The future of truck platooning in road freight industry

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Abstract

Road freight plays a key role in the transportation sector due to its large network, which makes access to such extensive infrastructure. As a result, goods are easily and smoothly moved to meet the demand and supply of any businesses. However, the road freight industry has faced tremendous challenges regarding both economic and environmental aspects. And truck platooning, among other technological innovations, is believed to be a solution giving way out of the dilemma.
The objectives were to study the most significant existing challenges in the road freight industry, also, the concept of truck platooning, its benefit and current implementation. Additionally, the future of this concept was examined as well.
The research was conducted with qualitative research approach. Primary data were collected from interviews. Secondary data were gathered from academic research, studies, and articles. The interviews' results were transcribed and discussed.
The results of this study emphasized that the road freight industry is in crisis, which requires the attention of key players in the industry to bring about revolutionary changes. They are beneficial not only to businesses but, at the same time, reducing the negative impacts on the living environment. Interview experts have no doubt about the indifferences that technological innovations like truck platooning may bring in the future.

Keywords/tags (subjects)

road freight, truck platooning, transportation

Miscellaneous (Confidential information)

Contents

Figures

Tables

1 Introduction

1.1 Background information

When it comes to choosing “which topic to research”, it either comes from personal viewpoints towards any challenges or merely just out of the author’s interest.

The author has been working as a logistics specialist for one Finnish manufacturing firm located in Kerava, Finland for four years. Her main responsibility is to monitor the import of material for production, as well as the export of goods to end customers in Finland and all over the world. The routine work concerns many types of transportation modes such as express parcel, airfreight, ocean freight and road freight. Among many challenges existing in transportation, the performance of road freight is the common topic in daily, monthly, quarterly meetings in every level of management. The shipping team, who is in the battlefield, has a chronic headache to monitor pick-ups and deliveries due to frequent unexpected delays of trucking companies. The management team is concerned about the monthly cost in the finance report due to extra spending for last mile deliveries to make up for those delays in order to reach customers expected time of arrivals. The challenge has been going on through years from countries to countries. And it is not the one-time-solved puzzle that any trucking company or freight forwarder can solve on their own. It is an economical challenge affected by many other external factors, which requires more attention from different stakeholders and perspectives to examine and hopefully a feasible solution could be found soon. But to that day, any effort digging into the issues and “thinking outside of the box” ideas should be raised and considered.

With that thought in mind, the topic about new technology as a solution for contemporary struggles of the trucking industry is formulated. When investigating further, the author is more persuaded by related studies and statistics about the development of technology and its impact on the human world in every aspect of living and working.

Since 2011, Industry 4.0 has had an ongoing effect on industrial manufacturing with newly developed technologies. When looking closely at the current digital trends, some important components could be spotted such as IoT platforms, smart sensors, location detection technologies or big

analytics and advanced processes. They are integrated to increase automation, improved communication, and self-monitoring, especially to lessen the need for human intervention. (Marr 2019)

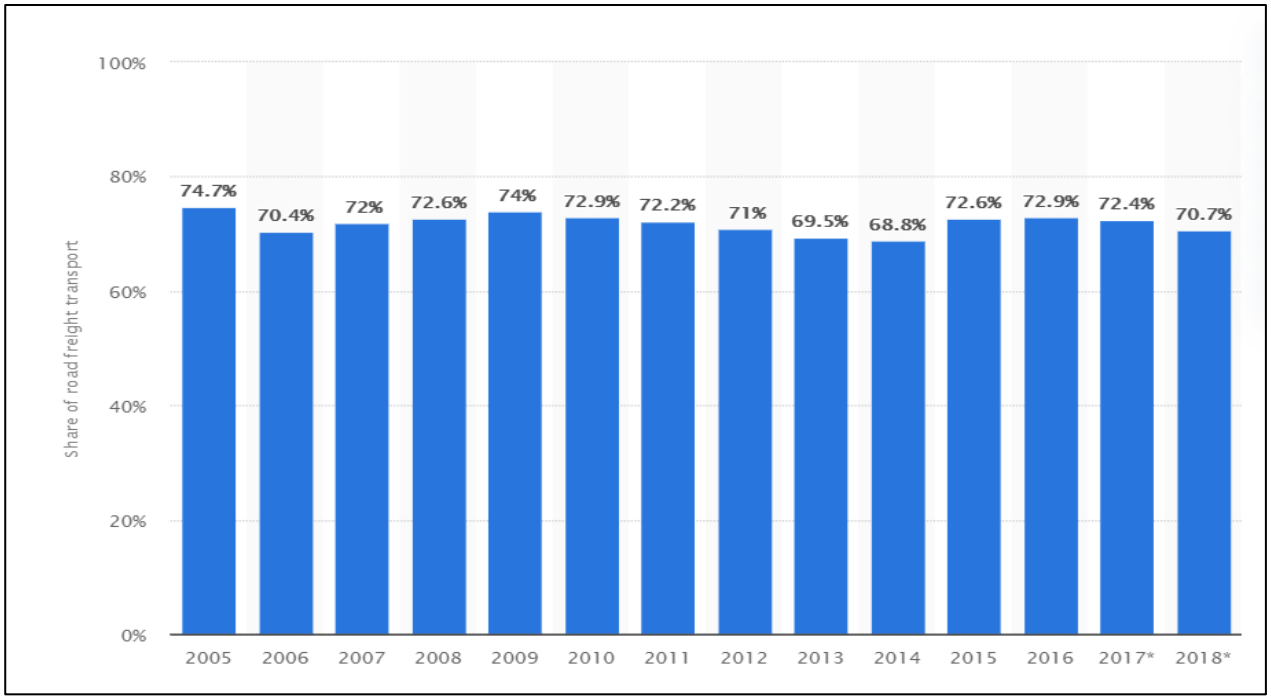

Figure 1.Road freight transport in Finland from 2005 to 2018 (Statista 2020)

Obviously, the transport industry is not excluded from the revolutions brought about by the emerging wave of advanced technologies. Apparently, transportation is crucial to society and the economy, a significant link of international chains and global trades. As shown in figure 1 below, road freight has always been a major division, accounting for over 70% of the total of inland transport from 2005 to 2018.

Also, the demand for road freight transport is expected to increase in the coming years according to Traficom, a Finnish Transport and Communications Agency. A survey conducted in 2019 by the agency proved that postal item volumes have increased throughout the year, which is illustrated in figure 2. The robust growth of online shopping by domestic's economy is a major contributing factor. (Traficom 2019)

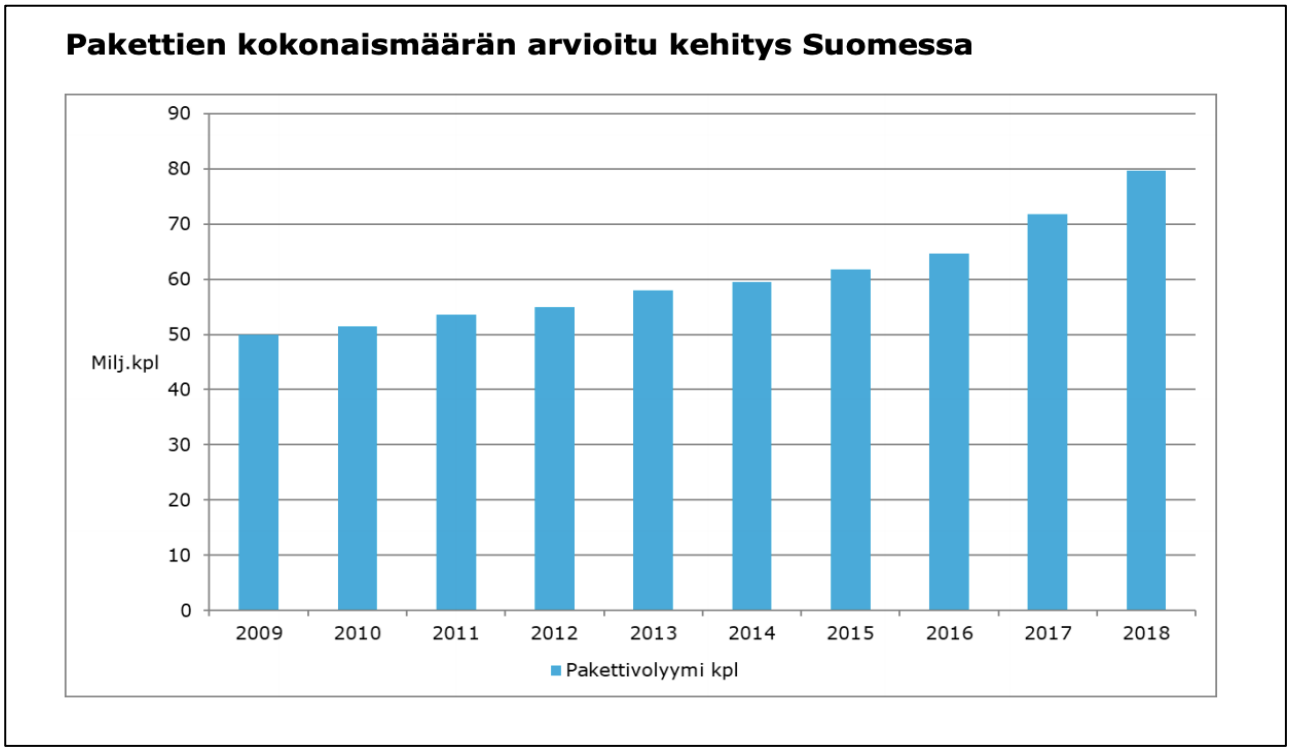

Figure 2. Estimation for the growth of parcel transport volume in Finland (Traficom 2019)

The booming demand often goes together with many corresponding problems. Consequently, AI technologies are expected to make key changes for the industry. In recent years, logistics experts have constantly discussed related topics namely the future of robotics, the maturity of autonomous driving technology and so on, aiming to cope with the demand while avoiding current hurdles of the road transport network. (Rizzoli 2021)

Overall, this topic is chosen out of the author's experience with the existing challenges in the road freight industry and the interest in new technology, which has been discussed extensively as a feasible solution for the future.

