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Qualitative data collection to identify truck drivers' attitudes toward a transition to platooning systems

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ABSTRACT

The platooning technology allows for two or more trucks running in convoy at a pre-defined distance between each other, being virtually connected using connectivity technology and automated driving support systems. It is recognized that truck platooning systems bring economical and environmental advantages. Thus, it is time for a transition from the existing truck freight activity towards truck platooning systems. This requires an important improvement in terms of in-vehicle technology, together with infrastructure improvement and truck drivers' acquisition of new technology-related skills.

A holistic approach is previewed to identify both the requirements for the development of truck platooning services and the requests for their safe deployment in the real world. Then, qualitative data were collected from truck drivers working for two different Portuguese freight companies using Focus Groups (FG). Thus, three FG sessions were organized and carried out with a total of 22 truck drivers.

Considering that age and experience on the job are important factors to take into consideration for technological changes on the job, their potential impact on truck drivers' activity was addressed on the focus group discussions. Anyway, the potential users' attitudes regarding any innovation on the job were addressed as a prevention of further negative attitudes or misuse.

Having safety in mind as a permanent attitude toward on job innovation is actually the most important factor toward success.

1. Introduction

The technological development in the automotive industry is shaping the future of transport services to meet mobility needs and the provision of the required goods in due time when and where they are needed. Thus, innovative solutions for decarbonization and economic improvement are being put into practice imposing to truck drivers' behavioural adaptation and new training needs (Gouy et al., 2014).

The freight transport sector is requiring new solutions to overcome both the increase of energy consumption costs and the environmental concerns about CO2 emissions (Bergenhem et al., 2012). However, new solutions, like automation and truck platooning, have created some personal uncertainty among truck drivers resulting from their fear of a decrease in truck drivers' employment due to their replacement by automated devices (Castritius et al., 2020a). Considering that the freight industry has a great economic importance, not only in Portugal but in most European countries, new solutions supported by the technological development should be studied targeting their application onto the goods transport. This requires applied research targeting the best solution towards efficiency, safety and sustainable transport, together with well-trained drivers, who should be prepared to deal with the new technology and the related changes compared to driving alone a classic truck for long hours facing several risks. Such changes impose behavioural adaptation, which require time and specific training.

Thus, truck platooning systems represent the right choice for the nowadays freight industry. This requires some research starting from a state of the art including past and running studies and their new testing experiences in different countries.

It is also considered that truck platooning systems represent the right choice for the Portuguese freight industry despite the recent lack of

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candidates applying to a truck driver position. The reason for this should be investigated requiring group discussions to explain

the two main positive effects of the introduction of the platooning technology in the freight transport: 1. the clear improvement of the previous truck drivers' working conditions, represented by long hours on the road (mostly alone) and the related passive fatigue leading to drowsiness and sleep risk, usually increased by sleep debt resulting from such working schedules (Matthews et al., 2012); 2. the fact of being assisted by the technology and being a team on the job cooperating in every task on board toward the main task completion.

Being identified the needs to improve the freight industry and, particularly, the working conditions of truck drivers, the following needs were identified: 1. to know the state of the art of platooning systems, and 2. to talk to truck drivers operating in international transport in order to collect their feelings, opinions, and mental representations of truck platooning, defined in the American Psychological Association (APA), Dictionary of Psychology (2023) as "a hypothetical entity that is presumed to stand for a perception, thought, memory, or the like during cognitive operations". These data collection is important to the transition process to truck platooning. Thus, the next section presents a literature review centred on platooning systems and their operational conditions, followed by detailed information about platooning, the related technology, the requests for improved infrastructures, and the human factors issues related to drive a platoon and the identified risks.

2. Truck platooning systems

The platooning technology allows for two or more trucks running in convoy, like a "short train", being virtually connected by means of connectivity technology and automated driving support systems, following at a pre-defined distance between each other (PPMC, 2021). The first truck is defined as the "leader", having the responsibility for the driving task with the Adaptative Cruise Control (ACC) support and the system monitoring (Willemsen et al., 2022). The second truck and following ones are defined as the "followers", reacting, and adapting their speed and position in the lane without (or with very little) human action (Janssen et al., 2015).

