterparts. The options for alternative job tasks (i.e. theoretical variable 6) are explored by consulting the stakeholders about what they perceive as the typical future truck drivers' job tasks that

currently cannot be executed while driving (i.e. because it is illegal or unsafe to perform these actions while driving). Therefore, the indicator variable for theoretical variable 6 is called 'currently unable but preferable truck driver job tasks'. For theoretical indicators 7 through 9, the current skillsets, knowledge and occupational mindsets of a truck driver are compared with the required skillsets, knowledge and occupational mindsets to determine the respective discrepancies between the current and required skillsets, knowledge and occupational mindsets. To find out which changes should be made in the educational programs for truck drivers (i.e. theoretical variable 10), the current components of these programs are compared with the required future educational program components in conjunction with the focal areas for the examination of student truck drivers. Moreover, an indicator variable is devoted to the focal areas for the examiner during an examination. Finally, since refreshing skills and knowledge is an important part of a truck driver's education, this theoretical variable also focusses on the interval of the obligated refreshment courses (i.e. Code95; currently 35 hours per 5 years) and on the respondents' views on the redesign of the contents of these refreshment courses.

4.3. Step 4: Constructing technological variables

This study only uses a limited number of technological variables. First, the moment and location at which the interview is conducted are noted. This is done because a moment and a location can help the researcher to remember what happened during the interview, and when it is needed to contact the respondent again after the interview for further clarification (Emans, 2002). Secondly, each interview (and thus each respondent) is given a unique identifier code (i.e. Respondent #X) in order to ease the data administration. The final technological variable used in this study is the duration of the interview, which is calculated by subtracting the starting time from the ending time.

4.4. Step 5: Transforming raw variables into an answering and notation system

Following the decision scheme in Figure 9 (in Paragraph 3.2.4.), Table 4 was constructed, in which the B-collections (i.e. the possible values of the respondents' answers) and answering- and notation systems for all indicator variables are summarized. All indicator variables require open questions, enabling the respondents to formulate their answers freely. The only indicator variables that enable field-coding to be used are indicator variables 1.2. through 1.5., because asking the respondents for the availability, their usage, their perceptions and their trust in certain ADAS enables the interviewer to categorize their answers, which is discussed further on in this chapter. For all indicator variables, key-words have been noted and the audio tape recordings of each interview were transcribed (anonymously).

Table 4 – Overview of answering and notation systems per indicator variable

Indicator variable	B-collection values	Answering system	Notation system
1.1. Knowledge about Truck Platooning	All possible values	Open question without field-coding	Key-words + audio recording
1.2. Availability of ADAS	□ (Connected) (Adaptive) Cruise Control; □ Brake assist; □ Lane keeping assist; □ Lane changing assist; □ Automated Highway System (AHS); □ Intelligent Vehicle Highway System (IVHS); □ Wireless communication systems □ Other, namely:……	Open question with field-coding	Key-words + audio recording
1.3. Frequency of ADAS usage	All possible values between 'never' and 'as often as possible'	Open question with field-coding	Key-words + audio recording
1.4. Attitude towards ADAS	All possible values between 'extremely negative' and 'extremely positive'	Open question with field-coding	Key-words + audio recording
1.5. Trust in ADAS	All possible values between 'no trust' and 'complete trust'	Open question with field-coding	Key-words + audio recording
1.6. Perception of job changes	All possible values	Open question without field-coding	Key-words + audio recording
1.7. Perception of job security	All possible values	Open question without field-coding	Key-words + audio recording
2.1. Facilitating factors	All possible values	Open question without field-coding	Key-words + audio recording
3.1. Slowing down factors	All possible values	Open question without field-coding	Key-words + audio recording
3.2. Blocking factors	All possible values	Open question without field-coding	Key-words + audio recording
4.1. Implications for job resources	All possible values	Open question without field-coding	Key-words + audio recording

5.1.	Implications for job demands	All possible values	Open question without field-coding	Key-words + audio recording
6.1.	Currently unable but preferable truck driver job tasks	All possible values	Open question without field-coding	Key-words + audio recording
7.1.	Current skillsets of a truck driver	All possible values	Open question without field-coding	Key-words + audio recording
7.2.	Required skillsets of a truck driver	All possible values	Open question without field-coding	Key-words + audio recording
7.3.	Discrepancies between current and required skillsets	All possible values	Open question without field-coding	Key-words + audio recording
8.1.	Current knowledge of a truck driver	All possible values	Open question without field-coding	Key-words + audio recording
8.2.	Required knowledge of a truck driver	All possible values	Open question without field-coding	Key-words + audio recording
8.3.	Discrepancies between current and required knowledge	All possible values	Open question without field-coding	Key-words + audio recording
9.1.	Current occupational mindsets of a truck driver	All possible values	Open question without field-coding	Key-words + audio recording
9.2.	Required occupational mindsets of a truck driver	All possible values	Open question without field-coding	Key-words + audio recording
9.3.	Discrepancies between current and required occupational mindsets	All possible values	Open question without field-coding	Key-words + audio recording

10.1.	Components of current truck driver educational programs	All possible values	Open question without field-coding	Key-words + audio recording
10.2.	Required components of future truck driver educational programs	All possible values	Open question without field-coding	Key-words + audio recording
10.3.	Required focus areas during examination	All possible values	Open question without field-coding	Key-words + audio recording
10.4.	Required interval for refreshment courses	All possible values	Open question without field-coding	Key-words + audio recording
10.5.	Required components of future truck driver refreshment courses	All possible values	Open question without field-coding	Key-words + audio recording

4.5. Step 6: Formulating instructions for asking questions

The interviews conducted in this study have been semi-structured interviews in the sense that the exact wording and order of the interview questions is determined up-front by the researcher, while the interviewer still had the opportunity to ask follow-up questions. This paragraph addresses, per theoretical variable, the exact wording for the questions, while the rationale for ordering the questions is discussed in the next paragraph. The interviewing scheme for the truck drivers is presented in Appendix 3 – Interviewing scheme truck drivers.

4.5.1. Theoretical variable 1: Perception about Truck Platooning

Asking about somebody's knowledge about a certain topic can best be done by asking the respondent to describe the phenomenon. First, a filter question (i.e. question 1.1.) is required to make sure that the respondent has heard about Truck Platooning ("*Are you familiar with the concept of Truck Platooning?*"). If the respondent answered affirmatively, question 1.2. ("*Could you please describe what Truck Platooning is according to you?*") was posed, which is the actual question corresponding with indicator variable 1.1., while a negative response to question 1.1. triggered the interviewer to skip question 1.2. and to briefly explain what is meant with Truck Platooning before continuing to question 1.3. ("*How many years from now do you think that Truck Platooning will be implemented in the Netherlands to such an extent that at least 25% of the trucks will be platooning regularly, say once per day?*"). Asking the

respondent to describe the concept of Truck Platooning to the interviewer (in question 1.2.) enabled the interviewer to check whether the understanding between the interviewer and the respondent about the subject was aligned, which was important for the remainder of the interview. If the interviewer, based on the respondent's answer on question 1.2., believed that their perceptions were not aligned, the interviewer informed the respondent about how Truck Platooning is defined in this study in order to ensure the alignment. Question 1.3. enabled the respondent to voice his/her opinion about when it is likely that Truck Platooning will be used often in practice. Often was here defined as 'at least 25% of all trucks are part of platooning activities at least once per (driving) day'. Question 1.4. assessed the respondents' expectations about the influences of Truck Platooning on traffic safety.

Indicator variable 1.2. resulted in an overview, only in the interviews with the truck drivers, of which ADAS systems are installed in their trucks. Consequently, indicator variables 1.3. and 1.4. aimed to find out how often the respondents use ADAS and what their attitudes towards ADAS are. The interviewer, however, first again needed to ensure that the understanding about the concept was aligned between the interviewer and the respondent. Therefore, another filter question (i.e. question 1.5. "*Are you familiar with the concept of Advanced Driving-Aid Systems (ADAS)?*") and alignment question (i.e. question 1.6. "*Could you please describe what Advanced Driving-Aid Systems are according to you?*") were used before posing the real questions (i.e. question 1.7. "W*hich ADAS are installed on the truck that you drive most of the time?*", question 1.8. "*How frequently do you use ADAS while driving your truck?*", question 1.9. "*Can you tell me how safe you think **you would feel** in a truck that highly relies on ADAS in order to drive autonomously?*" and question 1.10. "*What is your opinion on Advanced Driving-Aid Systems in a truck?*"). Question 1.6. thus again tested, if the respondent indicated in his/her response to question 1.5. that (s)he has knowledge about ADAS, whether the respondent's definition of ADAS complies with this study's definition, before continuing with the next questions.

Question 1.7. and the follow-up question of question 1.8. assessed the discrepancy between the availability and usage of ADAS in practice, which can provide indications about the truck driver's trust in the systems. Question 1.9. ("*Can you tell me how safe you think **you would feel** in a truck that highly relies on ADAS in order to drive autonomously?*") more specifically addressed the respondent's trust in ADAS (i.e. indicator variable 1.5.). If the respondent provided vague answers, a follow-up question, asking for further clarification, was used. Question 1.10 ("*What is your opinion on Advanced Driving-Aid Systems (ADAS) in a truck?")* was used to retrieve a summary of the former questions about ADAS (i.e. questions 1.5. through 1.9.).

To find out how the respondents perceive the foreseeable changes for the contents of their jobs (i.e. indicator variable 1.6.), it was important to emphasize in question 1.11. that the researcher wants to learn the respondent's opinion about changes that will occur within the job, because the next question (i.e. question 1.12.) aimed to find out how a respondent feels about his/her job security (indicator variable 1.7.). Question 1.11. was therefore formulated as "*What is your opinion about the potential consequences that Truck Platooning could have on the **contents** of your job?*" and question 1.12. as "*What is your opinion about the potential*

*consequences that Truck Platooning could have on your **job security**?*". If the researcher was not satisfied by the respondents' answers on question 1.11., he could ask follow-up questions aimed at truck drivers' mental workload and their situational awareness in platooning situations.

4.5.2. Theoretical variable 2: Facilitating factors

The interview question (i.e. question 2.1.) that belongs to theoretical variable 2 was formulated as "*Can you describe some factors of which you think that they can result in situations in which the implementation process of Truck Platooning is **sped up** or **facilitated**?*". There is a note for the interviewer in the interviewing scheme indicating that clarification questions can be posed in case that the response is deemed unsatisfactory.

4.5.3. Theoretical variable 3: Impeding factors

The theoretical variable about impeding factors was split into two indicator variables, namely factors slowing down the Truck Platooning implementation process and factors blocking this implementation process. The questions corresponding to this indicator variable (i.e. questions 3.1. and 3.2.) were posed in a comparable way, resulting in the following formulations: "*Can you describe some factors of which you think that they can result in situations in which the implementation process of Truck Platooning is **slowed down/blocked**?*". For both these questions again holds that if the researcher was not satisfied with the answers, he could ask for more clarification or for the respondent to highlight more factors or to provide additional examples.

4.5.4. Theoretical variable 4: Implications for job resources

The theoretical variable aiming at identifying implications for the truck drivers' job resources has one corresponding interview question (i.e. question 4.1.) that was formulated as follows "*What extra options do you expect to get in your job when you will have to start driving a truck capable of platooning?*".

4.5.5. Theoretical variable 5: Implications for job demands

The question that corresponds with theoretical variable 5 (i.e. question 5.1.) was formulated as follows *"What extra tasks do you expect to get in your job when you will have to start driving a truck capable of platooning?".*

4.5.6. Theoretical variable 6: Options for alternative job tasks

To find out what could be potential tasks that a truck driver can perform while the truck is platooning autonomously, a short imaginary scenario was sketched before asking the question. The respondent was asked to think about a scenario in which (s)he is the driver of a truck that is currently platooning as a 'follower', which means that the only requirement for the driver is that (s)he can regain manual control (in order to evade dangerous situations) within several seconds. Then, the respondents were posed the following question: "*Can you think of examples of activities you could be doing while platooning in such a situation?*". The respondent could be asked follow-up questions, if deemed necessary by the interviewer, to elaborate more on specific activities or whether they could think of more examples.

4.5.7. Theoretical variable 7: Required skillsets

In this set of questions, first, the respondent was asked with question 7.1. which skills a contemporary truck driver needs (i.e. a truck driver who only drives trucks that are not yet capable of platooning) by asking "*Which skills do you think that you need in order to be able to fulfill your job in a good way?*". Consequently, the respondent was asked with question 7.2. to voice his/her opinion about the additional skills (s)he thinks that a truck driver would require in order to be able to work well with a truck that is able to platoon. Therefore, the corresponding question was formulated as "*Which additional skills do you think that you will need if you are required to drive a truck that is able to engage in platooning activities?*". Then, the respondent was asked (with question 7.3.) which skills might become obsolete in driving in a platooning truck, which was formulated as "*Which of the current skills do you think that you will not need any more when you are required to drive a truck that is able to engage in platooning activities?*". Finally, the researcher summed up the discrepancies between the answers given by respondent on questions 7.1., 7.2. and 7.3. and asked with question 7.4. whether the respondent missed some aspects in this summary. This step could lead to the identification of more discrepancies by the respondent.

4.5.8. Theoretical variable 8: Required knowledge

Just as with the former group of indicator variables, belonging to the theoretical variable aiming to identify the required knowledge for the platooning truck drivers, the interviewer first asked for the current knowledge possessed by a typical truck driver, followed by asking what knowledge future platoon truck drivers would require and by asking what knowledge might become obsolete. Finally, the researcher again compared the discrepancies between the current situation and the prospected future situation and asked the respondents to confirm that his/her perspective is summarized correctly.

4.5.9. Theoretical variable 9: Required occupational mindsets

Theoretical variable 9 was operationalized in a comparable way as has been done with the former two theoretical variables. Again, the occupational mindsets of current truck drivers, the required occupational mindsets for platooning truck drivers and the occupational mindsets that might become obsolete in platooning situations were assessed, after which the researcher again compared the discrepancies between those answers to confirm that the respondent's view was summarized correctly. In order to provide the respondent with a possibility to come up with additional new insights, question 9.5. asked the respondent to indicate the characteristics of a typical person who is a stereotypical truck driver in 10 years.

4.5.10. Theoretical variable 10: Changes in truck driver educational programs

Regarding a truck driver's educational programs, the first question (i.e. 10.1. "*Can you describe what the educational process of becoming a truck driver looks like?*") asked the respondent to describe the components of a truck driver's education. Consequently, the respondent was asked to voice his/her ideas about how the education of future truck drivers should be adapted in order to have an educational program that prepares them properly for Truck Platooning (i.e. question 10.2. "*On which aspects do you think that the educational*

program for future truck drivers will differ from the educational program that you went through to become a truck driver?"). To further check the response given at question 10.2., the respondents were asked what they think the focus should be on in the examination of a student truck driver in question 10.3. (i.e. "*What are, according to you, the main focus areas at which examiners should be focused in the examination for the truck driver's license in order to prepare future truck drivers properly for Truck Platooning?*"). Questions 10.4 and 10.5. focused on the ideal interval between in-service trainings and refreshment courses (i.e. "*How often do you think that a truck driver should participate in 'in-service trainings' or a 'refreshment course' in order to stay properly skilled as a platooning truck driver?*") and on how these programs should be adapted ("*On which aspects do you think that these 'in-service trainings' or 'refreshment courses' should be adapted to anticipate for platooning trucks?*").

4.6. Step 7: Ordering the questions

In ordering the questions, first the overall topics have been put into a logical order by applying the funnel approach (Kahn & Cannell, 1957), which means that questions are becoming more detailed (and potentially more sensitive) as the interview proceeds. The topics start very general, by first assessing the respondents' perceptions about Truck Platooning before addressing the more detailed topics of facilitating and impeding factors. The second broad topic is the topic addressing the job implications for the truck drivers, which was discussed in more detail by the sub-topics about options for alternative job tasks that can be fulfilled while platooning and about the skills, knowledge and occupational mindsets that are required for truck drivers. With regard to the skills, knowledge and occupational mindsets, these topics have been addressed in this order so that they moved gradually from concrete towards more abstract concepts (i.e. knowledge is more abstract than skills and occupational mindsets are even more abstract). This again can be seen as applying the funnel approach. Finally, the interview concluded with the topic of the implications of Truck Platooning for truck driver educational programs.

As Emans (2002) states, the questions *within* each topic should be logically ordered as well. Here, a combination of the funnel approach and the inversed funnel approach was used to get a logical order of questions. The respondents were asked questions about Truck Platooning in general (i.e. questions 1.1., 1.3. and, if applicable, 1.2.) and about the relationship between Truck Platooning and traffic safety (in question 1.4.) before the interview questions started focusing on ADAS (i.e. questions 1.5. through 1.10.), so the funnel approach was adopted here. If the questions about ADAS would have been posed before the general question about safety, they would have probably influenced the way in which the respondents answered the latter (due to the consistency mechanism described in Paragraph 3.2.6.). Within the sub-set of questions addressing ADAS, the inversed funnel-approach was used by letting the respondent think about some ADAS-related issues (i.e. trust in automation systems and the extent to which the truck drivers use these systems in practice), before asking the more general question about their opinions on ADAS (i.e. question 1.10.). By having already discussed the aspect of using ADAS in practice, the researcher hoped to get more elaborated answers that are of a better quality. An example indicating that potentially sensitive questions should be posed later in the interview is the order of question 1.11. and

1.12., which asked the respondents about the expected changes in terms of the job contents and the job security, respectively. A question about job security could trigger a sense of a truck driver becoming obsolete in the end and is therefore more sensitive than a question generally asking about how one perceives that the job contents will change. Also, with regard to the topic of impeding factors, first a question was asked about which factors could potentially slow down the Truck Platooning implementation process (i.e. question 3.1.) before asking which factors could potentially completely block this process (i.e. question 3.2.). This order was chosen so that the interview first discussed the less extremely formulated questions before heading over to the more extremely formulated ones. In the fourth and fifth topic, corresponding to the theoretical variables of implications for job resources and for job demands, respectively, here was chosen to ask the positive-oriented question (i.e. 4.1. "*What extra options do you expect to get in your job when you will have to start driving a truck capable of platooning*?") before the more sensitively formulated question (5.1. "*What extra tasks do you expect to get in your job when you will have to start driving a truck capable of platooning*?").

The question sets that correspond with theoretical variables 7, 8 and 9 (i.e. required skillsets, required knowledge and required occupational mindsets, respectively) are consistently ordered chronologically. For each of those topics, first a question about the current situation was posed before asking about the prospected future of that specific aspect. The interviewer summarized afterwards, per aspect, the differences between the current and the prospected future state that the respondent pointed out.

The questions corresponding with theoretical variable 10 (i.e. changes in truck driver educational programs) were partly asked chronologically and both the funnel- and the inversed funnel approaches were used. The chronological order for question 10.1. and 10.2. is that the former question asks about the components of the educational program in the past, while the latter question focuses on how the respondent expects the educational program to change in the future. Questions 10.3. ("*What are, according to you, the main focus areas at which examiners should be focused in the examination for the truck driver's license in order to prepare future truck drivers properly for Truck Platooning?*") and 10.4. ("*How often do you think that a truck driver should participate in 'in-service trainings' or a 'refreshment course' in order to stay properly skilled as a platooning truck driver?*") are more detailed and therefore the funnel approach is visible there. The interviews concluded with question 10.5. ("*On which aspects do you think that these 'in-service trainings' or 'refreshment courses' should be adapted to anticipate for platooning trucks?*"), which asked the respondent a somewhat more general question about refreshment courses, which had already been introduced in the preceding questions to encourage the respondent to start thinking about the topic before asking such a broad question.

4.7. Step 8: Adding the lay-out, introduction and conclusion

Regarding the lay-out of the interviewing scheme, the exact wording of each interview question has been written in italic style, while the bold sections indicated that the interviewer should put an extra emphasis on those sections. Further, to indicate the sections that correspond with the theoretical variables, section titles were printed bold as well. Moreover,

in case a section requires the interviewer to introduce it, the exact introduction text was printed in a bigger font size, in italics and it was put between quotation marks.

The interview's introduction started by thanking the respondent for being willing to participate in this study and by briefly stating the subject of the study. Then the study's goals for practice (i.e. providing insights on how to anticipate on the implementation process of Truck Platooning) and for science (i.e. enriching the literature about the implications of Truck Platooning on the profession of truck drivers) were mentioned. Consequently, it was emphasized that there are no right or wrong answers, because the questions asked for their opinions or expectations. To comfort the respondents even more, they have been ensured that their answers will be analyzed anonymously and can therefore not be traced back to them. Finally, the introduction stated the prospected duration of the interview (i.e. 1 hour to 75 minutes) and permission was asked to make an audio recording of the interview. It was also explicitly mentioned that the audio-file was only accessible to the interviewer and that it would be deleted after the results had been analyzed.

The interview's conclusion first thanked the respondent for his/her time and effort, before emphasizing again that the results would be analyzed and reported anonymously. Finally, the respondent was asked whether (s)he wishes to receive the outcomes of the analysis (i.e. the final research report). If the respondent would like to receive this document, the interviewer wrote down the respondent's email address before wishing the respondent a nice day and leaving the interview location.

4.8. Step 9: Testing the draft interviewing scheme

As a test of the interviewing scheme, the researcher asked one of his friends to participate in the interview fictitiously in order to test whether the questions would be interpreted in the correct way and whether there existed some ambiguities in the way in which the questions were formulated. The, described by Emans (2002) and already mentioned in Paragraph 3.2.8., of '*asking test respondents*' was thus adopted.

4.9. Step 10: Constructing the final interviewing scheme

Testing of the draft interviewing scheme with a colleague student led to some minor changes in the formulation of the interview questions. Due to the fact that the adjustments that had to be made were insignificant, the researcher chose not to re-test the adjusted draft interviewing scheme with another test respondent. Therefore, the adjusted interviewing scheme became the final interviewing scheme, which can be found in Appendix 3 – Interviewing scheme truck drivers.

4.10. The other stakeholders' interviewing scheme

The preceding paragraphs discussed the steps by which the interviewing scheme that aimed at the truck drivers was developed. The way in which the interviewing scheme for all other stakeholder groups (see Appendix 4 – Interviewing scheme other stakeholders) was developed does not deviate strongly from the way in which the former interviewing scheme was constructed. Therefore, the differences between the interviewing schemes are discussed

in this paragraph instead of discussing the operationalization of each theoretical variable separately again.

The first difference between the interviewing schemes is that questions 1.7. ("*Which ADAS are installed on the truck that you drive most of the time?*"), 1.8. ("*How frequently do you use ADAS while driving your truck?*") and the follow-up question of the latter question ("*Which ADAS systems do you use frequently, that is every working day at least once, in practice?*") were excluded from the other stakeholders' interviewing scheme because these questions are only applicable to truck drivers.

Question 1.9. (i.e. question 1.7. in the other stakeholders' interviewing scheme) was rewritten by replacing "…you would feel…" into "…a truck driver would feel…". Questions 1.11. and 1.12. (questions 1.9. and 1.10. in the other stakeholders' interviewing scheme, respectively), about the implications for truck drivers' job contents and job security, were rewritten in a similar way, by replacing "…your job…" with "…a truck driver's job…".

As an introduction to questions 4.1. and 5.1., about implications for job resources and job demands, in the truck driver interviewing scheme the respondents were asked to assume that their employers have demanded from them to start driving in a platooning truck. The idea behind this is that such a short introduction triggers the respondents to imagine oneself in such a situation, which is likely to result in clearer and more valid answers.