1.2 Study objectives

There have been a certain number of theses discussed about the future of the transport industry under the influence of Artificial Intelligences. Several cases adopted AI technology such as drone delivery, autonomous vehicles, smart traffic system, ect.. The topic of how AI can transform the transportation industry is like a consortium under which are many possible approaches and answers.

This research aims to explore the concept of truck platooning and its practicality when being implemented. The scope of the thesis was limited to the road freight industry in Europe and in Finland. Obviously, the road transport industry in Finland has room to grow, therefore, solutions should be figured out to lessen the difficulties by taking advantage of technologies. A local company has planned to test the platooning technology on Finnish highways. While, The EU has been investing and making investments to pave the way for the truck platooning in the EU road network to improve fuel economy, traffic safety and throughput.

This thesis aims to discuss the question: **Could truck platooning be considered a solution for the road freight industry to cope with current challenges?**

To break down the main question, three secondary questions below need to be answered as well:

1. What are the current challenges of road freight?
2. What is the concept of truck platooning?
    - What is truck platooning?
    - What are the benefits?
    - What is the current status of concept adaptation?
3. What is the expectation of experts toward this new technology?

2 Research Methodology

2.1 Research Approach

Research approach acts as a guideline, based on which researchers could conduct their studies. It represents a structure for problems to be formulated and objective to be presented through the data obtained during the research process. (Sileyew 2019).

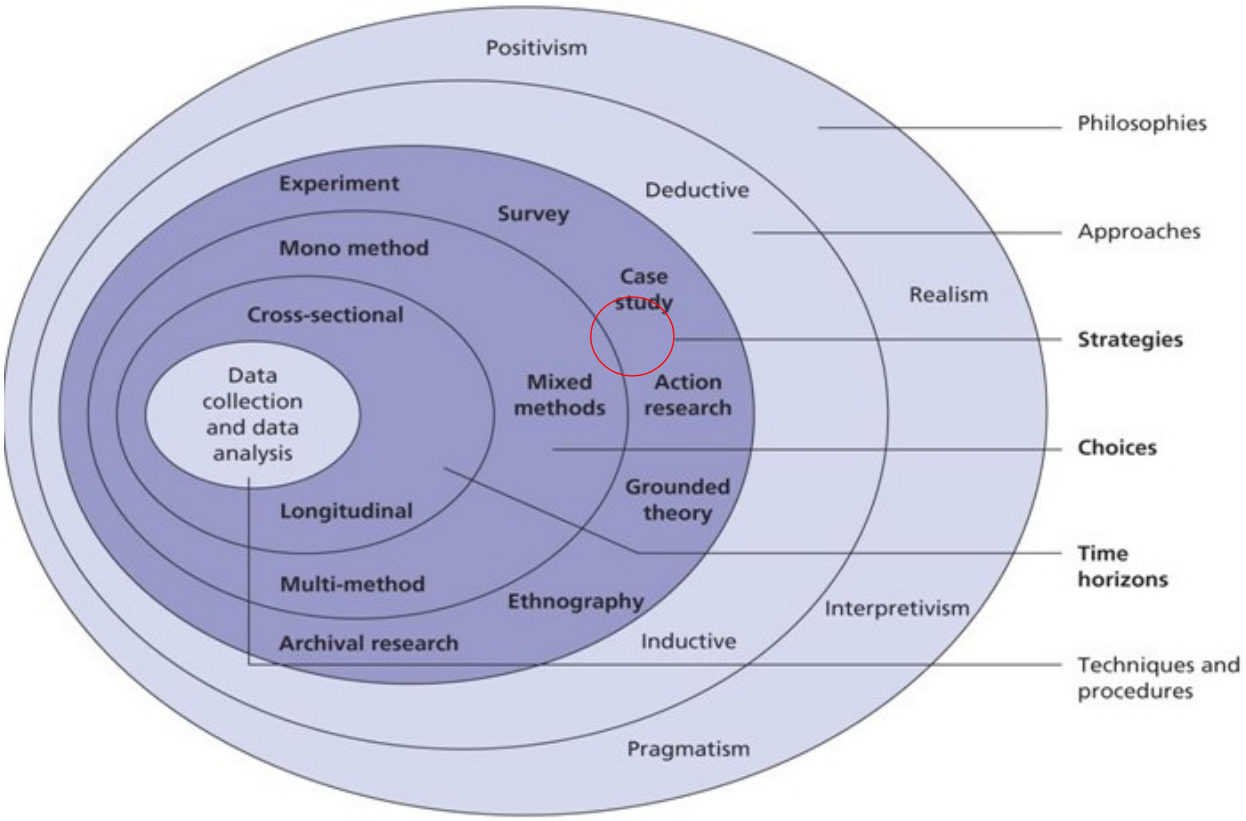

Figure 3. Case study in the research onion (Saunders et al. 2015,164)

This thesis is done with a mixture of literature research and qualitative case study to examine two research issues raised in the research questions:

1. The current challenges in road freight industry a new concept of truck-platooning
2. Whether or not the new concept is the solution for the existing challenges

The first part of this research is done with an inductive approach and primarily associated with qualitative literature research. Inductive approach begins with a topic: empirical literature is developed;

no hypotheses can be found at this stage of the research (Business Research Methodology 2011). The current challenges in road freight industry and the concept of truck platooning are two topics to begin. The result of this literature research answers research questions number one and two, as well as its sub-questions.

And, in order to discuss and validate the future adaptation of concepts, the second research approach with qualitative case study is carried out.

The case study had a long history since the late 1960s. It has been used for validation purposes in the field of psychology, sociology, and other studies by educational researchers. Case study has many approach methods such as interviewing, observation and document analysis, etc., by which maintaining the access to conduct, analyze and interpret the case. (Simon 2009,3)

Additionally, Simon (2009,3) addressed case study has the primary purpose to explore the distinctiveness of the researched case, which could be an individual, a policy, a concept or system, etc. In order to decide "the case" to study, a problem or challenge in a field or industry needs to be brought up. In this research, the concept of truck platooning in the road freight market is the case to study. The related information of the "research problem" could be gathered through relevant literature previously conducted, which is in best interest to answer the identified research questions and sub questions. Differing from qualitative literature research, the case study method involves perspectives of multiple stakeholders. Their participation and observation to "the case" helps to draw final validation or findings to the research questions.

Frequently, one to three research questions are sufficient for qualitative case study research. These questions act as guidelines, but more knowledge of the context arises during fieldwork research. Additionally, research questions are different from interview questions. Interview questions do not frame any analysis or interpret the research problem. On the contrary, its purpose is to discover the issues in depth, to generate data which will contribute to answering the research questions. (Simon 2009,32)

Overall, in this thesis, the process is carried out as the literature reviews of the research problem are gathered and presented first. Then those will be validated by the result from interviews with stakeholders, following with the findings of the research problems.

2.2 Data collection and analysis

Dudovskiy (2011) defined data collection as a process of collecting and evaluating information from relevant sources to find answers to research problems. Data collection methods comprises of two categories: secondary methods of and primary methods.

Secondary data refer to information existing from published books, articles, or any other online portals. (Sileyew 2019). To conduct the Empirical literature reviews, a secondary data collection method is used. The challenges of trucking industry, and concept of truck platooning are explored through data from academic documents including articles, reports, online discussion, webinars related to those topics.

According to (Simons 2009), there are three methods to gather data in case study research namely interviewing, observing and document analysis. In order to understand the core topic of this study, as well as have it explored more deeply, interview is a preferred method.

Interviews carried out are an open-ended or unstructured type of research interviews, in which understanding, and information obtained from empirical literature reviews acts as a foundation or guidance to lead the participants review and debate their ideas about the topic. Follow-up questions are asked to encourage and motivate interviewees to share more stories and their points of view.

For this study, three interviewees who have direct or related work with the transport industry were chosen for open-discussion interviews. Interviewees were people in such positions that they were able to answer research questions and to provide sufficient expertise. The questions were prepared after the researched topic had been explored in the literature review. Transcripts collected during the interviewing process are the primary data source, which were later on analyzed for discussion and validation of the main research question.

Additionally, this primary data is qualitative. Theoretically, it does not involve numbers or mathematical analysis. Rather than that, it is associated with non-quantifiable elements like words, feeling or emotions, from which results are conducted as a unique finding of each and every research. (Mezmir 2020).

Table 1: Data collection of the study

Data collection methods	Material
Primary data	Transcript from interviews
Secondary data	Articles, reports, books, online discussion videos (YouTube), webinars…

Table 1 above summarizes the data collection method used in this study. Apparently, secondary data is collected first in order to roll out the next steps for primary data to be gathered.

2.3 Research Design

The research was divided into five parts illustrated in the figure below. Data collection and outcome of each phase was displayed accordingly.