Trucks in platoon can move safely within short distances, since the reaction time of automated systems is much lower than that required from human drivers (Reis et al., 2020). Such vehicles maintain the short gaps using automated driving technology, radar-based collision avoidance system, and connectivity technology with wireless vehicle-to-vehicle communication (V2V) (Janssen et al., 2015; Willemsen et al., 2022). For highly-automated trucks (ERTRAC, 2019), the gap between vehicles can be as low as 0.2 s, which at 80 km/h represents a distance around 7 m. However, for lower automation levels, a distance between 15 and 30 m is recommended for safety concerns (Kuhn et al., 2017; Zhang et al., 2020).

Despite the technology support of platooning systems, most trucks are still moved by thermal engines. Thus, according to the EC funded ENSEMBLE Project research team, (Willemsen et al., 2022), the commonly accepted automation levels of the SAE J3016 are not recommended to be applied to platooning systems. Thus, two new categorizations for the technology support to platooning systems were proposed (Vissers, J., et al., (2018):

1. Platooning Support Function (PSF), which is a longitudinal control function, but lateral driver assistance systems, such as lane centring, might be optionally available as well. The driver is responsible for the driving task, meaning that (s)he is also responsible to choose a safe following distance and monitor the system. To give the driver enough time to react, a minimum time gaps around 1.5 s should be respected.
2. Platooning Autonomous Function (PAF) allowing the leading driver to be responsible for the driving task, being the following trucks fully automated, which means that the system performs the complete driving task within the specified operational design domain, being the driver out-of-the-loop. These conditions required time gaps reduced to 0.5 s depending on the system response time and accuracy of the brake force estimation.

For this categorization, the time or distance between vehicles, lateral automation, speed lane, and the required operational areas must be considered. This requires some research to avoid compromising road safety by the introduction of new risks, together with specific and intensive training for both categories of drivers: the leaders and the followers.

Due to the automation of longitudinal control through Adaptative Cruise Control (ACC) and supported by V2V communication, these vehicles have the capacity to follow so close from each other allowing the increase of road capacity, improving both the traffic flow (Gouy et al., 2014), and the delivery schedule. Traveling at short distance between the platoon vehicles contributes to reduce the air drag, which improves the aerodynamics decreasing the energy consumption with savings estimated in the order of 5–15 %. Furthermore, this improves the environment quality, even with fuel powered trucks, by a reduction of CO2 emissions up to 10 % for (ACEA, 2017; ERTRAC, 2019; Kuhn et al., 2017; PPMC, 2021; Zhang et al., 2020).

A higher time headway (THW) between vehicles, increases the likelihood of cut-ins from other vehicles, which create new risks. This situation has a significant impact on platooning behaviour, and the longer it takes, the greater its influence on traffic flow and energy consumption, as it will force trucks to accelerate more after the cut-out (Jallais et al., 2020). A set of automated functions are integrated on the platooning technology improving safety, and reducing the risks of human errors. According to the statistics presented by the European Parliament (2021), human behaviour is responsible by 95 % of accidents. Also, the use of this technology, can lead drivers to a less exposure to passive fatigue (Matthews et al., 2012) and consequent drowsiness (Hjälmdahl et al., 2017) with the related risks of falling asleep at the wheel.

The fact that truck platooning systems share the road with different types of vehicles, each one from different technology-related generations, together with the diversity of users, increase the complexity and uncertainty of the entire road transport system having an important impact on road users' safety. This requires more information about truck platooning systems in actual service circulating on roads.

"*Since the driver is not alone on the road, social processes can be expected to influence the driver's behavioural adaptation*" (Gouy et al., 2014, p. 265). However, it should be highlighted that the adoption of truck platooning imposes special training for truck drivers, being experienced or not.

As innovative system, truck platooning experiments have been carried out in Germany with results published by Castritius et al., (2020b). The authors provided results from platooning tests on roads reported by the truck drivers in individual interviews and questionnaires, before and after carrying out the experiments. When compared Germany and California public acceptance of partially automated truck platooning, the results are similar highlighting the technology reliability. In terms of main concerns, they agree on reliability issues of the technology, with expressed difficulties when ingress to or egress from the motorway, together with issues related to cut-in vehicles(Castritius et al., 2020b).

In the United States, Yang et al. (2018) developed an experiment centred on the preferred distances between trucks on-the-road experience using Cooperative Adaptive Cruise Control (CACC). Following post-experimental analysis, two groups have been identified: the conservative one - spent 30 % at the shortest time between vehicles, and the aggressive one - spent 60 % at the shortest time (Yang et al., 2018). At this stage approaching a transition from the existing freight industry towards truck platooning systems, there is much to learn from running research and related experiments allowing for a responsible related

dissemination.