In question 6.1., asking the respondent to think about potential alternative job tasks while platooning, both the truck drivers and the other stakeholders were asked to imagine that they have to drive in a platooning truck and to imagine what other tasks they could perform. In this case, therefore, there again is only a small difference in the introduction text (i.e. "…please think of the situation in which you are the driver of a truck that is currently engaged in a platoon…" versus "…please think of the situation in which a truck is currently engaged in a platoon…") and a slight adaptation of question 6.1. ("…you could be doing…" versus "…a truck driver could be doing…").

The final difference between the interviewing schemes is found in the section about the changes in truck driver educational programs (i.e. corresponding with theoretical variable 10). In the truck driver interviewing scheme, the respondents have been asked to imagine that someone in their close proximity, like a family member, would like to become a truck driver as well. Again, this strategy was applied to trigger the imagination of the respondent (i.e. the truck driver) to retrieve answers of better quality.

5. Data Analysis

This chapter indicates how the data has been analyzed. First, Paragraph 5.1. discusses how the data was prepared (i.e. transcribing, deleting irrelevant sections from the transcripts, replacing relevant fragments and determining the unit of analysis) and which decisions were made in this process. Paragraph 5.2. explains which data sources are used for coding and argues why the emerging coding style was used (Blumberg, Cooper, & Schindler, 2014). Consequently, Paragraph 5.3. describes how the initial coding scheme (see Appendix 5 – Initial coding scheme) was transformed into the final coding scheme (see Appendix 6 – Final coding scheme). An extensive description of every step that was taken in this process can be found in Appendix 7 – Reconstruction of the coding scheme. The results of the analysis are discussed in Paragraph 5.4., where each research question is addressed separately in Paragraph 5.4.1. through 5.4.11. Finally, the job profile for the future platooning truck driver is distilled from the results and visualized, by using the FPM technique, in Paragraph 5.5. (Oeij, van der Torre, van de Ven, Sanders, & van der Zee, 2017).

5.1. Data preparation

In the paragraph about data preparation methodology (Paragraph 3.3.1.), three decisions were identified that a researcher should make in the transcription phase of the data preparation process. Corresponding to the first decision, in this research it was decided to initially adopt the full transcription methodology and to only delete certain sections after all data has been reviewed, so that no data is disregarded without careful consideration. Secondly, the decision was made to write the transcripts in a non-verbatim way because respondents occasionally utilized fuzzy sentence structures and immediately rewriting these sentences into formal language significantly eases the analysis. Finally, with regard to the third transcription decision, only the spoken words are indicated in the transcripts because this is more suitable for non-verbatim transcripts (Blumberg, Cooper, & Schindler, 2014).

After transcribing the interviews, irrelevant sections have been deleted and the researcher had to decide upon which unit of analysis to use. The criteria for interpreting fragments in the transcripts as being irrelevant are 1) when respondents voiced their opinions about issues unrelated to any of the research questions (e.g. elaborating on the process of importing a truck), 2) when respondents repeated, with almost the exact same words, one of their stances, 3) fragments that are used to explain something to the respondent (e.g. the explanations of Truck Platooning and ADAS or the fragments in which respondents are asked to imagine a scenario), and 4) when respondents asked the interviewer to further clarify a question or a concept.

During the interviewing phase it became clear that respondents sometimes provided answers that were not (totally) relevant in answering the question at hand, but that are nevertheless very relevant as answers to other interview questions. Therefore, after deleting the irrelevant sections from the interview transcripts, sentences or fragments were coupled and replaced so that the answers to each question were indeed placed in the near proximity of those questions. Afterwards, the decision has been made to use sentences and fragments as the units of analysis and coding was done by attaching labels to every sentence or to every

fragment (i.e. in case the respondent expressed multiple stances in a single sentence or in the event that one stance encompassed multiple sentences).

5.2. Coding

The stance of Blumberg et al. (2014), as indicated in Paragraph 3.3.2., that textual data can provide richer information than numerical data is the main reason why in this study was decided to mainly retrieve data from face-to-face interviews. However, some additional data has been retrieved from the truck driver competence profile by STL (Sectorkamer mobiliteit, transport, logistiek en maritiem, 2017) and from a study report by TNO (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017).

In this study the emerging coding strategy was used due to the explorative nature of this study's main aim, namely to explore the effects that Truck Platooning will have on the profession of truck drivers. Emerging coding was identified to be very suitable, due to its more open and unstructured process, for the explorative nature of this study. The wish to explore new insights therefore strongly pleas for emerging coding and this was considered more important than the counter-argument that emerging coding is much more time-consuming.

5.3. Reconstructing the coding scheme

After the coding process, the initial coding scheme (see Appendix 5 – Initial coding scheme) had to be checked for consistency errors, for duplicates and to ensure that the most logical structure was found. This section describes what changes have been made to transform the initial coding scheme into the final coding scheme (see Appendix 6 – Final coding scheme). This step has been documented extensively so that his section adds to the reproducibility of this study and can be viewed in Appendix 7 – Reconstruction of the coding scheme. The initial coding scheme consisted out of 3,081 references (i.e. fragments) within 212 labels. The number of labels has been narrowed down to 180 in the final coding scheme, while the number of fragments has increased slightly to 3,094 because these were somewhat rearranged. The final coding scheme is more structured and was therefore easier to use in the analysis.

The approach for restructuring the coding scheme was to work top-down and to ask oneself the questions "is this label similar to another one?" and "will it become more structured and more logical if this label is replaced or merged?". If the answer on one of these questions was 'yes', an action was required. The original codes are written in Dutch, but the translation into English is provided within brackets (see Appendix 7 – Reconstruction of the coding scheme).

5.4. Results

After preparing and coding the data, the data was analyzed systematically in order to enable the researcher to formulate answers to the research questions. The results will be discussed in order of these research questions in Paragraphs 5.4.1. through 5.4.11. When there is a reference to a coding label in the remainder of this report, it automatically applies to the final coding scheme (see Appendix 6 – Final coding scheme).

5.4.1. Question 1: "How do truck drivers perceive the innovation of Truck Platooning?"

This section tries to formulate an answer to how truck drivers perceive Truck Platooning. This perception consists out of 1) the extent to which a truck driver is familiar with the concept, 2) an estimate of when Truck Platooning will penetrate the market (i.e. defined as 25% of all trucks are engaged at least once per day in a platooning activity), 3) a description of the prerequisites for Truck Platooning, 4) a summary of the expected consequences of Truck Platooning on the contents of the job and on the job security, 5) the expected effects on traffic safety, and 6) the understanding, trust in, and opinions about ADAS (i.e. this question is answered by filtering on the truck drivers' answers within the labels [1.1.] through [1.10.]).

Familiarity with Truck Platooning

Only one of the four truck drivers indicated to be somewhat familiar with Truck Platooning. The other truck drivers were given a brief explanation of the concept before continuing with the interview. Quite often the truck drivers mentioned that platooning in practice is already mimicked frequently by the usage of Adaptive Cruise Control (ACC). Further, half of the truck drivers compared Truck Platooning with the work of train drivers, indicating the fear that they, just like them, perhaps would be obligated to press a button every few seconds/minutes to notify the platooning systems that they are still awake.

Market penetration estimates

When talking about the moment at which the truck drivers expect Truck Platooning to be implemented in the sense that at least 25% of the trucks daily operate in a platoon, the truck drivers' answers varied greatly. They varied from "that penetration rate will never be met due to the complex traffic situations that are unlikely to be overcome in the near future" to "I think that it will be possible from 2020 onwards". All truck drivers, however, stressed that the platooning systems should be intelligent enough to handle most complex traffic situations (e.g. traversing traffic, dodging maneuvers and technical failures within the trucks) properly.

Prerequisites

Truck drivers indicated that there are several prerequisites for Truck Platooning to be successfully integrated in the field of logistics.

First of all, a solution has to be found to keep the driver in a state of utmost alertness, while simultaneously being less involved with the driving tasks, so that (s)he can intervene in the event that the platooning systems make wrong decisions.

One truck driver stated that platoons should be recognizable by other road users, either by indicators on the truck itself or by signs along routes where platooning will take place. Another truck driver aids to that claim by arguing that the other road users should be informed as well to ensure a smooth implementation of Truck Platooning on the normal road network.

Further, one truck driver identified the willingness of logistic services providers to invest in equipment that is capable to platoon as a strict prerequisite, which will only happen, according to him, when the management of those organizations will be aware of the (economical) advantages they can reap. A specific idea that was mentioned was that organizations investing in platooning can apply for grants in the beginning phase.

Next, 3 out of 4 truck drivers argued that the highway infrastructure is not ready yet for Truck Platooning. Moreover, two of them suggested the idea of creating separate lanes for Truck Platooning (i.e. just like the already existing bus lanes) to limit the amount of interferences by other road users and to enhance the traffic flow and the predictability of platoon planning, which probably results in enhanced safety.

Two truck drivers also mentioned that truck drivers must get stimulated to work together, for example by forming platoons with trucks from different companies (i.e. competitors).

The prerequisites for Truck Platooning indicated by the sample of truck drivers can be summarized by the claim, which is also specifically mentioned by half of the truck drivers, that a lot of testing is still required before it will be possible to broadly implement Truck Platooning.

Consequences

Besides identifying prerequisites, the truck drivers have also mentioned some expectations about the consequences of Truck Platooning, which are discussed in this sub-paragraph.

The real driving of the truck is an aspect of the job that will be taken over by the platooning systems on the highways when connected in a platoon, while the truck driver becomes responsible for monitoring these systems. The skills of maneuvering the truck can, however, not disappear, since all truck drivers agree that the truck must be driven manually when it is not capable to platoon (i.e. the first and last mile of a journey), so only the proportion between manual driving and platooning will shift. Two truck drivers expressed their expectation that this shift in job tasks will lead to an upgrade of the occupation of truck drivers and they think that the educational level for the job of a truck driver will therefore increase.

Concerning the mental workload, three truck drivers indicated that the mental workload will decrease due to the fact that less attention is needed when the truck is driving in a platoon. One person specifically expressed the fear that employers will therefore argue that it is defensible to increase the duration of a normal workday for truck drivers. There was, however, also one truck driver who argued that the mental workload of truck drivers would increase due to the planning-role that is likely to be shifted to the truck drivers' responsibilities.

The truck drivers also think that Truck Platooning will have several consequences that are somewhat more pragmatic. Those are economic advantages, sustainability advantages in the sense that fuel can be saved due to the short following distances, thereby decreasing the carbon dioxide emissions, and that the road network will be used more efficiently, which will enhance the traffic flow, eventually enhancing the traffic safety.

One truck driver also mentioned that logistic services providers can take advantage of the increased amount of data that is being registered in such modern trucks and that the planning can become more efficient, while another truck driver expects that many other truck drivers perceive the use of more data as if "Big Brother is watching you". Standardization of schedules and compatibility between systems was determined to be a requirement to effectively utilize this data.

Two of the truck drivers indicated that they would be skeptical about the platooning technology and that they probably would not like the new way of working in which they felt like becoming simply somebody who monitors the systems (i.e. becoming a 'system operator'). On the other hand, however, there was one truck driver who saw it as a positive development in which truck drivers receive the opportunity to play an important role in the logistics process. Although the contents of a truck driver's job will change when Truck Platooning is implemented, the truck drivers are confident that most of their colleagues can cope with the changes and that trust in the systems can develop if they receive enough time to get familiarized with what has changed.

One truck driver warned for the probability that a truck driver becomes bored and consequently loses his/her attention, which can lead to dangerous situations. Two truck drivers commented on the situational awareness, but their opinions differed strongly. The first said that he would probably just look at something interesting outside of his truck, unrelated to the driving task, if he would be driving in a platoon, while the other one argued that he would constantly actively monitor whether the platooning systems are working correctly.

All truck drivers expressed their discomfort with the short following distances (i.e. the 0.3 seconds aimed at by Truck Platooning) at which they will be constantly looking at the backside of the preceding truck, while not being able to respond in time when required. Although most of them (i.e. 3 out of 4) acknowledged that there probably is a process of familiarization involved, they all expect to experience a lot of discomfort when sitting in such a cabin.

None of the truck drivers fear for losing their jobs in the short-term. This is because truck drivers will still be needed to drive the first and last mile and to load and unload the truck. Moreover, there currently is an enormous shortage of truck drivers and the truck drivers expect the economy to grow further, which also leads to more road transport. They therefore argue that it will take a considerable amount of time until the demand for truck drivers will start to decline. They do, however, expect that there eventually will be a point in time where truck drivers will become obsolete. One truck driver mentioned that automation of road transport is generally seen as a threat among truck drivers.

To summarize, truck drivers expect that Truck Platooning will have many consequences. They do, however, not fear for losing their jobs in the short term, but anticipate that their job will become more complex because it will contain more tasks. This can result in an upgrade of the image of the job of a truck driver. Even though all truck drivers were confident that current truck drivers could eventually cope with Truck Platooning, some of them indicated to be skeptical about whether or not they would like their future jobs. The main reason for being skeptical was the expectation that truck drivers become 'system operators', which is not appealing to them. The most prominent factor that could cause truck drivers to experience discomfort during platooning, mentioned by all truck drivers, is the short following distance.

Traffic safety

Different opinions are voiced about the relationship between Truck Platooning and traffic safety. One truck driver mentioned that whether or not Truck Platooning improves traffic

safety heavily depends on the way in which it is being implemented. He later clarified that this is mainly dependent on the probability that the platooning systems fail. Another truck driver adds to that claim that it is dependent on how other road users anticipate on Truck Platooning. On the other hand, two other truck drivers stated that traffic safety will increase by Truck Platooning due to the fact that the traffic becomes more calm and predictable (e.g. there will be no differences in driving speeds within platoons and therefore overtaking is prevented). It can be concluded that half of the truck drivers in this study's sample are somewhat critical about whether Truck Platooning enhances traffic safety, while the other half believes that this certainly is the case.

ADAS

Three truck drivers indicated not to be familiar with ADAS, but after the short explanation, they all could provide some examples of ADAS. Two truck drivers indicated that the sounds that some ADAS (i.e. brake-assistance and Lane Departure Warning (LDW)) produce to warn the driver are very loud and are therefore perceived as annoying. Even though the truck drivers in this study do not disable the LDW system themselves, they indicated that they know many other truck drivers who frequently disable the LDW system. The truck drivers also mentioned that it is unlikely that they will trust ADAS for 100% in the short run, but that this might be possible after a very long familiarization period (i.e. 10 years was mentioned as an example).

All truck drivers perceive ADAS, especially ACC, as comfortable and useful. Lane departure warning is the least favored ADAS. Three out of 4 truck drivers drive in relatively well-equipped trucks, since they possess Cruise Control (but only one of those systems is Adaptive), brake-assistance and LDW. The truck driver whose truck possesses ACC also has hill climb/descend assistance and therefore drives the most modern truck. The least equipped truck only possesses normal Cruise Control. The truck drivers in this study unanimously use their (A)CC systems as often as possible and they do not disable the LDW system. These findings conform to their statements that they appreciate (A)CC and that, even though the warning sound of LDW is annoying, safety weighs stronger than annoyance. The brake assistance system is standardly enabled and the truck drivers hope that they will not end up in a situation that this system has to intervene.

To conclude and to answer research question 1 ("How do truck drivers perceive the innovation of Truck Platooning?"), all truck drivers perceive ADAS as comfortable and useful, but they are somewhat more skeptical about the superlative concept of Truck Platooning. The truck drivers' expectations about the speed of the implementation process vary greatly and their opinions also differ on whether Truck Platooning will enhance traffic safety or not. Truck drivers perceive Truck Platooning as a concept that will have a lot of consequences, for example for 1) the contents of their jobs, 2) the mental workload for truck drivers, 3) the image of their jobs, 4) the environment, and 5) for logistic services providers. All truck drivers expect that those consequences are unlikely to affect their job security in the short term, but they do foresee that several prerequisites still must be met before Truck Platooning can be successfully implemented.

5.4.2. Question 2: "How do other stakeholders perceive the innovation of Truck Platooning?"

To answer the second research question, the perception of the other stakeholder groups will be assessed in a similar manner as was done for the group of truck drivers in Paragraph 5.4.1.

Familiarity with Truck Platooning

Almost all respondents already had a reasonable understanding of the concept of Truck Platooning at the beginning of the interview. Only within the stakeholder group of the employees of logistic services providers, a few respondents were unfamiliar with the concept. After a brief explanation, they indicated that they understood the concept well enough to be able to continue with the interview.

Around one quarter of the respondents from the other stakeholder groups indicated, just as the truck drivers, that Truck Platooning is already being mimicked quite often. Almost all respondents stated that a convoy cannot be classified as being a platoon if they only anticipate on each other by radars without being electronically connected. Also, it was mentioned that Truck Platooning is probably, at least in the short-term, only going to work properly when it is applied on highways. The respondents agree that it is a highly complex endeavor to try to platoon in densely populated areas. On the other hand, several respondents indicated that flexibility is highly valued in logistical operations and should therefore be preserved at all costs. Truck Platooning can inhibit the flexibility when trucks have to wait for each other (i.e. to form platoons in the hub-to-hub scenario).

Rijkswaterstaat perceives the hub-to-hub scenario as the most feasible solution in the short term, while one of the truck manufacturers emphasizes the "logistical nightmare of planning platoons up-front with multiple transport companies". The hub-to-hub scenario is mentioned more often than the on-the-fly scenario, against what was hypothesized in Paragraph 1.2., also by representatives of logistic services providers, who are an important source because they can accurately forecast how they expect to work when having adopted Truck Platooning. They think that the tasks will be more divided in the future, so that, for example, tasks like loading or unloading of the truck are not done anymore by the truck driver, but by other employees. The expectation is that this will make the job of a truck driver less broad, but that the most interesting tasks will remain the truck driver's responsibility, while the routine tasks will be automated.

Most respondents agree on the stance that the truck driver should have the autonomy to decide when to overrule the platooning systems by taking back the control. On the other hand, there is the unanimous stance that the moment at which the systems give back the controls to the driver is the moment that the probability of errors, which could result in traffic accidents, is the highest.

In explaining the concept of Truck Platooning to the interviewer, the respondents often compared (getting used to) Truck Platooning with other innovations or occupations. The parallel between the introduction of the LZV's ('*Langere en Zwaardere Vrachtautocombinaties*'), the longer and heavier vehicles, and the prospected implementation of Truck Platooning was mentioned (i.e. there have been legislative issues on an EU-level in the introduction of the LZV's) in more than half of the interviews with the other

stakeholders (i.e. 9 out of 16 respondents). The job of the future platooning truck driver was mostly compared with the job of a pilot (6 times) and only once with that of a train driver. This is interesting to see, because apparently truck drivers are comparing their future jobs more with train drivers' jobs (see Paragraph 5.4.1.), while other stakeholders see more parallels with a pilot's job. Truck Platooning was also frequently compared to autonomous driving in passenger cars (e.g. Tesla's auto-pilot). The insurance company and a representative of an educational institution indicated that the technology for autonomous driving is much further developed within trucks than it is for passenger cars. The truck manufacturers confirm this statement, since they have indicated that the techniques for Truck Platooning are basically ready for implementation.

Market penetration estimates

Most respondents think that Truck Platooning is a stepping stone to fully autonomous driving, although they have all indicated that the latter is only feasible in the long-term. The estimates about when the penetration rate of 25% will be reached vary from the educational institutions, BOVAG and 4 out of 5 logistic services providers, of which the representatives think that it will take approximately 8 to 10 years from now, to the respondent from the vehicle authority (i.e. the RDW) who thinks that it might take up to 30 years from now before this rate will be achieved. Rijkswaterstaat is somewhat more optimistic by maintaining the ACEA roadmap[7], which indicates that cross-border multi-brand Truck Platooning is feasible in 2023. The truck manufacturers strengthen this stance by stating that the technology can be implemented around 2023, with the side note that it probably will take another 2 to 3 years before it will become a common phenomenon on the Dutch highway network. On the other hand, the representatives of the insurance firm and of one of the logistic services providers are less optimistic, since these persons think that a penetration rate of 25% will never be achieved, either because the automated highway will surpass Truck Platooning as a more interesting innovation or because the distances traversed by Dutch companies are too short to create efficiencies out of Truck Platooning. Among the two labor unions included in this study, there is quite some debate about when Truck Platooning becomes reality, since the expectations of successful implementation vary from as early as 2025 up to 15 to 20 years from now.

Prerequisites

Many respondents indicated that the systems must be extremely fail-safe, so that the truck driver has to intervene as little as possible. Some respondents argue at the same time that the ability to intervene must be preserved for the truck driver. The respondents agree that the truck driver therefore must be alert, at least to a certain extent, in the short term, until the systems are fail-safe enough that they could be classified as level 4 autonomous driving (see Figure 6). This aligns with their prognoses that truck drivers should stay aware of what happens around them until their trucks are driving autonomously at level 4 or higher.

Further, it was stated by several respondents that not all types of road transportation are eligible for Truck Platooning. An organization transporting containers can, for example, more

[7] Source: https://www.acea.be/publications/article/infographic-eu-roadmap-for-truck-platooning

easily engage in platooning activities than an organization facilitating city center distribution services.

Also, it was mentioned by almost all stakeholder groups that Truck Platooning should become a cross-border initiative. Furthermore, several respondents indicated that it is a prerequisite that trucks from different brands can form a platoon together (i.e. multi-brand platooning).

Just as indicated by a truck driver, several other stakeholders identified the importance of the recognizability of platoons, meaning that a solution should be found to make truck platoons clearly visible for other road users. Furthermore, a method should be found so that the number of other road users that are properly informed about Truck Platooning can be maximized.

Rijkswaterstaat, BOVAG, two logistic services providers and a truck manufacturer explicitly expressed the opinion that truck drivers should be given a voice in the development process of Truck Platooning in order to make the implementation a success. This study is a way by which the truck drivers are given this voice.

With regard to the incentives that logistic services providers demand, the other stakeholders agree with the truck driver who mentioned that the advantages should be clear and that monetary incentives are likely to increase the willingness to invest in Truck Platooning.

Furthermore, the infrastructure (i.e. the road network, but also the systems surrounding it) must be made ready for Truck Platooning. Specific ideas that were mentioned are separate Truck Platooning lanes on the highway, defining specific corridors where platooning should take place (which ideally have a minimum of 3 lanes) and the communication with IVRI's (Intelligent Vehicles and Road Infrastructure).

Finally, the respondents have identified several uncertainties that should be clarified before Truck Platooning can be implemented, which are 1) the implications for the driving and resting times legislation, 2) issues surrounding ethical and legal accountability, 3) whether logistic services providers in the future still have to apply for an exemption for every platooning activity, 4) how society, especially other road users, will react to Truck Platooning, and 5) how stakeholders will cooperate with each other in the future. With respect to legislation, policy employees from the ministry of Infrastructure and Waterways (I&W) said that adaptations in the laws can be realized fairly quickly from the moment that it is completely clear what exactly must be written down in these laws. Moreover, all other stakeholder groups agree that tests with Truck Platooning are useful in the development process of Truck Platooning. The uncertainty about the cooperation between stakeholder groups consists out of uncertainty about how to split the advantages of Truck Platooning, since the following trucks save considerably more fuel than the leading vehicle, about how the process of matching trucks will look like and about whether or not logistic services providers can go from competition towards cooperation.

Consequences

The other stakeholders have also identified some realistic consequences of Truck Platooning, which are discussed below.

The representatives of the insurance company and of three of the logistic services providers expect that there will be little changes for the truck drivers due to Truck Platooning. One of the truck manufacturers indicated that whether or not the job contents change significantly is dependent of the level of autonomous driving (see Figure 6). All other stakeholders expect the job of the truck driver to change dramatically. Examples given are 1) that truck drivers will only maneuver, 2) that they will pass on the truck and its contents to colleagues and drive back another truck, so that their routes and schedules can be standardized, and 3) that the truck drivers will become responsible for programming and monitoring the platooning systems (i.e. becoming 'system operators').