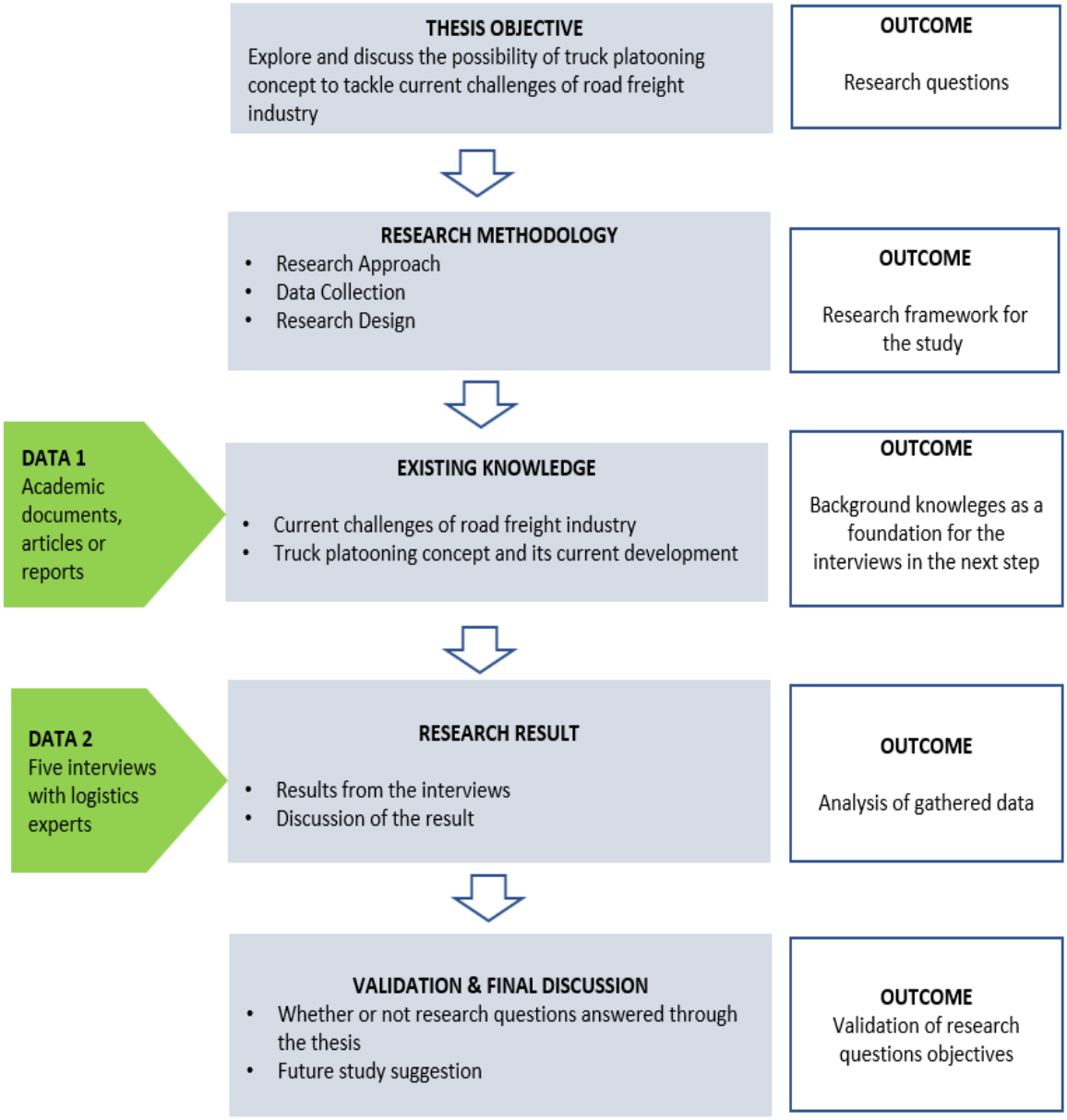

Figure 4: Research design for this study (adapted from Tran 2021,9)

The research was “getting started”, in section one, with an objective as to examine the concept of truck platooning as a feasible solution that could cope with current challenges in the road freight industry. Section two focused on introducing the research approach and data collection methods used to conduct this study. In section three, existing knowledge was gathered by a secondary data collection method, which was then developed as a framework for the interview used in the next step. After the interviews were carried out, theirs result and the analysis of primary data were presented in section four. Last but not least came the validation and final discussion of the study recorded in section five.

3 Empirical Literature Review

This section gathers the existing knowledge for the two areas of this research, which are the existing challenges of trucking and the concept of truck platooning.

3.1 Challenges of trucking industry

Europe is growing and so is one of the most important drivers of the economy and society. By 2025, statistics show that around 70% of all freight transport will travel on public roads. In that context, tremendous pressure is placed on European highway infrastructure and in the environment as well. (EU Truck Platooning 2016). This is to say, freight transport is facing enormous challenges, especially after the pandemic and the unstable economic situation currently.

In this part, three biggest challenges in road freight are examined namely environmental challenges, the shortage of truck drivers and the rise of fuel supply.

3.1.1 Environment alerts

CO2 emissions are the principal cause of global climate change. As the use of fossil fuels has no sign of declining, the global CO2 emissions has been correspondingly risen. As a consequence, the globe is thought to be put on a catastrophic path of global warming. (Mathis 2023)

These alerts have been raised strongly throughout the year, especially since the catastrophes caused by the COVID-19 Pandemic in 2019. Everyone wondered whether or not we have been draining out the earth's capacity, dooming our living environment by not having enough care towards sustainability.

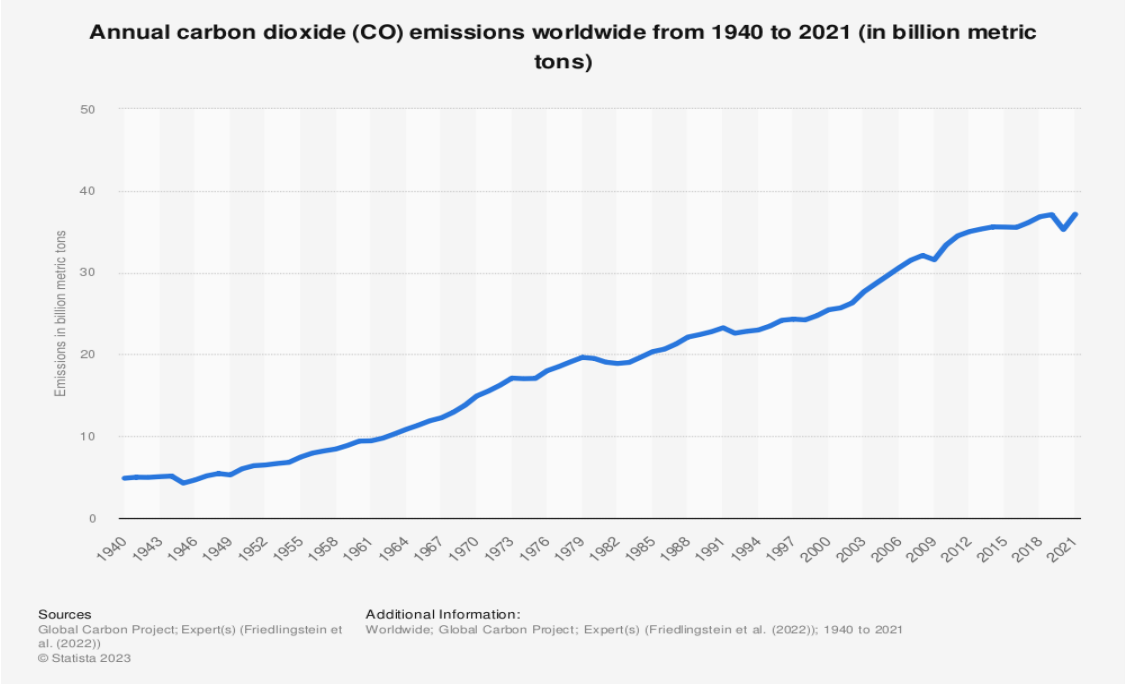

Figure 5.Carbon dioxide emissions have increased over the years (Mathis 2023)

Among other contributing factors, road freight accounts for 53 percent of CO2 emissions produced by transportation, and it is expected to climb to 56 percent by 2050. This happens due to two main reasons. E-commerce has increased adapted to the changes in shopping habits, requiring more road transport to deliver orders. Consequently, the increase of transport leads to progressively buying larger and heavier vehicles by transport providers to meet the high demand of the market. (Acciona 2020)

In addition, emission from transport activities causes air pollution. It is danger responsible for nearly seven million premature deaths every year. (WHO 2022)

While transportation was one of the sectors most affected by the COVID-19 pandemic, business resumed rising soon after that thanks to the booming demand of the market (IEA 2023). The transport industry must have a critical transition to lessen its impact on the environment. The innovation with smart technology to make transportation more efficient and less polluting is questionably a game changer for the future. In particular, certain technological innovations by Artificial Intelligence (AI) with ubiquitous communication and the decarbonization of transport will bring about significant changes in the road transport sector. (Alonso et al. 2019,11)

3.1.2 The shortage of truck drivers

That European market lacks truck drivers causes severe problems for both haulers and the whole trucking industry. Social and economic factors such as pandemic or Brexit seem to increase an extra gap on the demand side. Many haulers are experiencing troubles when not having enough drivers and, while the orders keep increasing on the customers' side, which constantly plays huge pressure on the freight businesses. (Stepper 2023)

BBC (2021) reported that national lockdowns due to COVID-19 resulted in the cancellation of forty thousand HGV driving exams in the UK, which meant a small number of new drivers about to join the industry. After the disruption of Covid came the Brexit, when UK proceeded its withdrawal from the European Union. It was estimated that around twenty thousand EU drivers left the UK due to Brexit, claiming that the uncertainty of their future rights to live and work in the country is their primary motivation. Moreover, additional reasons were revealed by a survey, of which the result was summarized in the figure below. Undoubtedly, it highlighted the growing issue within the freight sector of the country. (BBC 2021)

