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A Multi-Modal Warning–Monitoring System Acceptance Study: What Findings Are Transferable?

Christelle Al Haddad [1,*], Mohamed Abouelela [1], Graham Hancox [2], Fran Pilkington-Cheney [3], Tom Brijs [4] and Constantinos Antoniou [1]

1 Chair of Transportation System Engineering, Technical University of Munich, 80333 Munich, Germany
2 Digital and Technology Services, University of Nottingham, Nottingham NG7 2RD, UK
3 NTU Psychology, School of Social Sciences, Nottingham Trent University, Nottingham NG1 4FQ, UK; fran.pilkington-cheney@ntu.ac.uk
4 School for Transportation Sciences, Transportation Research Institute, UHasselt, Wetenschapspark 5, 3590 Diepenbeek, Belgium
* Correspondence: christelle.haddad@tum.de

Abstract: Advanced driving-assistance systems (ADAS) have been recently used to assist drivers in safety-critical situations, preventing them from reaching boundaries of unsafe driving. While previous studies have focused on ADAS use and acceptance for passenger cars, fewer have assessed the topic for professional modes, including trucks and trams. Moreover, there is still a gap in transferring knowledge across modes, mostly with regards to road safety, driver acceptance, and ADAS acceptance. This research therefore aims to fill this gap by investigating the user acceptance of a novel warning–monitoring system, based on experiments conducted in a driving simulator in three modes. The experiments, conducted in a car, truck, and tram simulator, focused on different risk factors, namely forward collision, over-speeding, vulnerable road user interactions, and special conditions including distraction and fatigue. The conducted experiments resulted in a multi-modal dataset of over 122 drivers. The analysis of drivers' perceptions obtained through the different questionnaires revealed that drivers' acceptance is impacted by the system's perceived ease of use and perceived usefulness, for all investigated modes. A multi-modal technology acceptance model also revealed that some findings can be transferable between the different modes, but also that some others are more mode-specific.

Keywords: driving simulator; warning system; technology acceptance model; multi-modal; professional drivers; road transportation

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1. Introduction

Road safety research has commonly focused on a specific set of risk factors, aiming to achieve a better understanding of the factors influencing risky situations, to develop a set of guidelines and policy recommendations that could help mitigate such cases. While existing studies cover different modes of transport, most focus on passenger cars, with fewer studies (in comparison) dedicated to professional driving modes (such as trucks, trams, etc.). In recent years, advances in technology have enabled the spread of advanced driving assistance systems (ADAS), to help drivers mitigate unsafe driving boundaries. Accordingly, it has also become crucial to better understand drivers' perceptions of such systems, to help improving their design and operation. One opportunity to test ADAS would be to install them in driving simulator environments, as the latter provide relatively safe boundaries within which they can be tested, thereby allowing the assessment of drivers' perceptions of them. While this was done in previous research, it was mostly limited to passenger cars [1–4], except in Schindler and Piccinini [5], who highlighted the importance of ADAS in preventing vulnerable road user (VRU) collisions for trucks. A study by Jung et al. [6] also highlighted the perceived importance of ADAS for tram drivers; this was, in particular, the case for navigation-based speed profile generator, driver fatigue warning, and emergency brake assist. Still, very limited research exists overall for truck and tram driving simulators. While certain risk factors may be a particular issue for certain transport modes, such as sleepiness and fatigue being an issue in shift-working truck drivers [7], many other factors are common across modes, such as vulnerable road user interactions or collisions, forward collisions, etc. A gap in research exists in investigating the similarities and differences across modes, which might help transferring findings where applicable, but also focusing research where needed. This paper aims to fill this gap by assessing drivers' acceptance to a warning–monitoring system, developed within the context of an EU naturalistic driving study project (i–DREAMS), and common across different modes, namely cars, trucks, and trams. The assessment will be done using questionnaire data from a multi-modal driving simulator study. In particular, the aim of this paper is to assess the findings in order to highlight the similarities and differences between professional drivers (trucks and trams) and passenger car drivers, to help advising future similar studies. The objectives of this work would be, therefore, to: (*i*) identify the factors affecting the system's acceptance for trucks and trams; (*ii*) compare those with the factors of interest for passenger cars; and (*iii*) develop a multi-modal ADAS acceptance model, highlighting the common findings across the modes, as opposed to the mode-specific ones.

In the rest of the manuscript, the methods used are presented under Section 2, including the study design, the study protocol for data collection, and the data analysis and model development tools. After that, Section 3 presents the data collected, including the sample characteristics, and an initial exploratory data analysis, including a descriptive analysis based on the questionnaire data, but also a qualitative analysis, resulting from the open-ended questions within those questionnaires. In Section 4, the developed models are given, including the exploratory factor analyses results, but also the models testing the different hypotheses within the technology acceptance models. Finally, Section 5 discusses the main findings for the truck and tram studies, compares them with the previous findings of the car driving simulator study, and presents the validated multi-modal technology acceptance model based on the different simulator experiments. The section also answers the research questions initially developed, highlights the study limitations, but also draws insights for future research.

2. Methods

As highlighted in Section 1, a comparison between different modes of transport, namely professional drivers of trucks and trams with passenger cars, is still scarce within the road safety literature. An opportunity therefore arises in pinpointing findings that are transferable across modes, as transport modes can, arguably, learn from each other (as previously indicated by Papadimitriou et al. [8]). This work focuses in particular on studying the multi-modal driver acceptance of a warning–monitoring systems (ADAS), based on a large-scale driving simulator experiment; the research will elaborate on a unique dataset collected within the context of a large-scale European naturalistic driving experiment (i–DREAMS), and result in a driving simulator dataset of 122 drivers (the number includes the data collected and analyzed within the scope of this manuscript only; in reality, and at the time of writing this paper, more data was collected, but were not yet available for analysis) across different modes (cars, trucks, trams).

2.1. Study Design

2.1.1. Objectives and Hypotheses

The overall objectives and hypotheses to be tested within the driving simulator experiments follow the experimental protocol defined within the i–DREAMS project [9,10]. The overarching project objectives is to setup a framework for the definition, development, testing and validation of a context-aware safety envelope for driving ('Safety Tolerance Zone'), within a smart Driver, Vehicle & Environment Assessment and Monitoring System (i-DREAMS). Taking into account driver background factors and real-time risk indicators associated with the driving performance, as well as the driver state and driving task complexity indicators, a continuous real-time assessment will be made to monitor and determine if a driver is within acceptable boundaries of safe operation. Then, safety-oriented interventions will be developed to inform or warn the driver in real-time, in an effective way as well as on an aggregated level after driving through an app- and web-based gamified coaching platform. The project has different stages, including both driving simulator experiments, but also on-road field trial experiments. The aim of the driving simulator experiments is to test the developed technology in a driving simulator context, in order to test its effectiveness, but also provide recommendations for further improvements.

In particular, driving simulator experiments are planned to take place in five countries for four transport modes (in this paper, data and findings from driving simulator experiments are presented except the ones in Greece and Portugal, which were not made available at the time this paper was written). The characteristics of the investigated parameters across the driving simulators are presented in Table 1.

Table 1. Characteristics of the multi-modal driving simulator experiments.

	Transport Mode	**Car**		**Tram**	**Truck**	**Bus**
	Country	**Germany**	**Greece**	**UK**	**Belgium**	**Portugal**
Risk factors	Forward collision	•	•		•	•
	Illegal overtaking		•			•
	Over-speeding			•	•	
	VRU collision	•		•		•
	Bad weather		•			
	Distraction	•				•
	Fatigue/ sleepiness			•	•	
	Environment	Rural Urban Highway	Rural Urban Highway	Urban Suburban	Rural Highway	Rural Urban Highway

2.1.2. Data Collection Instruments

This paper presents the findings from the simulator experiments conducted in Germany (cars), Belgium (trucks), and the UK (trams). An overview of the simulators in different modes is given in Figure 1. As previously mentioned, these simulators have been equipped with an advanced and customized warning–monitoring system, with warnings to prevent different risk factors, which come in different stages, including both visual and auditory warnings. An overview of the different warnings used within the experiments is given in Figure 2; at the beginning of the different driving sessions, participants were shown the different pictograms, along with an explanation of their meaning, so that they were briefed about the warnings before they started the experiments. In particular, for the experiments described and assessed in this paper, warnings of interest include forward collision warnings, pedestrian collision warnings, over-speeding warnings, illegal overtaking warnings, distraction warnings, and fatigue and sleepiness warnings.