Several respondents made a clear distinction between the jobs of a 'leading' truck driver and that of a 'following' truck driver. It is argued that the responsibility, and thus the mental workload, of the leading truck driver would increase significantly because (s)he is basically driving multiple trucks at the same time. There is some debate regarding the mental workload of the following truck drivers. Respondents who indicated that the mental workload would also increase for following truck drivers argue that the decline in viewing distance and the short times for handing over control to the platooning systems results in more psychological stress. Also, the fact that the truck driver becomes responsible for a wider array of tasks can lead to an increased mental workload. On the other side of the spectrum, respondents indicated that the workload is likely to decrease because Truck Platooning relieves the truck driver from duties while driving on the highways and it offers possibilities for standardizing working schedules, which can lead to more private life opportunities (e.g. the opportunity to make appointments in the evening, since you know at what time you will be done working). Moreover, the pressure from the planning department will probably decrease, since a truck cannot overtake while being in a platoon, so exerting pressure on truck drivers by planners will make no sense anymore.

The stakeholders are inconclusive regarding whether the job of a truck driver will become more or less attractive due to Truck Platooning. It seems to depend on what the truck drivers are interested in. If truck drivers like to work with new techniques, then the expectation is that their attraction to the job will increase, while attraction is expected to decrease when truck drivers are conservative and extremely proud about the way in which they manually operate the truck. Most respondents indicated to expect that most truck drivers are not keen on Truck Platooning. The policy employees of the ministry of I&W can imagine this stance, but are more optimistic because they argue that truck drivers might appreciate the efforts undertaken by their employers to support them in their work. Generally, the respondents agreed on the perspective that the job of a truck driver, or at least its image, will be upgraded due to the additional tasks and responsibilities.

Further, the other stakeholders mentioned the same pragmatic consequences that the truck drivers mentioned (i.e. economic advantages, sustainability advantages, an enhanced traffic flow and potentially improved safety). For example, a representative of a logistic services provider expects savings on material costs (e.g. on brake pads) due to the smooth driving style resulting from Truck Platooning.

Multiple respondents stated that the logistical chains will change completely due to Truck Platooning, but only a few respondents specified how this would change. They forecasted that a total new job will be formed, namely that of 'platoon planner' or 'platoon mediator'. Rijkswaterstaat and one of the logistic services providers' representatives indicated to be strong proponents of driving standard routes in standardized schedules as much as possible, so that the complexity in platoon planning can be decreased and the predictability thus can be increased. Moreover, BOVAG lobbied for standardization of all systems in order to improve interoperability and to facilitate multi-brand platooning.

Finally, with regard to the consequence that Truck Platooning will lead to shorter following distances, many of the respondents indicated that truck drivers will probably feel not at ease while driving that close behind a predecessor, just like what the truck drivers expressed themselves. Moreover, one representative of a logistic services provider explained that the weights of the trucks should be incorporated in the calculation of the ideal following distances, because weight and braking distances are directly related. This implies that the ideal following distance must be determined separately for each platoon and must be adapted every time that a truck merges with or splits from the platoon.

Traffic safety

One of the logistic services providers thinks that truck drivers will feel absolutely safe with the platooning systems, while most other respondents argue that, before being familiarized with Truck Platooning, the truck drivers would probably feel unsafe. When looking at the absolute safety, all respondents in this category have the expectation that Truck Platooning will have a positive effect on the traffic safety (e.g. by creating calmer traffic situations and by preventing human errors). There are, however, some prerequisites provided before Truck Platooning can really improve traffic safety. The systems should be properly constructed technically (i.e. so that they almost never fail), a lot of attention must be devoted to informing other road users about how to anticipate on Truck Platooning, and the platooning sections should have at least 3 lanes. The respondent who mentioned this, one of the logistic services providers, argued that it is unlikely that all (foreign) truck drivers will participate in platooning activities. Therefore, he said, the most right lane should be devoted to truck platoons, the middle lane can then be used by both trucks that are not engaging in platooning activities and other traffic, while the fast lane is kept for passenger vehicles only.

ADAS

All respondents, except the labor union representatives and three logistic services providers were unfamiliar with ADAS. After explaining the concept, they indicated that they understood what is meant with ADAS. The other stakeholder groups provided a wider range of examples of ADAS than the truck drivers did. For example, what the truck drivers did not mention, are eye motion sensors (to monitor the truck driver's fatigue), blind spot warning systems and vehicle stability control. In the descriptions of ADAS, two main ways of making distinctions between those systems were shared. The CBR's representative indicated that there is a distinction between systems that intervene in hazardous situations and systems that only support the truck driver in the driving tasks, while the RDW's representative differentiated between obligated and voluntary systems. This latter respondent also voiced his concerns

about brake-assistance, since this system does not yet recognize all situations in which an intervention is required (e.g. when an object stands completely still or when it is positioned less than half within the driving lane).

All respondents think that truck drivers will start to value and use ADAS as soon as they have experienced the comfort and when they have had a familiarization process, either with or without a specific ADAS training. A representative of one of the labor unions mentioned that this road to trusting the systems will be travelled faster by young and new truck drivers than by the more conservative and highly experienced truck drivers. The policy employees of the ministry of I&W and the insurance firm representative warn for the danger that truck drivers could start to 'overtrust' the systems. To arrive at an acceptable level of trust can require a considerable amount of time and one complication (i.e. a failure or an accident) can quickly deteriorate the trust (a representative of a logistic services provider shared the following saying that illustrates this statement: "trust arrives on foot, but departs on a horse"). An alarming conclusion was drawn in the report by TNO (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017), because it turned out that after having experienced the functioning of the ADAS that enable Truck Platooning in a simulator, the respondents (i.e. professional truck drivers) rated usefulness and satisfaction significantly lower than they did in the pre-test. Perhaps, this could be the result of having received too little information up-front about what to expect, thereby resulting in the situation in which the respondents experience so many difficulties that they automatically start to dislike the task.

The opinions of the other stakeholders on ADAS are all positive and 11 out of those 16 positive responses were highly positive. Statements like "the truck driver's job becomes more technological due to ADAS" and "the image of the truck driver's job will improve" are mentioned as arguments. Moreover, the policy employees of the ministry of I&W indicated that the division between the systems' responsibilities and the truck driver's responsibilities should be extremely clear and that the interoperability between ADAS systems must be satisfactory. The insurance firm representative stressed the importance of explaining to the truck driver how the ADAS work.

The results described above enable answering the second research question ("How do other stakeholders perceive the innovation of Truck Platooning?"). The other stakeholders think that Truck Platooning in the short term is only applicable for driving on highways due to the complexity of traffic situation in densely populated areas. Nevertheless, it is generally seen as an innovation that is going to have major implications for the whole logistics chain. Against what was hypothesized in Paragraph 1.2., most respondents perceive the hub-to-hub scenario as more feasible in the short term than the on-the-fly scenario. The concept of Truck Platooning is mostly compared with that of the LZV's and autonomous driving in passenger vehicles, while the job of a truck driver is often compared with a pilot's job. Truck Platooning is generally seen as a stepping-stone towards fully autonomous driving. Most stakeholders expect Truck Platooning to be implemented (i.e. with a penetration rate of 25%) within 5 to 30 years. Two respondents, however, think that Truck Platooning will never reach this penetration rate. All stakeholder groups stated that Truck Platooning must be extremely safe so that interventions are required only rarely. On the other hand, they are of opinion that the

truck drivers should remain able to intervene when necessary. Other prerequisites are that Truck Platooning should 1) become a cross-border and multi-brand initiative, 2) be familiar are recognizable for other road users, and 3) be made (financially) interesting for logistic services providers. Furthermore, the infrastructure should be ready and several uncertainties should be clarified before implementing Truck Platooning. Tests with Truck Platooning are considered important for a successful implementation process as well. Although almost all stakeholders expect that Truck Platooning will have strong consequences for the jobs of truck drivers, they are inconclusive about how Truck Platooning will influence their jobs (e.g. in terms of mental workload and job attractiveness). Most stakeholders expect truck drivers to experience discomfort while platooning as a follower due to the short following distance. These stakeholders perceive Truck Platooning as a concept that will enhance traffic safety, provided that some prerequisites, which are mentioned above, are met. Finally, all stakeholders expect that truck drivers will start to value the ADAS used in Truck Platooning after they have become familiar with these systems, which opposes the outcomes of TNO's study in which respondents rated usefulness and satisfaction of Truck Platooning lower after having experienced it in a truck simulator. Two respondents in this study also warned for the danger of 'overtrusting' the systems, thereby becoming less focused on the driving task.

5.4.3. Question 3: "What factors are likely to facilitate or to speed up the Truck Platooning implementation process?"

There are several things that may facilitate the speed at which Truck Platooning can be implemented. First of all, the implementation process can be sped up if legislation is adapted so that Truck Platooning can become a more common phenomenon (e.g. by cancelling the requirement of applying for an exemption for Truck Platooning or when logistic services providers receive grants from governmental organizations). Currently, it is impossible to incorporate Truck Platooning in the parameters that determine how ecologically friendly a vehicle is, since those parameters only measure vehicular characteristics, while the fuel and emission advantages in Truck Platooning come from a combination of vehicles and therefore cannot be measured within a single vehicle. If this legislation can be adapted so that Truck Platooning becomes an indicator of a vehicle's emission category, the incentives will be higher for truck manufacturers to speed up the developments.

Additionally, the representatives of Rijkswaterstaat, a truck manufacturer and the insurance firm expressed the expectation that changes in the legislation about driving and resting times can improve the implementation speed. If, for example, the legislation would be adapted so that the time in which a truck driver is platooning counts like a sort of 'half working time', thereby enabling them to drive longer without a break, then this would be a clear incentive for logistic services providers to invest in Truck Platooning, thereby speeding up the implementation process.

Further, the CBR's representative argued that simply starting to platoon somewhere is likely to have an accelerating effect and the perspective of the ministry of I&W complies with this idea, since the minister has said that "we need to start up to scale up". The underlying rationale is that if one simply starts to platoon, one will encounter situations not thought

about beforehand. The BOVAG has also indicated that conducting tests can help to speed up the pace at which Truck Platooning will be implemented in daily practice.

Finally, two representatives of logistic services providers and one of the interviewed truck drivers stressed the importance of creating enthusiasm among truck drivers. If truck drivers are positive about Truck Platooning, then the logistic services providers are confident that they will platoon in practice. In order to build enthusiasm, it is argued that several truck drivers should get the opportunity to try platooning in practice. One needs to ensure then that the functioning of the systems is explained thoroughly and that they are user-friendly enough so that these truck drivers become enthusiastic about Truck Platooning. If that is the case, the expectation is that positive messages will spread quite fast among the population of truck drivers, thereby creating curiosity and enthusiasm among other truck drivers.

Research question 3 ("What factors are likely to facilitate or to speed up the Truck Platooning implementation process?") can be answered by summing up the factors mentioned above. The Truck Platooning implementation process can be sped up by 1) adapting legislation (i.e. with respect to exemptions, low-emission grants, and driving and resting times), 2) simply starting to platoon, and 3) creating enthusiasm among truck drivers for Truck Platooning.

5.4.4. Question 4: "What factors are likely to block or to slow down the Truck Platooning implementation process?"

Multiple examples are provided of situations that are likely to slow down the implementation process of Truck Platooning. The most prevalent examples given by the respondents are related to other road users (i.e. drivers of passenger cars and foreign truck drivers not capable to platoon are mentioned in most cases). The interaction between truck platoon drivers and other road users is regarded as very important by almost all respondents. Complicated situations are mostly expected at moments when other road users wish to traverse a platoon (e.g. to exit or enter the highway). Therefore, if other road users are not adequately informed about how to interact with truck platoons, this is expected to strongly slow down the Truck Platooning implementation process.

Other frequently mentioned issues are the cases in which the platooning systems make errors or when accidents with (semi-)autonomous vehicles occur. These errors in automated systems are being judged far more fiercely than human errors. Moreover, if something goes wrong with a truck, most of the time this leads to severe accidents. That is why the representative of the CBR could imagine that the fact that society demands 100% safe systems could block the implementation of Truck Platooning. The survey by TNO (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017) also indicated that many questions about practical implementation issues were raised by the truck drivers they surveyed. Therefore, the platooning systems should be developed further at a rapid pace so that safety can be guaranteed in most complex traffic situations. Safety can, however, also be interpreted as cyber-security. The representative of the RDW argued that if it turns out that hackers are able to take over the controls of a truck platoon digitally, this can lead to a massive setback in the implementation process.

Other factors mentioned to potentially slow down this process are legislation and difficulties in motivating truck drivers to adopt the techniques. Opinions differ whether these legislative and motivational issues will cancel the implementation process or whether they will just slow down the pace at which Truck Platooning will be implemented. For example, one labor union representative indicated that if Truck Platooning is not adopted as a cross-border initiative, it probably also will not be adopted in the Netherlands. He argued that due to the density of the Dutch road network (i.e. many highway junctions, entrances and exits where formation and split activities would be required) and the relatively short distances being traversed within the Netherlands, Truck Platooning would be only feasible for international transport.

Further, stressed by the representative of Rijkswaterstaat and by two of the logistic services providers, the competitive attitudes of logistic services providers diminish the chances that those organizations will start to cooperate with each other in the short term. This can also slow down the Truck Platooning implementation process. To achieve this cooperation, a shift in the organizations' cultures is required. The representative of STL specifically mentioned, as part of the required adaptations within the organizational cultures, that the driver should be decoupled from the truck. A lack of cooperation between different member states of the European Union was also mentioned several times as a factor that could slow down the Truck Platooning implementation process.

Finally, the representatives of one of the labor unions and of the insurance company foresee that other innovative concepts (e.g. the automated highway) will surpass Truck Platooning, thereby blocking the Truck Platooning implementation process.

To answer research question 4 ("What factors are likely to block or to slow down the Truck Platooning implementation process?"), the issues that are most likely to slow down Truck Platooning are, in decreasing order of times mentioned by the respondents, related to 1) the interaction between truck platoons and other road users, 2) traffic safety (i.e. accidents with (semi-)autonomous vehicles, leading to a lot of 'bad press'), 3) legislation and 4) the lack of cooperation between logistic services providers and governmental organizations. The majority of the respondents do, however, not expect those issues to completely block the Truck Platooning implementation process. The most likely scenarios in which the Truck Platooning implementation is blocked come from other technological concepts that have greater advantages, thereby surpassing Truck Platooning, and from the scenario in which an acceptable safety-level cannot be guaranteed due to, for example, the complexity of contemporary traffic.

5.4.5. Question 5: "What are the implications of Truck Platooning for truck drivers' job resources while driving?"

Most of the respondents indicated that whether the truck drivers' job will change significantly depends heavily on whether or not truck drivers can perform other tasks while driving. If this is the case, then the respondents thought of several additional job tasks the truck drivers could be doing, which are discussed in Paragraphs 5.4.6. and 5.4.7. The additional tasks and responsibilities that truck drivers receive can be seen as options, or opportunities (i.e. job resources), to enhance the attractiveness of the job. Furthermore, a representative of a truck

manufacturer said that Truck Platooning results in the situation in which the tasks considered boring (e.g. driving on the highway) are automated, while the interesting ones remain the truck drivers' responsibility (e.g. maneuvering). These perspectives align well with the earlier identified expectation that the job of a truck driver will be upgraded.

Also, for truck drivers who are innovative and open-minded, Truck Platooning can mean that they would have more fun in fulfilling their jobs. An interesting notion was put forward by the representatives of the RDW and the CBR. They suggested that Truck Platooning should be framed as a sort of game so that the truck drivers will become motivated to play the 'game' of transporting the truck to its destination as smooth and economically as possible. For competitive and innovation-oriented people, this could lead to enhanced attractiveness of the job as well.

Several respondents have mentioned that the autonomy of the truck driver will be affected because (s)he cannot choose the routes (s)he prefers (i.e. the planning will determine which routes the truck driver is obliged to drive in order to engage in platooning activities). Also, the truck driver's autonomy can be inhibited when (s)he is compelled to cooperate with other logistic services providers' truck drivers.

Finally, as indicated by several truck drivers and logistic services providers, Truck Platooning can relieve the truck drivers from stress due to the fact that they can relax somewhat more while the platooning systems are executing the driving tasks.

To answer research question 5 ("What are the implications of Truck Platooning for truck drivers' job resources while driving?"), all respondents, except one logistic services provider and a truck driver, saw at least one opportunity for the truck drivers in the Truck Platooning situation. The representative of this logistic services provider expected that nothing will change for the truck driver, since this person should always remain focused on the driving task. The truck driver who did not see any new job resources for truck drivers indicated that all changes will be only beneficial for the employer instead for the employee. The main job resources that truck drivers could get are that they 1) potentially get the option to perform alternative job tasks, 2) might experience more pleasure in executing their jobs, and 3) potentially experience less stress. The autonomy of a truck driver, however, is likely to decrease (i.e. because platoon planners will determine when and via which route the truck driver should driver).

5.4.6. Question 6: "What are the implications of Truck Platooning for truck drivers' job demands while driving?"

The most obvious job demand that will be added to the job package of a truck driver by the arrival of Truck Platooning is that the truck driver should initiate and monitor all platooning systems. It was therefore argued that additional job demands will be that the truck driver has the discipline and the alertness to respond properly to unexpected situations.

Furthermore, as BOVAG's representative stated, the truck driver should communicate more with planning employees in order to accurately time platoon formations. Somewhat more specific, one of the truck manufacturers expressed the expectation that the truck driver could

be made responsible for sharing data about, for example, the route that will be driven and the estimated time of arrival.

The answer to research question 6 ("What are the implications of Truck Platooning for truck drivers' job demands while driving?"), is that Truck Platooning can change the job demands of a truck driver by 1) adding the task of monitoring the platooning systems (i.e. by being disciplined and alert), 2) increasing the need for effective communication, and 3) increasing the responsibilities of the truck driver (e.g. by making him/her responsible for sharing data).

5.4.7. Question 7: "What are (safe) options for alternative job tasks for truck drivers while driving in a platoon?"

All respondents agreed that in the foreseeable future no unmanned trucks will be driving on the Dutch road network. Therefore, it is worthwhile to look at which activities the truck drivers of the following trucks potentially could perform. In order to enable a truck driver to fulfill additional job tasks, most respondents agree that the truck driver should be relieved from all driving tasks while platooning as a follower, because they cannot perform any task while being required to be able to take back control within a few seconds. TNO found in their study that there was a significant difference, in terms of response times, between being attentive (i.e. focused on the driving task) and being non-attentive (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017).

If it is, legally or practically, impossible to relieve the truck driver from all driving tasks, the respondents foresee that no additional job tasks can be fulfilled at all. Therefore, the remainder of this paragraph will focus on what truck drivers could do in their cabins in case that they could be, partially or fully, decoupled from the driving tasks.

Performing administrative tasks was mentioned most often, by 10 respondents, followed by communicating (i.e. calling) with other stakeholders in the logistics chain (mentioned in 8 interviews), while utilizing the opportunity to get some rest (i.e. by sleeping or by entertaining themselves with, for example, books, a tablet or a telephone) was mentioned in 6 interviews. The main issue surrounding resting in the cabin is that it is unclear how this relates to the future driving and resting legislation. Other possibilities of alternative job tasks while platooning, which were mentioned only once or a few times, are 1) assisting in planning tasks, 2) following (online) courses, 3) looking for new customers and sales opportunities (i.e. telemarketing activities), 4) helping existing customers over the telephone (i.e. customer service activities), 5) cleaning the truck's cabin, and even 6) performing a totally different job (for another employer) by the means of flexible working. One of the labor union representatives, a truck driver and the STL representative foresee a debate about whether resting and performing private activities should be excluded from the (paid) working time or not.

A note was provided by the representative of the insurance company, who said that a lot of tasks are not suitable to perform as side-tasks next to platooning, since the truck driver never knows beforehand how much time he will be driving manually and thus how much time he can spend on secondary tasks. Those secondary tasks can, according to this respondent, not

be tasks like planning tasks or customer service activities due to the deadlines related to those tasks.

The representatives of the CBR and of one of the logistic services providers argued that, in determining the responsible options of alternative tasks that truck drivers could perform during platooning, it should be considered which alternative tasks truck drivers would like to perform. The representative of Rijkswaterstaat conforms to this claim by stating that one should determine beforehand whether or not the truck drivers have the skills and knowledge to perform those alternative tasks.

To conclude and to answer research question 7 ("What are (safe) options for alternative job tasks for truck drivers while driving in a platoon?"), if the systems become safe enough and if the legislation is adapted to such an extent that the truck drivers can be relieved from the driving tasks while engaging in platooning activities as a follower, there is a plethora of possible alternative job tasks. The most important of these are determined to be 1) performing administrative tasks, 2) resting and, as already determined in Paragraph 5.4.6., 3) communicating with their organization's planning department or with customers (e.g. about estimated arrival times).

5.4.8. Question 8: "What skillsets should a truck driver possess in order to successfully operate a platooning truck?"

All respondents agreed upon the stance that the truck driver should remain capable to drive the truck in manual mode. Therefore, most skills that a contemporary truck driver needs to have remain needed when the truck driver has to operate a platooning truck. Therefore, this paragraph first discusses the current skills required, followed by the skills that a truck driver must have when (s)he is going to drive in a platooning truck, and finally, which skills might become obsolete.

Current skills

The current skill that was mentioned most, in 15 of the 20 interviews, is that the truck driver should have excellent vehicle control (i.e. to be able to maneuver the truck in difficult traffic situations).

Next, 12 respondents and the competence document from STL indicated that a truck driver should be able to anticipate on (complex) traffic situations. Several respondents commented that a good truck driver can accurately predict what other road users are going to undertake and that they by doing so can prevent dangerous situations from developing. A skill that heavily relates with anticipating is the skill of having good insight in traffic situations. The need for this insight was stressed by 9 respondents and by the competence document.

Further, current truck drivers should 1) be resistant to stress (mentioned by 7 respondents and the competence document), 2) possess social skills, and speak multiple languages (mentioned in 6 interviews and the competence document), 3) have an acceptable amount of driving experience (mentioned in 7 interviews) and 4) be able to drive efficiently (expressed by 5 respondents and written in the competence document).

Finally, some characteristics that were mentioned only once or just a few times are that a truck driver must be able to 1) focus (i.e. to be alert), 2) determine the vehicle's state, 3) load the truck properly, 4) remain aware of the surroundings, 5) work precisely and 6) show that (s)he is confident.

The next subparagraphs discuss the required additional skills for platooning truck drivers and which skills are likely to become obsolete. If a skill mentioned above is not discussed in the following two sub-paragraphs, it can be assumed that the respondents think that the skill remains equally important for a platooning truck driver as for a current truck driver.

Future skills

The most prevalent additional skill for platooning truck drivers is, mentioned in 14 out of the 20 interviews, that (s)he can work with the platooning systems, which means that (s)he can form a platoon, that (s)he can decouple from it, that (s)he can put all the parameters in the correct systems and that (s)he can identify, and ideally also resolve, system errors.

Further, the representatives of the ministry of I&W and the CBR expect that the driver of a platooning truck (i.e. the leader) should become even better in anticipation, since the focus will now shift from maneuvering a single truck through traffic into maneuvering multiple trucks through traffic. The platooning truck driver needs to be able to anticipate the length of this combination of trucks and to predict how other road users will react to movements of the platoon.

Finally, there are again some additional skills that are mentioned once or only a few times. These are 1) communication skills, 2) an increased ability to concentrate (i.e. to be able to quickly switch between passive and active driving), 3) coordinating the alternative tasks (i.e. managing the proportion between monitoring the platooning systems and executing secondary tasks), and 4) being even more resistant to stress.

