

## Article

# Perceptions of Transport Automation amongst Small- and Medium-Sized Road Haulage Companies in Finland

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**Abstract:** Transport automation is increasingly being studied from different perspectives; however, the perceptions of road haulage companies have received less attention. This study explores the views of representatives of small- and medium-sized road haulage companies on transport automation in Finland. We conducted an online survey to gather perceptions of automation, which received 254 responses from representatives of a range of different transport industries. The respondents' views towards automation were generally negative. The overall view was that automation may not be possible for heavy vehicles in Finland due to the adverse weather and driving conditions. The perception was that road haulage automation is unlikely to occur before 2050 in Finland. The results provide valuable insight for vehicle manufacturers, technology developers, policy makers, and haulage companies. As the road haulage industry is dominated by small- and medium-sized companies, hauliers should be supported in actively implementing new technologies.

**Keywords:** road freight; road haulage; automation; automated vehicles; autonomous vehicles; survey



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## 1. Introduction

Road haulage is the backbone of freight transport, especially for domestic freight. In Finland, 86% of freight is transported by road, more than any other country in Europe [1]. The road freight sector directly employs approximately 50,000 drivers in Finland, while approximately 100,000 people are employed throughout the logistics chain [1]. Road freight supports both industrial (e.g., manufacturing and construction) and service (e.g., trade and maintenance) industries, and its operation is crucial to the functioning of society, as recently highlighted during the COVID-19 pandemic and the aftermath of Brexit. In 2019, the turnover of Finnish road freight companies was 6.5 billion euros [2], with logistics representing 12% of gross domestic product (GDP) in Finland [1]. These statistics highlight the importance of road freight to the Finnish economy and the need to understand and develop the industry in the future.

Companies in the road freight sector are typically small in terms of the number of people employed, their turnover, and the number of vehicles operated [3]. This is also the case in Finland, with most companies operating between one and three vehicles [1]. In Finland, small- and medium-sized enterprises (SMEs) are defined as companies which have fewer than 250 employees and have either an annual turnover of less than 50 million euros or an annual balance-sheet total below 43 million euros [4]. As such, SMEs represent about 90% of turnover amongst Finnish road freight haulage companies [2]. However, there is a trend towards larger organisations in the road freight sector in Finland, with the number of registered companies decreasing in recent years, while the total number of

employees across all organisations has increased [5]. The rising size of the industry and the growing number of employees have raised concerns regarding future driver shortages in Finland [6], an issue that has been reported in several other countries, including Ireland [7] and the USA [8].

To date, no studies have considered perceptions of automation amongst road freight haulage companies from the Finnish context, where there are unique factors associated with the operating environment, especially the Nordic climate with wintry weather and challenging road conditions [9]. As such, there is a need to understand road freight haulage companies' perceptions and readiness for automation. Investigating these issues will highlight the barriers that need to be addressed to realise the benefits of automation, understand political issues, and ultimately help facilitate road freight haulage companies' use of automated vehicles in the future. This study addresses the following questions regarding automation from the perspective of small- and medium-sized road haulage companies in Finland:

- How prepared are the hauliers for transport automation?
- What are the hauliers' perceptions of automation?
- What are the perceived barriers to automation for the hauliers?
- When do the hauliers consider that road haulage automation will become a reality?

To answer these questions, a survey was conducted amongst Finnish road haulage companies. As most Finnish road hauliers are employed by small- and medium-sized companies, it was decided to focus on the perceptions of these companies' representatives. Furthermore, it is likely that the challenges and perceptions faced by large companies are different.

The remainder of this manuscript is structured as follows: Section 2 presents the findings from the literature regarding the status and potential effects of automated road haulage vehicles. In Section 3, the methodology of the survey is presented. Section 4 presents the results of the survey, Section 5 includes a discussion of the findings, and Section 6 concludes the manuscript.