Figure 1. Driving simulators for the different modes: (**a**)—Passenger cars, (**b**)—Trucks (heavy vehicle simulator), (**c**)—Trams.

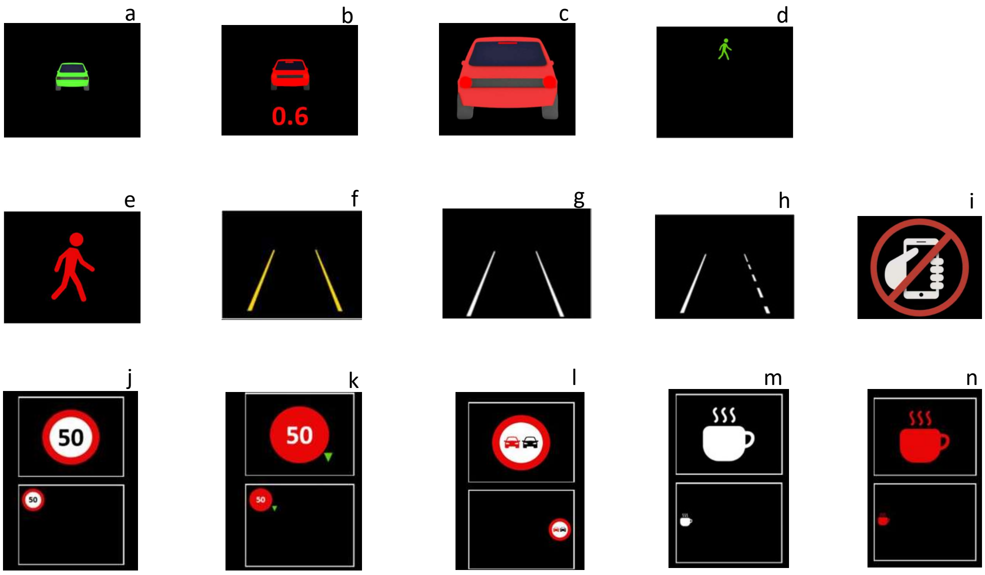

Figure 2. Warning symbols: (**a**)—Headway monitoring (normal driving); (**b**)—Headway monitoring (Stage 2); (**c**)—Forward collision warning (**d**)—Pedestrian warning (Stage 1); (**e**)—Pedestrian warning (Stage 2); (**f**)—Lane monitoring (Stage 0-unavailable); (**g**)—Lane monitoring (Stage 0—active); (**h**)—Lane departure warning (Stage 1); (**i**)—Distraction (smartphone usage) warning; (**j**)—Speed limit indication (Stage 0—speed limit is detected; (**k**)—Speed limit warning (Stages 1 and 2); (**l**)—Illegal overtaking warning; (**m**)—Fatigue warning (Stage 1); (**n**)—Fatigue warning (Stages 2 and 3).

2.2. Study Protocol and Data Collection

In order to mitigate risk factors presented in Table 1, this study has designed driving simulator experiments in different modes, each focusing on one or more risk factors. The experimental protocol consisted of a similar set-up for all modes: completing a set of consent forms, and driving in the simulator in three different drives including a baseline drive (normal drive, without any interventions), an intervention drive, and a third drive (with interventions, and with special conditions to be investigated, such as distraction, bad weather condition, or sleepiness and fatigue). In between the drives, a set of questionnaires were also filled, to assess drivers' intial perceptions of ADAS and driving, both before and after being exposed to the interventions to be assessed. The experimental protocol for the various modes followed a set of data handling guidelines, including a special focus on ethical, legal, and data protection considerations [11].

The detailed experimental design for the different modes is provided in Pilkington-Cheney et al. [9], de Vos et al. [12]. In particular, in Germany, the design focused on safety-critical events for vulnerable road user collisions, tailgating, and distraction; the full experimental design for the experiments conducted in Germany is given in Amini et al. [13]. For the truck experiments, participants first drove a baseline drive, followed by two drives where they received visual information about the enforced speed limit, but also visual and auditory warnings when exceeding the speed limit; the modified condition in the third driver consisted of a high level of sleepiness setting. Each of the drives was a 15 min drive; the total length for each scenario was approximately 15 km and took about 15–25 min to complete. Finally, the tram scenarios focused on VRU detection and fatigue/sleepiness. Participants were professional tram drivers for a UK tram company, which operates both suburban and urban routes. The drivers were asked to drive three times in the simulator, once without any interventions, once with interventions (speeding, vulnerable road user alerts), and a final time to discuss the fatigue/sleepiness warnings.

Various platforms were used to recruit drivers in the different experiments. These consisted in general of online advertisement, or offline recruitment, through posters, recruitment drives, etc. In Belgium, all participants were active professional truck drivers, except for two truck driver coaches. Participants were also selected to represent different distances driven per week and different transport types.

2.3. Data Analysis and Model Development

To reach the main objectives formulated in Section 1, the premises of the technology acceptance model (TAM) by Davis et al. [14] were tested within a multi-modal context. The hypotheses to be tested are therefore: the dependence of behavioral intention to use on perceived usefulness and perceived ease of use; the dependence of perceived usefulness on each of perceived ease of use and external variables; and the dependence of perceived ease of use on external factors.

After testing these hypotheses, the factors affecting the acceptance of warning–monitoring systems in a multi-modal context were identified (here: trucks, trams), then they were compared with the findings obtained from the car simulator study [15], after which, a multi-modal acceptance model can be developed, highlighting the findings that are transferable across modes. The methods used consisted first of a descriptive analysis of the questionnaire data, including demographics, attitudes and perceptions towards driving and safety systems, and basic statistics (including Chi-square of independence, correlation tests, etc.) and visualizations. After that, more advanced models were developed. First, exploratory factor analyses were conducted, in order to better understand attitudes of respondents, and extract latent variables stemming from the questionnaires' attitudinal statements. The resulting extracted variables were then used (in case they were meaningful and relevant) in the subsequent analysis, as explanatory variables in the developed models. The analysis then included statistical models (including simple regressions, or logistic regressions), with the final aim being to test the hypotheses and premises of the acceptance models, including the comparison across modes.

3. Data Collection and Exploratory Data Analysis

3.1. Sample Characteristics

As elaborated in Section 2, data assessed in this paper has been collected in a multi-modal context, including car, truck, and tram simulator experiments. An overview of the collected sample characteristics is given in Table 2. The table provides a summary for characteristics including gender, age, employment status, weekly kilometers driven (relevant for truck drivers), fines history, accidents history, number of working years, and number of years since drivers' license (for professional drivers, such as truck and tram drivers, this refers to the number of years since they acquired their licenses for the specific professional mode under investigation) was acquired.