Disappearing skills

The respondents unanimously indicated that they expect no skills to disappear due to the prognosis that the truck driver remains responsible for the first and last mile. Also, for maneuvering the vehicle, most respondents stressed the requirement that the truck driver will still be able to maneuver the truck manually (e.g. into a loading dock or in tight city center streets) so that the driver can function as a back-up for the platooning systems.

To answer research question 8 ("What skillsets should a truck driver possess in order to successfully operate a platooning truck?"), it is important that the platooning truck driver has the skills to 1) operate the platooning systems (i.e. merging, splitting, inputting parameters, and detecting and solving system errors), 2) anticipate (i.e. on the platoon length and on other road users), 3) communicate, 4) concentrate (i.e. focusing on the driving task), 5) coordinate (i.e. the alternative tasks), and 6) be resistant to stress. Furthermore, the platooning truck driver requires all skills that a current truck driver also must possess to be an excellent truck driver. These skills are 1) controlling the vehicle (i.e. normal driving and maneuvering), 2) determining the vehicle's state, 3) properly (i.e. safely) loading the truck, 4) remaining aware of the surroundings (i.e. situational awareness), 5) working precisely, and 6) expressing

confidence in the driving behavior. None of the skills that current truck drivers possess are likely to disappear due to Truck Platooning.

5.4.9. Question 9: "What knowledge should a truck driver possess in order to successfully operate a platooning truck?"

Since the respondents all agreed upon the opinion that truck drivers should be capable to drive a truck manually as well, there is also a broad overlap between the knowledge that current truck drivers should possess and the knowledge required for platooning truck drivers. This section is again divided in the required current knowledge, the required future knowledge and the knowledge that will disappear as the result of Truck Platooning.

Current knowledge

What is considered as the most important types of knowledge are knowledge of traffic rules and of legislation (e.g. national and international driving and resting times legislation), respectively referred to in 9 and 8 interviews and, in both cases, in the competence document by STL.

Further, a current truck driver should be aware of the functioning of the systems (e.g. ADAS) installed in his truck and (s)he should have some technological knowledge about how these systems, and the truck in general, work (mentioned in respectively 7 and 8 interviews and, in both cases, by the competence document).

As indicated by 5 respondents and by the competence document, contemporary truck drivers also should possess knowledge about securing loads. Especially knowledge about distributing weights in the trailer is considered important, since loading a trailer incorrectly can lead to disastrous accidents.

Geographical knowledge is considered important for current truck drivers by 3 respondents and in the competence document. The underlying rationale is that it is important that truck drivers roughly know where they are driving.

Finally, two somewhat more specific types of knowledge have been mentioned by a few respondents. Firstly, it was indicated that truck drivers should have knowledge about the loads they are hauling, especially if they are transporting hazardous or vulnerable cargoes. Secondly, the truck driver should have knowledge of the specific organizational procedures of the companies (s)he visits.

If a type of knowledge is not mentioned in the following two sub-paragraphs, it can be assumed that platooning truck drivers will also need this type of knowledge.

Future knowledge

Several respondents mentioned that the additional required knowledge depends on what tasks will be added to the truck drivers' job, for which (s)he obviously needs to possess certain knowledge. The respondents' responses can be classified into two broad categories.

Firstly, almost all respondents (in 16 out of the 20 interviews) pronounced that the future truck drivers should possess knowledge about the new systems they will be working with, whether these are systems within the trucks themselves or external systems (e.g. for forming

the platoons or for letting platoons communicate with infrastructure). This knowledge is argued to be required in order to be able to accurately monitor the systems and to anticipate on potential system errors.

The second broad category of responses fell into the area of legislation. 6 respondents have argued that the future truck drivers should know in which country they are allowed to use which systems and that they must know how driving and resting times legislation is formulated in the countries that they will be traversing.

Disappearing knowledge

There are some categories of disappearing knowledge identified (e.g. geographical knowledge and technological knowledge about the truck's functioning), but none of these are the outcome of the implementation of Truck Platooning. All respondents agree that Truck Platooning will, just as will be the case with skills, lead to more required knowledge, thereby not resulting in a situation in which certain types of knowledge will become obsolete.

Research question 9 ("What knowledge should a truck driver possess in order to successfully operate a platooning truck?") can be answered by concluding that platooning truck drivers require knowledge about 1) the platooning systems (i.e. systems internal and external of the truck), 2) legislation (i.e. platooning-specific, but also about road taxes and driving and resting times), 3) traffic rules, 4) the truck (i.e. in terms of technology), 5) securing cargo (i.e. distributing weights in the trailer), 6) cargo specifications (i.e. in case of hazardous or fragile cargo), 7) geography, and 8) organizational procedures of the customer organizations. Although it is considered likely that some types of knowledge will disappear eventually, the respondents agreed that this will not be a consequence of Truck Platooning.

5.4.10. Question 10: "What occupational mindsets should a truck driver possess in order to successfully operate a platooning truck?"

Just like Paragraphs 5.4.8. and 5.4.9., this section is divided in the current occupational mindsets, the required future occupational mindsets and the occupational mindsets that will disappear as the result of Truck Platooning.

Current occupational mindsets

It is frequently mentioned that there is not one single stereotype of a truck driver and that therefore the occupational mindsets (i.e. the mentalities) differ widely. In half of the interviews and in STL's competence document it was explicitly mentioned that contemporary truck drivers should have a professional working attitude. One way by which this was made explicit is by expressing that they should have a thorough sense of responsibility towards other road users, but also towards the cargoes being hauled (mentioned by 9 respondents and by the competence document). Further, as part of the professional working attitude, truck drivers should behave themselves calmly and peacefully on the road, so that they can function as 'driving billboards' for their employers. Finally, the truck drivers should be conscious about their driving behaviors and about the cargoes they are carrying.

Other occupational mindsets that current truck drivers require are 1) a friendly attitude (i.e. towards colleagues and clients), 2) a flexible mindset (i.e. explained as being prepared to work

at irregular working times and as having a problem-solving mindset), 3) an independent working attitude (i.e. willing to take decisions autonomously), 4) a mindset by which they obey their employers and 5) a mentality in which they work precisely.

Finally, the respondents also occasionally mentioned some required pragmatic occupational mindsets. Firstly, the truck drivers should think along with their employers about topics as efficiency and customer service. Also, ideally the contemporary truck drivers are satisfied in their jobs and they possess an open mindset (i.e. accepting and actively using innovative techniques like ADAS). Perhaps the most specific occupational mindset mentioned, by a single respondent and by the competence document, is that truck drivers should be conscious about their lifestyles. The reason why this mindset is considered important is that it is expected that having a healthy lifestyle results in shorter response times and thus enhances safety. This complies with a study that found that unhealthy truck drivers are significantly more often involved in traffic accidents (Stoohs, Guilleminault, Itoli, & Dement, 1994).

Just as in the paragraphs about skills and knowledge, it holds that if an occupational mindset is not mentioned in the following two sub-paragraphs, it can be assumed that platooning truck drivers will also need this occupational mindset.

Future occupational mindsets

Although most respondents indicated that the occupational mindsets of an excellent current driver will still be acceptable for a platooning truck driver in the future, some mentalities have been identified to be more important in the Truck Platooning situation.

The most prevalent statement was that future truck drivers should have an even more open mindset for innovative concepts, otherwise it is deemed unlikely that they will embrace Truck Platooning. Moreover, the perception reigns that creating enthusiasm works better than top-down obligations to adopt Truck Platooning. As was stated earlier, in Paragraph 5.4.5., working with the new systems can be framed as being a real-life game in order to create enthusiasm for Truck Platooning among truck drivers. Further, it was mentioned quite frequently, in 7 interviews, that the platooning truck driver should have adequate trust in the platooning systems. These respondents also mentioned that they expect this to be the attitude that is going to be the hardest to obtain.

Other, but less frequently, mentioned occupational mindsets were that future truck drivers should become more 1) resistant to pressure and stress, 2) customer-oriented, 3) cooperative (i.e. towards competitors and colleagues) and 4) conscious that they are driving with a combination of trucks (i.e. requiring an increased sense of responsibility for the leading truck driver).

Disappearing occupational mindsets

Although most respondents think, just as with the skills and knowledge, that no occupational mindsets can disappear, several respondents pronounced two main mindsets that might (require to) change. Firstly, the thought in which truck and driver are coupled should be relieved, since several respondents indicated that it is likely that truck sharing will become reality in a logistics chain where Truck Platooning is widely adopted. Secondly, the adventurous mentality (i.e. being on the road alone and never knowing what will happen

while being on the way) is likely to disappear, which will probably be regretted by many truck drivers.

Research question 10 ("What occupational mindsets should a truck driver possess in order to successfully operate a platooning truck?") can be answered by summarizing what occupational mindsets platooning truck drivers need. These are mindsets in which they 1) are open for innovations, 2) trust the platooning systems, 3) are affected less by pressure and stressful conditions, 4) are customer-oriented, 5) are keen on cooperating, 6) are conscious about their responsibilities, 7) express a professional working attitude, 8) are flexible, 9) have an independent working attitude, 10) obey their employer, and 11) have a healthy lifestyle. The mindsets that respondents think should change are the mindset in which a truck and a driver are coupled (i.e. so that a truck can be driven by multiple drivers to achieve more flexibility) and the mindset of 'going out on an adventure' (i.e. working days are likely to become more standardized and thus more predictable, resulting in a decreased feeling for a truck driver of going out on an adventure).

To conclude the answers to research questions 8, 9 and 10, the respondents' answers to interview question 9.5. (i.e. "*what do you think are typical characteristics of a person that could become a truck driver in 10 years?*") are discussed briefly below, since this strongly relates to the expected skills, knowledge and occupational mindsets of a future platooning truck driver.

Respondents argued that the future truck drivers still 1) have a lot of passion for the job, 2) behave consciously and responsibly (i.e. professionally) on the road, 3) can work with little supervision (i.e. work independently) and 4) are heavily interested in technological developments. Furthermore, these truck drivers are communicatively skilled and they are able to provide customers with excellent services. Also, they will trust the systems and the colleagues they are working with to a higher extent than currently is the case. The respondents also expect that the future truck drivers wish to have more standardized working times in order to maintain their social lives.

The expectations about future truck drivers can be summarized by the statement that they will possess more skills, knowledge and slightly changed occupational mindsets in comparison with contemporary truck drivers. Therefore, it was relatively often mentioned that the educational level of the future truck driver is likely to increase due to the higher amount of qualifications that the truck drivers will require.

5.4.11. Question 11: "What changes should be made in the education process of new truck drivers so that they are properly trained to operate a platooning truck?"

The answer to this final research question will be answered by first describing how the current educational programs are designed, before continuing with the required adaptations in these educational programs. These required adaptations are consequently split in required adaptations to 1) the initial educational programs, 2) the examinations at the CBR and 3) the mandatory refreshment courses (i.e. Code95).

Some respondents replied that they did not have an accurate or complete view of how the truck driver educational programs currently are designed. Therefore, this section is mostly based on answers provided by the representatives of STL and the CBR and the competence document. Several logistic services providers, however, mentioned that they frequently offer employees who work in the warehouses chances to become truck drivers. The rationale behind this is that those employees already have organization-specific experience and therefore can be of more value as a truck driver than a completely new truck driver who is unfamiliar with the business.

Basically, there are two main ways to become a truck driver. Firstly, a thorough vocational training can be followed, which takes approximately 1.5 to 2 years, in which a student works 4 days per week in an organization and is educated 1 day per week. The other road that somebody can take is a more direct approach in which only a driving course is followed at a driving school and one thus omits educational components aimed at practical logistics concepts. The training at the driving school consists out of theoretical lessons and practical driving lessons, a theoretical examination and two practical examinations (i.e. the regular driving examination and the Code95 examination).

Required adaptations to the initial educational program

Most respondents are of opinion that Truck Platooning should become a component of the educational programs, but they generally doubt whether it is possible to incorporate Truck Platooning in the practical driving lessons. Therefore, it is argued that it is more suitable to incorporate Truck Platooning in the vocational educational program. An example given is that data about a student's driving style can be extracted from the truck at the driving school and consequently forwarded to the educational institution so that this can be used to tailor the education to the student. This, however, requires close cooperation between driving schools and vocational education institutions.

The BOVAG's representative suggested that studies should be conducted into the ideal methods for educating truck drivers. This respondent also pointed out the advantage of assessments, as part of the educational programs, to quickly identify whether somebody is suitable or not to become a future truck driver. Related to this stance, one of the truck drivers plead for practically oriented trainings in order to get familiarized with new technologies.

Further, 9 of the respondents mentioned that students must be taught how to use the systems in platooning trucks (i.e. ADAS and platooning-specific systems), which is thereby the most important required addition to the educational programs. Also, one of the logistic services providers, the CBR and STL put forward the possibility to categorize truck drivers so that different educational programs could be developed for 1) leading truck drivers, 2) following truck drivers and 3) truck drivers who will not engage in platooning activities. The representatives of the insurance company and the ministry of I&W also forecasted that a separate driving license will be required for Truck Platooning. Most other respondents argued that *all* truck drivers should become capable to platoon to maximize the flexibility in allocating truck drivers to assignments. 7 respondents expressed the belief that during their education students should experience the ease of use and the comfort of Truck Platooning, which will

probably lead to more support and enthusiasm for Truck Platooning, resulting in a smoother implementation process.

Finally, although this is not within the span of control of the educational institutions, one of the truck drivers advised to arrange that a new truck driver in the first weeks is being accompanied by an experienced colleague (i.e. a job coach) to accelerate the process of on-the-job learning.

Required adaptations to the examination moment

Several respondents indicated that the examiners' attention should be more focused at the student's traffic insights and professional communication with other road users. Therefore, the CBR's representative argued that it would be logical if the duration of the driving exam would be extended somewhat more in order to create more possibilities to assess how the student responds to different traffic situations.

Another idea was pronounced by the RDW's representative and a logistic services provider, who would like students to demonstrate in an exam to be capable to merge with and split from a platoon correctly. The RDW's representative acknowledged, however, that this is probably not practically feasible and he therefore suggested, together with a representative of a logistic services provider, to incorporate a session in a truck simulator as part of the driving exam. The BOVAG's representative and two truck drivers had a slightly different idea, namely to equip the truck in which the exam is conducted with possibilities to simulate platooning situations (and to trigger errors) so that the examiner can choose a scenario to which he wants to assess the student's reaction. Again, if this turns out to be practically infeasible, a truck simulator as a component of the exam was seen as a suitable alternative. One of the logistic services providers argued that this can become problematic, because the exam is currently conducted in the vehicle that was also used during the driving lessons. Therefore, all driving schools should renew their equipment before this suggestion can be realized.

As the representative of STL mentioned, ideally one would like to test in an exam whether the student can regain concentration quickly enough after having been out of the loop for several hours. This can however, practically not be assessed in an exam. Therefore, the truck simulator could again serve as a practical alternative.

Required adaptations to the refreshment courses

Most respondents agreed that the frequency of the refreshment courses (i.e. Code95), which is currently 35 hours per 5 years, is good. One logistic services provider argued that more refreshment courses are required due to all newly introduced technologies for which the truck drivers should be prepared properly. Further, one of the truck drivers indicated that when Truck Platooning is introduced, perhaps more trainings will be required to quickly familiarize the existing population of truck drivers with Truck Platooning. Then, when every truck driver is familiarized with Truck Platooning, the frequency of the refreshment courses can be lowered. Representatives of a logistic services provider, the insurance firm, the RDW and STL expect that the frequency can decline immediately. The representatives of the RDW and STL, more explicitly, stated that a truck driver (or their employers) should decide to do a

refreshment course when the truck driver is expecting job changes. At those moments, the truck driver can subscribe for a refreshment course or an online toolbox course can be followed.

Furthermore, some specific ideas were suggested about adapting the Code95 refreshment courses. Firstly, several respondents think that a separate platooning course should be developed as part of the Code95 structure. In this course, topics like platooning systems, traffic insight and (inter-)national legislation could be discussed. Most of those respondents also explicitly mentioned that they think that such a course should become mandatory. Only one truck driver suggested to keep this course separated, but still mandatory, from the Code95 structure, because a truck driver can wait almost 5 years before completing the Code95 courses and could therefore be not informed timely about Truck Platooning.

Secondly, it was frequently mentioned, by several stakeholder groups, that it makes no sense that the refreshment courses can be chosen voluntarily, since this leads to the possibility to choose the simplest, and often completely unrelated to the job contents, courses in order to 'pass' the Code95 program. Those respondents would prefer a system in which an overview of the tasks of the truck driver is made and in which the refreshment courses are selected so that they match the job contents of the truck driver. One of the truck drivers, however, suggested to create some sort of a score-card with several topics that truck drivers have to refresh every 5 years, of which the truck drivers themselves can determine the order in which these courses are followed.

Finally, the representative of STL thinks that courses can be developed in which truck drivers' driving data is assessed and discussed to provide them with insights about their driving styles.

To answer the final research question, question 10 ("What changes should be made in the education process of new truck drivers so that they are properly trained to operate a platooning truck?"), the distinction again is made in the required changes in the 1) initial education process, 2) practical examination, and 3) refreshment courses (i.e. Code95). A Truck Platooning component should be incorporated in the educational programs for future truck drivers. Most of the respondents expressed the opinion that all truck drivers should become capable of Truck Platooning and that truck drivers should get practical experience with the platooning systems in their educational processes. Due to the infeasibility to incorporate it in the regular driving lessons, it is argued that the vocational educational programs should include Truck Platooning lessons. Another idea that was suggested to overcome this feasibility issue is to let students drive in a platoon in a truck simulator, both during the driving lessons and during the driving exam. In the practical examination, the examiner should focus, even more than currently is being done, on the student's traffic insight and professionalism in communicating with other road users (e.g. by extending the duration of the examination). An idea that was suggested to enable examiners to specifically assess students' problem solving-skills and response times (i.e. crucial for platooning truck drivers) is that examiners should be able to 'trigger' some truck malfunctions. Most respondents expressed the opinion that the current refreshment interval (i.e. 35 hours per 5 years) is satisfactory, while a few respondents suggested that truck drivers should proactively refresh their skills and knowledge when job changes are expected, thereby implying to make these courses voluntary. Finally,

an additional refreshment course on Truck Platooning, which should become mandatory for all truck drivers, should be added to the Code95 program.

Since all this research's sub-questions have been answered above, the next chapter formulates conclusions in order to answer the main research question. However, first, in the final paragraph of this chapter, the new job profile for the future platooning truck driver is constructed.

5.5. New truck driver job profile according to the FPM technique

The results from the former paragraphs are used to construct a job profile for the future platooning truck driver by applying the FPM technique that has been discussed in Paragraph 2.1. An example of the current truck drivers' job profile according to the FPM technique can be found in Appendix 1 – Example of visual representation job profile according to FPM, while the version adapted for the future platooning truck driver, constructed by using this study's results, can be viewed in Figure 10. In the remainder of this paragraph, it is described in which respects these job profiles differ.

Firstly, educational demands, and therefore also the educational level, are expected to increase (to mbo level 3 or even to mbo level 4) for a truck driver when Truck Platooning is being implemented. Secondly, the job profile is extended by adding some occupational mindsets as well. For example, having trust in the platooning systems is a new occupational mindset that is both important for the leader and the followers in the platoon. Thirdly, being able to safely merge with a platoon and to safely split from it are additional skills for truck drivers that are placed under the task of establishing the connection. Also, the truck drivers should be capable to put all the correct parameters (e.g. weight and dimensions) into the platooning systems.

Further, the driving task is separated from the tasks of loading and unloading (i.e. called 'picking up' and 'delivering' in the job profile), because loading and unloading is unlikely to change for the future truck driver as the result of Truck Platooning, while the driving task will be subjected to change (i.e. will become less in the sense that the truck driver will drive manually less frequently). The driving task is split into three different driving tasks, namely 1) driving manually, 2) driving in platoon mode (as a leader) and 3) monitoring the platooning process (as a follower). Since it is expected that every truck driver who is able to platoon will occasionally lead the convoy, while also often be attached as a follower, every future platooning truck driver should possess all the skills that are needed for both leading and following in a platoon.

The skills and knowledge required for driving in manual mode are equal to a current truck driver's skills and knowledge. In this study, however, more skills and types of knowledge have been identified than were incorporated in the initial version of the job profile. Therefore, some skills and types of knowledge have been added to the job profile. Driving efficiently is an example of such a current required skill that is not included in the old job profile. However, driving efficiently becomes more important in the platooning situation and therefore increases. This skill is placed under the tasks of manual driving and driving as the platoon leader, since the following truck drivers do not have major influences on the driving efficiency.

Job profile future truck driver

Educational demands/ educational level	mbo-2, driving license C, additional certificates (i.e. LZV and/or Truck Platooning) Future truck driver should possess more skills and knowledge Therefore, level mbo 3/4 will be required
Avoidance opportunities	Is a chance-creating occupation

Legend

Increases	Remains equal	Decreases	Is new

	Tasks	Job-related knowledge, skills and mindsets
Executing tasks	Checking the status of the vehicle and equipment, establishing the connection	Knows the instructions and regulations, checks vehicle for damage, system indicators and fuel
		Connects the trailer
		Attaching vehicle signaling
		Ability to safely merge in a platoon
		Ability to safely split from a platoon
		Inputting the platooning systems' parameters
	Picking up and delivering cargo	Uses a tachograph
		Checks quantities, type of cargo and for visual damages, draws up (damage) reports
	Driving the truck manually	Adapts driving style to cargo that is transported
		Maneuvers the truck in complex traffic situations
		Possessing knowledge about ADAS systems
		Anticipating on complex traffic situations
		Driving efficiently
		Knows (inter-)national regulations
	Driving in platooning mode (as leader)	Adapts driving style to platoon length
		Trusting the platooning systems
		Possessing knowledge about platooning systems
		Anticipating on complex traffic situations
		Driving efficiently
		Knows (inter-)national platooning regulations
	Monitoring the platooning process (as follower)	Trusting the platooning systems
		Interpreting platooning systems
		Anticipating on errors in platooning systems
		Resolving errors in platooning systems
		Being able to quickly take over vehicle control
		Resistance to stress
	Organizing and checking the process of loading cargo into the vehicle or loading and unloading him-/herself (with the use of tools)	Knows loading and carrying techniques and stacks, stows, unstacks, and anchors the load according to instructions and weight distribution
		Knows modalities of loading and unloading and works according to the loading plan, the route planning and rules for loading safely
		Estimates the load, knows and applies ergonomic lifting and raising techniques
	Registering follow-up and activity information	Uses on-board computer and communication devices
		Keeps up with information about the execution and, if applicable, reports deviations to responsible supervisor
	Checking packing list together with customer	Aiming at the needs and expectations of the customer
	Communicating with customers	Aligning with customer during loading and unloading
		Possessing social skills
		Speaking multiple languages (among which English)

Figure 10 – Future truck driver's job profile

Job profile future truck driver (continued)

Legend

Increases	Remains equal	Decreases	Is new

	Tasks	Job-related knowledge, skills and mindsets
Regulating tasks	Communicating with internal and external services (e.g. roadside assistance and emergency services)	Asks for help in case of problems
		Possessing social skills
		Speaking multiple languages (among which English)
		Thinking along with planners about ideal moment and locations for platoon formations
		Knowledge about communicating platoon behavior with other platoon members
	Executing urgency measures in the event of an accident	Knows prescriptions and regulation, estimates the kind and scale of the breakdown, accident or other emergency situation
Supporting tasks	Determining the route according to the characteristics of the vehicle, the load and the delivery priorities	Uses navigation material (route planner, GPS, road maps, city maps)
		Executing a route check (traffic jams, accidents, roadworks)
	Checking the presence and validity of boarding and transportation documents	Knows customs formalities and reports problem concerning boarding and transportation documents to responsible supervisor
	Executing basic maintenance	
	Cleaning the vehicle	
	Maintaining and strengthening job-related knowledge	Attends trainings and courses in the context of Code95
Additive tasks	Executing alternative job tasks while platooning	Being able to execute alternative tasks
	Warning the services involved in case of an emergency situation	Know prescriptions and regulation, reports the problem to the qualified institution and the responsible supervisor
	Guarantees the safety of the cargo	Is aware of the value of the cargo and takes preventive measures against theft

Figure 10 – Future truck driver's job profile (continued)

It was frequently argued that anticipating becomes more important, especially for leading truck drivers. Therefore, anticipating has been added and it is indicated that this skill should increase. Resistance to stress is determined to be most important for following truck drivers, since stress is experienced mostly in the following role due to the short following distances. Resistance to stress should also increase.