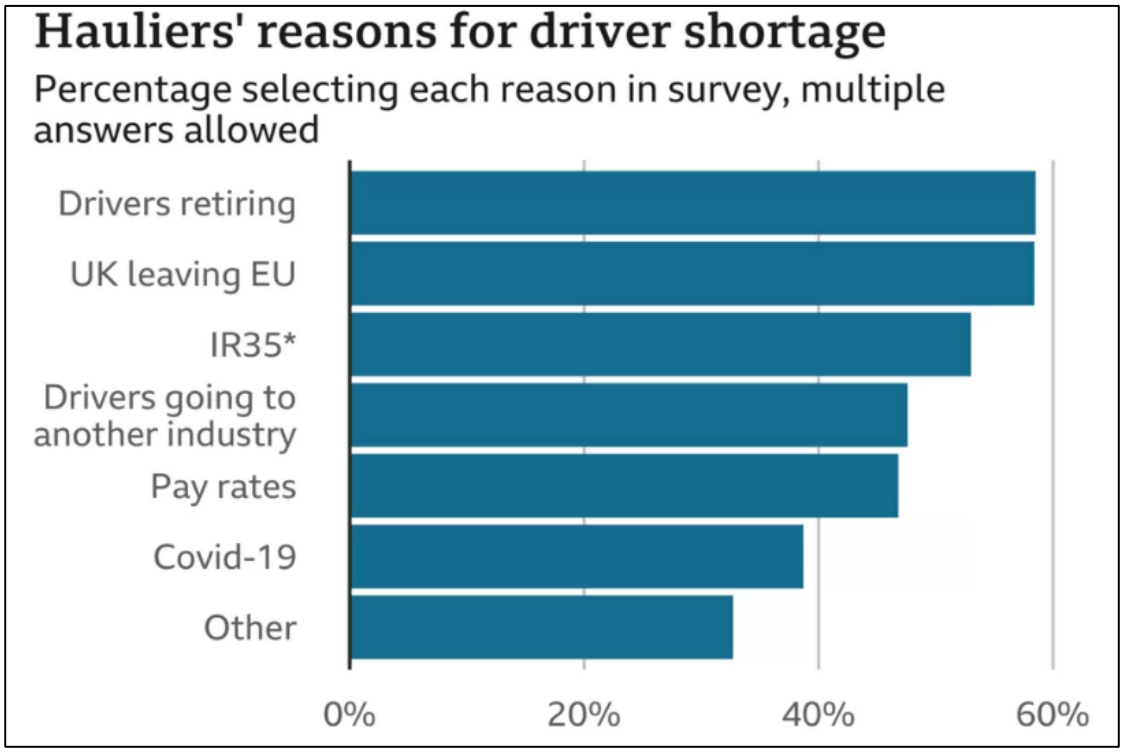

Figure 6. Hauliers' reasons for driver shortage in UK (BBC 2021)

The situation has been devastating for business and people's lives. The supply chain was disrupted resulting in service stations having no gas supply, hence vehicles left with empty tanks. A diverse choice of products is increasingly scarce on supermarket shelves. For example, Mailonline (2021) published breaking news on Ikea running out of mattresses in some of its stores because of lorry driver shortages, which continued to hinder the company's supply networks.

The situation is not better for Germany. A shortage of 80,000 truck drivers is projected. The profession finds it hard to recruit new drivers locally, hence there is an upward trend in the need for foreign workers. (Zsófia 2023)

In Finland, Ahola, the Finnish transport company, revealed on its portal news that driver shortage is becoming a bigger worry when the attitude of young people towards this profession is not positive. From the company's own survey, interviewing a group of 15–24-year-old people in Finland, only 38% of respondents wanted to join the workforce. They were demotivated by factors such as physically demanding, monotonous, and lack of free time. (Ahola 2022)

Data from figure 7 show that the shortage of heavy truck drivers is widespread in Europe. This situation is worsened due to the aging of current workforce, and the difficulty of recruiting young people, similar to cases reviewed previously. (IRU 2022)

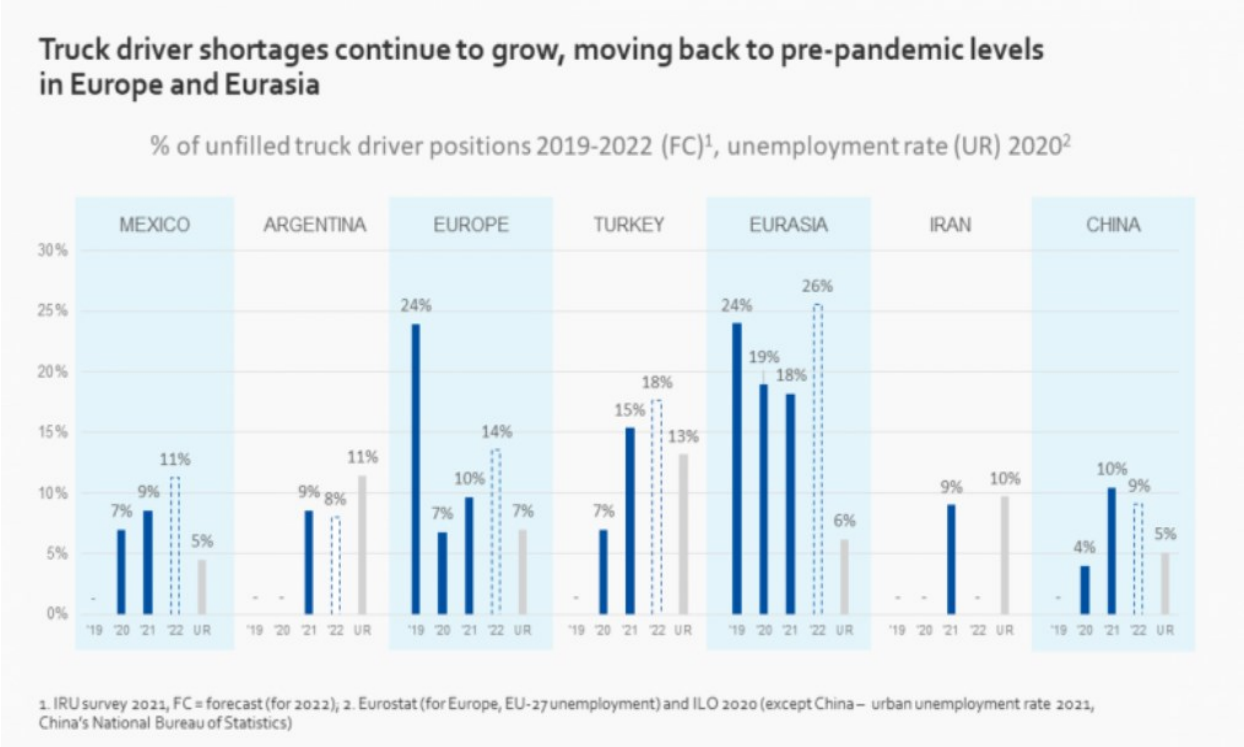

Figure 7. Shortages of truck drivers across Europe (IRU 2022)

Aging population is a threat to the future of the global economy since it affects many important economic nations like China, Japan, or the EMEA. Besides instant solutions such as increasing the retirement ages of the current workforce, leveraging the emerging technologies to handle autonomous and unmanned tasks is very much a worldwide theme currently. (Lee 2023)

3.1.3 Fuel supply

The war in Ukraine has caused disruption and continual uncertainties for resource supplies, for example food or petroleum products. It is said that the European countries are reliant on Russia for 40% of its natural gas and 25% of its oil (Reed 2022). Because of Russia's big influence, fuel prices hit levels not seen in nearly a decade. (J.P. Morgan 2022)

In road transportation, around 20% of personal vehicles and 40% of commercial trucks still use diesel as their primary fuel. Therefore, operating costs in road freight transport remain on the rise for 2023. (Zeist 2023)

Figure 8. Diesel price vs road freight capacity (Zeist 2023)

When the price of fuel soars, carriers are forced to increase their prices or endure losses. The growing cost of gasoline creates a domino effect on the whole industry. When the freight cost climbs, sellers need to increase the cost of goods sale to make up for their loss from the transportation of products. In this sense, the problem is not only staying in the freight industry, but expanding to the global economy since the continuing rise of price will result in a certain inflation, which is ongoing right now. Global inflation has been reported by the IMF around 7% for the year 2023, and it is not expected to improve before 2025. (IMF 2021)

At this point, it is still very difficult to predict what the conflict in Eastern Europe will have on economies, prices, and supplies. Maersk (2022) suggests that business should “get out of regular habits”, making use of digital innovation, as well as emerging technologies to develop the action plan for the issues.

3.2 The concept of truck platooning

This section discusses the concept of truck platooning including the definition, its benefits and current development in the respective order.

3.2.1 What is truck platooning?

Before diving into the details of truck platooning. It is advisable to understand briefly about Artificial Intelligence (AI), a consortium of data driven technologies and innovation currently being applied to social humanitarian life and the global economy.