Remark 1. *While the statistics reported in Table 2 intend to be for the entire sample, for some variables, there were some missing values (usually 1 or 2 at most); therefore, values are generally provided in absolute values, but also in percentages. Moreover, the interquartile range is provided for variables whose answer options were not discrete, but rather continuous, such as age, number of years worked, or number of years since acquiring the license.*

Remark 2. *Both "Fine" and "Accident" variables refer to the last three years of using the truck or the car.*

Remark 3. *Weekly kilometers is an estimate of the mileage using the truck.*

Remark 4. *The variables "fines", "accidents", "working years", and "license years" refer to the main mode investigated. For instance, even if truck drivers also drive cars, the reported numbers refer to accidents or fines or working years as a truck driver; the same applies for tram drivers.*

Remark 5. *For each of the modes, different surveys were used; therefore, some statistics were not available for all modes. For instance, for car drivers, the weekly kilometers driven were not requested, as they are not professional drivers, and it was not as relevant for those participants; the same applies for working years for cars. Similarly, fines were not relevant for tram drivers, for instance.*

Table 2. Socio-demographic characteristics of the multi-modal driving simulator samples.

Variable		**Car (N = 60)**	**Truck (N = 34)**	**Tram (N = 28)**
Country		Germany	Belgium	UK
Gender	Male	25 (42%)	28 (82.4%)	27 (96.4%)
	Female	35 (58%)	6 (17.6%)	1 (3.6%)
Age		30 (26, 37)	37 (22, 49.25)	47.3 (36, 57.3)
Employment	Full-time	-	-	3 (82.1 %)
	Part-time	-		5 (17.9%)
Weekly kms	<500 km	-	4 (12.5 %)	-
	500 to 1000 km	-	7 (21.9 %)	-
	1000 to 2000 km	-	9 (28.1 %)	-
	>2000 km	-	12 (37.5 %)	-
Fines	None	41 (68%)	11 (33.3 %)	-
	At least one	19 (32%)	22 (66.7 %)	-
Accidents	None	56 (93%)	23 (69.7 %)	-
	At least one	4 (7%)	10 (33.3 %)	-
Working years		-	-	10.2 (3.5, 18)
License years		9 (6, 15)	-	10 (4, 15)

An overview of the demographics reveals findings on the different samples. While gender seems to be balanced for car drivers, this was not the case for truck and tram drivers, who tend to be mostly (exclusively) males; however, this makes sense as it reflects the population of professional drivers, who usually are male drivers. Similarly to car drivers, most fines for truck drivers pertained to overspeeding, the same way accidents resulted in material damage only. Still, it is interesting to note that, on average, the percentage of truck drivers having had at least one fine is double that for car drivers, the same way the percentage having had an accident is way higher for truck drivers.

In addition to the demographics and variables reported in Table 2, additional questions were asked on the roadway environments, but also sleep quality, for each of truck and tram drivers. Results indicated that truck drivers mostly drove on motorways (a distribution of, on average, 42%), followed by rural (on average 36%), then urban roads (on average 27%). Their working time was mostly during the day (53%), followed by a combination of both daytime and night-time (44%). On the other hand, tram drivers worked an average of 28 h per week, mostly (71%) in a combination of day and night shifts. This mostly indicates that tram drivers drove, on average, more mixed day and night shifts.

Regarding sleep patterns, on average neither truck or tram drivers reported any sleep issues; no sleep disorders were reported (except one tram driver who had sleep apnoea). Both truck and tram drivers indicated that their sleep quality was mostly good or very good (about 64% of drivers), while only 21% of truck drivers revealed that their sleep quality was not so good, as opposed to 18% for tram drivers. The majority of truck drivers (61%), only very occasionally (less than 2 to 4 times per month in the last year) had to fight sleep to stay awake, as opposed to only 12% of them indicating that they never had to do so in the past year. For tram drivers, the last two figures were 57% and 36%, respectively. Most truck drivers (52%) never had to stop driving due to drowsiness in the past year, and about 21% of them had to do so more than three times that year. The percentages were similar for drivers who wanted to stop driving due to drowsiness, but were not able to do so at that time; on the other hand, no tram driver indicated that they had to stop because of feeling sleepy. Only one person indicated that they wanted to stop the tram but were unable to (3.6 %).

The last figures indicate that sleepiness was potentially more of an issue with truck drivers, which could potentially be explained by the longer distances travelled. On the other hand, it could be argued that truck drivers have more opportunity to stop than tram drivers who are confined to their cab. Finally, very few truck drivers indicated that in the previous year they fell asleep while driving (only one driver), as opposed to no tram driver; also, only one driver indicated that they had a sleep-related incident in the previous year (incident due to falling asleep while driving), as opposed to only two tram drivers (in the past 10 years).

3.2. Exploratory Data Analysis

3.2.1. Descriptive Analysis

This sub-section provides an overview of respondents' exposure and overall attitudes towards ADAS [mostly for car and truck participants, as both modes have very similar ADAS; on the other hand, tram ADAS are a bit more different, and even the ones having the same functionalities have different names, therefore the comparison of ADAS perceptions and exposure for the rail mode (with other modes) is less feasible.], but also their attitudes and perceptions towards the i–DREAMS system.

1. Exposure and attitudes towards ADAS:
   Drivers' familiarity with the advanced driver assistance system (ADAS) has been assessed for different modes through a series of questions, in which they were requested to indicate whether the different ADAS were present in the vehicle(s) they were driving, with "yes" and "'no" as possible answer options. In general, it seemed that car and truck drivers' exposure to and attitudes towards ADAS were not so different (Figures 3 and 4, respectively). However, to further investigate potential differences, Chi-square tests of independence between car and truck modes were conducted, for each of ADAS exposure and perceptions towards ADAS. For the former, the test results revealed significant differences (up to a 95% level of confidence) between car and truck drivers' exposure to following ADAS: automatic emergency break, forward collision warning, lane keeping assistance (higher exposure for truck drivers), and parking assist (higher exposure for car drivers). The results of this test are provided in Table A1 of the Appendix A. For perceptions towards ADAS systems, the test results indicated significant differences (up to a 95% level of confidence) for perceptions of distraction (overall truck drivers seemed to agree less that ADAS would distract them from driving in comparison with car drivers; 30% vs. around 60%, respectively), driving performance improvement, accident risk reduction, driving behavior maintenance (for the later statements, it seemed that car drivers seemed to have a higher level of agreement on the usefulness of ADAS, compared to truck drivers). The results of this test are provided in Table A2 of the Appendix A.

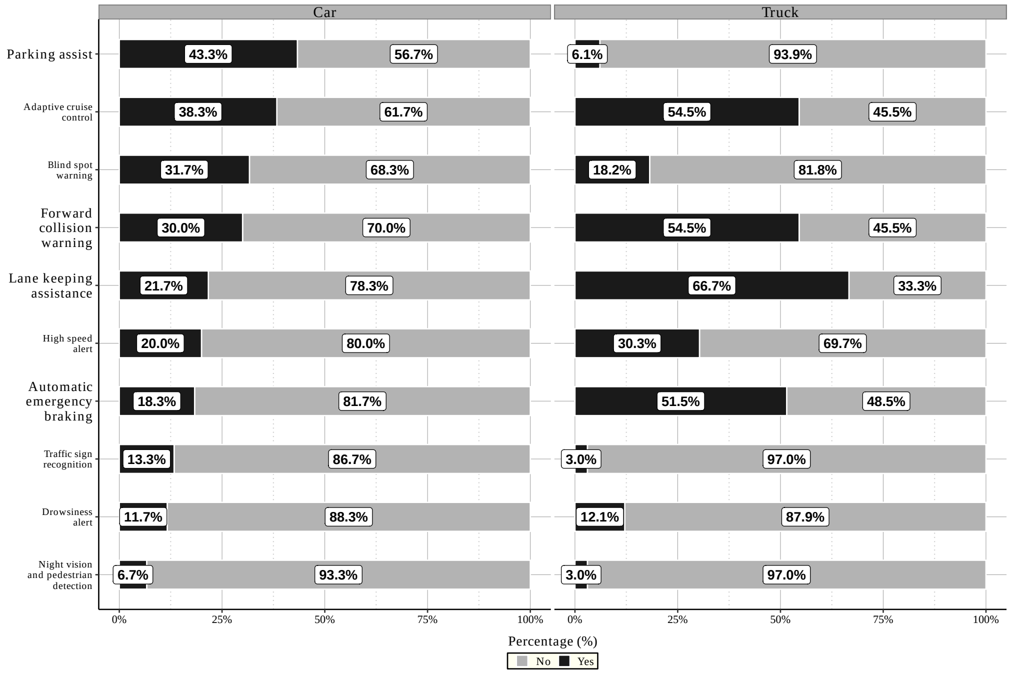

Figure 3. Car (N = 60) and truck (N = 36) participants' exposure to ADAS.