Interpreting the platooning systems is a new skill that is part of the task of monitoring the platooning process, which is most crucial for the following truck driver. For the following truck driver, it also becomes more important to be able to quickly become focused again, since it can happen that the platooning systems demand a quick control take-over. Therefore, the skill to take over control quickly is also exclusively placed under the task of monitoring the platooning process. Other skills that are heavily related to monitoring the platooning process, and are therefore indicated as underlying skills, are the skills of anticipating on errors in these platooning systems and resolving them.

Attaching vehicle signaling might become of more importance to both 'leading' and 'following' truck drivers, if it will be determined that the truck driver becomes responsible for indicating that (s)he is driving a platooning truck. This is independent from whether the truck

driver is the ‘leader’ or a ‘follower’, since it should be visible on all platooning trucks that they are engaged in a platoon.

Both in driving in manual mode as when the truck driver is the platoon leader, the truck driver should have knowledge of (inter-)national (platooning) legislation. This type of knowledge is therefore added for both the tasks of manual driving and platoon leading.

Further, when driving manually, the truck driver requires knowledge of ADAS. This is not changed by Truck Platooning. Knowledge about the platooning-specific systems is required both for leading and following truck drivers.

Possessing social skills and speaking multiple languages become also more important, therefore these skills are placed under both the (already existing) tasks of communication with customers and communication with internal and external parties.

The task of communicating more with both internal and external stakeholders is likely to increase somewhat more, mainly due to the skills of communicating more with the planning department (e.g. to determine ideal times and locations for platoon formations) and with the other platooning truck drivers (e.g. to communicate about specific situations that influence the movements of the platoon).

Finally, the skills required for executing the alternative tasks while platooning are obviously depending on which tasks are determined acceptable in terms of safety. These skills are not replicated for every possible alternative task and are therefore summarized as ‘being able to execute alternative tasks’.

The next chapter will draw the conclusions from this study’s results, thereby answering the main research question.

6. Discussion and Conclusion

The sub research questions have been answered in Paragraph 5.4., based on which an answer to the main research question of this study can be derived. This study's main research question is "How will the implementation of Truck Platooning influence the profession of truck drivers?". The answer to this question is discussed in the following three paragraphs. The three main ways in which Truck Platooning will influence the profession of truck drivers are via the 1) pragmatic consequences of Truck Platooning, 2) prerequisites and consequences of the Truck Platooning implementation process itself, and 3) consequences of Truck Platooning that directly affect the truck driver's occupation. These are discussed in Paragraphs 6.1. through 6.3. Paragraph 6.4. discusses the suggestions for further research and this report is concluded by Paragraph 6.5., which discusses several recommendations for the Truck Platooning stakeholder groups.

6.1. Pragmatic consequences of Truck Platooning

The truck drivers mentioned several pragmatic consequences of Truck Platooning, both positive and negative ones, of which the positive consequences are the economic, sustainability, efficiency and safety advantages. The economic benefits come from the fuel savings that can be achieved by the shorter following distance. Sustainability benefits mainly come from the lower emissions that are related with the lowered fuel consumption. Enhanced efficiency is also the result of the short following distances in Truck Platooning, since this leads to a higher capacity of the road network. There was some discussion among the stakeholders about the consequences of Truck Platooning for traffic safety. A truck driver expressed his doubts about whether the traffic will become safer or not, because a calm traffic flow is only possible if other road users interact correctly with truck platoons. Moreover, another truck driver had his doubts about the safety level of the platooning systems. The other two truck drivers think that Truck Platooning will enhance traffic safety. Most respondents of the other stakeholder groups expect Truck Platooning to improve traffic safety, as long as 1) the systems work properly, 2) other road users are adequately informed, and 3) the infrastructure is ready. The other positive pragmatic consequences of Truck Platooning (i.e. economic, sustainability and efficiency advantages) were also mentioned by almost all other stakeholder groups.

On the other hand, there was a debate among the stakeholders about one of the negative pragmatic consequences of Truck Platooning, the perceived level of stress (i.e. a very high workload). Some respondents think that Truck Platooning will increase the stressful feelings for following truck drivers due to the short following distance and the short timespan for taking over control from the platooning systems, while other respondents expect that the mental workload (i.e. and thus stress levels) will decrease because the platooning systems temporarily relieves the following truck driver from his/her duties. The other negative pragmatic consequence of Truck Platooning is the expectation that following truck drivers will become less aware of what happens around them (i.e. situational awareness), since they have a limited view due to the short following distance. Most respondents, however, also indicated that they consider it crucial that the truck driver remains aware of his/her surroundings.

There is thus a discrepancy between the required and the expected situational awareness, which indicates an alarming situation for which a solution should be found.

The truck drivers who already have had some experience with systems that are stepping-stones towards platooning systems (i.e. ADAS) were very positive about (Adaptive) Cruise Control and the brake-assistance, while being neutral or mildly negative about Lane Departure Warning (LDW). Nevertheless, even though they are capable of disabling LDW, they did not disable it because apparently truck drivers consider safety as more important than comfort. Although the development of trust in ADAS and consequently in platooning systems is considered a long-lasting process, which can be easily slowed down by bad press (e.g. due to accidents), several respondents warned for the danger of eventually developing 'overtrust' in the systems. 'Overtrust' could result in situations where the truck driver is distracted while an intervention is required. An alarming discrepancy in findings was found between the outcomes of this study and TNO's study (Willemsen, Heuting, Joosten, Uittenbogaard, & Martens, 2017). Respondents in this study mainly indicated that letting the truck drivers experience platooning systems in practice is likely to improve acceptance, while TNO found that truck drivers rated usefulness and satisfaction of the platooning systems significantly lower after having driven in a truck simulator than they had rated them in the pre-test. This could be the result of not providing them with enough information beforehand about how these systems work and about how they should be operated, but it is unclear what exact information TNO's respondents had received beforehand.

To conclude, most pragmatic consequences of Truck Platooning, both the positive (e.g. fuel savings and efficient road usage) and negative ones (e.g. increased feelings of stress and decreased situational awareness) come forth out of the short following distances between trucks. Therefore, to overcome the negative consequences and to take advantage of the positive ones, a suitable method must be found to let truck drivers familiarize themselves with Truck Platooning so that their fears can be relieved and so that they become enthusiastic about working with platooning systems.

6.2. Prerequisites and consequences of the Truck Platooning implementation process

Estimates about when Truck Platooning will be widely commercially available, defined in this study by a penetration rate of 25%, in the Netherlands varied, interestingly, more within the group of truck drivers than they did in the other stakeholder groups. Truck drivers estimated that this rate is possible two years from now (i.e. in 2020) earliest and latest at around 30 years from now (i.e. around 2048), while the other stakeholders estimated that the earliest moment at which this penetration rate could be achieved would be around 2023 (i.e. following the ACEA roadmap[8]) and latest around 2038.

The most important prerequisites for Truck Platooning, mentioned by truck drivers, are that 1) platooning truck drivers are kept alert enough to be able to overrule the platooning systems when necessary, 2) other road users can easily recognize a truck platoon and can anticipate

[8] Source: https://www.acea.be/publications/article/infographic-eu-roadmap-for-truck-platooning

accordingly on it, 3) logistic services providers should have been made eager to invest, 4) the infrastructure is prepared, 5) truck drivers (from different organizations) are willing to cooperate and 6) adequate testing is required prior to the implementation.

An overlap between the expressed prerequisites existed among truck drivers and the other stakeholders, since the other stakeholders also identified that recognizability of a platoon, the willingness to invest, infrastructural adaptations and adequate testing all serve as prerequisites for the Truck Platooning implementation process. Further, the other stakeholders mentioned that 1) the platooning systems must be extremely safe, 2) it must be identified for which categories of road transport Truck Platooning is feasible, 3) it should be a cross-border and multi-brand initiative and 4) truck drivers should be incorporated in the development and implementation processes of Truck Platooning. Finally, the other stakeholder groups identified several areas of uncertainty that must be clarified as a prerequisite for a successful implementation process. These uncertainties lie within the realms of 1) legislation, 2) accountability, 3) exemptions, 4) societal acceptance and 5) multi-stakeholder cooperation.

The implementation process of Truck Platooning can be sped up 1) if legislation, mainly about driving and resting times, is adapted, 2) when (monetary) incentives for logistic services providers are offered, 3) if several parties simply start driving with the first platoons and 4) when a bottom-up perspective will be applied by creating enthusiasm for Truck Platooning among truck drivers. On the other hand, factors that could slow down Truck Platooning are that 1) other road users are inadequately informed about how they should interact with truck platoons, 2) safety levels (including cyber-security) of the platooning systems cannot be guaranteed, 3) truck drivers cannot be motivated to adopt Truck Platooning or 4) cannot be motivated to cooperate with other truck drivers and organizations (i.e. competitors). Furthermore, failing to achieve cooperation on an international (i.e. the EU) level can, according to some respondents, completely block the Truck Platooning implementation process, just as can happen when other innovative concepts turn out to having more advantages than Truck Platooning and thus surpass it.

In order to prepare truck drivers, both current and new truck drivers, for Truck Platooning, several adaptations have to be realized in the truck drivers' educational programs. Although Truck Platooning seems difficult to incorporate in the driving schools' educational programs, specific lessons can be devoted to the principles of Truck Platooning in the vocational truck driver's educational programs. To ensure that all truck drivers have at least basic knowledge about Truck Platooning, which is considered as a strict requirement by most stakeholder groups, it might be best if Truck Platooning is incorporated in the Code95 structure as a non-voluntary component. Because the Code95 serves both as a prerequisite for obtaining the truck driver's license and as the refreshment course program for which 35 hours of refreshment courses must be followed every 5 years, it can be ensured that all truck drivers are sufficiently familiar with Truck Platooning. An educational component that can and should, according to most respondents, be incorporated in the practical driving lessons at the driving schools is experiencing the ADAS and platooning-specific systems. This underlines Kessel & Wickens' (1982) conclusion that hands-on experience is a prerequisite for a

successful implementation of an automated system. Obviously, to let student truck drivers experience Truck Platooning during the driving lessons, driving schools need to renew their truck fleets, which they probably will do in a couple of years anyway.

Also, the idea was pronounced, by multiple respondents, to design separate educational programs for 1) leading truck drivers, 2) following truck drivers and 3) truck drivers who will not engage in platooning activities. This, however, conflicts with the perspective of the majority of the respondents, who indicated that *all* truck drivers should become capable to platoon in order to preserve the flexibility that is generally conceived as extremely important in logistics.

During the driving exam, the examiner should direct more attention to the truck driver's traffic insight and the professional communication with other road users. Some respondents expressed that the truck driver should be the most professional person on the road by being able to anticipate on, and to solve, other road users' mistakes or anti-social driving behaviors. It was suggested to extend the duration of such a driving exam to be able to assess more traffic situations and perhaps even to enable connecting to a platoon in practice, so that the student can demonstrate that (s)he can properly interact with a platoon. If connecting to a platoon is not feasible in practice, a back-up suggestion was provided, which is to let students platoon fictively in a truck simulator. Another suggestion was to let the students during a driving exam drive a truck owned by the CBR instead of one owned by the driving school. In this truck, then, a system can be built in which the examiner can trigger specific events, for example a sudden disconnection from a platoon, in order to assess the student's reaction and problem-solving skills.

Most respondents think that the current interval of 35 hours per 5 years is suitable for the Code95 refreshment program. One respondent argued that more refreshment courses are needed due to the increased number of systems a truck driver will have to work with, while several others stated that less refreshment courses, or none at all, are necessary. This latter group argued that the Code95 should be changed into either a program in which the courses cannot be chosen voluntarily, but that they are selected for the truck driver so that they fit his actual job tasks, or that the truck driver (or his/her employer) should enroll for a refreshment course or online toolbox in the event that the truck driver's job is expected to change. Moreover, a specific Truck Platooning course should be introduced into the Code95 program. An interesting idea that was raised by a respondent is that real data of the truck driver's driving behavior could be downloaded and discussed in-depth during the Code95 courses in order to increase the consciousness of the truck driver's driving behavior and how this behavior must be changed to successfully participate in platooning activities.

6.3. Truck Platooning consequences directly affecting the truck driver's occupation

Even though truck drivers are currently already frequently mimicking Truck Platooning by driving at short following distances from their predecessors, the fact that automation systems will take over several aspects of truck drivers' jobs at specific route sections (i.e. highways in the short term and perhaps even on rural roads in the medium to long term) will lead to significant changes within these jobs. Although truck drivers do not fear the loss of their jobs

in the short term, they are afraid that their jobs will become less interesting. Another interesting finding is that truck drivers themselves compared their future jobs, and thereby (either implicitly or explicitly) expressed the fear of becoming merely a process operator, with that of a train driver, while most other stakeholders compared the truck drivers' job with that of a pilot, which is generally a more prestigious and appreciated job than that of a train driver.

With regard to Truck Platooning's consequences for the truck drivers' occupation, truck drivers indicated that the proportion between manual and automated driving will change. Most truck drivers therefore expect that the mental workload will decline unless their job package will be heavily extended. The truck drivers generally expect that their job will shift from a pure operational job to a more analytical (i.e. monitoring) one, leading to higher requirements and consequently to an improved image of the job. Even though they are all confident that most truck drivers would be able to adapt to the new working situation eventually, their opinions differ in whether they would appreciate the old or new working situation better. Moreover, all truck drivers expressed negative feelings about the short following distances implied by Truck Platooning.

Among the other stakeholders, some respondents expect little or no changes in the job contents of the truck drivers, while others foresee an upgrade of the job by situations like truck sharing, standardized routes and schedules, the responsibility of the truck driver to program and monitor the platooning systems, and perhaps even a classification structure of the truck driver's job. In such a classification structure, distinctions between a 'leading', a 'following' and a 'non-platooning' truck driver can be made, who then would have different capabilities and responsibilities. Although most respondents agreed that mental workloads would increase for leading truck drivers (e.g. by the increased responsibilities), opinions differed on whether this will also be the case for following truck drivers (e.g. by the short following distances). Whether the job of a platooning truck driver will be regarded as more or less attractive depends on the interests of the truck driver (i.e. if the truck driver is interested in innovative technologies, this will probably relate positively with the attractiveness of Truck Platooning).

If society concludes that it is safe enough to let truck drivers execute other tasks than the main driving tasks while being attached in a platoon as a follower, there are several potential job resources (i.e. options), job demands (i.e. obligations) and specific alternative tasks that can be identified for the truck drivers. Firstly, the options mainly consist out of the enhancement of the attractiveness of the job by the additional tasks and responsibilities, and the chance to relieve the truck driver from stressful conditions. The level of autonomy, however, is expected to decline due to Truck Platooning. Then, the obligations consist mainly out of the obligations to 1) be more disciplined (and therefore be more alert), 2) be more communicative with other stakeholders in the logistics chain, 3) drive specific, perhaps non-preferred, routes and 4) cooperate with other logistic services providers' truck drivers in order to efficiently form platoons.

An interesting finding is that, even though the logistic services providers can strongly benefit from a situation in which truck drivers could perform alternative job tasks while driving in a platoon as a follower, 3 out of the 5 logistic services providers indicated that they think that

this is impossible in practice or that they do not want the truck drivers to do other things besides the main driving (or monitoring) tasks. However, if it is practically feasible for the following truck driver to execute alternative tasks while platooning, then these tasks could be 1) performing administrative tasks, 2) communicating with other stakeholders of the logistics chain, 3) resting, 4) performing planning tasks, 5) following (online) courses, 6) performing telemarketing activities, 7) cleaning the truck's cabin or 8) working for another employer by the means of flexible working. Concerning resting in the cabin, some respondents expressed their expectations that a debate will arise about whether this should be seen as working time, as pause time, or as something in between. Also, it has been mentioned several times that many of those tasks are infeasible as alternative tasks due to the deadlines attached to them (i.e. a platooning truck driver never knows beforehand how much time (s)he will be actually platooning and therefore how much time can be spent on alternative tasks).

There was unanimity among the respondents that no skills and knowledge may disappear from the truck drivers' job due to the fact that in Truck Platooning, at least in the short term, the truck drivers should be able to manually drive and maneuver the truck at the sections where platooning is not feasible. At those moments, is argued, the truck drivers still require all skills and knowledge that current truck drivers also require. There are, however, some skills and types of knowledge identified that a platooning truck driver should possess or should develop even further than a current truck driver has. Obviously, the platooning truck drivers need to have the skills and knowledge to work with the platooning systems and, if deemed acceptable, to execute the alternative tasks identified earlier. They should possess knowledge of these systems so that they are able to program the systems' input parameters and to attach to or disconnect from a platoon. The leading truck drivers should improve on anticipation skills due to the extended length of the combination of vehicles that are being operated. Other skills that have to improve, but not exclusively for leading truck drivers, are 1) communication skills, 2) the ability to quickly switch between passive and active driving, 3) coordinating the alternative tasks, 4) being resistant to stress and 5) having traffic insight. Additional types of required knowledge are that a platooning truck driver knows how to 1) properly monitor and interpret the platooning systems, 2) resolve issues in the platooning systems, 3) comply with (inter-)national platooning legislation.

Truck drivers' occupational mindsets vary due to the variation in the characteristics of these persons. Nevertheless, a set of ideal occupational mindsets for platooning truck drivers has been identified. Even though the professional mindset was identified as being currently ideal, there are some aspects that could change so that the current occupational mindsets are changed into the most ideal ones for platooning truck drivers. Firstly, truck drivers' mindsets should become more open for innovative concepts to facilitate the acceptance process. Further, a platooning truck driver should get satisfaction from performing his/her job to transport his/her truck as efficiently as possible (i.e. gamification of the job). Also, his/her occupational mindsets should be more focused on 1) customers, 2) cooperation with competitors and colleagues and 3) being conscious about the dimensions of the platoon-combination and about the cargo that (s)he transports. Finally, the platooning truck driver should have a mindset in which (s)he can adequately trust the systems, which is unanimously

determined to be the hardest mindset to obtain, thereby relieving him/her from stressful factors.

The competence profile document for truck drivers (Sectorkamer mobiliteit, transport, logistiek en maritiem, 2017), constructed by STL, indicates several additional types of skills, knowledge and occupational mindsets that a truck driver should possess when compared to the respondents' answers (e.g. attaching and detaching a trailer to or from a truck, but also what strategies the truck driver can employ to prevent cargo theft). This could indicate that the respondents either take some of those skills, knowledge and occupational mindsets for granted and/or that they forgot to mention them.

To answer the main research question ("How will the implementation of Truck Platooning influence the profession of truck drivers?"), it can be concluded that most stakeholders think that Truck Platooning will strongly redefine logistics as we currently know it in numerous ways described in this chapter and that thereby the job of a truck driver will also change significantly. The number of skills and types of knowledge are expected to increase, while no skills or knowledge will become obsolete. Also, several of the current skills and types of knowledge will become more important. In addition, some of the occupational mindsets of current truck drivers will become more important and several new occupational mindsets have been identified. Although some occupational mindsets are expected to disappear in the future, it is unlikely that this is the result of Truck Platooning. Finally, there are still some uncertainties about when and about the exact ways in which Truck Platooning will influence this redefinition of the field of road transportation and of the people working in it. Therefore, further research into the implications of Truck Platooning is required.

The suggestions for improving this study (i.e. methodological improvements), but also suggestions for further research, are discussed in Paragraph 6.4. This research report concludes, in Paragraph 6.5., with recommendations that are specifically aimed at some of the stakeholder groups within this research's scope.

6.4. Suggestions for further research

Two suggestions for further methodological improvements are given before discussing the suggestions for further research that are distilled from the results of this study.

The sample size of each stakeholder group can be classified as relatively small (i.e. varying from 1 to 6 respondents per stakeholder group). Therefore, in order to strengthen the reliability of the results, it would be beneficial to increase the sample size in further research (e.g. in a replication of this study). When extending the sample of truck drivers, it is advised to ensure the availability of different types of truck drivers. Although the 4 truck drivers interviewed in this study varied significantly in the type of trucking, all of them were recently re-schooled into the occupation of truck driver, due to becoming obsolete in their former jobs or because of the wish to have more job security. Therefore, in a follow-up study, also truck drivers should be interviewed that have a longer job history as a truck driver, especially because this study's results suggest that the older, and consequently often more experienced, truck drivers are likely to experience more difficulties in accepting the concept of Truck Platooning.

Further, although Baarda et al. (2005) indicate that, in cases in which idea generation is the main goal, group interviews are generally to be preferred over one-on-one interviews, the diversity in backgrounds and the geographical dispersity of the respondents in this study made it infeasible to arrange such group interviews in a face-to-face setting. Therefore, it is an opportunity for future research to replicate this study in group interview settings.

Additional research is required in order to determine how truck drivers perceive platooning systems and how the user-friendliness of these systems could be enhanced, because conflicting results were found between this study and TNO's research with regard to the truck drivers' perceptions about the usefulness and satisfaction of platooning systems. Research should be devoted to finding out whether the fact that respondents in TNO's study were more negative about Truck Platooning after experiencing it in a truck simulator was the result of inadequate information provision up-front or whether this finding was the result of some other factor(s). In more general terminology, future research should determine the relationship between information provision up-front and the attitude of truck drivers towards Truck Platooning after having experienced working with these systems, either in real life or in a truck simulator.

Trust in the platooning systems plays an important role, since this trust is determined to be a prerequisite for a successful Truck Platooning implementation. A danger that respondents have warned for is the hazard that truck drivers will over-rely (i.e. have 'overtrust') on the platooning systems. Further research should determine how this hazardous situation can be prevented.

Another interesting idea that was mentioned by a few respondents is to incorporate the concept of serious gaming into the truck drivers' job, so that one can 'play the game' of driving as sustainable and smooth as possible. It remains a topic for further investigation to determine whether the population of truck drivers can be motivated in playing these serious games.

Further, the hub-to-hub Truck Platooning scenario was mentioned more often in this study than the on-the-fly scenario, indicating that respondents generally perceive that scenario as more feasible than the on-the-fly scenario. This is opposed to what was hypothesized in Paragraph 1.2. based on this study's preceding literature study (Vos, 2018a). One of the arguments against the hub-to-hub scenario is that precisely planning platoon formations, while simultaneously minimizing the amount of waiting time for individual truck drivers, is extremely difficult due to the high dependence on external influences. Therefore, additional research should be conducted that assesses the feasibility of the hub-to-hub scenario and the embodiment of its planning components.

