Logistics Research (2024) 17:1
DOI_10.23773/2024_1

From inside the cabin – truck drivers' technology acceptance of driving assistance systems

T. Gruchmann[1], W. Grenzfurtner[2] and A. Salzmann[1]

Received: 20 November 2023 / Accepted: 7 February 2024 / Published online: 04 April 2024

ABSTRACT

Driving assistants offer opportunities for innovation in transportation logistics by preventing accidents and improving workers' well-being. The related transition towards technological interaction, however, changes the spectrum of job tasks and the drivers' perceptions of their workplace. In this vein, driving assistants are not always viewed positively and deactivated. Using a quantitative research approach of conducting online surveys among truck drivers in Germany (N=142), a theoretical framework based on the Technology Acceptance Model and Innovation Diffusion Theory is tested with PLS-SEM and mediation analyses. As a result, the use of assistance systems and its acceptance is mainly driven by social norms, functionality, and trialability. The research contributes to the behavioral operations management discourse concerned by studying of how behavioral factors, such as cognitive biases and social preferences, influence and impede the interaction with assistance systems. Managerial and policy recommendations are further provided for improving the job design in transport logistics and related incentives for advanced use.

KEYWORDS: Behavioral operations management · Driving assistance · Technology acceptance model · Innovation diffusion theory · PLS-SEM.

Tim Gruchmann[1]
Wolfgang Grenzfurtner[2]
Axel Salzmann[1]

[1] Westcoast University of Applied Sciences,
Faculty of Management,
Heide, Germany

[2] University of Bayreuth,
Faculty of Life Sciences: Food, Nutrition and Health,
Bayreuth, Germany

1 INTRODUCTION

The working environment in business logistics is becoming increasingly technified and digitalized [1]. The related technological innovations pose managerial challenges through the required transition of traditional, manual workplaces and alters the employee's perceptions of their workplaces [2]. For the workplace of professional truck drivers, specifically, a negative attitude toward the use of driving assistants can derive from technological malfunctions and the drivers' mental and emotional stress involved in their use [3]. In turn, driving assistants can reduce the number of accidents and avoid them and bring other benefits, such as reducing the fuel consumption of heavy-duty vehicles [4]. Indeed, while initial reactions from drivers to the potential of driving assistance systems are reported to be positive after initial contact, these technologies will not realize their potential if no acceptance of their actual use in everyday situations is achieved [5].

The transformation of the workplace of professional truck drivers is accompanied by regulative action. Article 10 of the Regulation No. 661/2009 of the European Parliament and of the Council [6] mandates collision avoidance systems and lane departure warning systems for vehicles of classes N2 and N3 (total vehicle mass of more than 3.5 tons). A 2017 resolution of the European Parliament advocates the mandatory use of turning assistants in line with other European directives [7]. Latest legislation of the European Parliament and Council makes additional assistance systems legally binding for new type-approved vehicles from 2022 on [8]. In addition to collision avoidance systems, turning assistants, and lane departure warning systems, driver fatigue warning, and accident data recording technologies will also be mandated. Acknowledging the multiple levels involved in influencing the acceptance of assistance systems, this study applies a multi-level perspective including the individual, organizational and political dimensions of assisted driving.

This contribution accordingly seeks to analyze the multiple factors driving the acceptance of assistance systems in road freight traffic. Further questions arise concerning the functionality of truck assistance systems and the aspects of social norms, company image, and trialability. We thereby apply constructs of the Innovation Diffusion Theory (IDT) [9] and the Technology Acceptance Model (TAM) [10] as theoretical grounding. The TAM is particularly developed to model the user acceptance of technologies and information systems. Related studies regularly facilitate psychological models such as the TAM, Job-Demand-Resource models, and Job Characteristics models to incorporate behavioral aspects in logistics research [2]. Particularly the assessment of digital technologies from the perspective of freight forwarding companies or the individual drivers themselves provide potential for future research [11]. We accordingly ask the following research questions:

RQ1: How do social norms, the image of assistance system manufacturers as well as the trialability and functionality of truck assistance systems affect user behavior?

RQ2: What managerial recommendations can be derived to foster the acceptance and use of truck assistance systems?

Based on a quantitative, single-respondent questionnaire (N=142) being administered in Germany, the factors influencing the use of legally mandatory assistance systems (e.g., emergency brake assist) and currently voluntary assistance systems (e.g., adaptive cruise control, turn-off assistant) are studied. Single respondent surveys are particularly acceptable for behavioral operations studies focusing on individuals [12]. The survey data was analyzed using partial least squares structural equation modeling (PLS-SEM) and mediation analysis to test the hypotheses that have been put forward. As a result, we found perceived usefulness as the strongest predictor for using assistance systems, being positively influenced by social norms, functionality, trialability, and image. Thus, technological innovations with assistance systems are an essential component for more safety and job satisfaction in transportation logistics.