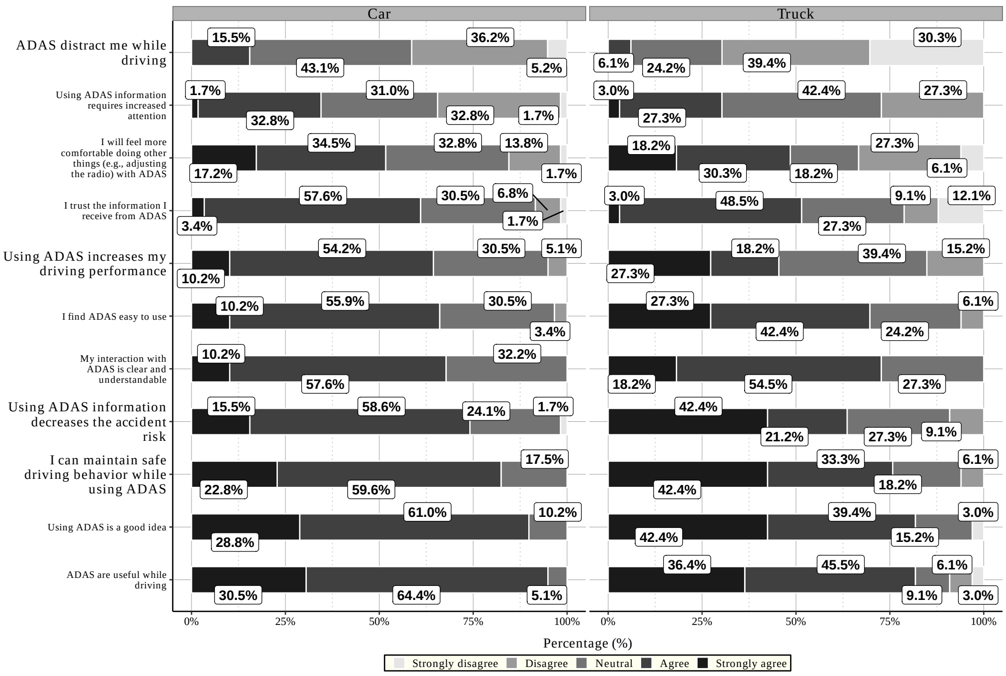

Figure 4. Car (N = 60) and truck (N = 36) participants' attitudes towards ADAS.

2. Attitudes towards the system (clarity and overall perceptions):
   Responses generally indicated a high level of perceived clarity (overall, sound, and visual). However, it seemed that both truck and car drivers had a higher perceived visual clarity than sound clarity. Furthermore, overall, truck drivers perceived the system as less clear than car drivers did; notably, a significant difference (higher than 95% confidence) was noted for sound clarity, wherein perceived sound clarity for truck drivers was lower than that for car drivers. Figure 5 presents clarity perceptions described above.

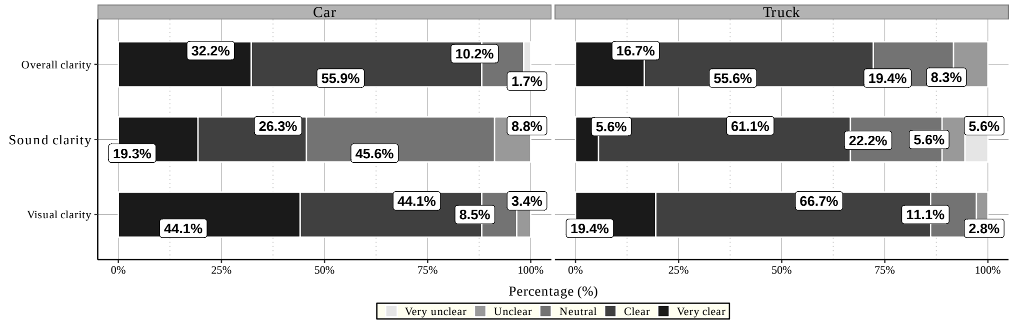

Figure 5. Car (N = 60) and truck (N = 36) participants' perceptions of the system clarity.

Figures 6 and 7 present the results for car and truck driver participants' attitudes towards the i–DREAMS system. Significant differences between the different modes were noted for perceptions on whether people would encourage participants to use the system, whether they would be proud to show it to people, whether they knew how to use it, whether it required increased attention from drivers, and whether it improved drivers' driving performance. These differences were significant at a 90% level of confidence, as noted in Table A3 of the Appendix A. After that, pairwise chi-square tests (for all three modes) between those highlighted differences were conducted. The results then revealed the modes for which these differences were notable and significant; those are presented in Table A4 of the Appendix A, with differences highlighted for a 95% level of significance. In particular, between car and truck drivers, differences were noted on the perceptions of increased attention induced by using the system, and social perceptions (proud to show it to people and people would encourage me to use it); between car and tram drivers, differences were noted on whether they knew how to use the system or not.

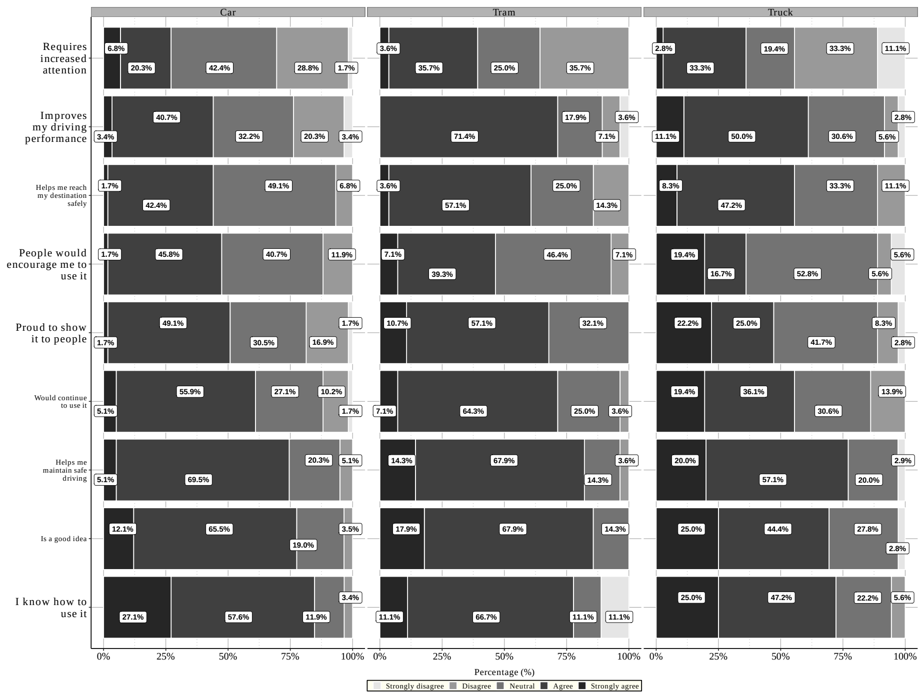

Figure 6. Car (N = 60) and truck (N = 36) participants' perceptions of the system (part 1).