The phrase AI was initially presented by John McCarthy at a conference in 1956. The concept originated for over six decades and has always been developed through time since then, figure 9 below, by scientists with the effort to teach machines the algorithm so that it could function, or more ambitiously, think like a human brain. (Anyoha 2020)

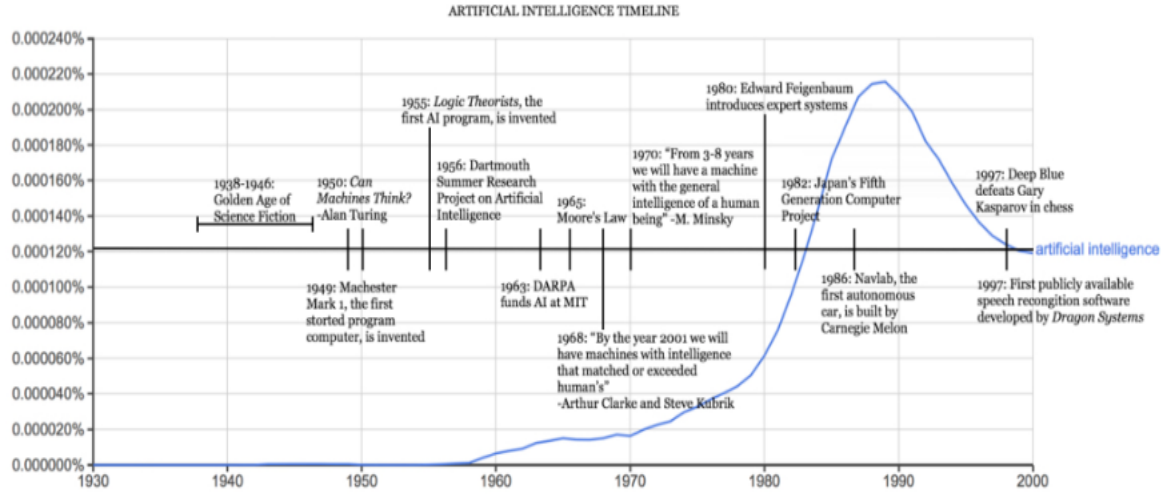

Figure 9. Artificial Intelligence Timeline (Anyoha 2020)

Due to the availability of large volumes of data generated through various devices and networks, this concept has gained recent buzz by enabling many breakthrough innovative business solutions, including its influence on future mobility with automated vehicles as the future substitute for passenger cars and trucks. (Poola 2017)

Another great application of Artificial Intelligence (AI) for commercial vehicles found in truck platooning which is now in the testing phase (AVTSimulator 2023). By definition, platooning is the action of *"connecting vehicles either physically or using computer technology so they can travel close together in a group, as a way to save space, fuel, or money"* (Cambridge Dictionary 2023). With that being said, a truck platoon is a convoy of semi-trucks or vans driven simultaneously for

shipping purposes. It can be fully or semi-automated thanks to automated driving (AD) technology. (Ministerie van Infrastructuur en Waterstaat 2020).

AD technology was invented with the aim to make vehicles drive autonomously, in a safe and comfortable way. Vehicles equipped with this technology are thought to possibly reduce accidents, fuel consumption and pollution. AD has commercialized many systems, which are integrated to vehicles lately such as Adaptive Cruise Control (ACC), Lane Keeping Assist (LKA), Autonomous Emergency Braking (AEB) and Automated Parking (AP), etc.... Another AD system called Cooperative Adaptive Cruise Control (CACC) provides the fundamental framework for the development of platoons of commercial trucks. (Janssen et al. 2015)

Janssen et al. (2015) also discussed that the automation of truck platooning is aligned with the level of driving automation summarized in figure 10 below. For each level, the minimum capabilities of the driving assistance system are indicated. From level 0 with no automation during the process, which human driver is on full accountability, it's expected to have a full automation of all aspects, that driving assistance system can replace a human driver totally.

Level	Name	Narrative definition	Execution of steering and acceleration/ deceleration	Monitoring of driving environment	Fallback performance of *dynamic driving task*	System capability (*driving modes*)	BASt Level	NHTSA Level
***Human driver* monitors the driving environment**								
0	**No automation**	The full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	N/a	Driver only	0
1	**Driver assistance**	The *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes	Assisted	1
2	**Partial automation**	The *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes	Partially automised	2
***Automated driving system* ('system') monitors the driving environment**								
3	**Conditional automation**	The *driving mode*-specific performance by an automated *driving system* of all aspects of the *dynamic driving task*, with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes	Highly automised	3
4	**High automation**	The *driving mode*-specic perfomance by an automated *driving system* of all aspects of the *dynamic driving task*, even if a human driver does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes	Fully automised	3/4
5	**Full automation**	The full-time performance by an automated *driving system* of all aspects of the *dynamic driving task*. under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**		

Figure 10. Levels of Driving Automation (Janssen et al. 2015)

With the understanding of levels of driving automation, Figure 11 shows an example of high automation of a truck platoon infrastructure.

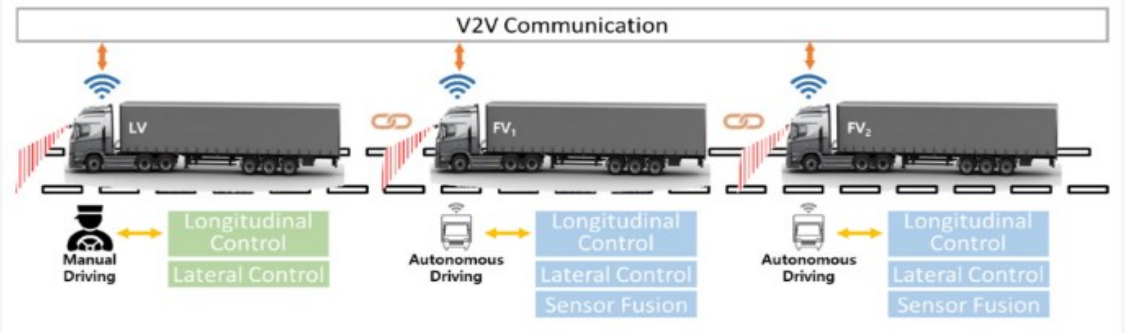

Figure 11. Overall architecture of truck platooning system (Lee et al. 2020)

(Lee et al. (2020) listed the component of a platoon system as:

- The leading vehicle (LV): driven manually by a human driver.
- The following vehicles (FVs): run by AD technology.
- Sensors from radar and camera: used by the following vehicle (FV) to perceive vehicles and lanes.

Lee et al. (2020) also suggested that the number of trucks in one platoon is usually limited to three or four trucks for safety purposes, because GPS signals in unreceivable under specific circumstances. Furthermore, the current infrastructure of urban areas is still developing to match with the evolution of AI technologies, therefore, the truck platooning is presently tested and evaluated for semi-automation, which requires the supervision of human drivers.

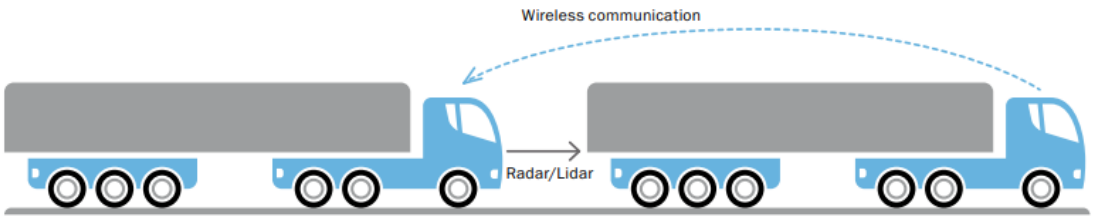

Figure 12. A two-truck platoon with wireless communication and radar technology (Janssen et al. 2015)

The gap between the two trucks is monitored to be as little as 0.3 seconds, or 6.7 meters at 80 km/h, which is when the platoon system is activated. The trucks are then driven without the driver's intervention. FV automatically follows the LV. The speed and route could be modified by the two-way communication between the vehicles. Additionally, the vehicles are wirelessly connected, hence it is simple to connect or disconnect from a platoon without any hassle. (Janssen et al. 2015)

3.2.2 Benefits of truck platooning

Truck platooning is said to provide both environmental and social benefits.

With the effort of bringing down CO2 emissions, ACEA (2021) believes that platooning results in lower fuel consumption. When the trucks drive closer together at a constant speed, with less braking and accelerating, it produces less emission to the environment. With that being said, truck platooning has the potential to reduce CO2 emission by up to 10%, depending on the degree of automation.

Scania, a global leading provider of commercial vehicles explained that:

> *As the trucks driving close together at a uniform acceleration, the lead truck cuts through the air and decreases the amount of air striking the front of and flowing between the following trucks. In truck platooning, trucks communicate with each other maintaining two seconds 'distance' between them, consuming 5 % less fuel. One second 'distance' will save at least 7 % fuel [...]*

(Scania takes part in multi-brand Platooning Project 2020)

According to ACEA (2021), platoons have the ability to improve logistical efficiency and optimize the labor market. Platooning technology saves fuel, which means lower fuel expenses for transportation businesses. Furthermore, with automatic platooning, the drivers of following trucks can perform other jobs such as administrative work or phone calls.

3.2.3 Current development of the concept

Does this concept of truck platooning have a future? Experts say yes. Mc Kindsey discussed the four waves of rolling out the concept into real practice in one of their reports summarized in the figure below.