## 2. Status and Potential Effects of Automated Heavy-Duty Vehicles

The adoption of automation and advanced driver assistance systems (ADAS) is a key action promoted by the European Union to improve road safety [10]. Various ADAS, such as intelligent speed control (ISA), will become compulsory in new cars, buses, and heavy vehicles by 2022 in accordance with Regulation (EU) No. 2019/2144 [11]. Other systems, including automatic emergency braking (AEB) and lane departure warning systems (LDW), were made compulsory in new heavy vehicles in 2015 in accordance with Regulation (EC) No. 661/2009 [12]. These ADAS technologies represent level 1 and 2 automation in accordance with the taxonomy developed by SAE [13]. However, currently there are no clear timelines regarding the implementation of higher levels of automation in the EU. Research investigating LDW shows that heavy vehicles without this system have a 1.9 times higher crash rate compared to equipped vehicles [14] and comparable benefits have been estimated for lane keeping assistance (LKA) technologies [15]. Similarly, estimates suggest that AEB could prevent between 6 and 12% of heavy vehicle crashes [16,17]. Furthermore, when ADAS are utilised in combination, it is estimated that they could prevent approximately 25% of fatal car crashes [18]; however, comparable evaluations are needed to quantify the cumulative benefits for heavy vehicles.

Beyond road safety, the development of connected and autonomous driving technologies can increase productivity and freight haulage profitability due to reductions in labour and fuel costs [19,20], which may help to address labour shortages. Furthermore, autonomous vehicles may also offer societal benefits through reductions in emissions [21]. Given these benefits, it is easy to see why automation could represent an attractive option for road freight haulage companies. However, Lehtonen posits that the automation of vehicles will not ease the problems faced by the freight industry [6]. Instead, solutions should be sought to create more direct routes for young people to become drivers and

efforts should be made to increase the attractiveness of the profession by employers and the industry. These views are in line with findings from Ji-Hyland and Allen, who note that driver shortages are linked with recruitment strategies, driver vocational training, and job satisfaction [7]. However, the automation of freight vehicles could make the profession of freight haulage driver redundant. With fewer drivers, the cost structure and business model for freight operators would change significantly [22]. Given that staff expenses in Finnish road haulage companies represent 25.9% of company turnover [5], automation could present a significant cost saving. Furthermore, automation technologies offer a range of road safety benefits for freight operators, which could help to reduce operational costs.

Heavy vehicle platooning is seen as the first step towards achieving these efficiency savings from automation [23]. Some have predicted that autonomous heavy vehicles, where the driver is not needed most of the time, could become a reality on specific roads in the 2020s and be widespread by the 2040s [24]. This could allow heavy vehicles to travel without the driver needing to take long breaks and lower operating costs [25]. However, adverse weather conditions and large variations in road types and geometry challenge the development and introduction of automated vehicles in Finland [26]. As such, while a driver might not be needed throughout the whole journey, they may be required for some parts and would still need to perform a monitoring role. Other issues regarding the adoption of autonomous technology include social consequences, such as job losses, the misuse of data, deficiencies in technical infrastructure, the potential that automation could increase costs, and general uncertainties surrounding the way that the vehicles will function [27].

Notwithstanding these potential issues, research has demonstrated positive views towards automation amongst freight companies. In their study of potential users' acceptance of automation technology amongst logistics and forwarding companies, Müller and Voigtländer stated that companies see potential benefit for automated trucks due to the increasing scarcity of drivers, the increasing cost pressure, low margins, and the increasing need for efficient logistics processes [23].

Similarly, Anderhofstadt and Spinler found that freight companies evaluate autonomous heavy-duty trucks (HDTs) as beneficial and are generally open to utilising autonomous HDTs [21]. They also emphasise that, in order to spur the penetration of autonomous HDTs, a close collaboration between different stakeholders such as truck manufacturers, customers, infrastructure companies, and policymakers is crucial. Furthermore, freight companies view conditional and full driving automation as being able to enhance and modify the job of truck drivers as well as helping to solve the current and forthcoming issue of the shortage of qualified truck drivers [21].

Engholm et al. analysed driverless trucks in Sweden based on twenty expert interviews using a technical innovation framework [28]. They found a general view that driverless trucks represented an important opportunity for Sweden and that driverless trucks were expected to bring sustainability benefits. However, it remained unclear amongst the interviewees if these benefits would be realised and what potential negative side effects could occur. Engholm et al. also noted that, while a few studies have investigated the perception of vehicle automation amongst freight companies, there has been a scarcity of research compared to the number of studies investigating the perceptions of automation in passenger transport [28]. This study provides insight into the perceptions of transport automation amongst representatives of small- and medium-sized road haulage companies to address this gap.

### 3. Methods

#### 3.1. Survey Participants and Procedure

There are approximately 10,000 road freight haulage companies operating in Finland [1]. Nearly half of these belong to the organisation Finnish Transport and Logistics SKAL (Suomen Kuljetus ja Logistiikka). SKAL is a lobbying organisation and represents companies offering road haulage and logistics services in Finland. In addition to lobbying,

SKAL also offers different services, including legal, financial counselling, and interpretation of decrees to its members.