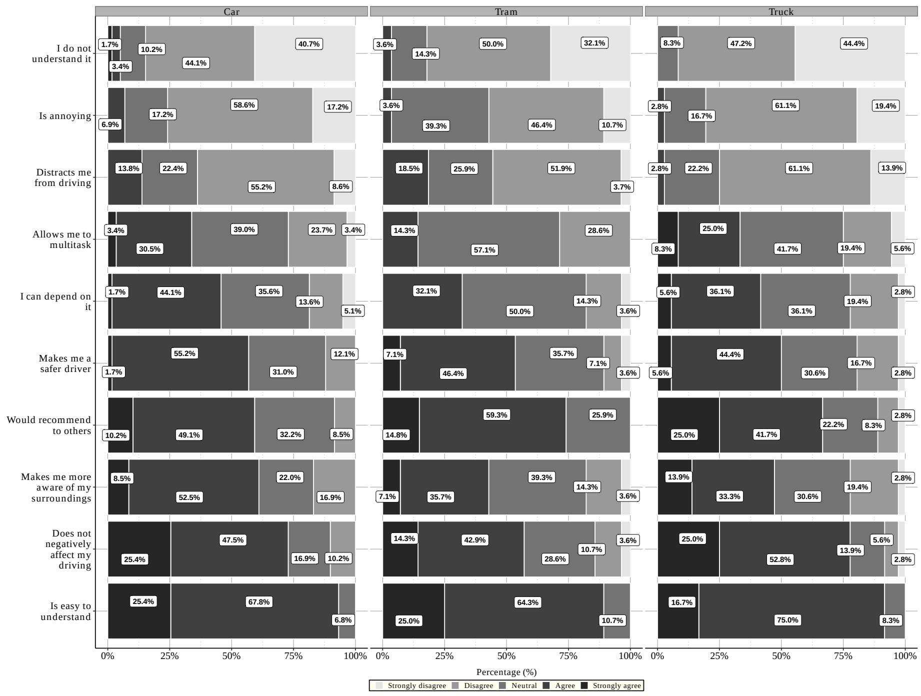

Figure 7. Car (N = 60) and truck (N = 36) participants' perceptions of the system (part 2).

3.2.2. Qualitative Analysis

Besides attitudinal questions, the survey included open-ended questions, whose answers have been analyzed qualitatively. Truck drivers generally found the system to be clear, simple, easy to understand, useful (bringing awareness), realistic, and quite timely (warnings on time). The visuals and auditory systems were well perceived. However, there seemed to be a confusion with regards to the numbers on the pictograms. A suggestion was to replace the time in seconds with distance in meters. Further comments included the integration of the system into the existing dashboard devices, and the improvement in screen resolution (and size of display screen), and in road signs recognition (for it to be faster). Moreover, while the auditory system was generally found to be good, there seemed to be a lack of consensus on whether it was loud enough or not, some finding it possibly distracting. An overall suggestion was to possibly reward participants based on their "good" behavior. Participants also praised the "coffee" sign, which they seemed to understand as a warning to stop for a few minutes, to avoid fatigue. Yet, some participants were skeptical about it, stating they would prefer to rely on themselves to know when they are tired or not.

An analysis of the open-ended questions for tram participants highlighted the driving challenges tram drivers often face: drivers indicated mostly that driving can be more demanding during rush hours, due to the presence of additional road users, including pedestrians, school children, scooters, delivery riders, bikes, or other vehicles. Additionally, bad weather conditions were indicated as a factor making driving more demanding, such as having wet, or frosty (and therefore slippery) roads. Finally, fatigue was mentioned, mostly when driving long continuous hours (consistent environments without much change, leading to repetition), or due to very early or very late shifts. Tram assistance systems (Drivers Safety Device, Correct Side Door Enabling, Emergency Stop Button, and Emergency Pantograph Down button) were found to be useful, reliable, important and essential, although the latter was less used. For the overspeeding aid, it was found to be necessary and positive, with a few saying that it is distracting. Finally, the Guardian (a system to detect fatigue and distraction) received some skepticism; while many described it as useful, some found it distracting and unreliable. Additional desired safety systems included warnings for: upcoming signals or bends, speed limits and over-speeding, proximity to pedestrians or other vehicles (collisions), obstacles or object detection in swept path. Moreover, tram drivers indicated their wish for louder warnings, but also for improvements for the current "Guardian" system.

4. Modeling Results

4.1. Exploratory Factor Analysis Results

The below sub-section includes results from the exploratory factor analyses conducted using the attitudinal statements for respondents' perceptions on ADAS systems, and the i–DREAMS system; the former was conducted for truck participants (as tram ADAS are not comparable with car ADAS) and the latter was conducted using the data from all three modes (car, truck, tram). As mentioned in the methodology section (Section 2.3), the aim of this analysis is to extract latent variables from the attitudinal parts of the questionnaires, so that they can be later on used in the developed models, as part of newly generated attitudinal explanatory variables.

4.1.1. Prior Perceptions of ADAS Systems

Table 3 presents the factor analysis results of truck participants' prior perceptions towards ADAS, including factor loadings for the different constructs, the sum of square loadings, the proportion of variance, and the cumulative variance. The results highlight two constructs: ADAS perceived usefulness and ADAS perceived ease of use. Comparing those with factor analysis results applied to ADAS perceptions for car participants, we observe similar findings (even if the new factors are not one to one based on the same constructs, but generally do reflect the same main idea).

Table 3. Factor analysis on truck participants' perceptions of ADAS.

Loadings	Factor 1	Factor 2
ADAS are useful	0.84	
ADAS reduce accident risks	0.83	
ADAS are a good idea	0.81	
ADAS improve driving performance	0.71	
I can rely on ADAS	0.57	
ADAS are easy to understand		0.82
ADAS are clear and understandable		0.70
ADAS distract me while driving		−0.66
Sum of square of loadings	3.12	2.06
Proportion variance	0.39	0.26
Cumulative variance	0.39	0.65
Factor interpretation	ADAS usefulness	ADAS ease of use

4.1.2. Perceptions of the i–DREAMS System

Tables 4 and 5 present findings drivers' attitudes towards the i–DREAMS system, for truck and tram drivers, respectively. Table 4 shows the two extracted factors: perceived usefulness, and perceived ease of use. Findings obtained are similar to those of car drivers participants; perceived ease of use for truck drivers also include attributes related to perceived system clarity. Similar factors were also extracted for tram drivers (Table 5); for both tram and truck drivers, system annoyance was found to negatively impact perceived usefulness, which was not observed in the factor analysis using car drivers' questionnaire data.

Table 4. Factor analysis on truck participants' perceptions of the i–DREAMS system.

Loadings	**Factor 1**	**Factor 2**
Persons I like would recommend me to use the system	0.83	
While using the i-DREAMS system, I can maintain safe driving behavior	0.78	
I would be proud to show the i-DREAMS system to people close to me	0.78	
If I use the system, I will reach my destination safely	0.74	
I think I can rely on the system	0.73	
I think the system is annoying	−0.73	
I think by using the system I am a safer driver	0.72	
Using the i-DREAMS system is a good idea	0.69	
The system makes driving more enjoyable	0.67	
Using the system improves my driving performance	0.67	
Using the system makes me more aware of my surroundings	0.63	
The system will not negatively affect my driving performance	0.62	
How clear the i–DREAMS system generally is		0.92
How clear the visuals of the system are		0.60
Sum of square of loadings	6.23	1.74
Proportion variance	0.45	0.13
Cumulative variance	0.45	0.57
Factor interpretation	Perceived usefulness	Perceived ease of use

Table 5. Factor analysis on tram participants' perceptions of the i–DREAMS system.