Based on the results of the above-referred experiments, our research questions were defined:

1. How far the users' interactions with the existing in-vehicle technology have any influence on their a priori acceptance of platooning systems?
2. How far their mental representations of truck platooning systems are reflected on their level of a priori acceptance and the development of an attitude in favour of their willingness of use?
3. In case of a transition toward truck platooning systems, how far their mental representations will favour a behavioural adaptation?

3. Methods

As a first stage to collect data from truck drivers serving in European freight transport, it was decided to set up Focus Groups sessions according to the procedures defined in Krueger & Casey (2009). Following the exploratory sequence model (Jensen, 2002, p. 272), the FG were administered targeting the collection of qualitative data to identify the main variables for the development of a questionnaire to be applied to an extensive group of Portuguese truck drivers. These methods will address the following issues: (i) their level of knowledge about platooning technology; (ii) their perception of its usefulness; (iii) their perception of the degree of easy use, and (iv) their interest and intention to use it. The involvement of key players on the transport sector will be required to foster dissemination and increase the sample of participants together with its representativity.

Thus, three groups of truck drivers were selected for Focus Groups sessions (FG) aiming at collecting qualitative data influencing their a priori acceptance of platooning systems, together with the development of practice on technology use, and their willingness to use it among Portuguese freight companies and their truck drivers.

3.1. Focus Groups

Focus Groups (FG) are a special type of group discussion aiming at better understanding how people feel or think about an issue, product, or service (Krueger & Casey, 2009). The sessions' structure and contents were based on some previous experience of the research team on ADAS evaluation (Bianchi Piccinini et al., 2012, 2015), being updated through the literature review. Each group was composed of 6–8 participants, to allow for discussions under the coordination of a session moderator. Discussions were conducted within each interactive group allowing for free expression of their perceptions, opinions, beliefs, and attitudes towards truck platooning as the future of their activity as truck drivers. The issues about the nowadays safety-related concerns about truck platooning, such as, the load, the time gap between vehicles, and road infrastructure, were discussed. Following this method, it was also intended to understand the sample's main communication needs while performing their main job-related activities.

3.2. Procedure

The sessions took place on the December 12, 2022, January 6, and January 25, 2023, in a meeting room of companies' premises. With a duration of 1 h30 minutes each, one of them was carried out in the morning (10:30 am − 12:00 pm) and the two others in the afternoon (2:30 pm − 4:00 pm). On each FG session, one moderator was directing the session and two assistants were present to collect relevant or more detailed information completing the required transcriptions. The moderators were assigned to make a short description of the project and clarify any doubts that participants may have regarding the study. After agreeing to participate in the FG session, each selected participant had to fill and sign a Consent Form, which is composed of the following items: information about the session main topic, duration, confidentiality of the collected information, use of the collected data just for the research purpose, possibility of excusing and leave if wanted, confirmation the understanding of the information, and totally voluntary participation. To help on data analysis, the sessions were recorded in video and audio format.

Each session was based on a discussion guide (annex 1), containing the sequence of questions that were prepared to be launched, previously approved by the Ethics Committee of the Faculty of Psychology and Science Education from the Porto University. During the sessions, a short video about truck platooning (available at: https://www.youtube.com/watch?v = X7vziDnNXEY&t = 4 s), was also presented for a better understanding of the targeted system, followed by the questions raising their thoughts about the technology and its effect on their job. It has been noticed that drivers without any experience with the platooning technology base their opinion on what they hear, considering this technological development as a threat to their jobs. Being a common fear that contributes to their resistance to the introduction of this new technology, the adopted methodology focused on the need to obtain as much information as possible on the main feelings, opinions, and attitudes of drivers about the platooning system. Thus, an investigation with a mixed triangulation methodology was considered relevant, to achieve several perspectives on the same subject, minimizing the limitations of qualitative and quantitative methods (Jensen, 2002, p. 272).

3.3. Participants

To conduct the FG sessions and achieve the defined objectives, one of the major concerns was to define the participants' characteristics required for their selection to participate on the FG sessions. The main criterion for recruiting participants is that they work as truck drivers holding a valid license, having some experience with driving assistance systems and work at a large long-distance transport company. The professional truck drivers participated voluntarily and had no prior experience with truck platooning systems. There was no monetary reward for participation.