This study reports on a quantitative survey conducted amongst SKAL members that ran between November and December 2019. SKAL members are Finnish road freight companies, and the email went out to company representatives who, in most cases, are the owners of these companies or other decision-makers.

An invitation to participate in the survey was sent via email to all SKAL members (4421) on 6 November. The survey was also advertised in a newsletter posted to SKAL members on 16 November. Survey responses were received between 6 November and 5 December. The survey was conducted using the online survey platform Webropol.

The survey questionnaire consisted of three parts: Part I: automation of road transport; Part II: energy efficiency and the environment; and Part III: background information. The total number of questions was 28.

The analysis presented in this study relates mostly to the questions investigating the automation of road transport (Part I) and respondents' background information (Part III), while only a few questions relating to energy efficiency and the environment (Part II) are addressed in this study. The original survey language was Finnish.

In total, 256 responses to the survey were received. As SKAL members are mostly small- and medium-sized companies, we decided to focus on these companies' perceptions when analysing the survey results. Thus, responses from the largest companies with more than 50 vehicles were removed from the analysis. After removing the large companies from the sample, 254 responses were included in the reported analysis. A summary of company information obtained for respondents is provided in Table 1. Approximately one quarter of the companies operated only one freight vehicle, while 39.4% operated 2 to 3 vehicles.

**Table 1.** Company size in terms of the number of vehicles and the transport industry in the analysed sample. The respondents could choose several transport industries.

		N	%
Number of vehicles	1	61	24.0
	2–3	100	39.4
	4–5	34	13.4
	6–10	35	13.8
	11+	20	7.9
	Not reported	4	1.6
Transport industry	Distribution	54	21.3
	Groceries transport	49	19.3
	Log/paperwood transport	42	16.5
	General cargo	73	28.7
	Transport with interchangeable platform/body	52	20.5
	Soil transport	57	22.4
	Other bulk cargo	40	15.7
	Tanker/ADR transport	14	5.5
	International transport	20	7.9
	Waste transport	22	8.7
	Other	35	13.8

Companies were asked to report the transport industries they worked within. There was a good distribution of reported industries across the responding companies. The most common responses were for general cargo (28.7%) and soil transportation (22.4%). Approximately half of companies worked in only one transport industry, with one-fifth working in two industries and around a quarter within three or more.

### 3.2. Analysis

This study presents a descriptive analysis of survey responses in terms of the status of preparation for automation within each company, the respondents' perceptions of automation, and their perceptions of barriers and polices related to automation in the road haulage sector.

The cross-tabulation of results was performed to assess differences in respondents' opinions regarding their preparation for transport automation and perceptions of automation based on the size of the company and if the company had begun to prepare for the automation of their fleet. Chi-squared tests ( $\chi^2$ ) were utilised to test statistical relationships between variables of interest. Fisher's exact test was used when individual cell sizes were below 5. Effect size was assessed using Cramer's V statistic ( $\varphi_c$ ). All data were analysed using IBM © SPSS v. 27 with alpha ( $\alpha$ ) set to 0.05.

## 4. Results

### 4.1. Status of Preparing for Automation

Company policies were assessed with two questions addressing if the company had set targets to reduce fuel consumption and if the company had prepared for transport automation (Table 2). Over half (55.2%) of the companies had implemented targets to reduce fuel consumption. However, preparation for automation was less common, with 55.9% of respondents stating that the issue had not been raised, while 39.0% of the responding organisations had only had informal discussions such as engaging in office talk about automation. Only one company had made decisions regarding plans for automation; interestingly, this company only operated one vehicle. All companies who had begun investigating automation operated at least two vehicles.

**Table 2.** Preparation for transport automation, setting targets for fuel consumption reduction, and driver assistance functions in company trucks in freight haulage companies.