Loadings	**Factor 1**	**Factor 2**
While using the i–DREAMS system, I can maintain safe driving behavior	0.77	
I think the i-DREAMS system is annoying	−0.75	
Using the i–DREAMS system makes me more aware of my surroundings	0.71	
The i-DREAMS system makes me a safer driver	0.66	
I think the i-DREAMS system is easy to understand		0.71
I am afraid that I do not understand the system.		−0.60
I would be proud to show the i-DREAMS system to people close to me		0.53
Sum of square of loadings	2.37	1.19
Proportion variance	0.34	0.17
Cumulative variance	0.34	0.51
Factor interpretation	Perceived usefulness	Perceived ease of use

4.2. Hypotheses Models

To answer the research questions laid out in Section 1, particularly relating to identifying the factors affecting drivers' acceptance of warning–monitoring systems, models are developed as described in Section 2.3. Essentially, the premises of the technology acceptance models are tested. First, models are developed to investigate the relation between behavioral intention to use and perceived usefulness and perceived ease of use (Section 4.2.1). Then, models are developed to test the relation between perceived ease of use and external variables (Section 4.2.2). Finally, models are developed to test the relation between perceived usefulness and perceived ease of use and external variables (Section 4.2.3). For the below models, it is important to use that the constructs for "perceived usefulness" and "perceived ease of use" for each mode (car, truck, tram) were based on the newly generated variables resulting from the factor analyses presented in Tables 4 and 5.

4.2.1. Behavioral Intention to Use

To test the first hypothesis, namely whether behavioral intention of the warning–monitoring system (ADAS) strongly depends on its perceived usefulness and perceived ease of use, ordered logit models were developed, due to the discrete and ordered nature of the dependent variable: behavioral intention to use. This was the variable based on the statement: "I would continue to use the system". Due to the ordered nature of this dependent variable, ranging from "strongly disagree" to "strongly agree", ordered logit models were used. Due to the unbalanced responses (only one respondent for each of "disagree" and "strongly agree"), the ordered categories were re-grouped under: "disagree" (combining "strongly disagree" and "disagree"), "neutral", and "agree" (combining "agree" and "strongly agree"). The developed models already validated for cars were also validated for the truck data, but not for the tram data; for the latter, this relation between behavioral intention to use and perceived usefulness could not be validated.

Concretely, this means that for each of the assessed transport modes, ordered logit models were developed, where "behavioral intention to use" (discrete ordered variable) was used as a dependent variable, and "perceived usefulness" and "perceived ease of use" (continuous variables resulting from the factor analyses) were used as independent variables. For the truck models, "behavioral intention" had four answer options (as elaborated above due to re-merging), whereas for car models, this variable only had three answer options ("disagree", "neutral" and "agree"), also based on re-merging the initial groups. A summary of the results of this hypothesis for both car and truck data are given in Table 6; in this table, estimate results for the independent variables (namely perceived ease of use and perceived usefulness) along with their statistical significance are given. Due to the nature of the model, cut-off values between the different ordered categories for the dependent variable are also given (represented by the last three rows of the table). The obtained models validate the hypotheses, wherein behavioral intention to use directly impacts perceived usefulness (PU) and perceived ease of use (PEU); for each of the car and truck models, the estimates for PU and PEU are significant at a 95% confidence level (except for PEU for the truck model, which was validated at a 90% confidence level).

Table 6. Ordered logit models for the behavioral intention to use (cars and trucks).

	Car (N = 60)		**Truck (N = 36)**	
Variable	**Estimate**	***t*-Test**	**Estimate**	***t*-Test**
Perceived usefulness	2.11	4.63	1.23	3.03
Perceived ease of use	0.66	2.04	0.65	1.81
Disagree | Neutral	−3.41	−5.11	−2.34	−4.05
Neutral | Agree	−0.59	−1.6	−0.51	−1.29
Agree | Strongly agree	-	-	1.95	3.56
AIC	77.5		85.2	
BIC	85.8		92.8	

Only highly significant variables (>95%) are presented in Bold.

4.2.2. Perceived Ease of Use

To test the second hypothesis, namely whether "perceived ease of use" was strongly dependent on external variables, ordinary least square regressions were developed for each of the datasets (for trucks and trams), due to the continuous nature of the "perceived ease of use" variable; the value for the latter was extracted from the newly generated factors of the factor analyses. This hypothesis was tested for each of the truck and tram datasets, as was already done for the car dataset.

For each of the modes, external variables used included socio-demographic variables presented in Table 2, but also attitudinal variables based on the survey's attitudinal statements. The final and best performing models are given in Table 7. Results highlighted the following strongly significant explanatory variables: license years (or years since obtaining the driver's license) for car drivers, drivers' age for tram drivers, and fine history for truck drivers. All of the revealed external variables were significant at a level above 95% and pertain in one way or the other to driving history.

Table 7. Ordinary least square regressions for perceived ease of use (cars, trucks, trams).

	Car (N = 60)		Truck (N = 36)		Tram (N = 28)	
Variable	**Estimate**	***t*-Test**	**Estimate**	***t*-Test**	**Estimate**	***t*-Test**
Intercept	0.41	2.08	0.75	1.89	1.58	2.42
License years	−0.034	−2.65				
Fine			−0.32	−2.06		
Age					−0.034	−2.51
R-squared	0.11		0.13		0.195	
Adjusted R-squared	0.09		0.098		0.164	

Only highly significant variables (>95%) are presented in Bold.

4.2.3. Perceived Usefulness

To test the final hypothesis that is part of the technology acceptance model, namely that perceived usefulness strongly depends on perceived ease of use and on external variables, ordinary least square models were developed for each of the datasets, due to the continuous nature of the dependent variable (perceived usefulness, which results from the factor analysis newly generated factor).

The developed models validated these hypotheses for car and truck drivers, but not for tram drivers. Results obtained are presented in Table 8. For all modes, the relation between perceived usefulness and perceived ease of use was not validated; only the relation between perceived usefulness and external variables was confirmed, the latter being drivers' prior attitudes and perceptions towards ADAS, or ADAS perceived usefulness, which is in turn a new factor generated from the factor analyses applied to attitudes and perceptions towards ADAS (see Table 3). For both models (for cars and trucks), ADAS PU was significant to the 99% level of confidence.

Table 8. Ordinary least square regressions for perceived usefulness (cars, trucks).

	Car (N = 60)		Truck (N = 36)	
Variable	**Estimate**	***t*-Test**	**Estimate**	***t*-Test**
Intercept	−0.01	−0.083	−0.077	−0.53
ADAS PU	0.33	2.67	0.6	4.07
R-squared	0.11		0.13	
Adjusted R-squared	0.09		0.098	

Only highly significant variables (>95%) are presented in Bold.

5. Discussion and Conclusions

The investigated ADAS (the i–DREAMS system) seemed to be well perceived and accepted across the different modes. It was generally found to be clear, with a higher perceived visual (as compared to auditory) clarity; while the warning visuals were found to be clear, there was a slightly lower consensus with regards to the sound clarity, wherein some respondents found it to be too loud, or not loud enough. This was noticed in the different experiments (in all modes), meaning there was room for improvement for that particular feature. For truck drivers, a previous analysis of the simulator data [16] already confirms the assessed acceptance (based on the questionnaire analysis); in fact, speed warnings within the truck simulator experiments were found to reduce speed behavior by giving drivers feedback about the enforced speed limit, which in some cases was different to the limits seen on the roads (that were only applicable to car drivers).

Furthermore, perceived ease of use and perceived usefulness of the system were identified as the main factors resulting from the factor analyses applied to the attitudinal statements that were part of the different questionnaires. Findings on the system's perception for trucks and trams were therefore quite comparable with those of the car experiments. Overall, it means that a higher acceptance of a warning–monitoring system can be reached by focusing on highlighting the usefulness of the product (might come with awareness, or might depend as well on previous experiences, etc.) and its ease of use (this could be actually improved based on the product development). In this case for instance, it can be achieved by improving the sound system, which seemed to be less clear for some of the participants.