A total of 22 truck drivers participated on the three sessions. The sample is 100 % male truck drivers aged 44–62 (mean 53.9 ± 4.9). 100 % of the selected drivers operate on long haul transport (more than 150 km per day). However, only one driver (4.5 %) operates nationally while the rest (95.5 %) operate internationally. On average, there driving license last for 30.3 years (±7.4) and they are still operating as truck drivers for the company for 24.2 years (±5.3).

Table 1 summarizes the total sample that has participated in the FG sessions, which have been carried out in two companies from the north region of Portugal.

3.4. Analysis of the collected data

The registered sessions were transcribed onto a Word document allowing for a systematic analysis of each session contents. Then, age and experience on the job were aligned as independent variables allowing for the participants' expression of their opinions regarding potential or actual impacts on their activity and related safety. The citations are presented on section 4 according to their relevance, identifying the participants ID and each one's assigned group.

Table 1
The sample for the FG sessions.

		Automated Vehicles Age Group	
Total		44–53	54–63
Company A	15	6	9
Company B	7	2	5
Total	22	8	14

4. Results

Considering that none of these drivers had experience using this technology, the questions were directed towards their experience in driving conventional vehicles, although most already with some in-vehicle technologies with a certain level of automation. The discussion centred on two distinct points: 1) knowing their opinions and attitudes regarding the automation of heavy vehicles and the platooning system; 2) understand the notions of the limits of technology and its impact on security.

4.1. Working conditions

Qualitative data shows that truck drivers feel unmotivated by their professional life and recognize a set of factors that contribute to the lack of interest of young people for this profession. When questioned about these factors, the participants (n = 10) mention the lack of career progression, poor pay, time away from the family, and the poor image of this professional category. As it can be seen on Table 2, participants consider that the increasing new in-vehicle technologies will require new skilled future truck drivers.

Regarding the in-vehicle technologies (Table 3), 9 participants do not have ACC, one of the main important technologies for platooning systems. These truck drivers work for the same company. In what concerns the use of driving assistance technology, 17 participants claimed to disconnect some of these devices for personal safety reasons, since the braking system is so strong that it locks the vehicle, having a great impact on the loads they carry, often considered by them as dangerous (iron and coils). *"Even being so much tight as the load is, the way the vehicle breaks could dislocate the load so that it can go over the driver's cockpit and hurting the driver"* (driver 3, group 2).

4.2. Truck Drivers' mental representations

In response to the question of whether truck drivers had ever heard about automated vehicles in freight industry (Table 4), participants highlighted the needs for specific conditions, such as roads, lanes and/or guiding lines, with markers and sensors connecting to GPS.

It should be highlighted that three participants expressed their mental representations about truck platooning as following: *"What I think is that at least the front truck has to be driven by a driver and two or three or four go next. This means that everything I do, others do. I think it's more or less that"* (driver 3, group 3). However, for some participants these vehicles will follow without a driver (n = 2) and can be controlled remotely (n = 2). Thus, some participants (n = 4) expressed some fear of losing their jobs as a result from automation. However, this fear was not expressed by the majority, as they recognized the lack of professional truck drivers in Portugal and the impossibility of automating some tasks (n = 7), aggravated by the lack of conditions in many customers. *"It will probably be a profession out of a risk of unemployment due to the increasing lack of professional drivers interested on that profession* (driver 7, group 3). Once the automated vehicles in freight industry represent an "*evolution"* (driver 1, group 2), the truck drivers believe that it can transform their profession as they consider that the new generation of drivers will need more and more specific training to know how to deal with the situation (n = 5).

Table 2
Truck drivers' opinions about their profession.

Opinions and Attitudes Regarding Truck Driver Profession		N
Driver profession	Loss of autonomy on task performance in carrying out tasks that they are no longer performing.	1
	Lack of career progression.	1
	Loneliness, Family-related incompatibility.	2
	New skills required for future drivers.	3
	Health issues resulting from poor diet and out-of-hours meals.	1
	Unattractive profession for young people due to high workload and low payment.	1
	An increasingly aging population.	1

Table 3
Main results about professional drivers' opinion about In-Vehicle Technology.