Question	Response	N	%
Has your company set targets to reduce fuel consumption?	Yes	138	54.3
	No	112	44.1
	No response	4	1.6
Has your company prepared for transport automation for the coming decades?	Decisions, future plans or other, e.g., written documents, have been made about the utilisation of automation	1	0.4
	The effects of automation on business have been investigated	11	4.3
	Automation has been discussed informally	99	39.0
	The issue has not been raised at all	142	55.9
	No response	1	0.4
What driver assistance functions are currently available in your company trucks?	Automatic emergency braking (AEB)	91	35.8
	Adaptive cruise control (ACC)	86	34.0
	Lane departure warnings (LDW)	102	40.3
	Lane keeping assistance (LKA)	17	6.7
	All of the above	10	3.9
	None	126	49.6

Results were collapsed into a binary variable to compare companies that had and had not raised the issue of automation. Companies where the issue had been raised were found to be significantly more likely to have also set targets to reduce fuel consumption ( $\chi^2(1) = 20.52, p < 0.01, \varphi_c = 0.29$ ). Companies with larger fleet sizes were also more likely to have raised the issue of automation ( $\chi^2(4) = 24.8, p < 0.01, \varphi_c = 0.31$ ).

When asked what driver assistance functions were currently present in the company's fleet, the most commonly reported technologies were lane departure warnings (LDW) (40.3%), automatic emergency braking (AEB) (35.8%), and adaptive cruise control (ACC) (34.0%). Lane keeping assistance (LKA) was relatively rare compared to the other technologies. This may signify that the technology is only beginning to be adopted in heavy vehicles; however, it could also reflect a decision to not adopt this technology, perhaps due to the cost associated with new investment in vehicle technologies. All four technologies were reported by 10 respondents (3.9%). Almost half of the respondents did not have any of the four technologies available in their company vehicles.

Companies working in international transport (81%), tanker/ADR transport (79%), and food transport (68%) had the highest rates of technology adoption. Meanwhile, companies working in timber and log transport (33%), and soil transport (36%) were the least likely to have driver assistance functions available in their company trucks.

Companies which had raised the issue of automation had significantly higher rates of AEB ( $\chi^2(1) = 8.5, p = 0.03, \phi_c = 0.18$ ), ACC ( $\chi^2(1) = 14.6, p < 0.01, \phi_c = 0.24$ ), and LDW ( $\chi^2(1) = 15.5, p < 0.01, \phi_c = 0.25$ ) available in their vehicles. No significant differences were identified for LKA. Companies which had not raised the issue of automation were significantly more likely to not have any driver assistance functions in their fleet ( $\chi^2(1) = 10.8, p < 0.01, \phi_c = 0.21$ ). Similarly, smaller companies, particularly those with less than four vehicles, were significantly more likely to not have any driver assistance functions in their fleet ( $\chi^2(4) = 32.9, p < 0.01, \phi_c = 0.36$ ).

#### 4.2. Perceptions of Automation

Respondents were asked a series of questions regarding their perceptions of automation in the freight industry, including questions regarding how automation technology would impact their business, the preparedness of Finland for autonomous freight vehicles, and when they believe that automation technologies would be widely implemented across the road freight industry.

The majority (60.3%) of the respondents viewed the automation of freight vehicles negatively (Table 3). However, companies which had raised the issue of automation had significantly more positive views compared to companies which had not raised the issue ( $\chi^2(5) = 18.4, p < 0.01, \phi_c = 0.27$ ).

**Table 3.** Attitude and knowledge regarding road freight automation.

Question	Response	N	%
How do you feel about the automation of freight transport and autonomous trucks?	Very positive	16	6.3
	Slightly positive	25	9.8
	Neutral	49	19.3
	Slightly negative	70	27.6
	Very negative	83	32.7
	Unsure	11	4.3
I feel that my knowledge of the current level and the outlook for next years about road freight automation is:	Excellent	2	0.8
	Good	47	18.5
	Average	97	38.2
	Satisfactory	48	18.9
	Weak	54	21.3
	Unsure	6	2.4

Respondents most commonly felt that they had an average knowledge of road freight automation (38.2%), with only one-fifth of respondents feeling that they had good or excellent knowledge. Lower rates of self-reported knowledge of road freight automation were found for companies who had not raised the issue of automation ( $\chi^2(5) = 27.7, p < 0.01, \phi_c = 0.33$ ).

Next, the respondents were asked, on a five-point Likert scale, about their perceptions of automation (Table 4). The respondents generally held the view that larger companies would benefit the most from automation. This view was shared amongst the respondents irrespective of whether they had raised the issue of automation ( $\chi^2(4) = 490., p = 0.297, \phi_c = 0.14$ ).