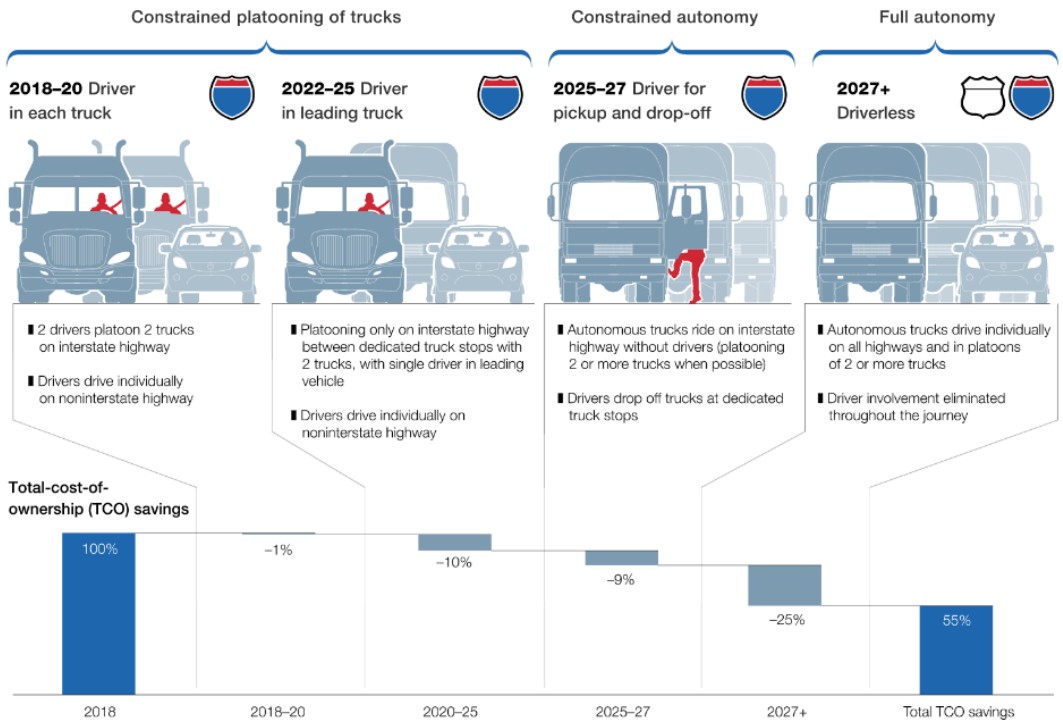

Figure 13.The fast track to the future of commercial vehicle industry (Chottani et al. 2018)

Chottani et al. (2018) predicts that the application of autonomous trucks will be rolled out in four phases:

- Phase 1: The concept rolled out in 2018, featuring the “platooning” technique that has been discussed in the previous section, which is to wirelessly connect a convoy of trucks to a lead truck. Those trucks then operate safely closer together, resulting in fuel efficiency. In this phase, a driver is still required for each truck.

- Phase 2: Expectedly till year 2025, on interstate highways, a driver is needed only in the lead truck, unmanned trucks follow close behind. After leaving the highway, drivers will re-turn to each vehicle. Fuel and labor are estimated to be cut by 10 percent, depending on the proportion of highways. Road freight, which is much about long-haul routes, will offer greater savings.

- Phase 3: Roughly around 2027, unmanned trucks will operate throughout the interstate-highway network. Drivers will only meet the trucks at the interstate exit and drive them to the final destination. This constrained autonomy will produce total savings of about 20 percent.

- Phase 4: Within the time span of more than ten years from now, the first fully autonomous trucks are expected, operating without drivers from loading to delivery.

The report was published in 2018, prior to the Pandemic and political issues happening in Europe. Those unfortunate events apparently cause disruption to the development and application of platooning to the economy.

Nevertheless, EMR (2022) was positive about the global truck platooning market outlook in their report issued in 2022. The market was forecasted to reach 659,98 million USD by 2027.

Truck platooning legislation is being actively prepared in the United States. The National Conference of State Legislatures reports that 30 states have passed legislation permitting autonomous vehicles. (Goble 2023)

In Europe, the European Conference on Connected and Automated Driving 2023 took place in Brussels on 3 and 4 May 2023. The event gathers representatives of industry to discuss the readiness of our societies for the deployment of smart, inclusive, and sustainable mobility solutions.

One of the key players in truck manufacturer, Scania CV AB, has reached an agreement with Finnish company Ahola Transport. The cooperation intends to implement the new platoon technologies on Nordic roads. Ahola Transport will conduct semi-autonomous platooning of three or more connected trucks on Finnish highways with Scania trucks. All trucks will be manned by drivers throughout these testing. The first truck's driver is in charge of the entire platoon, and the subsequent trucks are driven by themselves with the help of an assisted driving system. (Scania and Ahola transport agree on semi-autonomous platooning 2018)

The company has continued to develop the truck platooning concept with a four-step ladder summarized in the table below, with the aim not only to increase the automation of road transport.

But it is thought to be a good factor attracting more workforces for the professions. The status of the profession is raised, which encourages higher-skilled drivers. (Automated platooning – step by step 2020)

Table 2. A four-step ladder of truck development by Scania (Automated platooning – step by step 2020)

Step	Emphasis	Details
#1	Manual driving	• Driver in each vehicle • Distance: approx. 40 metres
#2	Connected vehicles	• Driver in each vehicle • Vehicles wirelessly connected to each other and to cooperating control system. • Simultaneous braking • Distance: approx. 20 metres
#3	Semi-autonomous	• First driver takes lead, others can rest or sleep • Vehicles wirelessly connected to each other and to cooperating control system. • Simultaneous braking • Distance: approx. 10 metres
#4	Autonomous	• First driver takes lead, others autonomous. • Vehicles wirelessly connected to each other and to cooperating control system. • Simultaneous braking • Distance: approx. 10 metres

For Ahola, this is considered as a major investment of the company with the hope for a bigger load and less fuel on the road, but more importantly is to improve the situation of lacking workforces that the company is trying to combat presently. Hans Ahola, CEO of Ahola Transport emphasized:

> *For us it is important to enhance our drivers' work situation with the help of new technology. The planned solutions also help us to meet customer expectations for faster deliveries and environmental targets [...]*

(Co-operation with Scania reaches new heights 2018)

4 Research results

In this part of the study, the results from conducted interviews would be presented and discussed.

4.1 Overview

For this study, five participants currently working directly and indirectly in the field of road transportation in Finland were selected. Interviewees were people in such positions that they were able share their insight about the researched areas, at the same time providing additional expertise, which are helpful to answer the main research questions. These interviewees, however, wished to have their names and workplace disclosed. Therefore, only the company description and their positions are revealed in the table 3 below.

Table 3. Overview of interviewees

	Company /Industry	Position	Interview duration
Participant 1	Dental machine manufacturing	Logistics Manager	30 minutes
Participant 2	Freight-forwarding	Sale Manager	30 minutes
Participant 3	Dental machine manufacturing	Shipping Specialist	30 minutes
Participant 4	Intra-logistics (Warehousing)	Warehousing Coordinator	30 minutes
Participant 5	Consultant	Sustainability Lead	30 minutes

All interviews were conducted in two ways, face-to-face or online via Teams. As requested by the participants, the interviews were not recorded, instead they were transcribed during the interview sections. The interview topics were described briefly to the interviewees beforehand, without having the interview questions revealed. And all interviewees were interviewed separately. The discussion would be focusing on two topics:

1. The current challenges of road freight industry
2. Truck platooning concept and its future for implementation

The results in Table 4 present a summary of the result. All the interviewees agree with the fact that road transportation is facing a huge challenge and its negative impact on the global economy is tremendous. Regarding the truck platooning, two out of three participants have not yet heard about the concept but were extremely interested in the benefit it would bring to change the current game. The other interviewees kept it neutral, not totally being against the concept's future, but he believed the focus will be on other solutions.

Table 4. Summary of the interviews' result

	Participant 1	Participant 2	Participant 3	Participant 4	Participant 5
Challenges in road freight transport	Agreed	Agreed	Agreed	Agree	Agree
Direct impact on your work	Yes	Yes	Yes	To some extent	Not really
Solution needed	Yes	Yes	Yes	Yes	Yes
Aware of the truck platooning concept	Yes	Yes	No	No	No
The future of truck platooning	Neutral	Neutral	Yes	Yes	Yes

4.2 Analyzing the interview results

4.2.1 Participant I

The first participant has a long experience in the transportation industry on the carriers' side and during five years recently, he switched the table, working on the "customer's side", purchasing transport services from carriers like DHL Freight, Keuner Nagel, Schenker…

> 20 years ago, I worked as a truck driver for one subcontractor of UPS in the Netherlands, driving across European borders [...] When I returned to Finland, I continued to work for UPS, but in the airfreight business sector (UPS SCS) for the Finnish market. [...] In 2017, I started to work in this manufacturing company, monitoring both inbound material flow and outbound products flow. [...] This work involves different modes of transportation from various carriers. For example, we have contracted rates with UPS, DHL Express and TNT/FedEx for parcel shipping, airfreight and ocean freight are shipped via DHL Global Forwarding or Kuehne-Nagel, and domestics trucking with Logate [...].

From the participant's point of view, the challenges of road freight industry have been realized long time ago and emphasized the short of labor in this industry its root causes.

> *When mentioning the solution for the challenges, the author was surprised when the term "autonomous truck" mentioned by the interviewed manager. To him it's not a new thing to hear; instead, it's been around for more than a decade foreseen that there will be a future supply chain with little dependent on truck drivers.*

> *With regard to the solutions, there have been tremendous efforts to attract more workforce to the industry. The salary has been increasing remarkably throughout the year comparing, let's say, that for nurses in Finland. [...] In terms of technology, many people discussed about autopilot trucks back to when I drove the truck in Netherlands. I was even advised to switch the work because there would not be enough work for truck drivers in the future due to the development of robotics. But I haven't seen that future arrived yet, at least for now.*

Near the end of the discussion, the author took a courage move to directly open the topics regarding "truck platooning" concept to gain more valuable feedback from the manager. The interviewee knew about the concept but keep a neutral attitude about its possibilities. Because he's still afraid that the external challenges like infrastructure or environmental aspects may delay the application of the researched autonomous systems for trucking in reality.