Opinions and Attitudes Regarding In-Vehicle Technology				N
In-Vehicle Technology	Existing		Lane Keep Assistance	22
			Cruise Control and Speed Limit	22
			Adaptive Cruise Control	6
			GPS	
			Collision Avoidance System	
			Bluethooth	22
			Emergency Brake System	
			Company system ASTRATA to communicate and know the truck location.	15
			Mercedes Systems/Economic Systems of Mercedes	7
	Using it	Yes	Cruise Control	2
			Navigation System	
		No	Cruise Control	17
			Lane Keep assistance	
			Mercedes Systems/Economic Systems of Mercedes	
			Emergency brake system	
	Evaluation	Positive	Consider most of them helpful on driving task	1
			Recognize that technology has contributed to safety	1
		Negative	Automatic braking sensors detect an object too close and block the vehicle.	7
			Given the characteristics of the load being transported, the braking system can compromise driver safety	22
			The systems to be more economical, delay the service.	2
			The CC enhances drowsiness and can be dangerous in specific wethear conditions	4
			Lane keep systems it's annoying, specially at night and sometimes it scares.	1
	Not existing		Collision Avoidance System	1
			GPS	1
			ACC	9

4.3. Truck platooning technology

The participants gave their opinion about truck platooning mentioning positive and negative aspects and also safety concerns (Table 5). The drivers' opinions expressed about this technology consider it as not impossible, but this requires straight roads and long distances, together with a combination of several factors, such as, load weight, available driving time and type of truck (n = 5). "*There has to be a combination of several factors"* (driver 2, group 2). Basically, they consider impossible to follow in a platoon with differences in the loas weight (n = 3). Some drivers mentioned that the feeling of following a truck with this technology activated, is like going in the "passenger seat" (n = 4). "*We end up being a bit of the passenger in that situation*" (driver 4, group 1). The drivers also considered that platooning technology could make driving more tiring and monotonous, imposing more attention due to the possibility of something failing (n = 3) as a result of the long periods of time at a reduced distance from the truck in front. *"How does our brain behave spending hours looking at the back of the truck in front at such a short distance?"* (driver 3, group 2). Reasons for preferring a longer interval between trucks: it increases the visual field, it becomes

Table 4
Main results about professional drivers' mental representations about automated vehicles in freight industry.

Opinions and Attitudes Regarding Automated Vehicles in Freight Industry		N
Mental Representations about automated vehicles in Freight Industry	Remote controlled trucks	2
	Vehicles without driver following a specific line	2
	Existence of a lead truck with a driver who defines what the followers do	3
	Trucks driven by a driver on specific roads or lane equipped with sensors that connect to GPS	9
	Concern about civil liability in the event of an accident with a driverless vehicle	1
	Concerns about unemployment and lack of discounts for social security	4
	Does not directly affect them due to being close to retirement, the lack of drivers and the impossibility of automating some tasks that will always require the presence of a driver	7
	Requires more technology fitting new training needs to deal with specific situations	5
	Something that will never happen or not possible to be 100 % automated	2

Table 5
Main results about professional drivers' opinions on Truck platooning.

Opinions and Attitudes Regarding Truck platooning			N
Opinions about Truck Platooning	Positive	Recognition of economical savings for company	3
		It works for the safety of the drivers who park together	1
	Negative	Impossibility to follow in platoon due to differences in weight of loads	3
		Difficulty on recover the position if the leader keeps the speed	1
		Feeling just like when they seat next to the driver.	4
		Difficulty in understanding how drivers will accept to drive in a platoon.	1
		Driving will be more monotonous and more tiring requiring more attention due to the possibility of something failing	3
		Not impossible, but in straight roads and long distances and a combination of several factors: load weight, available driving time and type of truck	5
	Safety related Concerns	The behaviour and characteristics of the load in case of emergency braking	4
		The need to have to rely on machines creates a feeling of insecurity	2
		Concern about the possibility of sensors failing and drivers' reaction being slow.	3
		Concern about not knowing the lead driver	1
		Concern about animals crossing the roads	2
		All the vehicles must be automated	2
Platoon Position	Leader	Safer.	2
		Sensation of freedom	2
	Followers	Low visibility of the road environment	1
		Only with equal loads in every platoon vehicle	1
Distance Inter-Vehicle	Short distance	More tiring and uncomfortable	3
		Less than 25 m, only as a leader	2
		Less than 10 m seems to them to be impossible	3
		Agree on a distance of 15 m if the loads weight is identical on each vehicle.	1
	Safety distance	At least 25 m are required for a safe stop	1
		Must be adjusted by the driver him/herself	1

less tiring, and safety concerns related to the load. The main positive aspect was the recognition of the benefit *"economical savings for the company"* (n = 3).