**Table 4.** Perceptions of the four statements. The respondents were asked to assume that the development of automation would allow autonomous trucks to operate in all conditions on paved roads in Finland in 2030.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Large logistics and transport companies would benefit more from automation than small ( $N = 250$ ).	134 (53.6%)	76 (30.4%)	25 (10.0%)	9 (3.6%)	6 (2.4%)
Autonomous vehicles would bring significant savings to my company ( $N = 251$ ).	20 (8.0%)	54 (21.5%)	51 (20.3%)	36 (14.3%)	90 (35.9%)
Autonomous trucks would increase the efficiency of my company ( $N = 251$ ).	19 (7.6%)	50 (19.9%)	50 (19.9%)	44 (17.5%)	88 (35.1%)
Autonomous trucks would significantly change my company's haulage and its current practices ( $N = 251$ ).	57 (22.7%)	51 (20.3%)	55 (21.9%)	27 (10.8%)	61 (24.3%)

Most respondents did not feel that automation would bring cost savings to their business, and views towards efficiency improvements were also mostly negative. There was a more even distribution regarding if automation would change company practices; however, most respondents still disagreed.

Companies which had raised the issue of automation held favourable views towards autonomous vehicles, resulting in cost savings ( $\chi^2(4) = 20.0, p = 0.001, \phi_c = 0.28$ ) and efficiency improvements ( $\chi^2(4) = 18.2, p = 0.001, \phi_c = 0.27$ ), and were more likely to hold the view that automation would change the way their business operates ( $\chi^2(4) = 21.5, p > 0.001, \phi_c = 0.29$ ).

#### 4.3. Barriers and Policies Related to Automation

When asked about the possible barriers to automation in Finland (Table 5) most respondents felt that Finland's main and minor road networks were not suitable for autonomous trucks to operate in poor conditions. This was associated with the view that Finland's weather was too demanding for the full automation of trucks and that autonomous vehicles could not be built to operate in all conditions safely and reliably.

**Table 5.** Perceptions of possible barriers to road freight automation in Finland.

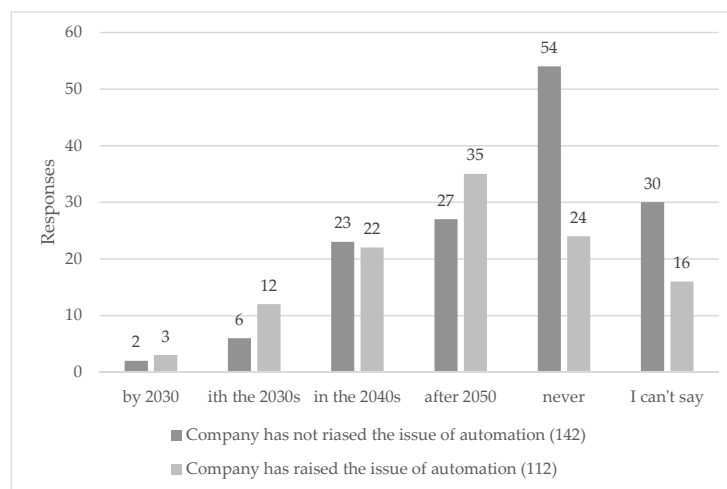
	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Finland's main road network does not allow autonomous trucks to drive due to inadequate characteristics or poor condition ( $N = 254$ ).	162 (63.8%)	73 (28.7%)	13 (5.1%)	3 (1.2%)	3 (1.2%)
Finland's minor road network does not allow autonomous trucks to drive due to inadequate characteristics or poor conditions ( $N = 254$ ).	220 (86.6%)	24 (9.4%)	7 (2.8%)	1 (0.4%)	2 (0.8%)
Finland's weather conditions are too demanding for autonomous driving in poor conditions ( $N = 254$ ).	171 (67.3%)	60 (23.4%)	16 (6.3%)	4 (1.6%)	3 (1.2%)
Autonomous trucks cannot be built to operate safely and reliably enough, even on motorways and in good weather conditions ( $N = 254$ ).	70 (27.6%)	83 (32.7%)	56 (22.0%)	34 (13.4%)	11 (4.3%)

Respondents' views regarding the role of the public sector and legislation are presented in Table 6. The respondents felt that Finland should allow autonomous vehicles to be tested on sections of the road network. However, the view was generally that the government should not provide financial support to develop pilot automation projects and that Finland should not be one of the first countries to legislate for autonomous trucks.