Finally, this study found that there still are some uncertainties that require clarification before Truck Platooning can be successfully implemented. These uncertainties are 1) the implications for the driving and resting times legislation, 2) issues surrounding ethical and legal accountability, 3) whether logistic services providers in the future still have to apply for an exemption for every platooning activity, 4) how society, especially other road users, will react to Truck Platooning and 5) if, and how, stakeholders will cooperate with each other in the

future, for example with regard to splitting the savings on fuel between logistic services providers or with regard to matching trucks from different organizations in forming platoons. Additional research is required to clarify these uncertainties.

6.5. Recommendations

This final paragraph has the aim to provide several groups of stakeholders with recommendations that can be formulated as the result of this study's outcomes.

The main recommendation of this study, directed at TLN, comes forth out of the opinion of the majority of the respondents and out of Kessel and Wickens' study (1982), which is that all future truck drivers should be adequately prepared for Truck Platooning as a prerequisite for a safe implementation process. Many of the respondents wish that a course within the Code95 program is devoted to Truck Platooning and that this course would become mandatory for every truck driver of who platooning becomes part of the job. To ensure that all truck drivers, both new and experienced truck drivers, are familiarized with Truck Platooning, both a separate certificate and a refreshment course for Truck Platooning should be developed. This certificate should be constructed in a similar way as the certificate that is required for being allowed to drive a LZV combination, namely that a separate exam for Truck Platooning must be passed next to the exam for the general truck driving license (license C). When a truck driver passes this additional Truck Platooning exam, a note should be added to his/her driving license that indicates that this truck driver is qualified, and therefore legally allowed, to platoon on public roads. A high safety level can be guaranteed this way, but it is also beneficial for law enforcement, since it can be easily checked whether a truck driver is qualified to drive in a platoon or not. Furthermore, truck drivers who possess such a Truck Platooning certificate on their driving licenses will become more valued by employers, since this certificate demonstrates that the truck driver possesses some additional skills and knowledge in comparison with truck drivers who do not possess the certificate. This can improve the truck drivers' job security, which they are often fearful about.

The separate driving education for Truck Platooning should contain the actions of merging with and decoupling from a platoon, but should also assess how the student responds to unexpected events (e.g. system errors). Therefore, it is suggested that the examiner gets the possibility to trigger some events to observe how the student reacts. In order to do so, driving schools should ensure that every student learns to work with platooning systems, while the driving exam will take place in a truck owned by the CBR, instead of using a truck owned by the driving schools, in which the equipment is installed so that the events mentioned above can be triggered. When this suggestion turns out to be practically infeasible, assessing the students' reactions in a truck simulator could serve as a feasible alternative.

Recently, the Code95 structure has been changed so that several categories are constructed that truck drivers must complete within 5 years (conversation C. Blom, TLN, 01-08-2018). It is highly recommended for the CBR that, for all truck drivers who possess a Truck Platooning certificate, the course about Truck Platooning is made such a mandatory component within the Code95 program so that it can be ensured that the skills and knowledge required for Truck Platooning are updated frequently.

Furthermore, a specific recommendation for STL is to adapt their job profile document (i.e. BCP; Beroeps Competentie Profiel) (Sectorkamer mobiliteit, transport, logistiek en maritiem, 2017) so that the changes in the required skills and knowledge, as proposed by this study and visualized in Figure 10 in Paragraph 5.5., are incorporated. By doing this, a more complete job profile for the future truck driver, who will be confronted with Truck Platooning, can be composed.

Further, a recommendation aimed at the (inter-)national legislative organizations (e.g. the ministry of I&W) is that monetary incentives should be made available for logistic services providers that fulfill the 'early adopter' role by investing vast amounts of money into replacing their contemporary fleet by trucks that are capable of platooning. This can help to speed up the Truck Platooning implementation process, because this study found that the implementation process can be sped up if some logistic services providers create momentum for platooning by simply starting to platoon. Therefore, it would be preferable that the big logistic services providers start making these investments in the short term, so that consequently other, smaller, logistic services providers can also invest in Truck Platooning and then can immediately start engaging in platooning activities with the big logistic services providers. When these partnerships have been established, all parties can benefit from Truck Platooning's advantages.

Also, legislation should be adapted so that logistic services providers participating in platooning activities can also benefit from the grants that are currently only provided to owners of low-emission trucks. It is, however, difficult to measure the exact emissions of a platoon because platoons by definition consist out of multiple vehicles with differing emission levels. Nevertheless, a method should be developed to measure the proportion of time that a truck is engaging in platooning activities and how this could be translated into (the height of) low-emission grants.

Furthermore, it is recommended for the ministry of I&W to put effort into the further acceleration of getting clarity about the driving and resting legislation in Truck Platooning.

For Rijkswaterstaat and the ministry of I&W, as the overarching entity of Rijkswaterstaat, it is recommended to seriously consider constructing separate Truck Platooning highway lanes, at least at the most frequently used transport corridors (e.g. A15, A16 and A58). The main reason for doing so comes forth out of the positive safety consequences, anticipated by most of this study's respondents, of constructing these separate lanes. By letting platoons drive separated from other traffic, most dangerous situations can be evaded, since it is argued that most unsafe situations are the result of mixing platooning vehicles with manually driven vehicles.

Respondents frequently stressed the difficulties in the interaction between platooning trucks and other road users and that it is extremely important that all road users are aware of the existence of truck platoons. Moreover, all those road users should know how to interact with these platoons and how to anticipate on their movements. It is recommended that a suitable way is sought by which all road users can be properly educated about truck platoons.

Since it was frequently determined that the fact that logistic services providers must apply for an exemption at the RDW for every platooning activity can serve as an inhibiting factor for

the Truck Platooning implementation process, the RDW is recommended to facilitate (i.e. speed up) this application process. Moreover, although preferred less because the controlling possibilities regarding safety will thereby decline, it could also be a possibility to totally cancel out this requirement, so that platooning activities can take place without requiring exemptions.

Because it was indicated several times that Truck Platooning systems do not work properly in specific traffic situations, the truck manufacturers are recommended to keep identifying these problematic situations and to keep searching for solutions to these deficits. Thereby, the error rate of the platooning systems can decline, which can lead to a faster adoption rate of Truck Platooning technology.

Finally, it is recommended to all involved stakeholders that testing initiatives should be initiated until Truck Platooning is a common phenomenon in traffic. Truck drivers should be incorporated as much as possible in these tests to distill as much information as possible about how Truck Platooning can be successfully implemented, while minimizing the negative consequences for those truck drivers. In order to let truck drivers perceive Truck Platooning as a positive development, which is a requirement for a smooth implementation process, enthusiasm should be created from the bottom up. One of the factors that can facilitate the creation of enthusiasm is to actively approach truck drivers to voice their opinions about their experiences. Moreover, truck drivers, but also many other stakeholders, often indicated that truck drivers would probably not feel at ease when driving at the very short following distances that the developers of the Truck Platooning concept are aiming at (i.e. 0.3 seconds). Also, it was frequently argued that driving at shorter following distances than one is used to requires a familiarization process. Therefore, it is recommended that truck drivers who start driving in platoons are asked to gradually decrease the following distance at the moment that they feel safe enough for doing so. Thereby, they can get familiarized to Truck Platooning at their own pace and they feel that their opinions and feelings are seriously being taken into account, which will lead to a smoother implementation process due to heightened enthusiasm about Truck Platooning among truck drivers.

7. References

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8. Appendixes

8.1. Appendix 1 – Example of visual representation job profile according to FPM

Job profile truck driver

Educational demands/ educational level	mbo-1/2, driving license C, additional certificates Transport for mbo 1 is increasingly being conducted by Eastern European countries. Dutch drivers more in niches with higher service levels. Therefore, level mbo 2/3
Avoidance opportunities	Is a chance-creating occupation

Legend

Increases	Remains equal	Decreases	Is new

	Tasks	Job-related knowledge and skills
Executing tasks	Checking the status of the vehicle and equipment, establishing the connection	Knows the instructions and regulations, checks vehicle for damage, system indicators and fuel
		Connects the trailer
		Attaching vehicle signaling
	Picking up cargo, transporting and delivering	Uses a tachograph
		Adapts driving style to cargo that is transported
		Checks quantities, type of cargo and for visual damages, draws up (damage) reports
	Organizing and checking the process of loading cargo into the vehicle or loading and unloading him-/herself (with the use of tools)	Knows loading and carrying techniques and stacks, stows, unstacks, and anchors the load according to instructions and weight distribution
		Knows modalities of loading and unloading and works according to the loading plan, the route planning and rules for loading safely
		Estimates the load, knows and applies ergonomic lifting and raising techniques
	Registering follow-up and activity information	Uses on-board computer and communication devices
		Keeps up with information about the execution and, if applicable, reports deviations to responsible supervisor
	Checking packing list together with customer	Aiming at the needs and expectations of the customer
	Communicating with customers	Aligning with customer during loading and unloading
Regulating tasks	Communicating with internal and external services (e.g. roadside assistance and emergency services)	Asks for help in case of problems
	Executing urgency measures in the event of an accident	Knows prescriptions and regulation, estimates the kind and scale of the breakdown, accident or other emergency situation
Supporting tasks	Determining the route according to the characteristics of the vehicle, the load and the delivery priorities	Uses navigation material (route planner, GPS, road maps, city maps)
		Executing a route check (traffic jams, accidents, roadworks)
	Checking the presence and validity of boarding and transportation documents	Knows customs formalities and reports problem concerning boarding and transportation documents to responsible supervisor
	Executing basic maintenance	
	Cleaning the vehicle	
	Maintaining and strengthening job-related knowledge	Attends trainings and courses in the context of Code95
Additive tasks	Warning the services involved in case of an emergency situation	Know prescriptions and regulation, reports the problem to the qualified institution and the responsible supervisor
	Guarantees the safety of the cargo	Is aware of the value of the cargo and takes preventive measures against theft

Figure 11 – Example of a job profile for truck drivers according to FMP[9]

[9] Source, Oeij et al., 2017, p. 29

8.2. Appendix 2 – The Level of Autonomy Taxonomy (LOAT)[10]

A INFORMATION ACQUISITION	B INFORMATION ANALYSIS	C DECISION AND ACTION SELECTION	D ACTION IMPLEMENTATION
A0 **Manual Info Acquisition**	**B0** **Working Memory Based Info Analysis**	**C0** **Human Decision Making**	**D0** **Manual Action and Control**
The human acquires relevant information on the process s/he is following without using any tool.	The human compares, combines and analyses different information items regarding the status of the process s/he is following by way of mental elaborations. S/he does not use any tool or support external to her/his working memory.	The human generates decision options, selects the appropriate ones and decides all actions to be performed.	The human executes and controls all actions manually.
A1 **Artefact-Supported Info Acquisition**	**B1** **Artefact-Supported Info Analysis**	**C1** **Artefact-Supported Decision Making**	**D1** **Artefact-Supported Action Implementation**
The human acquires relevant information on the process s/he is following with the support of low-tech non-digital artefacts. *Ex. 1) Identification of aircraft positions on an aerodrome/airport according to Procedural Air Traffic Control rules and without use of radar support.*	The human compares, combines, and analyses different information items regarding the status of the process s/he is following utilising paper or other non-digital artefacts. *Ex. 1) Use of flight strips to compare altitudes/levels/pl. times of different aircraft and to pre-plan future traffic.*	The human generates decision options, selects the appropriate ones and decides all actions to be performed utilising paper or other non-digital artefacts.	The human executes and controls actions with the help of mechanical non-software based tools. *Ex. 1) Use of a hammer or leverage to increase the kinetic energy of human gesture.* *Ex. 2) Use of a mechanical or hydraulic rudder to achieve a change in direction.*
A2 **Low-Level Automation Support of Info Acquisition**	**B2** **Low-Level Automation Support of Info Analysis**	**C2** **Automated Decision Support**	**D2** **Step-by-step Action Support:**
The system supports the human in acquiring information on the process s/he is following. Filtering and/or highlighting of the most relevant information are up to the human. *Ex. 1) Identification of aircraft positions in the airspace by way of Primary Radar working positions.*	Based on user's request, the system helps the human in comparing, combining and analysing different information items regarding the status of the process being followed. *Ex. 1) Activation by ATCOs of Speed Vectors for specific tracks on the CWP, in order to anticipate potential conflicts in a defined time frame.*	The system proposes one or more decision alternatives to the human, leaving freedom to the human to generate alternative options. The human can select one of the alternatives proposed by the system or her/his own one. *Ex.1) AMAN visualization of the proposed sequence of aircraft.*	The system assists the operator in performing actions by executing part of the action and/or by providing guidance for its execution. However, each action is executed based on human initiative and the human keeps full control of its execution. *Ex. 1) The aural and visual component of TCAS RA in current TCAS II version 7.0 (also LOA C5)*

[10] Source: Save & Feuerberg, 2012, pp. 48-50

A3 **Medium-Level Automation Support of Info Acquisition**	B3 **Medium-Level Automation Support of Info Analysis**	C3 **Rigid Automated Decision Support**	D3 **Low-Level Support of Action Sequence Execution**
The system supports the human in acquiring information on the process s/he is following. It helps the human in integrating data coming from different sources and in filtering and/or highlighting the most relevant information items, based on user's settings. *Ex. 1) CWP allowing ATCOs to set flight level filters to display only certain traffic on the screen.*	Based on user's request, the system helps the human in comparing, combining and analysing different information items regarding the status of the process being followed. The system triggers visual and/or aural alerts if the analysis produces results requiring attention by the user. *Ex. 1) ERATO Filtering and What-if function.* *Ex 2). VERA Tool to display the closest point of approach between two aircrafts.*	The system proposes one or more decision alternatives to the human. The human can only select one of the alternatives or ask the system to generate new options.	The system performs automatically a sequence of actions after activation by the human. The human maintains full control of the sequence and can modify or interrupt the sequence during its execution. *Ex. 1) Explicit initiation of an electronic coordination with adjacent sector via digital input (replacing use of telephone).*
A4 **High-Level Automation Support of Info Acquisition**	**B4** **High-Level Automation Support of Info Analysis**	**C4** **Low-Level Automatic Decision Making**	**D4** **High-Level Support of Action Sequence Execution**
The system supports the human in acquiring information on the process s/he is following. The system integrates data coming from different sources and filters and/or highlights the information items which are considered relevant for the user. The criteria for integrating, filtering and highlighting the relevant information are predefined at design level but visible to the user. *Ex.1) D-TAXI tool (including graphical route information)*	The system helps the human in comparing, combining and analysing different information items regarding the status of the process being followed, based on parameters pre-defined by the user. The system triggers visual and/or aural alerts if the analysis produces results requiring attention by the user. *Ex. 1) MTCD visual alerts (allowing some tuning of parameters by the user)*	The system generates options and decides autonomously on the actions to be performed. The human is informed of its decision. *Ex.1) Aural and visual component of TCAS RA in current TCAS II version 7.0 (also LOA D2)*	The system performs automatically a sequence of actions after activation by the human. The human can monitor all the sequence and can interrupt it during its execution. *Ex.1) Acknowledgment by pilot of a clearance received trough CPDLC (data-link) and automatically sent to FMS and autopilot.* *Ex. 2) Autopilot following the FMS trajectory.*

A5 **Full Automation Support of Info Acquisition**	B5 **Full Automation Support of Info Analysis**	C5 **High-Level Automatic Decision Making**	D5 **Low-Level Automation of Action Sequence Execution**
The system supports the human in acquiring info on the process s/he is following. The system integrates data coming from different sources and filters and/or highlights the information items considered relevant for the user. The criteria for integrating, filtering and highlighting are predefined at design level and not visible to the user	The system performs comparisons and analyses of data available on the status of the process being followed based on parameters defined at design level. The system triggers visual and/or aural alerts if the analysis produces results requiring attention by the user. *Ex. 1) STCA visual and aural alerts.*	The system generates options and decides autonomously on the action to be performed. The human is informed of its decision only on request. (Always connected to to an *Action Implementation* level not lower than D5.)	The system initiates and executes automatically a sequence of actions. The human can monitor all the sequence and can modify or interrupt it during its execution. *Ex. 1) Implicit initiation of an electronic co-ordination with adjacent sector as agreed exit conditions (according to Letter of Agreement) cannot be met anymore after changes to the a/c trajectory has been made.*
		C6 **Full Automatic Decision Making**	D6 **Medium-Level Automation of Action Sequence Execution**
		The system generates options and decides autonomously on the action to be performed without informing the human. (Always connected to an *Action Implementation* level not lower than D5.)	The system initiates and executes automatically a sequence of actions. The human can monitor all the sequence and can interrupt it during its execution. *Ex.1) TCAS AP/FD during a corrective TCAS RA.*
			D7 **High-Level Automation of Action Sequence Execution**
			The system initiates and executes a sequence of actions. The human can only monitor part of it and has limited opportunities to interrupt it.
			D8 **Full Automation of Action Sequence Execution**
			The system initiates and executes a sequence of actions. The human cannot monitor nor interrupt it until the sequence is not terminated.

8.3. Appendix 3 – Interviewing scheme truck drivers

Introduction

Dear participant,

First of all I would like to thank you for participating in this study into the implications of Truck Platooning on the job of truck drivers, conducted in cooperation with Transport en Logistiek Nederland (TLN) and the Technical University of Eindhoven (TU/e). By participating in this study you are contributing to accomplishment of both the practical and scientific goals of this study. This study aims to provide the logistics sector with accurate prospects on how to anticipate on the implementation of Truck Platooning, while simultaneously aiming to enrich the literature available on Truck Platooning implications. Since the questions will mainly ask you to express your opinions and behaviors, there are no right or wrong answers. Further, your responses will be analyzed anonymously and therefore the answers that you give cannot be traced back to you. This interview will approximately take between 45 minutes and 1 hour. Hereby I would like to ask for permission to make an audio recording of this interview, so that your answers can be processed more easily. The audio recording will only be accessible to me, as the primary researcher, and after an analysis of the responses has taken place, this audio recording will be deleted.

Perception about Truck Platooning

1.1. *Are you familiar with the concept of Truck Platooning?*

□ If yes, continue to **question 1.2.**

□ If no, explain what Truck Platooning is before proceeding to **question 1.3.**

1.2. *Could you please describe what Truck Platooning is according to you?*

If the answer is clearly not aligned with what is being meant with Truck Platooning in this study, explain what Truck Platooning is before proceeding to question 1.3.

Explanation Truck Platooning:

Truck Platooning is defined as the act of, figuratively spoken, coupling a multitude of trucks together in a convoy of which only the first truck has to be driven manually and in which the following trucks are 'attached' to each other and respond to the leading truck and other external factors (i.e. other motorists) by using Vehicle-to-vehicle communication (V2V) systems (i.e. Wi-Fi), a Global Positioning System (GPS), radars and cameras.

1.3. *How many years from now do you think that Truck Platooning will be implemented in the Netherlands to such an extent that at least 25% of the trucks will be platooning regularly, say once per day?*

1.4. *What influences do you expect Truck Platooning to have on traffic safety?*

1.5. *Are you familiar with the concept of Advanced Driving-Aid Systems (ADAS)?*

□ If yes, continue to **question 1.6.**

□ If no, explain what ADAS are before proceeding to **question 1.7.**

Explanation Advanced Driving-Aid Systems (ADAS):

ADAS is a collective name for systems that can aid the driver while driving. Examples of systems that are prerequisites for Truck Platooning are (Cooperative) (Adaptive) Cruise Control (CACC), brake assist, a lane keeping system, a lane changing system, an Automated Highway System (AHS) or an Intelligent Vehicle Highway System (IVHS) and wireless vehicle communication systems (i.e. such as Wi-Fi).

1.6. *Could you please describe what Advanced Driving-Aid Systems are according to you?*

If the answer is clearly not aligned with what is being meant with ADAS in this study, explain what ADAS are before proceeding to question 1.7.

1.7. *Which ADAS are installed on the truck that you drive most of the time?*

□ (Connected) (Adaptive) Cruise Control;

□ Brake assist;

□ Lane keeping assist;

□ Lane changing assist;

□ Automated Highway System (AHS);

□ Intelligent Vehicle Highway System (IVHS);

□ Wireless communication systems;

□ Other, namely:……

1.8. *How frequently do you use ADAS while driving your truck?*

If the answer is insufficient to answer to select the appropriate answer category, ask as a follow-up question:

"Can you give some examples of typical driving situations in which you use ADAS?"

Note which answer category is most applicable to respondent's answer:

□ Never;

□ Rarely (i.e. approximately once per month);

□ Sometimes (i.e. once per week);

□ Often (i.e. at least every day);

□ As often as possible (i.e. if traffic situations permit).

If the answer is <u>not</u> 'never', ask: *"Which ADAS systems do you use frequently, that is every working day at least once, in practice?"*

□ (Connected) (Adaptive) Cruise Control;

□ Brake assist;

□ Lane keeping assist;

□ Lane changing assist;

□ Automated Highway System (AHS);

□ Intelligent Vehicle Highway System (IVHS);

□ Wireless communication systems;

□ Other, namely:……

1.9. *Can you tell me how safe you think **you would feel** in a truck that highly relies on ADAS in order to drive autonomously?*

Note which answer category is most applicable to respondent's answer:

□ No trust;

□ Little trust;

□ Neutral;

□ Quite some trust;

□ Complete trust.

Note: if answer is unclear, ask follow-up question: *"Can you give me some more insight in why you do have (not) these trust issues?"*

If nothing is mentioned about the inter-truck distance of 0.3 seconds, ask the follow-up question: *"And how do you think you would feel when driving a truck with an inter-truck distance as little as 0.3 seconds?"*

1.10. *What is your opinion on Advanced Driving-Aid Systems (ADAS) in a truck?*

Note which answer category is most applicable to respondent's answer:

□ Extremely negative;

□ Rather negative;

□ Neutral;

□ Rather positive;

□ Extremely positive.

1.11. *What potential consequences do you think that Truck Platooning could have on the **contents** of your job?*

With contents of the job the truck driver's job package is meant.

Note: if answer does not contain any indications about (mental) workload and situational awareness, ask follow-up questions.

Examples for follow-up questions:

Mental workload: *"How do you think that Truck Platooning will influence the mental workload you will be experiencing while driving a platooning truck?"*

Situational awareness: *"How do you think that Truck Platooning will influence the way in which you are aware of what happens around you on the road?"*

1.12. *What is your opinion about the potential consequences that Truck Platooning could have on your **job security**?*

Facilitating factors

2.1. *Can you describe some factors of which you think that they can result in situations in which the implementation process of Truck Platooning is **sped up** or **facilitated**?*

In case of an unsatisfactory response (i.e. when nothing about human factors is told), ask for clarifications or for more examples.

Impeding factors

3.1. *Can you describe some factors of which you think that they can result in situations in which the implementation process of Truck Platooning is **slowed down**?*

In case of an unsatisfactory response (i.e. when nothing about human factors is told), ask for clarifications or for more examples.

3.2. *Can you describe some factors of which you think that they can result in situations in which the implementation process of Truck Platooning is **blocked**?*

In case of an unsatisfactory response (i.e. when nothing about human factors is told), ask for clarifications or for more examples.

Implications for job resources

"For the following two questions, please assume that your employer has adopted Truck Platooning and requires you to start driving in a truck that is capable to platoon."

4.1. *What extra options do you expect to get in your job when you will have to start driving a truck capable of platooning?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

Implications for job demands

5.1. *What extra tasks do you expect to get in your job when you will have to start driving a truck capable of platooning?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

Options for alternative job tasks

"For the following question, please think of the situation in which you are the driver of a truck that is currently engaged in a platoon as a follower. This implies that you currently do not have to operate the truck manually, but you have to be able to regain control of the truck within several seconds in case of a system error that is causing a dangerous situation."

6.1. *Can you think of examples of activities you could be doing while platooning in such a situation?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

Required skillsets

"The upcoming questions are about the skills, knowledge and occupational mindsets that a typical truck driver currently has and that a driver of a platooning truck needs to have."