> *We haven't seen autonomous truck yet so let's talk about Tesla. It functions quite well in normal weather conditions, but what happens in the winter, especially in Finland, when heavy snows cover all the road markings and traffic signs? Not sure about the others but I don't dare to use the autopilot function. [...] I can see the future of technology coming but it will be slow. [...] For instant solutions, I can see the trend of more women joining the workforce and green fuel is also a hot topic nowadays.*

4.2.2 Participant II

The second participant has even stronger contact with the road freight industry. He has been in the freight forwarding business for most of his career and has been with DHL Global Forwarding as a Key Account Manager for more than 15 years. He's actually acting as a freight supplier for the author and 1st participant's company. He's fully acknowledged about the challenges of road freight, and it's directly affected the routine work due to complaints coming from his customers.

> *Me and the company are well-aware of the young workforce missing, however, it's not the biggest problem we are facing. Instead, during the last two years, when fuel prices skyrocketed, our customers were not so happy about the increased rate, especially when it came to Fuel surcharge. [...] I don't recall correctly, but there was a period in 2022, DHL Freight fuel surcharge is up to 45% for each transportation booking. [...]*

The author went on to discover the solutions that the participant's company prepared to, and the emphasis of his responses is on the "green aspect" and how to achieve it.

> *We are forerunners of green logistics service with no extra cost to our customers. [...] Our goal is to become completely climate-neutral by 2050 [...] Our premium product Eurapid guarantee*

certified climate neutralization along their entire supply chain [...] By 2030, 60 percent of our last-mile will be executed by battery electric commercial vehicles. [...]

From the participant's answer, it seemed that all the players in the industry are following very closely the advance of technology, as well as how to integrate it into their business. However, only "matured concept" with final ready-to-use products will be on the development agenda of the freight forwarding companies.

We utilize what is ready in the market to play our game efficiently. Currently we run full speed with electric trucks since the products and their ecosystem are ready. [...] I have heard about the truck platooning concept, but it seems still new in the freight forwarding industry. [...] I believe we currently have other things to fix to improve the day-to-day road freight business. [...] Investment for concepts like truck platooning maybe more for truck manufacturers. [...]

4.2.3 Participant III

The third participant is a shipping specialist at the author's company, taking charges of direct booking for road freight to export the finished goods from Finland to Europe.

The author began the interviews with questions regarding the challenges she is currently facing at her work and learnt that trucking play important roles in the daily operation of the company.

We have every day pick-up by truck at our company. It's important for the products to depart on the planned scheduled to reach orders' ETA [...] Recently, we missed some of the departure due to the late arrival or no-show of pick-up trucks. [...]

The participant expressed her wonder as why the same obstacle kept happening throughout the years, at least since her first day at this position 3 years ago. Apparently, it's not her responsibility to deal directly with carriers when it comes to problem-solving or rate freight issue.

The shipping team is in charge of booking transportation. All the issues happened due to the carriers will be then forwarded to T&L, who is in charge of carriers' negotiations for matters like time in transit, scheduling, or quotation… [...]

The concept of truck platooning is new to her. When being briefly introduced by the author, she's quite impressed but wondered about its practicality.

This whole idea of truck platooning is impressive, especially when it would reach the full autonomy and no truck drivers are needed [...] However, if thinking about the nature of our business, which human drivers are needed for loading work, I think the concept is more suitable for long-haul with long driving distance on highway [...]

4.2.4 Participant IV

The next interviewee is a warehouse coordinator, working for a local trucking company in Päijät-Häme, Finland. She's responsible for in-house picking tasks for various companies, who have their stocks stored in the warehouse of that trucking company. In the past, her company majored in only transportation. However, currently, they provide warehousing, orders picking … as extra services for their customers.

Apparently, she does not have direct contact with truck drivers, however, it still affects her work when the chain is breached.

It occurs very often that we have no products to picked because the trucks are arrived late in the same day afternoon, instead of in the evening on the day before [...] At the end of the day, orders are picked and packed to pallets ready to dispatch from our warehouse. [...] The company often lacks truck drivers, especially in the summer when our drivers are on yearly holiday [...] We sometimes joke about becoming a truck driver since we heard about the high salary one may receive [...]

The participant is very positive about the future that technology may bring.

Isn't it obvious that technology can reform anything? [...] I heard about AI a lot on the news nowadays [...] Our company is looking into the development with Drone technology for inventory counting and other robotics projects for warehouse automation [...] Autonomous truck is the future. If one truck is designed to function without human intervention, no doubt a series of truck couldn't make that happen. [...]

4.2.5 Participant V

The fifth participant is not working in the freight industry, rather than that, she is a Sustainable lead in a consultant firm in Helsinki. Her views on this research are significant due to the sustainable issues raised in the current status quo of the road freight industry. Additionally, through the interviews, the attitude of the companies towards the adaptation to correct the issues is studied.

The participant highlighted the goal of the EU as to reduce greenhouse gas emissions in every corner of life and business. The demand and supply for foods and other products after Corona has created havoc in the environment.

The increase of mobility means the same upward trend for the carbon footprint[...] Electric vehicles and green fuel are two solutions already on the checklist of many companies to undertake the EU2030 Sustainable missions [...]

When being introduced to the truck platooning, the interviewee was unsure about the sustainability of the concept, as how much carbon dioxide could be saved for the environment.

This concept seems to be another breakthrough of technology, thinking about the scenario with one or even without human drivers would monitor 2 to3 trucks [...] There needs to be more concrete report to show the green aspect of this idea. As far as I understand, when driving close to each other, the platoon could help to save consumed fuel. However, it's still fuel needing to function the whole system, am I correct? [...] It's interesting to see which one will become more common in the near future, either electric trucks or truck platooning or a platoon of electric trucks. [...]

5 Discussion

In this section, a final discussion about the research is presented after having data collected and analyzed in the previous parts.

The research questions raised at the beginning of the study are:

1. What are the existing challenges of road freight?
2. What is the concept of truck platooning (the concept, benefits, and current developments)
3. What is the expectation of experts toward this new concept?

The first two questions have been thoroughly covered in the Empirical literature part of the study, providing the insight to answer the researched areas. To recap, the three most significant challenges existing in the road freight industry are the lack of truck drivers, the impact of fuel emissions on the surrounding environment, lastly the remarkably increase of fuel prices. Afterwards, the concept of truck platooning was introduced in the next part of the Literature reviews with the aim to explore its benefits, which can tackle mentioned challenges in the previously.

Truck platoon is a group of trucks connected by wireless connection and radars so that those trucks are driven at constant speed. Subsequently, the fuel consumption of each truck is reduced which results in a decrease in emissions to the environment as well. Truck platooning is believed, when reaching the last stage of development with full autonomy, to improve the lack of human workforce. With just one or even none of truck drivers, depending on transportation scenarios, up to three trucks are monitored to complete the transport work. The collected statistics positively foresee the future of the concept thanks to its current market value, with a number of key players having invested heavily. Some first tests have been carried out in the US, the regions of Asia-Pacific (APAC) and Europe - Middle East - Africa (EMEA). The infrastructure, as well as its ecosystem, is being constructed and encouraged greatly by local authority.

To answer the last question of the research, the author decided to conduct a couple of interviews to collect the primary data with the aim to debate whether or not the road freight industry is in crisis, and the future of truck platooning is awaited.

The result of the interview is not a surprise to the author when all of the participations, directly and indirectly related to the road freight business, agreed on the point that trucking industry needs more attention, especially after the Pandemic and during the political conflicts between Russia and the EU.

In terms of exploiting technology, specifically truck platooning, to improve the business, there are still questions. Obviously, the whole concept is a big chunk to digest when its development is not even completed and widely published. On the other hand, all the participants are either neutral or positive about what the future of truck platooning may bring. They all suggested a unanimous conclusion that technology is surely a game changer.

The research was carried out still in the early phase of the concept implementation when the real product is not yet commercialized. Therefore, data collected are still based on other research and people's perspective. Additionally, truck manufacturers are one of the key players in the field. Their views on the researched topic may alter the outcome of the study. Unfortunately, sample data from truck manufacturers were not collected, which weakens the author's argument and expectation about the future reality of the truck platooning concept.

6 Conclusions

The road freight industry has a huge impact on the environment, because transport is among the major users of the world's petroleum, which produces carbon emissions to the natural and human environment. Undoubtedly, its negative effects are reducing the quality of life for not only the present, but also for the next generation.

However, it goes without saying that modern lives will keep being busy; subsequently less mobility is not an option. Rather than that, how to transform future mobility to better suit our lives is a math to solve. A decade ago, who would ever imagine seeing electric charging points popping up in your neighborhood, and a common view of electric vehicles cruising down the streets. Technological innovation is a way out of dilemma for future mobility issues, especially for businesses engaging in the transportation industry.

> *It's interesting to see which concept will become more common in the near future, whether it is electric commercial vehicles, truck platooning or a platoon of electric trucks. [...]*

References

Ahola (2022) Driver shortage is turning into a real problem in the logistics industry, Ahola Transport. Accessed on 06 May 2023. Retrieved from https://www.aholatransport.com/articles/driver-shortage-is-turning-into-a-real-problem-in-the-logistics-industry/.

ACEA (2021) What are the benefits of truck platooning? ACEA. Accessed on 08 May 2023. Retrieved from https://www.acea.auto/fact/what-are-the-benefits-of-truck-platooning/#:~:text=Platooning%20results%20in%20a%20lower,emissions%20by%20up%20to%2010%25.