**Table 6.** Perceptions of three statements on the role of the public sector and legislation related to road traffic automation in Finland.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
The legislation should allow autonomous trucks to be tested on limited basis on certain road sections (e.g., specific motorway sections), provided that there is an assigned driver responsible for the safety on board (N = 254).	75 (29.5%)	94 (37.0%)	45 (17.7%)	19 (7.5%)	21 (8.3%)
Public administrations should provide financial support for pilot projects aimed at automation of road freight transport (N = 254).	27 (10.6%)	45 (17.7%)	73 (28.7%)	47 (18.5%)	62 (24.4%)
Finland should be among the first countries to legalise autonomous driving (N = 254).	11 (4.7%)	24 (9.4%)	47 (18.4%)	50 (19.5%)	122 (48.0%)

Finally, the participants were asked when they thought autonomous vehicles would be capable of driving on all paved roads and in all weather conditions in Finland. The largest proportion of respondents (n = 78, 31%) did not believe that this would ever occur in Finland (Figure 1). Approximately 24% (n = 62) of the respondents believed that this would happen after 2050, and 18% (n = 45) of the respondents believed that this would occur in the 2040s. Only 7% (n = 18) of the respondents believed that implementation would take place in the 2030s, and 2% (n = 5) believed that it would take place by 2030. Respondents from companies where the issue of automation had been raised were more positive regarding the timeline, albeit the general view was that automation under all conditions was unlikely to occur in the next 20 years.



**Figure 1.** Responses to survey question “When do you believe autonomous trucks will be able to drive on all paved roads in Finland in all circumstances?”.



## 5. Discussion

The automation of road freight haulage represents an important opportunity and promises a myriad of benefits, including improved safety, increased productivity, and increased profitability through reductions in labour and fuel costs [28]. The aim of this study was to assess the perceptions of the automation of Finnish road freight haulage companies. This section is structured following the four research questions presented in the introduction. Following the discussion of the research question, the limitations and areas for future research are presented.

The first research question addressed the question “How prepared are Finnish road haulage companies for transport automation?”. Overall, the responses revealed some anticipation of transport automation amongst the surveyed road freight haulage companies. However, more than half of the respondents reported that the issue of automation had not been raised in the company. In companies where the issue had been raised, it was generally in the form of informal conversations, while very few had begun to formally prepare. The analysis highlighted that preparedness for automation was associated with the size of the companies’ fleet, with larger companies being more likely to have commenced preparation for automation.

The respondents considered that larger road freight haulage companies would be more likely to benefit from transport automation compared to smaller operators. Automation offers potential for cost savings—for example, through the platooning of vehicles, either when travelling on freeways or when making large deliveries to the same destination [24], or through increasing vehicle utilisation and operating times and reducing labour costs [19,29]. The purchase of autonomous vehicles also represents a major capital expenditure which may not be feasible for the SMEs that dominate road haulage in Finland [3], as these SMEs are typically characterised as having small margins, making it difficult for them to invest in new technologies [30]. It is noted that there are only a small number of large road freight companies in Finland and, due to their different operational characteristics, future research investigating their perceptions and use of automation is warranted.

Exposure to new technologies also plays an important role in their acceptance [31]. Larger organisations have been shown to have previous experience with other vehicle technologies, such as telematics systems for driver and fuel monitoring and vehicle tracking [3]. These experiences may increase their willingness to embrace other technology innovations. In fact, when asked if ADAS systems were currently being utilised in their fleet, there was a significant association with fleet size and variations were noted across different transport industries. Similarly, companies in which the issue of automation had already been raised were significantly more likely to have ADAS technologies in their vehicles—in essence, they had already adopted low levels of automation technologies [13]. These findings show that the size of the road freight haulage company and the current situation regarding the use of technologies in its fleet are associated with preparedness for automation. In general, Finnish road freight haulage companies have made limited preparation for implementing higher levels of automation, and the smaller companies in particular should be encouraged to implement new technologies to gain the benefits already available—for example, increased safety.

The lack of preparation for automation was found to be associated with generally negative attitudes towards automation, which was the theme of the second research question. Most respondents believe that automation is likely to only benefit large organisations, with small operators not believing that automation would bring savings or efficiency benefits to their business. Müller and Voigtländer state that companies see potential benefit for automated trucks due to the increasing scarcity of drivers, the increasing cost pressure, low margins, and the increasing need for efficient logistics processes [23]. However, research by Oberhofer and Fürst found that SME road haulage companies tended to be unlikely to invest in environmental measures unless they came under economic or legislative pressures, and the same is likely to be true for safety and automation technologies [30]. This is likely to represent a barrier to automation, with the cost of upgrading a fleet of vehicles being

prohibitive for SMEs who have a general reluctance to make capital investments due to the small margins in the industry.