Throughout the three sessions, the issue of the load distribution on the vehicle was the truck drivers' main concern. They considered that it is always necessary to keep in mind the type and weight of the load they are transporting for their appropriate distribution on the vehicle box. The drivers attribute a great importance to these issues as they considered that, for this technology to be viable, it is always necessary to keep in mind the type and weight of the load they are transporting. *"(…) there are certain types of loads that with a sudden braking will meet us in the cabin"* (driver 7, group 3). The kind of load and their distribution on the vehicle box proved to be a factor that makes drivers feel insecure and uncomfortable in the use of their assistance technology. "*We have to know how to distribute the load and tie it as it should be, for a safe driving along the trip"*.

In terms of position in platooning, the preference of the participants fell in the leading position, because they consider that it is safer and even allow for a sense of freedom. *"I think it's safer to go ahead. I'll be the one setting the route and driving"* (driver 1, group 1).

Respecting the distances between vehicles, in addition to being more tiring and uncomfortable, they consider that the distance of 25 m is safer because it allows vehicles to stop safely. Lower distances between trucks may be considered only if the characteristics of the loads are identical (15 m) and will be impossible for distances below 10 m. *"Concerning the 15 m, I agree with them, depending on the type of load that is transported"* (driver 7, group 3).

4.4. Dealing with technology

It has been noticed that the age factor had not any influence on the participants' opinions and attitudes regarding platooning systems (Table 6).

In general, the age factor was not relevant in the acceptance of new technologies, since there were participants from both age groups who showed distrust and reluctance regarding their implementation and predisposition to use them in relation to the acceptance of new technologies. The most favourable participants recognized the technological advances as a safety improvement factor. *"We are 200 % better. There is no comparison"* (driver 1, group 2). According to their mental representations, many participants showed: (1) some lack of confidence in the technology, largely due to their experience when using the automated braking system (n = 7); and (2) they recognized that technology fails (n = 3). The existence of a specific lane for these vehicles would help to increase confidence.

5. Discussion

The discussion is presented in a way to highlight how the Focus Groups results meet the following defined research questions:

How far the users' relationship with the in-vehicle technology has any influence on the users' a priori acceptance of platooning systems?

The focus groups results have shown that most drivers feel some lack of confidence, discomfort, and unsafety in the use of some driving assistance systems, admitting that they switch them off and/or do not use most of them. One explanation for such behaviour focuses on the risks related to the characteristics of the load that they often carry and the potential effects of such abrupt breaking behaviour caused by

Table 6
Main results of drivers' opinions about how they deal with platooning technology.

Opinions about Dealing with Platooning Technology.			N
Dealing with Technology	Notion of the system limits	Technology failure.	3
		Humans make errors, but machines too.	2
		Technology today is already pushing the boundaries of what is safe.	1
	Training Request	Requires a specific training to know how to deal with situations.	3
	Mental Representations	Lack of confidence on machines and automatic systems break.	7
		A specific lane for truck platooning is required.	3
		Knowing that the equipment has the ACC, I will be more relaxed.	1
	Acceptance	Everything that is technology is welcome.	3
		There is too much technology.	2
	Implications for safety	Improvements for security are required.	2
		Technology inside cars jeopardizes the way of drive on the road.	1

automatic braking systems, that can endanger, not only the load itself, but also the driver's life.

Regarding their resistance to the use of driving assistant systems, it was not possible to characterize the sample regarding the age group, since there were younger and older drivers against. However, the greatest resistance was on the part of older drivers. This resistance was also verified regarding the a priori acceptance of platooning technology, which concerns predominated on the load-related behaviour, the trucks behaviour in lane changes and after cut-ins by other vehicles (Castritius et al., 2021; Castritius et al., 2020a). In a generalized way, the more resistant participants to new technologies consider that currently there is now "*more technology*", mainly inside the vehicle, and such technology is gradually taking them out of control of the vehicle (Neubauer et al., 2019) getting them intrigued about *"who is the boss*".

2. How far their mental representations of truck platooning systems are reflected on their level of a priori acceptance and the development of an attitude in favour of their willingness of use?