Alonso Raposo, M. (Ed.), Ciuffo, B. (Ed.), Alves Dies, P., Ardente, F., Aurambout, J-P., Baldini, G., Baranzelli, C., Blagoeva, D., Bobba, S., Braun, R., Cassio, L., Chawdhry, P., Christidis, P., Christodoulou, A., Corrado, S., Duboz, A., Duch Brown, N., Felici, S., Fernández Macías, E., Ferragut, J., Fulli, G., Galassi, M-C., Georgakaki, A., Gkoumas , K., Grosso, M., Gómez Vilchez, J., Hajdu, M., Iglesias, M., Julea, A., Krause, J., Kriston, A., Lavalle, C., Lonza, L., Lucas, A., Makridis, M., Marinopoulos, A., Marmier, A., Marques dos Santos, F., Martens, B., Mattas, K., Mathieux, F., Menzel, G., Minarini, F., Mondello, S., Moretto, P., Mortara, B., Navajas Cawood, E., Paffumi, E., Pasimeni, F., Pavel, C., Pekár, F., Pisoni, E., Raileanu, I-C., Sala, S., Saveyn, B., Scholz, H., Serra, N., Tamba, M., Thiel, C., Trentadue, G., Tecchio, P., Tsakalidis, A., Uihlein, A., van Balen, M., Vandecasteele, I., The future of road transport - Implications of automated, connected, low-carbon and shared mobility, EUR 29748 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-14318-5, doi: 10.2760/668964, JRC116644.

Anyoha, R. (2020) The history of Artificial Intelligence, Science in the News. Accessed on 08 May 2023. Retrieved from https://sitn.hms.harvard.edu/flash/2017/history-artificial-intelligence/.

Automated platooning – step by step (2020) Scania Group. Accessed on 15 May 2023. Retrieved from: https://www.scania.com/group/en/home/newsroom/news/2018/automated-platooning-step-by-step.html.

AVTSimulator (2023) The future of automobiles: Automated Truck platooning, Home. Accessed on 08 May 2023. Retrieved from: https://www.avtsim.com/automated-ai-truck-platoon/.

Business Research Methodology (2011). Inductive Approach (Inductive Reasoning). Accessed on 09 November 2020.Retrieved from: https://research-methodology.net/research-methodology/research-approach/inductive-approach-2/.

Cambridge Dictionary (2023) Platoon, Cambridge Dictionary. Accessed on 08 May 2023. Retrieved from: https://dictionary.cambridge.org/dictionary/english/platoon.

Chottani, A. et al. (2018) Distraction or disruption? Autonomous Trucks gain ground in US logistics, McKinsey & Company. McKinsey & Company. Accessed on May 2, 2023. Retrieved from: https://www.mckinsey.com/industries/travel-logistics-and-infrastructure/our-insights/distraction-or-disruption-autonomous-trucks-gain-ground-in-us-logistics#/.

Co-Operation with Scania Reaches New Heights (2018).

Goble, K. (2023) Eight states pursue truck platooning rule changes, Land Line. Accessed on 15 May 2023. Retrieved from: https://landline.media/eight-states-pursue-truck-platooning-rule-changes.

IMF (2021) World Economic Outlook, April 2023: A Rocky Recovery, IMF. Accessed on 06 May 2023. Retrieved from: https://www.imf.org/en/Publications/WEO#:~:text=Global%20headline%20inflation%20in%20the,before%202025%20in%20most%20cases.

Lee, G. (2023) Japan is leading the way into the elderly-population future. its solution? AI-powered "society 5.0", Verdict. Accessed on 06 May 2023. Retrieved from: https://www.verdict.co.uk/japan-is-leading-the-way-into-the-elderly-population-future-its-solution-ai-powered-society-5-0/.

Lee, Y., Ahn, T., Lee, C., Kim, S., & Park, K. (2020). A novel path planning algorithm for truck platooning using V2V communication. Sensors, 20(24), 7022.

Mailonline, R.B.F. (2021) IKEA sees shortages on 1,000 products as lorry driver shortage and global supply crisis hits chain, Daily Mail Online. Associated Newspapers. Accessed on 05 May 2023. Retrieved from: https://www.dailymail.co.uk/news/article-9961113/Ikea-sees-shortages-1-000-products-lorry-driver-shortage-global-supply-crisis-hits-chain.html.

Marr, B. (2019). What is Industry 4.0? Here's A Super Easy Explanation For Anyone. Forbes. Accessed on 11 July 2023. Retrieved from: https://www.forbes.com/sites/bernard-marr/2018/09/02/what-is-industry-4-0-heres-a-super-easy-explanation-for-anyone/.

Mathis, W. (2023) Climate change news: Global CO2 emissions hit record in 2022; Europe's dipped, Bloomberg.com. Bloomberg. Accessed on 4 November 2020. Accessed on 04 May 2023.Retrieved from: https://www.bloomberg.com/news/articles/2023-03-02/global-co2-emissions-hit-record-in-2022-even-as-europe-s-dipped.

Maersk (2022) How increasing fuel prices are affecting supply chains, Maersk. Accessed on 04 May 2023 . Retrieved from: https://www.maersk.com/insights/resilience/fuel-price2023.cting-supply-chains.

Mezmir, E. A. (2020). Qualitative data analysis: An overview of data reduction, data display, and interpretation. Research on humanities and social sciences, 10(21), 15-27.

Ministerie van Infrastructuur en Waterstaat (2020) Truck platooning, Mobility, public transport and road safety | Government.nl. Accessed on 09 May 2023.Retrieved from: https://www.government.nl/topics/mobility-public-transport-and-road-safety/truck-platooning.

Janssen, G. R., Zwijnenberg, J., Blankers, I. J., & de Kruijff, J. S. (2015). Truck platooning: Driving the future of transportation.

Jilcha Sileyew, K. (2019). Research Design and Methodology. Text Mining - Analysis, Programming and Application. Accessed on 08 October 2020. Retrieved from: https://www.intechopen.com/online-first/research-design-and-methodology.

J.P. Morgan (2022) How are sanctions against Russia impacting oil and gas prices? Energy outlook: J.P. Morgan, How are sanctions against Russia impacting oil and gas prices? | Energy Outlook .Accessed on 06 May 2023. Retrieved from: https://www.jpmorgan.com/insights/research/oil-gas-energy-prices.

Poola, I. (2017). How artificial intelligence is impacting real life everyday. International Journal for Advance Research and Development, 2(10), 96-100.

Reed, S. (2022) The European Union seeks independence from Russian oil and gas., The New York Times. The New York Times. Accessed on 06 May 2023. Retrieved from: https://www.nytimes.com/2022/03/08/business/european-union-russia-oil-gas.html#:~:text=Some%2045%20percent%20of%20the%20European%20Union%E2%80%99s%20gas,these%20goals%20by%20saving%20energy%20and%20diversifying%20supplies.

Rizzoli, A.R. (2021) Ai in transportation: 9 disruptive use cases [2023 update], AI in Transportation: 9 Disruptive Use Cases [2023 Update]. Accessed on 02 May 2023. Retrieved from: https://www.v7labs.com/blog/ai-in-transportation.

Saunders, M. N. K., Lewis, P., & Thornhill, A. (2015). Research Methods for Business Students (7th ed.). Essex, England: Pearson Education Limited.

Scania and Ahola transport agree on semi-autonomous platooning (2018) Green Car Congress.Accessed on 15 May 2023. Retrieved from: https://www.greencarcongress.com/2018/03/20180308-scania.html.

Scania takes part in multi-brand Platooning Project (2020) Scania Group. Accessed on 15 May 2023. Retrieved from: https://www.scania.com/group/en/home/newsroom/news/2017/scania-takes-part-in-multi-brand-platooning-project.html.

Simons, Helen. Case Study Research in Practice, SAGE Publications, Limited, 2009. ProQuest Ebook Central. Retrieved from: http://ebookcentral.proquest.com/lib/jypoly-ebooks/detail.action?docID=743724.

Statista (2020). Road freight transport as a percentage of total inland freight transport in Finland from 2005 to 2018. [online] Statista. Accessed 5 November 2020. Retrieved from: https://www-statista-com.ezproxy.metropolia.fi/statistics/1069248/finland-road-freight-share-of-inland-transport/.

Stepper, M. (2023) Truck driver shortage in Europe, DHL Freight Connections. Accessed on 05 May 2023.Retrieved from: https://dhl-freight-connections.com/en/business/truck-driver-shortage-in-europe/.

Tran, T.K. (2021) Freight Spend Visualization and Analytics with BI Tools. dissertation.

Traficom (2019). Postal Market Report. [online] Traficom. Accessed on 5 November 2020. Retrieved from: https://www.traficom.fi/en/news/parcel-volumes-continued-strong-growth-letter-newspaper-and-magazine-deliveries-declined.

Vision truck platooning 2025: Creating next generation mobility (2016) YouTube. EU Truck Platooning. Accessed on 02 April 2023. Retrieved from: https://www.youtube.com/watch?v=I-xMdybBzUY.

WHO (2022) Ambient (outdoor) Air Pollution, World Health Organization. World Health Organization. Accessed on 05 May 2023.Retrieved from: https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health.

Zeist, S.van (2023) DHL Road Freight Market News – January/February 2023, DHL Freight Connections.Accessed on 02 April 2023. Retrieved from: https://dhl-freight-connections.com/en/trends/dhl-road-freight-market-news-january-february-2023/.

Zsófia, P. (2023) German hauliers call for suspension of Sunday HGV ban to mitigate Monday's "Mega strike". Trans.INFO. Accessed on 06 May 2023.Retrieved from: https://trans.info/en/mega-strike-in-germany-33302