7.1. *Which skills do you think that you need in order to be able to fulfill your job in a good way?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

7.2. *Which additional skills do you think that you will need if you are required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

7.3. *Which of the current skills do you think that you will not need any more when you are required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

The interviewer summarizes the answers given at question 7.1., 7.2. and 7.3., thereby identifying the discrepancies between those answers. The respondent is being asked in question 7.4. whether the interviewer understood everything correctly.

7.4. *Do I summarize your view correctly when I conclude that the main differences in the required skills for you, as a truck driver, between the contemporary situation and the platooning truck situation are … , …. and ….?*

Required knowledge

8.1. *What knowledge do you think that you need in order to be able to fulfill your job in a good way?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

8.2. *What additional knowledge do you think that you will need if you are required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

8.3. *Which of the current knowledge do you think that you will not need any more when you are required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

The interviewer summarizes the answers given at question 8.1., 8.2. and 8.3., thereby identifying the discrepancies between those answers. The respondent is being asked in question 8.4. whether the interviewer understood everything correctly.

8.4. *Do I summarize your view correctly when I conclude that the main differences in required knowledge for you, as a truck driver, between the contemporary situation and the platooning truck situation are … , …. and ….?*

Required occupational mindsets

9.1. *Which occupational mindsets do you think that you need in order to be able to fulfill your job in a good way?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

9.2. *Which adaptations to your occupational mindsets do you think need to be made if you are required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

9.3. *Which of the current occupational mindsets do you think that you will not need any more when you are required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

The interviewer summarizes the answers given at question 9.1., 9.2. and 9.3., thereby identifying the discrepancies between those answers. The respondent is being asked in question 9.4. whether the interviewer understood everything correctly.

9.4. *Do I summarize your view correctly when I conclude that the main differences in required occupational mindsets for you, as a truck driver, between the contemporary situation and the platooning truck situation are … , …. and ….?*

9.5. *As a summary of the former set of questions, what do you think are typical characteristics of a person that could become a truck driver in 10 years?*

Changes in truck driver educational programs

"The final set of questions will address the way in which new truck drivers are educated."

10.1. *Can you describe what the educational process of becoming a truck driver looks like?*

"Now I would like to ask you to imagine that your son or nephew wants to become a truck driver, just like you."

10.2. *On which aspects do you think that the educational program for future truck drivers will differ from the educational program that you went through to become a truck driver?*

10.3. *What are, according to you, the main focus areas at which examiners should be focused in the examination for the truck driver's license in order to prepare future truck drivers properly for Truck Platooning?*

10.4. *How often do you think that a truck driver should participate in 'in-service trainings' or a 'refreshment course' in order to stay properly skilled as a platooning truck driver?*

Possible follow-up question: *"Why do you think this would be a good interval between those trainings or courses?"*

10.5. *On which aspects do you think that these 'in-service trainings' or 'refreshment courses' should be adapted to anticipate for platooning trucks?*

Conclusion

This was the end of the interview. I would like to thank you for participating in this research, by which you have helped both the logistics sector and the scientific research into this sector. Once again, I would like to stress that the answers you have given will be processed anonymously can therefore not lead back to you. Finally, I would like to ask you whether you would like the master thesis report after completing this study?

[If yes, write down respondent's email address]

Do you have any additional questions, remarks or additions to this interview session?

8.4. Appendix 4 – Interviewing scheme other stakeholders

Introduction

Dear participant,

First of all I would like to thank you for participating in this study into the implications of Truck Platooning on the job of truck drivers, conducted in cooperation with Transport en Logistiek Nederland (TLN) and the Technical University of Eindhoven (TU/e). By participating in this study you are contributing to accomplishment of both the practical and scientific goals of this study. This study aims to provide the logistics sector with accurate prospects on how to anticipate on the implementation of Truck Platooning, while simultaneously aiming to enrich the literature available on Truck Platooning implications. Since the questions will mainly ask you to express your opinions and behaviors, there are no right or wrong answers. Further, your responses will be analyzed anonymously and therefore the answers that you give cannot be traced back to you. This interview will approximately take between 45 minutes and 1 hour. Hereby I would like to ask for your permission to make an audio recording of this interview, so that your answers can be processed more easily. The audio recording will only be accessible to me, as the primary researcher, and after an analysis of the responses has taken place, this audio recording will be deleted.

Perception about Truck Platooning

1.1. *Are you familiar with the concept of Truck Platooning?*

□ If yes, continue to **question 1.2.**

□ If no, explain what Truck Platooning is before proceeding to **question 1.3.**

1.2. *Could you please describe what Truck Platooning is according to you?*

If the answer is clearly not aligned with what is being meant with Truck Platooning in this study, explain what Truck Platooning is before proceeding to question 1.3.

Explanation Truck Platooning:

Truck Platooning is defined as the act of, figuratively spoken, coupling a multitude of trucks together in a convoy of which only the first truck has to be driven manually and in which the following trucks are 'attached' to each other and respond to the leading truck and other external factors (i.e. other motorists) by using Vehicle-to-vehicle communication (V2V) systems (i.e. Wi-Fi), a Global Positioning System (GPS), radars and cameras.

1.3. *How many years from now do you think that Truck Platooning will be implemented in the Netherlands to such an extent that at least 25% of the trucks will be platooning regularly, say once per day?*

1.4. *What influences do you expect Truck Platooning to have on traffic safety?*

1.5. *Are you familiar with the concept of Advanced Driving-Aid Systems (ADAS)?*

□ If yes, continue to **question 1.6.**

□ If no, explain what ADAS are before proceeding to **question 1.7.**

Explanation Advanced Driving-Aid Systems (ADAS):

ADAS is a collective name for systems that can aid the driver while driving. Examples of systems that are prerequisites for Truck Platooning are (Cooperative) (Adaptive) Cruise Control (CACC), brake assist, a lane keeping system, a lane changing system, an Automated Highway System (AHS) or an Intelligent Vehicle Highway System (IVHS) and wireless vehicle communication systems (i.e. such as Wi-Fi).

1.6. *Could you please describe what Advanced Driving-Aid Systems are according to you?*

If the answer is clearly not aligned with what is being meant with ADAS in this study, explain what ADAS are before proceeding to question 1.7.

1.7. *Can you tell me how safe you think that a truck driver **would feel** in a truck that highly relies on ADAS in order to drive autonomously?*

Note which answer category is most applicable to respondent's answer:

□ No trust;

□ Little trust;

□ Neutral;

□ Quite some trust;

□ Complete trust.

Note: if answer is unclear, ask follow-up question: *"Can you give me some more insight in why you think this?"*

If nothing is mentioned about the inter-truck distance of 0.3 seconds, ask the follow-up question: *"And how do you think that a truck driver would feel when driving a truck with an inter-truck distance as little as 0.3 seconds?"*

1.8. *What is your opinion on Advanced Driving-Aid Systems (ADAS) in a truck?*

Note which answer category is most applicable to respondent's answer:

□ Extremely negative;

□ Rather negative;

□ Neutral;

□ Rather positive;

□ Extremely positive.

1.9. *What consequences do you think that Truck Platooning will have on the **contents** of a truck driver's job?*

Note: if answer does not contain any indications about (mental) workload and situational awareness, ask follow-up questions.

Examples for follow-up questions:

Mental workload: *"How do you think that Truck Platooning will influence the mental workload truck drivers will be experiencing while driving a platooning truck?"*

Situational awareness: *"How do you think that Truck Platooning will influence the way in which truck drivers are aware what happens around them on the road?"*

1.10. *What consequences do you think that Truck Platooning will have on a truck driver's **job security**?*

Facilitating factors

2.1. *Can you describe some factors of which you think that they can result in situations in which the implementation process of Truck Platooning is **sped up** or **facilitated**?*

In case of an unsatisfactory response (i.e. when nothing about human factors is told), ask for clarifications or for more examples.

Impeding factors

3.1. *Can you describe some factors of which you think that they can result in situations in which the implementation process of Truck Platooning is **slowed down**?*

In case of an unsatisfactory response (i.e. when nothing about human factors is told), ask for clarifications or for more examples.

3.2. *Can you describe some factors of which you think that they can result in situations in which the implementation process of Truck Platooning is **blocked**?*

In case of an unsatisfactory response (i.e. when nothing about human factors is told), ask for clarifications or for more examples.

Implications for job resources

4.1. *What extra options do you expect that truck drivers will get when they have to start driving a truck capable of platooning?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

Implications for job demands

5.1. *What extra tasks do you expect that truck drivers will get when they have to start driving a truck capable of platooning?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

Options for alternative job tasks

"For the following question, please think of the situation in which a truck is currently engaged in a platoon ***as a follower****. This implies that the driver currently does not have to operate the truck manually, but has to be able to regain control of the truck* ***within several seconds*** *in case of a system error that is causing a dangerous situation."*

6.1. *Can you think of examples of activities a truck driver could be doing while platooning in such a situation?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

Required skillsets

"The upcoming questions are about the skills, knowledge and occupation mindsets that a typical truck driver currently has and that a driver of a platooning truck needs to have."

7.1. *Which skills do you think that current truck drivers need in order to be able fulfill their jobs in a good way?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

7.2. *Which additional skills do you think that a truck driver will need if (s)he is required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

7.3. *Which of the current skills do you think that the truck driver will not need anymore when (s)he is required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

The interviewer summarizes the answers given at question 7.1., 7.2. and 7.3., thereby identifying the discrepancies between those answers. The respondent is being asked in question 7.4. whether the interviewer understood everything correctly.

7.4. *Do I summarize your view correctly when I conclude that the main differences in the required skills for a truck driver between the contemporary situation and the platooning truck situation are … , …. and ….?*

Required knowledge

8.1. *What knowledge do you think that current truck drivers need in order to be able fulfill their jobs in a good way?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

8.2. *What additional knowledge do you think that a truck driver will need if (s)he is required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

8.3. *Which of the current knowledge do you think that the truck driver will not need anymore when (s)he is required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

The interviewer summarizes the answers given at question 8.1., 8.2. and 8.3., thereby identifying the discrepancies between those answers. The respondent is being asked in question 8.4. whether the interviewer understood everything correctly.

8.4. *Do I summarize your view correctly when I conclude that the main differences in required knowledge for a truck driver between the contemporary situation and the platooning truck situation are … , …. and ….?*

Required occupational mindsets

9.1. *Which occupational mindsets do you think that current truck drivers need in order to be able fulfill their jobs in a good way?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

9.2. *Which adaptations to a truck driver's occupational mindsets do you think need to be made if (s)he is required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

9.3. *Which of the current occupational mindsets do you think that the truck driver will not need any more when (s)he is required to drive a truck that is able to engage in platooning activities?*

In case of an unsatisfactory response, ask for clarifications or for more examples.

The interviewer summarizes the answers given at question 9.1., 9.2. and 9.3., thereby identifying the discrepancies between those answers. The respondent is being asked in question 9.4. whether the interviewer understood everything correctly.

9.4. *Do I summarize your view correctly when I conclude that the main differences in required occupational mindsets for a truck driver between the contemporary situation and the platooning truck situation are … , …. and ….?*

9.5. *As a summary of the former set of questions, what do you think are typical characteristics of a person that could become a truck driver in, for example, 10 years?*

Changes in truck driver educational programs

"The final set of questions will address the way in which new truck drivers are educated."

10.1. *Can you describe what the educational process of becoming a truck driver looks like?*

10.2. *On which aspects do you think that the educational program for future truck drivers will differ from the educational program current truck drivers went through?*

10.3. *What are, according to you, the main focus areas at which examiners should be focused in the examination for the truck driver's license in order to prepare future truck drivers properly for Truck Platooning?*

10.4. *How often do you think that a truck driver should participate in 'in-service trainings' or a 'refreshment course' in order to stay properly skilled as a platooning truck driver?*

Possible follow-up question: *"Why do you think this would be a good interval between those trainings or courses?"*

10.5. *On which aspects do you think that these 'in-service trainings' or 'refreshment courses' should be adapted to anticipate platooning trucks?*

Conclusion

This was the end of the interview. I would like to thank you for participating in this research, by which you have helped both the logistics sector and the scientific research into this sector. Once again, I would like to stress that the answers you have given will be processed anonymously can therefore not lead back to you. Finally, I would like to ask you whether you would like the master thesis report after completing this study?

[If yes, write down respondent's email address]

Do you have any additional questions, remarks or additions to this interview session?

8.5. Appendix 5 – Initial coding scheme

Nodes

Name	Files	References
[1.01.] Truck Platooning	20	23
[1.2] Omschrijving TP	16	29
[1.3.] Prognose implementatie	20	61
Besturing voertuig	0	0
Bemanning volgvoertuigen	3	4
Noodzakelijkheid rijbewijs	1	1
Complexe verkeerssituaties	14	24
Hub-2-hub TP scenario	7	9
Invulling wachttijden voor chauffeur bij hub	3	3
On-the-fly TP scenario	3	5
[1.04.] Verkeersveiligheid	16	31
Inhalen	6	9
Korte volgafstand	10	15
Mens verantwoordelijk voor fouten	7	12
Ongevallen	12	16
Rustig verkeersbeeld	7	9
Vertrouwen	0	0
[1.05.] ADAS	20	23
[1.6.] Omschrijving ADAS	12	20
Voorbeelden ADAS	10	20
[1.7.] Vertrouwen in ADAS	18	53
[1.8.] Mening ADAS	19	39
Comfort	11	18
Beschikbaarheid ADAS-systemen	6	33
Gebruik ADAS systemen	5	23
[1.09.] Gevolgen inhoud beroep	8	11
Gereguleerd werk	1	1
Omgevingsbewustzijn	8	9
Upgrading beroep	7	16
Verandering werkdruk	18	38
Verandering werkzaamheden	20	54

Nodes

Name	Files	References
Verveling	6	9
[1.10] Gevolgen baanzekerheid chauffeurs	9	16
Andere banen	9	12
Chauffeurstekort	14	25
Sociale onrust	5	9
Verdwijnende banen	15	28
[10.1.] Huidig opleidingstraject	18	56
[10.2.] Benodigde aanpassingen opleidingstraject voor TP	19	63
Aparte platooning-opleiding	7	24
[10.3.] Focuspunten examinator	15	49
[10.4.] Nascholingsinterval	20	56
[10.5.] Benodigde aanpassingen Code95	20	84
[2.1.] Versnelling Truck Platooning implementatie	20	50
[3.1.] Vertragingen Truck Platooning implementatie	18	30
[3.2.] Blokkade Truck Platooning implementatie	17	39
[4.1.] Kansen of mogelijkheden voor chauffeur	20	47
[5.1.] Taken of verplichtingen voor chauffeur	16	31
[6.1.] Alternatieve werkzaamheden tijdens platooning	20	82
[7.1.] Vaardigheden huidige chauffeur	8	14
Alert	3	3
Anticiperen	12	19
Beoordeling technische staat voertuig	2	2
Creëren ruimte-kussen	2	2
Duurzaam rijgedrag	6	11
Ladingzekering	3	6
Omgevingsbewustzijn	2	2
Reactievermogen	1	1
Rijervaring	6	6
Secuur	2	2
Sociale vaardigheden	6	18
Stressbestendig	8	11
Verantwoordelijkheidsgevoel	4	9
Verkeersinzicht	10	12

Nodes

Name	Files	References
Voertuigbeheersing	15	24
Zelfvertrouwen	1	1
[7.2.] Vaardigheden platoonende chauffeur	9	13
(Ont-)koppelen platoons	6	6
Anticiperen	2	2
Communicatieve vaardigheden	2	3
Concentratievermogen	3	5
Controle weggeven	1	1
Coördineren bijkomende activiteiten	2	3
Omgang afmetingen platoon	4	4
Omgang platooning-systemen	12	17
Stressbestendig	3	4
Topografische kennis	1	1
Verkeersinzicht	3	5
Vertrouwen in platooning systemen	5	6
[7.3.] Verdwijnende vaardigheden bij platoonende chauffeur	17	42
[8.1.] Kennis huidige chauffeur	4	12
Bedrijfsprocedures	3	12
Geografische kennis	3	4
Goederenkennis	3	4
Ladingzekering	5	10
Praktische kennis vrachtwagen	9	15
Technische kennis vrachtwagen	8	15
Verkeersregels	9	9
Wetgeving	7	13
[8.2.] Kennis platoonende chauffeur	7	14
(Internationale) wetgeving omtrent TP	5	8
Kennis over gewichten	1	1
Kennis over platooning-systemen	16	41
[8.3.] Verdwijnende kennis bij platoonende chauffeur	18	31
[9.1.] Mentaliteit huidige chauffeur	9	12
(Klant)vriendelijk	4	7

Nodes

Name	Files	References
Acceptatie	2	6
Bewustzijn	0	0
Gewichten	1	1
Net rijgedrag	4	5
Plaats op de weg	2	2
Veiligheid	3	3
Flexibiliteit	3	7
Gezonde leefstijl	2	4
Meedenken	3	5
Nauwkeurig	3	3
Open houding	4	6
Professionele houding	9	17
Punctualiteit	1	1
Rustig	10	11
Verantwoordelijkheidsgevoel	9	12
Volgzaam	3	4
Werkplezier	1	1
Zelfstandigheid	2	10
[9.2.] Mentaliteit platoonende chauffeur	11	15
Acceptatie	8	22
Besef verantwoordelijkheid voor platoon	4	6
Discipline	1	1
Gewenning innovatie	4	4
Innovatieve mindset	10	17
Klant-georiënteerd	3	5
Meedenken	2	3
Samenwerkingsgericht	4	9
Sociaal rijgedrag	1	1
Stressbestendig	4	4
Vertrouwen	7	12
[9.3.] Verdwijnende mentaliteit bij platoonende chauffeur	12	17
King-of-the-road	5	7
Ontkoppelen chauffeur en truck	5	9

Nodes

Name	Files	References
Zelfstandigheid	1	1
[9.5.] Typische kenmerken toekomstige chauffeur	15	28
Communicatief vaardig	3	3
Klant-georiënteerd	3	3
Passie	5	8
Professionele houding	6	7
Technologie-gericht	6	7
Verandering in kwalificaties	5	6
Verhoging denkniveau	7	9
Zelfstandig	2	2
Aanpassingen logistieke keten	6	10
Aantrekkingskracht beroep vrachtwagenchauffeur	11	22
Alertheid	12	24
Autonomie chauffeur	7	12
Capaciteit wegennet	5	8
CO2-emissie	6	11
Concurrentie	2	2
Controle chauffeur	8	17
Cyber-criminaliteit	1	1
Doorstroming verkeer	7	11
Duurzaamheid	9	12
Enthousiasmeren	3	11
Filedruk verlichten	4	6
First and last mile delivery	10	18
Flexibiliteit	4	5
Gamification	3	3
Geschiktheid vormen van goederenvervoer	6	9
Gevoelens chauffeur	14	23
Gewenning	12	32
Grensoverschrijdend	7	12
Herkenbaarheid platoon	5	11
Implicaties voor vervoerders	6	7
Brandstofbesparing	17	33

Nodes

Name	Files	References
Trainingskosten	1	1
Veiligheid	4	5
Werktijd volgende chauffeur	8	10
Incentive investeren in platoonende trucks	8	21
Klantcontact	3	3
Learning by doing	3	3
Logistieke keten herinrichten	2	4
Maatschappelijke acceptatie	4	8
Multi-brand platooning	4	6
Nabootsing Truck Platooning	8	8
Niveau's autonoom rijden	4	5
Onrustig	1	4
Ontheffing aanvragen	5	5
Onzekerheid van uitkomsten	8	15
Opstap naar autonome voertuigen	6	10
Overige weggebruikers	16	67
Platooning tests	13	24
Platoons plannen	9	16
Regelvrije zone	1	1
Responstijd	11	25
Rij- en rusttijden	11	15
Rijstroken voor TP	9	15
Samenwerking stakeholder-groepen	7	24
Chauffeurs onderling	4	12
Conceptontwikkeling	5	5
Transportondernemingen	2	6
Truck matching	5	9
Winstverdeling	4	6
Standaardisatie	3	3
Roosters	3	6
Routes	3	5
Systemen	2	2
Systemen ervaren	7	15

Nodes

Name	Files	References
Taakverdeling chauffeur en TP-systemen	17	39
Tegen achterzijde vrachtwagen aankijken	10	15
Training chauffeurs	14	30
Veiligheid	16	38
Vergelijking TP andere innovaties en beroepen	18	55
Vergevorderde techniek	6	15
Data	5	7
See-through functie	3	6
Vergrijzing	3	5
Verminderde luchtweerstand	1	1
Volgafstand	14	33
Voorwaarden voor Truck Platooning	5	8
Inbreng vanuit chauffeurs-populatie	5	7
Infrastructuur	11	23
Ingrijpmogelijkheden	6	13
Verantwoordelijkheid - aansprakelijkheid	9	18
Wetgeving	11	18

8.6. Appendix 6 – Final coding scheme

Nodes

Name	Files	References
[1.01.] Truck Platooning	20	23
[1.2.] Omschrijving TP	16	29
Flexibiliteit	4	5
Hub-2-hub TP scenario	9	13
Nabootsing Truck Platooning	8	8
On-the-fly TP scenario	3	5
Opstap naar autonome voertuigen	9	15
Taakverdeling chauffeur en TP-systemen	17	39
Vergelijking TP andere innovaties en beroepen	18	55
Vergevorderde techniek	6	15
Data	5	7
See-through functie	3	6
[1.3.] Prognose implementatie	20	61
Gevolgen van TP	0	0
Aantrekkingskracht beroep vrachtwagenchauffeur	14	25
Doorstroming verkeer	10	23
Duurzaamheid	12	23
Implicaties voor vervoerders	6	8
Onzekerheid van uitkomsten	8	15
Platoons plannen	9	16
Standaardisatie	3	3
Roosters	5	9
Routes	3	5
Systemen	2	2
Veiligheid	17	42
Volgafstand	14	33
Brandstofbesparing	17	33
Responstijd	11	25
Tegen achterzijde vrachtwagen aankijken	10	15
Verminderde luchtweerstand	1	1
Voorwaarden voor Truck Platooning	5	8
Alertheid	12	24
Geschiktheid vormen van goederenvervoer	6	10
Grensoverschrijdend	7	12
Herkenbaarheid platoon	5	11

Nodes

Name	Files	References
Inbreng vanuit chauffeurs-populatie	5	7
Incentive investeren in platoonende trucks	8	21
Infrastructuur	15	34
Ingrijpmogelijkheden	6	13
Logistieke keten herinrichten	7	14
Maatschappelijke acceptatie	4	8
Multi-brand platooning	4	6
Ontheffing aanvragen	5	5
Platooning tests	13	24
Samenwerking stakeholder-groepen	7	24
Chauffeurs onderling	4	12
Conceptontwikkeling	5	6
Transportondernemingen	4	8
Truck matching	5	9
Winstverdeling	4	6
Verantwoordelijkheid - aansprakelijkheid	9	18
Wetgeving	15	34
[1.04.] Verkeersveiligheid	16	31
Inhalen	6	9
Korte volgafstand	10	15
Rustig verkeersbeeld	7	9
Ongevallen	12	16
Mens verantwoordelijk voor fouten	7	12
[1.05.] ADAS	20	23
[1.6.] Omschrijving ADAS	15	38
[1.7.] Vertrouwen in ADAS	18	55
[1.8.] Mening ADAS	20	55
Beschikbaarheid ADAS-systemen	6	33
Gebruik ADAS systemen	5	23
[1.09.] Gevolgen inhoud beroep	8	11
Verandering werkdruk	18	38
Verandering werkzaamheden	20	57
Upgrading beroep	8	17
Omgevingsbewustzijn	8	9
Gevoelens chauffeur	14	23