Other perceived barriers included the condition of the Finnish road network. While views of the major road network were more favourable, respondents identified that upgrades to both the major and minor roads in Finland were required in order to facilitate autonomous vehicle operation. These upgrades can include dedicated lanes to safely facilitate platooning [24,32]. In a recent study undertaken in northern Finland using autonomous buses, the respondents felt that buses would only be suitable in the centre of towns and that operation would not be suitable for the unpaved minor roads in the area, especially in winter [33]. Similar to the study by Launonen et al., weather conditions were identified as a significant barrier to automation in this study [33]. This combination of poor roads and adverse weather conditions appears to lead to the view held by many that autonomous vehicles cannot be built to operate safely in Finland. This highlights a potential avenue for future research: quantifying to what extent the Finnish road network could accommodate automation while also determining the infrastructure upgrades required.

Finally, the participants were asked when they felt that automation would become a reality in Finland. Generally, the responses to this question were pessimistic, and many respondents thought that automation would never be possible across the entire road network. This result was somewhat surprising, as previous research conducted amongst road haulage companies in Germany identified positive views towards switching to autonomous heavy vehicles [21]. Similarly, research carried out amongst Finns found that 64% were positive about transport automation and that they were generally ready to use autonomous vehicles, provided that safety and reliability could be guaranteed [34]. However, it should be noted that this survey focused specifically on the automation of road freight, while the question in the citizens' survey referred to road traffic automation in general.

Pessimistic views towards automation may be more likely to change as exposure increases. Similarly, upgrades to the road network that facilitate automation are likely to improve perceptions. When asked about using Finnish roads for technology trials in real-world conditions, the responses were generally positive. However, respondents tended to disagree that trials should be financially supported by the government, with the view that Finland did not need to be one of the first countries to legalise autonomous driving. Yet, Finland presents unique challenges due to the Nordic environment and climate conditions, and these issues warrant further research and trials to address these issues within a Finnish context.

This study provides insight into the perceptions of transport automation amongst road haulage companies in Finland based on a survey of SKAL member companies. While the insights provide perspective on this issue, this study is not without limitations. SKAL members represent about half of Finnish road haulage companies. Despite the large sample included in the study, the use of SKAL members represents a selection bias and there may be differences between the opinions of members and non-members.

This research is also susceptible to common limitations of self-reported surveys. This method could potentially have introduced a self-selection bias into the sample, with those with strong views towards automation being more inclined to participate in the study. Similarly, the self-reported nature of the research may introduce social desirability biases. However, some of these issues are likely to have been overcome due to the anonymity of the study. Future research to develop a more comprehensive understanding of transport automation amongst Finnish haulage companies is warranted. Furthermore, there are a range of important issues that have not been addressed in this study, such as the prerequisites, enabling factors, and benefits as well as the challenges and threats related to automation that could provide further understanding. There is also a need to explore the internal and external barriers to the adoption of automation in greater detail, particularly focusing on organisational barriers to automation. It is recommended that future research should adopt a mixed-methods approach and include semi-structured interviews to gather in-depth knowledge from road freight haulage operators. Future studies should also

investigate larger hauliers, as this group of companies are likely forerunners in the field and may have a higher potential to adopt automation. Notwithstanding, this research presents a unique insight into road freight haulage companies in Finland and their perceptions of automation.

## 6. Conclusions

This study aimed to provide an improved understanding of road freight haulage companies' perceptions of and readiness for automation. Overall, the findings of this study highlight a generally negative view towards road freight automation amongst SME road haulage companies, which contrasts with the views of the general population towards road traffic automation. Key issues identified by freight operators related to implementing haulage automation in Finland include the condition of the Finnish road network and the ability of automated vehicles to operate safely in all conditions. According to the respondents' views, road haulage automation is unlikely to occur on all paved roads before 2050 in Finland.

Further research and development will enhance automation technology, while upgrades to the road network are needed to facilitate automation. Successful demonstrations of automation should lead to improved perceptions of these technologies, and ultimately this should lead to safety and efficiency benefits for the road freight haulage sector. As such, there is a need for further research on this topic to increase understanding of the issues and perspectives among road freight haulage companies as automation technologies advance.

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