However, tram drivers seemed to have specific concerns, such as driving challenges with regards to VRU interactions. Tram drivers expressed their interest in having additional safety systems including warnings for upcoming signals or bends, speed limits and over-speeding, proximity to pedestrians or other vehicles (collisions), obstacles or object detection in swept path. This aligns with findings from a previous study, in which route familiarity appeared to be an important factor influencing driving stress for tram drivers [17]. As VRU warnings already exist in other modes, this finding might be transferable across modes, from cars to trams for instance. While trucks and tram driver groups did not have major sleep problems, both indicated that they would appreciate a system telling them when they are tired. For trucks, this was relevant also to be able to make stops if there is a high level of fatigue. Tram drivers did not seem to particularly like the existing "Guardian" system; therefore, further improvement on a fatigue safety assistance would be needed there. In particular, tram drivers reported challenges faced driving early and late hours. Fatigue and sleepiness were therefore concerns shared by professional drivers. In other words, although the tram drives faced similar road safety challenges to cars and trucks as they share the road (e.g., pedestrians, traffic etc), rail also has a different operation than road driving, and therefore is it unsurprising that tram drivers suggested additional warnings more suited to their transport mode.

To summarize, some risk factors have transferable findings across modes, as they are of interest in different contexts, such as forward collision warning (FCW) and VRU collision warning; in the case of our study, this was observable between cars and trucks for FCW, and between cars and trams for VRU collision warning. On the other hand, some other warnings such as fatigue and sleepiness were rather common between trucks and trams, and not very common for car drivers, at least not typically. There is a potential, therefore, to use the proposed system to monitor the sleepiness and fatigue levels of truck and tram drivers, using minimally invasive techniques such as heart rate and heart rate variability.

However, despite seemingly closer findings between trams and trucks, with respect to fatigue mostly, the tested hypotheses within the technology acceptance model (TAM) for the different modes showed rather similar findings between cars and trucks, than for trucks and trams. For the former, most relations were validated, namely the relation between the intention to use, as a function of the perceived ease of use and the perceived usefulness, which was not validated for tram drivers. Similarly, the relation between perceived usefulness and external variables was proven for trucks and cars, but not trams. Only the relation between perceived ease of use and external variables was confirmed for all modes. The technology acceptance model was therefore mostly validated for truck drivers (as was for car drivers), but not for tram drivers. This indicates that despite some transferable findings, the relation may not be as similar for rail, which should be perhaps assessed separately.

A summary of the findings on the validated multi-modal technology acceptance model is given in Figure 8; in this representation, an indication of the modes where specific links were validated is given where possible.

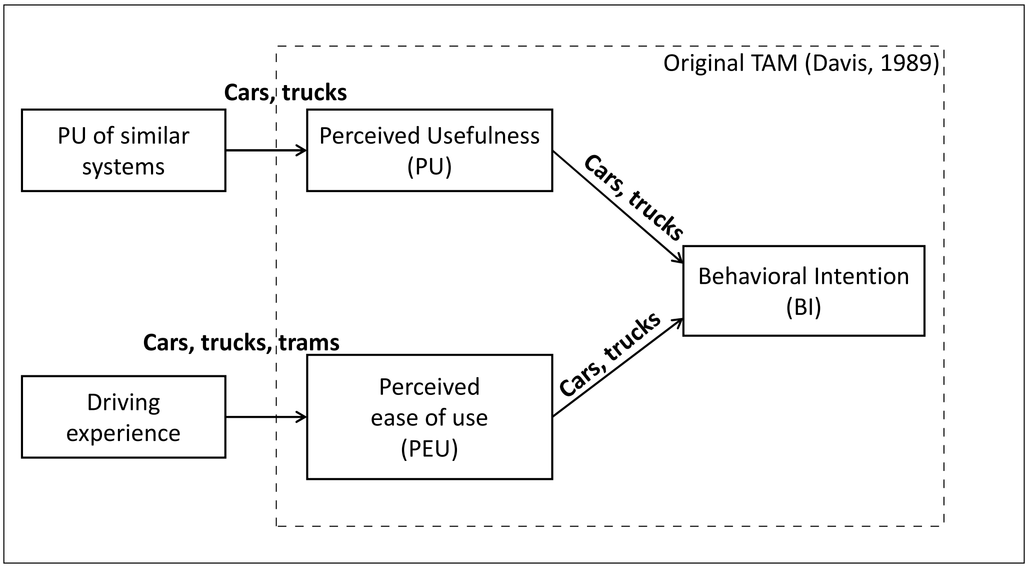

Figure 8. Validated TAM based on the multi-modal driving simulator experiments *(own illustration)*; this is an application and an extension from the original TAM by Davis et al. [14].

This paper contributed to the body of research by answering the different research questions formulated in Section 1, namely: identifying the factors impacting the acceptance of warning–monitoring systems in different modes, comparing those with the car mode, extending the technology acceptance model for the multi-modal context, and highlighting the transferable findings. However, this work does not come without limitations. This included the well-known simulator sickness challenges during data collection, but also the fact that there was not enough time to investigate sleepiness within the limited simulator experimental timeline, and generally that the duration of exposure to the system was limited. Moreover, the analysis also relied on self-reported data, which could at times have had biases. Finally, despite challenges in data collection and recruitment within driving simulator experiments (experiments are time- and effort-consuming and participants are particularly challenging to recruit, especially truck and tram drivers), the sample size remains limited.

Still, the findings highlighted by this research point out to the commonalities, but also differences across modes, with the key takeaways of the common attributes between car and truck modes (in the acceptance model), between truck and tram (in fatigue and sleepiness), but also the unique features that tram drivers have, which makes sense as it is the only rail transport investigated here. Transport modes can indeed learn from each other, and this research has shown that it can be relevant to investigate the acceptance of a specific technology in a professional mode, to make use of the learning obtained in another mode, laying the founding for future work modal transferability which would possibly help better scope multi-modal studies and also allow more efficient research where resources are limited.

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Abbreviations

The following abbreviations are used in this manuscript:

ADAS	Advanced driver-assistance system
AIC	Akaike's Information Criteria
BIC	Bayesian Information Criteria
PEU	Perceived ease of use
PU	Perceived usefulness
TAM	Technology acceptance model
UK	United Kingdom
VRU	Vulnerable road user

Appendix A

In the following section, Chi–square test results to test the independence of the mode on difference attributes are presented. First, Table A1 presents results of mode independence with the exposure of difference ADAS (for trucks and cars drivers). Then, Table A2 presents the results of mode independence with perceptions towards ADAS (for cars and trucks); for the above–mentioned tables, results with 95% level of significance are presented in Bold. Finally, Tables A3 and A4 present the results of mode independence (for cars, trucks, and trams) with perceptions towards the i–DREAMS system. Table A3 starts by highlighting the significant attributes (at a 90% level of confidence, presented in Bold) between the three modes, after which pairwise tests for those attributes are conducted and results with a 95% level of confidence are highlighted (presented in Bold) in Table A4.

Table A1. ADAS presence by mode (car and truck).

Variable	X-Squared′	*p*-Value′
Adaptive cruise control	2.27	0.132
Automatic emergency braking	**11.14**	**0.001**
Blind spot warning	1.97	0.160
Drowsiness alert	0.00	0.948
Forward collision warning	**5.41**	**0.020**
High speed alert	1.25	0.263
Lane keeping assistance	**18.37**	**0.000**
Night vision and pedestrian detection	0.55	0.457
Parking assist	**14.06**	**0.000**
Traffic sign recognition	2.59	0.108

Table A2. ADAS perception by mode (car, truck).

Variable	X-Squared′	*p*-Value′
Using ADAS information requires increased attention	1.92	0.751
My interaction with ADAS is clear and understandable	1.25	0.536
I will feel more comfortable doing other things (e.g., adjusting the radio) with ADAS	4.99	0.288
ADAS distract me while driving	**12.97**	**0.005**
I find ADAS easy to use	5.19	0.158
Using ADAS is a good idea	5.25	0.154
Using ADAS increases my driving performance	**13.42**	**0.004**
Using ADAS information decreases the accident risk	**18.48**	**0.001**
I can maintain safe driving behavior while using ADAS	**9.04**	**0.029**
I trust the information I receive from ADAS	4.79	0.309
ADAS are useful while driving	7.43	0.115

Table A3. Attitudes towards the i–DREAMS system (between car, trucks, and trams).