Nodes

Name	Files	References
Autonomie chauffeur	7	12
Controle chauffeur	8	17
Gewenning	12	32
Onrustig	1	4
Verveling	6	9
[1.10.] Gevolgen baanzekerheid chauffeurs	9	16
Chauffeurstekort	15	29
Sociale onrust	5	9
Verdwijnende banen	16	31
First and last mile delivery	10	18
[10.1.] Huidig opleidingstraject	18	56
[10.2.] Benodigde aanpassingen opleidingstraject voor TP	15	43
Aparte platooning-opleiding	8	27
Extra aandacht voor ADAS en platooning systemen	9	24
Learning by doing	3	3
Systemen ervaren	7	15
Training chauffeurs	14	30
[10.3.] Focuspunten examinator	15	49
[10.4.] Nascholingsinterval	20	56
[10.5.] Benodigde aanpassingen Code95	20	84
[2.1.] Versnelling Truck Platooning implementatie	20	50
Enthousiasmeren	3	11
[3.1.] Vertragingen Truck Platooning implementatie	18	30
Complexe verkeerssituaties	14	24
Cyber-criminaliteit	1	1
Overige weggebruikers	16	69
[3.2.] Blokkade Truck Platooning implementatie	17	39
[4.1.] Kansen of mogelijkheden voor chauffeur	20	47
[5.1.] Taken of verplichtingen voor chauffeur	16	31
[6.1.] Alternatieve werkzaamheden tijdens platooning	0	0
Rij-en rusttijden	8	11
Bemanning volgvoertuig	3	5
Overige activiteiten	9	17
Geen	10	18
Administratie	10	17

Nodes

Name	Files	References
Communicatie	8	13
Telemarketing	3	4
Persoonlijk entertainment	5	7
Planning	5	6
Transitie van controle	4	11
[7.1.] Vaardigheden huidige chauffeur	1	5
Duurzaam rijgedrag	6	11
Voertuigbeheersing	15	25
Verkeersinzicht	10	12
Beoordeling technische staat voertuig	2	2
Ladingzekering	3	7
Alert	4	4
Rijervaring	7	8
Stressbestendig	8	11
Anticiperen	13	21
Secuur	2	2
Sociale vaardigheden	7	19
Omgevingsbewustzijn	2	2
Zelfvertrouwen	1	1
[7.2.] Vaardigheden platoonende chauffeur	6	9
Anticiperen	4	6
Communicatieve vaardigheden	3	4
Concentratievermogen	3	5
Coördineren bijkomende activiteiten	2	3
Omgang platooning-systemen	14	23
Stressbestendig	3	4
Verkeersinzicht	3	5
[7.3.] Verdwijnende vaardigheden bij platoonende chauffeur	17	42
[8.1.] Kennis huidige chauffeur	2	3
Verkeersregels	10	10
Wetgeving	9	15
Technische kennis vrachtwagen	8	16
Praktische kennis vrachtwagen	9	15
Ladingzekering	6	11
Bedrijfsprocedures	3	12

Nodes

Name	Files	References
Goederenkennis	4	8
Geografische kennis	4	6
[8.2.] Kennis platoonende chauffeur	5	6
(Internationale) wetgeving omtrent TP	6	11
Kennis over platooning-systemen	17	50
[8.3.] Verdwijnende kennis bij platoonende chauffeur	18	31
[9.1.] Mentaliteit huidige chauffeur	7	10
Bewustzijn	6	10
Verantwoordelijkheidsgevoel	10	21
(Klant)vriendelijk	5	8
Rustig	10	12
Professionele houding	11	19
Flexibiliteit	3	7
Volgzaam	3	4
Nauwkeurig	4	4
Zelfstandigheid	2	10
Meedenken	4	6
Gezonde leefstijl	2	4
Open houding	6	14
Werkplezier	6	6
[9.2.] Mentaliteit platoonende chauffeur	11	17
Besef verantwoordelijkheid voor platoon	4	6
Innovatieve mindset	13	40
Gamification	3	3
Klant-georiënteerd	4	6
Samenwerkingsgericht	4	9
Stressbestendig	4	4
Vertrouwen	12	20
[9.3.] Verdwijnende mentaliteit bij platoonende chauffeur	11	13
Avontuurlijkheid	7	12
Ontkoppelen chauffeur en truck	5	9
[9.5.] Typische kenmerken toekomstige chauffeur	15	28
Communicatief vaardig	3	3
Klant-georiënteerd	3	3

Nodes

Name	Files	References
Passie	5	8
Professionele houding	6	7
Technologie-gericht	6	7
Verandering in kwalificaties	5	6
Verhoging denkniveau	7	9
Zelfstandig	2	2

8.7. Appendix 7 – Reconstruction of the coding scheme

This appendix explains how the initial coding scheme (see Appendix 5 – Initial coding scheme) was transformed into the final coding scheme that was used in the analysis (see Appendix 6 – Final coding scheme).

The labels '*Bemanning voertuigen*' (staffing of following vehicles) and '*Werktijd volgende chauffeur*' (working times following truck driver) both focus on the role of the truck driver in the following truck, just as the label corresponding with question 6.1., '*[6.1.] Alternatieve werkzaamheden tijdens platooning]*' (Alternative activities during platooning). Therefore, it was decided to merge these former labels with the label about alternative activities that truck drivers can perform while platooning as a follower.

In the code '*Noodzakelijk rijbewijs*' (necessity of driving license) a respondent (i.e. only 1 reference fell within this label) voiced the doubt whether a future truck driver will need a driving license or not. This coincides with '*[10.2.] Benodigde aanpassingen opleidingtraject voor Truck Platooning*' (required adaptations in the educational program for Truck Platooning) and was therefore merged with label 10.2. This results in the fact that '*Besturing voertuig*' (handling vehicle) is completely empty and thus can be deleted as a label.

Within the label '*Complexe verkeerssituaties*' (complex traffic situations) almost all answers indicated that the complex traffic situations mentioned could pose issues for, and therefore potentially slow down, the implementation process of Truck Platooning. Therefore, this label was placed as a sub-label for '*[3.1.] Vertraging Truck Platooning implementatie*' (delay Truck Platooning implementation). Furthermore, the label '*Overige weggebruikers*' (other road users) contains fragments indicating that other road users complicate the implementation process of Truck Platooning. Therefore, this label is also made a sub-label for the delaying factors label (i.e. [3.1.].

'*Invulling wachttijden voor chauffeur bij hub*' (activities for a truck driver to do while waiting at a hub) is an example of an issue surrounding the hub-to-hub platooning scenario, therefore this label was merged with '*hub-2-hub TP scenario*'. Furthermore, the labels '*hub-2-hub TP scenario*' and '*on-the-fly TP scenario*' are specific Truck Platooning scenario's and were therefore placed as sub-labels underneath '*[1.2.] Omschrijving TP*' (description TP). Further, the references in the label '*flexibiliteit*' (flexibility) all describe the wish for flexibility in conjunction with Truck Platooning. Therefore, this label was placed under the description label as well. Other things that were mentioned quite often when talking about the Truck Platooning concept are the mimicking of Truck Platooning by the use of contemporary assistant systems (i.e. '*Nabootsing Truck Platooning*'), the division of tasks between the truck driver and the Truck Platooning systems (i.e. '*Taakverdeling chauffeur en TP-systemen*'), the parallels with other occupations and other innovative concepts (i.e. '*Vergelijking TP andere innovaties en beroepen*') and advanced techniques related to Truck Platooning (i.e. '*Vergevorderde techniek*'). These labels were therefore also placed under the Truck Platooning description label. The levels of autonomous driving (i.e. '*Niveau's autonoom rijden*') were merged with the label in which the respondents state that Truck Platooning can be considered like a stepping stone towards fully autonomous driving (i.e. '*Opstap naar*

autonome voertuigen') due to the fact that these labels are strongly related. Consequently, '*Opstap naar autonome voertuigen*' was put under the Truck Platooning description label as well.

The label '*Vertrouwen*' (trust) had no references (i.e. a similar label can be found elsewhere in the coding scheme) and was therefore deleted. Also, all 3 references within '*Klantcontact*' (contact with clients) could be relocated within other labels, resulting in the ability to delete it.

Because most of the respondents answered the question to describe what they think that ADAS are (i.e. Question 1.6.) by providing some examples, the choice was made to merge '*Voorbeelden ADAS*' (examples ADAS) with '*Omschrijving ADAS*' (description ADAS).

Since '*Comfort*' is one of the argument expressed by the respondents on why they have a certain opinion about ADAS, this label is merged with '*[1.8.] Mening ADAS*' (opinion about ADAS).

'*Gereguleerd werk*' (regulated work) has only 1 reference about the future truck driver's wish to work at regulated times. This complies with the standardization of the working schedules. Therefore, this label is merged with '*Roosters*' (schedules), a sub-label of '*Standaardisatie*' (standardization).

The fragments that were placed in the label '*Andere banen*' (other jobs) have been replaced into either '*Verandering werkzaamheden*' (change in activities), '*Verdwijnende banen*' (disappearing jobs) or into '*Upgrading beroep*' (upgrading of the occupation). These fragments suited these labels better, since it is either the case that one loses his/her job or that the job will change due to Truck Platooning. If this change is seen as a positive thing, then one could call it an upgrading of the occupation. '*Andere banen*' has been deleted when all fragments were rearranged.

Label '*[6.1.] Alternatieve werkzaamheden tijdens platooning*' (Alternative activities during platooning) initially contained 94 references. This was an indication that it in this case might be smart to create sub-labels. Labels have been created for the staffing of the following vehicles (i.e. '*Bemanning volgvoertuigen*'), issues surrounding the driving and resting times (i.e. '*Rij- en rusttijden*'), issues surrounding the take over time (i.e. '*Transitie van controle*') and for every activity one could do while platooning that was mentioned frequently (i.e. at least 5 times). These activities are doing administrative activities (i.e. '*Administratie*'), communicating (i.e. '*Communicatie*'), planning tasks and personal entertainment (i.e. '*Persoonlijk entertainment*'). Within the communication label, a sub-label '*Telemarketing*' has been made to enable distinguishing between communication with clients with a direct commercial aim and communication without this aim. Further, a label containing all potential activities that were mentioned less than 5 times are placed within the new label '*Overige activiteiten*' (other activities). Finally, a category had to be created for the fragments indicating that no alternative tasks can be done (i.e. '*Geen*').

Within label '*[7.1.] Vaardigheden huidige chauffeur*' (skills current truck driver), '*Reactievermogen*' (ability to react) is merged with '*alert*' (alertness), since these labels

basically mean the same thing. '*Creëren ruimte-kussen*' (creating space around the truck) is merged with '*Anticiperen*' (to anticipate), because maintaining a safe distance from other road users is a specific type of anticipating.

There are duplicate labels between label [7.1.] and '*[7.2.] Vaardigheden platoonende chauffeur*' (skills platooning truck driver), namely '*Anticiperen*' (to anticipate) and '*Verkeersinzicht*' (traffic insight). Because the fragments placed in these labels underneath [7.2.] indicate that respondents replied that a platooning driver should possess these skills even more than a current truck driver, here is chosen to keep those labels separate in order to preserve clarity. '*Verantwoordelijkheidsgevoel*' (sense of responsibility) was also a duplicate label within labels [7.1.] and [9.1.]. In this case, however, it was reasoned that the sense of responsibility is more an attitude than a skill. Therefore, these labels have been merged and became a sub-label of '*[9.1.] Mentaliteit huidige chauffeur*' (mentality current truck driver). Furthermore, '*Controle weggeven*' (to give away control) basically says that one should have trust in the platooning systems, just like '*Vertrouwen in platooning systemen*' (trust in platooning systems), which was initially placed under the required skills for platooning truck drivers label. '*Controle weggeven*' and '*Vertrouwen in platooning systemen*' both were merged with '*Vertrouwen*' (trust), a sub-label of '*[9.2.] Mentaliteit platoonende chauffeur*' (the required mindsets for future platoon truck drivers). Also, '*Omgang afmetingen platoon*' (to handle platoon dimensions) was merged with the label about anticipating, because the respondents meant that the truck driver should anticipate on the increased length and weight of the platoon. Finally, '*(Ont)koppelen platoons*' (attaching and detaching platoons) was merged with '*Omgang platooning-systemen*' (to handle platooning systems), since attaching and detaching are examples of actions coming forth out of the handling of the platooning systems.

'*Kennis over gewichten*' (knowledge about weights) was merged with '*[8.2.] Kennis platoonende chauffeur*' (knowledge platooning truck driver), because knowledge about weight was mentioned only once and this latter label functions as a collection label for all answer fragments that could not be placed within '*(Internationale) wetgeving omtrent TP*' ((international) legislation surrounding TP) or '*Kennis over platooning systemen*' (knowledge about platooning systems). Further, '*Topografische kennis*' (topographical knowledge) was incorrectly placed as a sub-label of '*[7.2.] Vaardigheden platoonende chauffeur*' (skills platooning truck driver). Because this is clearly a fragment referring to knowledge, but since it only contained one reference, it was merged with '*[8.2.] Kennis platoonende chauffeur*' (knowledge platooning truck driver) instead of making it a sub-label.

All sub-labels of '*Bewustzijn*' (consciousness) were placed within consciousness, since they all consisted out of only several references and this limits the number of branches within the coding tree, while the label still is easy to evaluate.

Within the section of mindsets of current truck drivers, the label '*Punctualiteit*' (punctuality) was merged with '*Nauwkeurig*' (precisely), because punctuality is a time-focused way of being precise. '*Acceptatie*' (acceptance) was merged with '*Open houding*' (open attitude), because accepting novelties is a specific way of displaying an open attitude.

Three merges and one addition were made within the label about the required mindsets for future platoon truck drivers (i.e. '*[9.2.] Mentaliteit platoonende chauffeur*'). Firstly, '*Gewenning innovatie*' (getting used to innovations) is merged with '*Innovatieve mindset*' (innovative mindset), as getting used to innovations can only be realized when one has an open mindset toward innovations. Secondly, just as in the former section about current truck driver mentalities, '*Acceptatie*' (acceptance) was merged with the label about the open mindset towards innovations. '*Discipline*' and '*Sociaal rijgedrag*' (social driving behavior) are merged with the container label for the future platoon truck driver mentalities because they both contained only one reference. '*Gamification*' is mentioned by several respondents as a way to keep the job of a truck driver interesting. If somebody has a competitive mentality, he or she is deemed to be more suitable as a future truck driver involved in Truck Platooning activities. To enjoy playing this real life 'game', one needs an innovative mindset. Therefore, '*Gamification*' was replaced to become a sub-label of '*Innovatieve mindset*' (innovative mindset), which was already situated under the required mentalities for future truck drivers (i.e. label [9.2.]).

'*Meedenken*' (thinking along with others) is deleted, since the fragments could be placed within '*Klant-georiënteerd*' (client-oriented) and '*Overige weggebruikers*' (other road users).

The name of the label '*King-of-the-road*' is changed into '*Avontuurlijkheid*' (adventurousness), because that better explains what the label entails. Further, '*Zelfstandigheid*' (independence) is merged with '*[9.3.] Verdwijnende mentaliteit bij platoonende chauffeur*' (disappearing mindsets within platooning truck drivers) due to the fact that the independence label only contained one reference.

With regard to the adaptations that should be made to the educational program for truck drivers that will have to platoon in the future, a new sub-label ('*Extra aandacht voor ADAS en platooning systemen*' (extra attention for ADAS and platooning systems) was created in order create categories within the 63 references within label '*[10.2.] Benodigde aanpassingen opleidingstraject voor TP*' (required adaptations for the educational program for TP). Eventually label [10.2.] still contains 43 fragments and the newly created label accommodates 24 fragments. '*Learning by doing*', experiencing the platooning systems (i.e. '*Systemen ervaren*') and the training of the truck drivers (i.e. '*Training chauffeurs*') are related to the changes that respondents have suggested for a truck driver's educational program. Therefore, these labels are also made sub-labels of [10.2.].

In the following section, the labels initially created but not directly coupled with an interview question are reviewed. Special attention was paid to whether it was possible or not to include labels into a label corresponding to an interview question. In case that this seemed not logical, it was considered whether it made sense to create new category labels to accommodate several labels in order to enhance the structure of the coding scheme.

First of all, a new category label has been created to accommodate all the consequences of Truck Platooning (i.e. '*Gevolgen van Truck Platooning*'). '*Capaciteit wegennet*' (capacity road network) and '*Filedruk verlichten*' (diminishing traffic jams) were merged with '*Doorstroming verkeer*' (traffic flow) because the former labels indicate outcomes of an improved traffic

flow. The traffic flow label is placed as a sub-label of this new category label, just like '*Duurzaamheid*' (sustainability) after '*CO2-emissie*' (CO2 emission) was included within the sustainability label due to the similarity of the concepts. '*Veiligheid*' (safety) is a duplicated label, so those labels are combined and consequently inserted as a sub-label of the category label indicating the consequences of Truck Platooning. '*Volgafstand*' (following distance) is placed as a sub-label of the consequences of Truck Platooning because shorter following distances are one of the main advantages of Truck Platooning. This is an advantage because the air resistance will be lowered and fuel will be saved. Therefore, the labels '*Brandstofbesparing*' (fuel savings) and '*Verminderde luchtweerstand*' (lowered air resistance) were moved to become sub-labels of the following distance label. Another consequence of the short following distance in platooning is that the truck driver can only see the backside of the preceding truck, so '*Tegen achterzijde vrachtwagen aankijken*' (to look at the backside of the preceding truck) is included as a sub-label of the following distance label as well. '*Responstijd*' (response time) is directly related to the following distance and therefore also became a sub-label of the following distance label. Other consequences that Truck Platooning is likely to have are '*Aantrekkingskracht beroep vrachtwagenchauffeur*' (attractiveness occupation of truck driver), '*Onzekerheid van uitkomsten*' (uncertainty of outcomes) and '*Platoons plannen*' (planning platoons). '*Trainingskosten*' (costs of training) has only one reference and thus is merged with '*Implicaties voor vervoerders*' (implications for shippers), which is consequently moved to become a sub-label of the label about the consequences of Truck Platooning. Another consequence of Truck Platooning is that certain logistical phenomena will be standardized, resulting in the decision to move '*Standaardisatie*' (standardization) and its sub-labels to the consequences of Truck Platooning label as well.

Besides a category label for the consequences of Truck Platooning, a category label for its prerequisites was already present in the initial coding scheme (i.e. '*Voorwaarden voor Truck Platooning*' (prerequisites for Truck Platooning)). There are, however, still some labels that can be included in this category label. Firstly, '*Alertheid*' (alertness) has been moved into the prerequisites label because all fragments within this label imply or specifically mention that the truck driver should stay alert at all times, even when platooning. Therefore, it is seen as a prerequisite for Truck Platooning. Secondly, '*Aanpassingen logistieke keten*' (adaptations to the logistics chain) and '*Logistieke keten herinrichten*' (redesigning the logistics chain) are merged before including it as a prerequisite for Truck Platooning, because these labels mean the same. Thirdly, '*Platooning tests*' are required in order to be able to safely introduce Truck Platooning and this label is thus also added as a prerequisite. Further, many respondents indicated that it must be possible to platoon cross-border and with multiple truck brands in order to be a success. Therefore, '*Grensoverschrijdend*' (border-crossing) and '*Multi-brand platooning*' are also moved into the prerequisites category label. Other issues that are necessary in order to commercially introduce Truck Platooning are that the goods that are being transported are eligible for Truck Platooning (i.e. '*Geschiktheid vormen van goederenvervoer*'), that other road users recognize platoons (i.e. '*Herkenbaarheid platoons*'), that shippers are willing to invest in trucks that are capable of platooning (i.e. '*Incentive investeren in platoonende trucks*'), that it is broadly accepted by society (i.e. '*Maatschappelijke acceptatie*'), that the right exemptions are requested in time (i.e.

‘*Ontheffing aanvragen*’) and that several stakeholder groups cooperate with each other (i.e. ‘*Samenwerking stakeholder-groepen*’). All these labels were therefore placed under the prerequisites label. ‘*Regelvrije zone*’ (rule-free zone) contained only a single reference that expressed the idea of alleviating legislation in certain zones. ‘*Rij- en rusttijden*’ (driving and resting times) are also a specific form of legislation. Therefore, these labels were both merged with ‘*Wetgeving*’ (legislation), which is a sub-label of the prerequisites of Truck Platooning label. The specific idea, voiced by several respondents, to create separate Truck Platooning lanes, is a concrete specification of possibly required infrastructure for Truck Platooning. Therefore, ‘*Rijstroken voor TP*’ (lanes for TP) is merged with ‘*Infrastructuur*’ (infrastructure), which was already a sub-label of Truck Platooning’s prerequisites.

The label ‘*Gevoelens chauffeur*’ (feelings of the truck driver) has been made another container (i.e. category) label, since multiple other labels have been identified as being specific types of feelings that respondents think truck drivers will experience. These labels are ‘*Autonomie chauffeur*’ (autonomy of truck driver), ‘*Controle chauffeur*’ (control of truck driver), ‘*Gewenning*’ (habituation) and ‘*Onrustig*’ (restless) and these labels were placed as sub-labels of ‘*Gevoelens chauffeur*’. Consequently, the feelings label is moved to become a sub-label of ‘*[1.09.] Gevolgen inhoud beroep*’ (consequences for a truck driver’s job), since these feelings are about the expected changes in the truck driver’s job. Since boredom is a feeling too, this label (i.e. ‘V*erveling*’) became a sub-label of the feelings label as well.

The label about competition between transporters (i.e. ‘*Concurrentie*’) was merged with ‘*Transportondernemingen*’ (transporting organizations), a sub-label of ‘*Samenwerking stakeholder-groepen*’ (cooperation between stakeholder groups), because respondents voiced their doubts about cooperation between transporters.

Since the only reference of ‘*Cyber-criminaliteit*’ (cybercrime) strongly emphasized that cyber-attacks would drastically slow down the Truck Platooning implementation process, it was decided to attach this label as a sub-label to ‘*[3.1.] Vertraging Truck Platooning implementatie*’ (delay Truck Platooning implementation). The reason that it was not merged is that the researcher does not want to overlook this important reference, even though it was mentioned only once.

‘*Enthousiasmeren*’ (to create enthusiasm) was replaced and became a sub-label of ‘*[2.1.] Versnelling Truck Platooning implementatie*’ (speeding up Truck Platooning implementation) since respondents who mentioned enthusiasm mainly indicated that forging enthusiasm can strongly speed up the implementation process.

As all references with the label ‘*First and last mile delivery*’ indicate that truck drivers will not lose their jobs in the upcoming years due to the fact that it is extremely complex to automate the first and last mile delivery of a shipment. Therefore, this label was replaced into ‘*[1.10.] Gevolgen baanzekerheid chauffeurs*’ (consequences job security truck drivers).

The label about the aging of the current group truck drivers (i.e. ‘*Vergrijzing*’) strongly related to the shortage of truck drivers (i.e. ‘*Chauffeurstekort*’), a sub-label of label [1.10.], so they were merged.

Finally, to improve the coding scheme's structure, both the labels concerning the prerequisites and the consequences of Truck Platooning were attached as sub-labels of '*[1.01.] Truck Platooning*' so that all general info directly related to Truck Platooning is centralized. Even though this resulted in a four-tier coding structure, which was discouraged by Blumberg et al. (2014), the researcher decided that a logical structure is more important than the disadvantages of a high-level tier coding structure.

All labels that were not attached to an interview question are renamed, replaced or deleted after completion of the steps above. This has led to the final coding scheme (see Appendix 6 – Final coding scheme) that was used to derive results in the analysis phase (i.e. in Paragraph 5.4.).