Although participants never had contact with any platooning technology and automated vehicles in the freight industry sector, they have shown some knowledge about studies with automated vehicles in the sector, mentioning some case studies taking place in Europe and the United States. The representation they have is focused on vehicles with or without driver, which circulate on specific roads or lanes connected by GPS. However, several concerns were expressed, not only related to safety (Richardson et al., 2017), but resulting from their fear of being unemployed due to the evolution of automation (Castritius et al., 2020a; Neubauer et al., 2019; Richardson et al., 2017). Anyway, such fear is not shared by most of them, believing that the loading and unloading conditions require the presence of a human driver. However, the experimental phase of the study developed by Castritius, et al. (2020), revealed that this feeling was no longer valid, considering that the current state of platooning technology still requires the system to be constantly supervised. Due to this need for supervision, participants consider it important for future drivers, since they do not believe that the platooning system will be implemented in their time. Thus, future drivers should have other qualifications and technical skills to deal with new technology-related situations.

Although the most enthusiastic participants about new technologies believe that the technology has contributed a lot to safety, they do not consider that platooning technology will increase safety (Neubauer et al., 2019). On the contrary, they consider that driving will become more tiring and monotonous due to the short distance to the vehicle in front. The feeling of insecurity and lack of confidence in the system is compounded by the lack of confidence in the automatic braking system and the behaviour of the load they can carry now. Thus, the leaders' position is most pointed out as being preferred, because it conveys a perception of freedom and safety since it allows them to increase the visual field (Yang et al., 2018). For the participants, the distance between vehicles along with the load they carry, are the factors that most influence their levels of a priori acceptance and willing to use.

In case of a transition toward truck platooning systems, how far their mental representations will favour a behavioural adaptation?

In general, drivers were reticent about the introduction of this technology. One of the reasons leading to the lack of confidence is the fact that they do not know the platoon leader. Actually, they highlighted the following requests for accepting such transition: they need to know more about each one's position in the platoon and the load they carry, being similar in terms of weight and type. Furthermore, the transition involves teamwork, which represents a huge difference regarding their actual working conditions: driving alone with a great autonomy for decision making. Thus, a behavioural adaptation and an efficient teamwork should be provided by means of a high-quality training program.

6. The study limitations and next steps

The main limits of the present study are the reduced number of participants on the Focus Groups. However, they provided enough information for the design of the questionnaire to be applied among truck drivers working on Portuguese Freight companies, targeting an important number of responders in a face-to-face application. At the present stage, the survey is being prepared to collect quantitative data from a representative sample of Portuguese active truck drivers. The aim is to address several variables related to the platooning technology, such as their notion of the technology limits, together with acceptance, trust, fatigue perception, the effects of sleep quality and deprivation, as well as any past accidents, incidents or near misses. The collected data will be analysed and discussed towards the planning of a future experimental study.

Declaration of competing interest

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

Data availability

The data that has been used is confidential.

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Appendix 1. – Discussion guide – Truck drivers opinions about truck platooning systems

Opening	Presentation of the Moderator, Assistant and Observer Short presentation of each truck driver including his/her activity, length of service in the profession and at the company.	5 min
Nowadays Professional Activity	1. Which vehicles they use to drive? Which driving assistive technologies or automation level exist on the service vehicles? Which of these Technologies are used in these vehicles? Which are the minimum and maximum driving distances each one daily perform? Is there any driver performing dangerous goods transport? Daily activity is just composed of driving the vehicle or is there any other activity completing the main one? How is the daily activity organised? Which is each one's daily Schedule? Is it regular or variable? Have you already felt fatigue or drowsiness while driving the vehicle? Which communications do you perform during your activity?	15 min
Mental Representation about truck platooning	2. Have you already heard about truck platooning systems for the goods transport?Presentation of a video about truck platooning systems What do you know or heard about truck platooning? What do you think about this technology for your regular activity? Which advantages do you identify in this transport system?Which disadvantages do you identify in this transport system? Based on your previous experience and on the video which risks do you anticipate? Based on your knowledge and professional experience, which are your main doubts, concerns, and new risks you identify? What do you think about the distances between vehicles in a platoon? Which are the advantages and disadvantages related to longer or shorter distances between vehicles in platooning? Which are the challenges imposed to a platoon leader? And to the followers? Are there new costs at a different level that could compromise the environmental and economic sustainability gains? Is this a question already discussed by the truck drivers? Which impacts do you anticipate with the introduction of truck platooning on your job?	35 min
The End	Would you like to share any additional comment or suggestion?	5 min

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