Variable	X-Squared′	*p*-Value′
Proud to show it to people	**21.12**	**0.007**
People would encourage me to use it	**20.81**	**0.008**
I know how to use it	**17.17**	**0.028**
Improves my driving performance	**14.27**	**0.075**
Requires increased attention	**13.98**	**0.082**
Makes driving interesting	12.88	0.116
Would continue to use it	10.72	0.218
Is a good idea	10.33	0.243
Helps me reach my destination safely	7.78	0.255
Helps me maintain safe driving	9.68	0.288
Would recommend to others	9.65	0.290
Is annoying	7.20	0.303
Allows me to multitask	8.34	0.401
Distracts me from driving	5.94	0.430
Makes me aware of my surroundings	7.51	0.482
Does not negatively affect my driving performance	6.04	0.643
Makes me a safer driver	5.42	0.712
I can depend on it	5.02	0.755
Is easy to understand	1.49	0.829
I do not understand it	3.64	0.888

Table A4. Attitudes towards the i–DREAMS system (significant results between car, trucks, and trams).

Variable	Modes	X-Squared′	*p*-Value′
Requires increased attention	**Car & Truck**	**9.58**	**0.048**
Requires increased attention	Car & Tram	4.44	0.350
Requires increased attention	Truck & Tram	3.42	0.491
People would encourage me to use it	**Car & Truck**	**18.75**	**0.001**
People would encourage me to use it	Car & Tram	2.37	0.499
People would encourage me to use it	Truck & Tram	6.47	0.166
Improves my driving performance	Car & Truck	5.91	0.206
Improves my driving performance	Car & Tram	7.97	0.093
Improves my driving performance	Truck & Tram	5.44	0.245
I know how to use it	Car & Truck	2.26	0.521
I know how to use it	**Car & Tram**	**9.88**	**0.043**
I know how to use it	Truck & Tram	9.20	0.056
Proud to show it to people	**Car & Truck**	**15.34**	**0.004**
Proud to show it to people	Car & Tram	8.83	0.065
Proud to show it to people	Truck & Tram	8.87	0.064

References

1. Hegeman, G.; van der Horst, R.; Brookhuis, K.A.; Hoogendoorn, S.P. Functioning and acceptance of overtaking assistant design tested in driving simulator experiment. *Transp. Res. Rec.* **2007**, *2018*, 45–52. [CrossRef]
2. van Driel, C.J.; Hoedemaeker, M.; van Arem, B. Impacts of a congestion assistant on driving behaviour and acceptance using a driving simulator. *Transp. Res. Part F Traffic Psychol. Behav.* **2007**, *10*, 139–152. [CrossRef]
3. Cho, Y.; Park, J.; Park, S.; Jung, E.S. Technology acceptance modeling based on user experience for autonomous vehicles. *J. Ergon. Soc. Korea* **2017**, *36*, 87–108.
4. Rossi, R.; Gastaldi, M.; Biondi, F.; Orsini, F.; De Cet, G.; Mulatti, C. A driving simulator study exploring the effect of different mental models on ADAS system effectiveness. In Proceedings of the International Conference on Augmented Reality, Virtual Reality and Computer Graphics, Lecce, Italy, 7–10 September 2020; Springer: Berlin/Heidelberg, Germany, 2020; pp. 102–113.
5. Schindler, R.; Piccinini, G.B. Truck drivers' behavior in encounters with vulnerable road users at intersections: Results from a test-track experiment. *Accid. Anal. Prev.* **2021**, *159*, 106289. [CrossRef] [PubMed]
6. Jung, H.; Rüffer, M.; Schindler, C. Fahrerassistenzsysteme fuer die Strassenbahn: Eine Umfrage bei den Verkehrsbetrieben. *Nahverkehr* **2018**, *36*, 26–35.
7. Onninen, J.; Pylkkönen, M.; Hakola, T.; Puttonen, S.; Virkkala, J.; Tolvanen, A.; Sallinen, M. The self-reported causes of sleepiness in shift-working tram and truck drivers. *Transp. Res. Part F Traffic Psychol. Behav.* **2021**, *78*, 153–163. [CrossRef]
8. Papadimitriou, E.; Schneider, C.; Tello, J.A.; Damen, W.; Vrouenraets, M.L.; Ten Broeke, A. Transport safety and human factors in the era of automation: What can transport modes learn from each other? *Accid. Anal. Prev.* **2020**, *144*, 105656. [CrossRef] [PubMed]
9. Pilkington-Cheney, F.; Talbot, R.; Hancox, G.; Filtness, A.; Cuenen, A.; Polders, E.; Brijs, T.; Brijs, K.; Ross, V.; Papadimitriou, E.; et al. *D3.4 Experimental Protocol. Deliverable 3.4 of the EC H2020 Project i-DREAMS*; Technical Report; EU: Brusells, Belgium, 2020.
10. Hancox, G.; Talbot, R.; Pilkington-Cheney, F.; Filtness, A.; Brijs, K.; Brijs, T.; Ross, V.; Katrakazas, C.; Yannis, G.; Fortsakis, P.; et al. *D5.1 Simulator & Field Study Organisation & Support. Deliverable 5.1 of the EC H2020 Project i-DREAMS*; Technical Report; EU: Brusells, Belgium, 2020.
11. Al Haddad, C.; Alam, M. R.; Yang, K.; Antoniou, C.; Talbot, R.; Fitness, A; Hancox, G.; Adnan, M.; Vanrompay, Y; Stieglitz, T.; et al. *D3.5 Standard Protocol for Handling Big Data. Deliverable 3.5 of the EC H2020 Project i-DREAMS*; Technical Report; EU: Brusells, Belgium, 2020.
12. Pilkington-Cheney, F.; Talbot, R.; Hancox, G.; Filtness, A.; Cuenen, A.; Polders, E.; Brijs, T.; Brijs, K.; Ross, V.; Papadimitriou, E.; et al. *D5.2 Description of the Driving Simulator Experiment for Identifying Safety Tolerance Zones and the Performance of in-Vehicle Interventions. Deliverable 5.2 of the EC H2020 Project i-DREAMS*; Technical Report; EU: Brusells, Belgium, 2020.
13. Amini, R.E.; Michelaraki, E.; Katrakazas, C.; Al Haddad, C.; De Vos, B.; Cuenen, A.; Yannis, G.; Brijs, T.; Antoniou, C. Risk scenario designs for driving simulator experiments. In Proceedings of the 2021 7th International Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS), Heraklion, Greece, 16–17 June 2021; IEEE: Piscataway, NJ, USA, 2021; pp. 1–6.
14. Davis, F.D.; Bagozzi, R.P.; Warshaw, P.R. User acceptance of computer technology: A comparison of two theoretical models. *Manag. Sci.* **1989**, *35*, 982–1003. [CrossRef]
15. Al Haddad, C.; Abouelela, M.; Brijs, K.; Polders, E.; Brijs, T.; Antoniou, C. Drivers' acceptance of warning–monitoring systems. Findings from a car driving simulator study. Working paper, *unpublished*.
16. De Vos, B.; Cuenen, A.; Ross, V.; Dirix, H.; Brijs, K.; Brijs, T. The effectiveness of an intelligent speed assistance system with real-time speeding interventions for truck drivers: A Belgian simulator study. In Proceedings of the 8th Road Safety & Simulation International Conference, Athens, Greece, 8–10 June 2022.
17. Tzouras, P.G.; Farah, H.; Papadimitriou, E.; van Oort, N.; Hagenzieker, M. Tram drivers' perceived safety and driving stress evaluation. A stated preference experiment. *Transp. Res. Interdiscip. Perspect.* **2020**, *7*, 100205. [CrossRef]