Our study contributes to the domain of behavioral operations management (BeOM) by testing the effects of technological innovations through driving assistant systems on individual behavior and organizational processes [13]. We add to the BeOM discourse by explaining how behavioral factors, such as cognitive biases and social preferences, influence the work and interaction with operating systems [14]. The (non-) acceptance of assistance systems is influenced by the perceived practicality linked to previous experiences with technological interventions and a driver's subjective emotional approach to professional driving, which depends on unconscious or unintentional mechanisms [14]. Our study lastly provides managerial and policy recommendations for the European transportation sector building on the driver's perception and appreciation of the activities associated with their occupational profile.

The remainder of this paper is organized as follows: Section 2 presents the literature background, while Section 3 outlines the theoretical lens of IDT and TAM and the associated hypotheses. Section 4 presents the applied research design. Section 5 then presents the findings of the quantitative investigations. Sections 6 and 7 discuss the empirical results on the acceptance factors of assistance systems against previous research and reviews the managerial implications for its application in truck freight transportation. Limitations of this study will be considered in last section 8, and the resulting directions for future research in the field will be pointed out.

2. LITERATURE BACKGROUND

BeOM is a multi-disciplinary research field addressing the impact of cognitive biases, personal and social preferences, group dynamics and cultural norms on operational performance [15]. A core assumption of BeOM is that people's behavior depends on unconscious or unintentional mechanisms [14]. In the following, we present the discourse on assisted driving from an individual perspective (2.1) and complement this perspective by the organizational and political perspectives of assisted driving (2.2).

2.1 The individual level of assisted driving

Previous research on the safety of driving assistants and the human-machine interaction of these systems has been conducted. In an early study, Lee and See [16] reported on the not always proper application of automation technologies, which will result in increasingly cost-intensive errors as the level of technology advances. They identified trust as an important factor influencing human-technology interaction: "As computer technology grows more pervasive, trust is also likely to become a critical factor" [16, p. 76]. At the individual level, accordingly, the respective workers, their perceptions, beliefs, and attitudes toward technological advances are decisive for the adoption of new technologies [9, 17] which is also connected to the question of related workplace safety, particularly in transportation and logistics industry.

To tackle existing problems causing occupational stress, such as stressors in the driving environment or specific job conditions, John et al. [3] propose using driving assistants to relieve bus drivers together with crucial relaxation of time targets in response to increased traffic volumes. Salmon et al. [18] came to similar results in their study on bus driver distraction. Critical physical errors while driving can be remedied using driving assistants "to automate some of the bus operation tasks" [18, p. 608]. In an inter-occupational view on drivers, Rahman et al. [5] investigated time pressure, fatigue levels, and different driving times (morning, evening). Their results show a significant influence of fatigue and time pressure on drivers' behavioral intention to use driving assistance systems and a higher willingness to use these systems in a fatigued or time-pressured state [5].

The effect of feedback from driver assistant systems on drivers was investigated by Roberts et al. [19] with the help of sophisticated driving simulations. Systems that provide real-time warnings and information to users were matched with post-drive mitigation systems that provide post-drive performance reports and comparisons to other road users, trying to encourage social conformism. Their results indicate a higher overall acceptance rating of post-drive systems, and participants who had no prior experience with real-time assistance systems rated those systems as more useful and easier to use than those who got to utilize them [19]. The influence of driver experience on the effective use of the assistance systems was studied by Lyu et al. [20]. While assistance systems showed positive effects on both skilled and inexperienced drivers, skilled drivers were negatively affected by the emergency brake assistant.

Son et al. [21] explored the influence of age and gender on the acceptance of forward-collision-warning and lane departure systems. Significant differences in the acceptance of forward-collision-warning by gender were reported, with a higher acceptance rate for male drivers [21]. A possible explanation for the higher scores of male drivers is seen in the link to gender-specific differences in risk-taking. Similar data on this is found in Li et al. [22] where male drivers had significantly higher mean scores for aggression. In contrast, the earlier data of Ervin et al. [23] gave no significant results for gender as an acceptance predictor as either main effect or combined with age for forward-collision-warning systems. Just recently, Scott and Davis-Sramek [24] found that women are still underrepresented in the job leading to a sampling bias when conducting research on the trucking industry.

With an emphasis on the influencing factor of age, Günthner and Proff [25] conducted a literature review on influencing factors on the acceptance of driving assistance systems. A positive influence of age on acceptance could be deduced from the results, showing differing levels of impact of central constructs between the age groups [25]. The results on the influence of age align with previous findings, such as those of Ervin et al. [23], where older drivers viewed the tested assistance systems more favorable. However, Li et al. [22] came to opposite conclusions in their investigation of the acceptance of three driving assistance systems. Here, younger drivers showed higher acceptance rates among all systems and age groups.

Assessing the truck drivers' attitudes towards automated driving, Richardson et al. [26] found concerns in their test groups about legal liability, safety, and reliability of the technologies employed. Whilst comfort and safety are of great importance in promoting automated driving, at the same time, freight truckers are concerned that the use of additional systems will decrease the enjoyment of driving [26]. More recently, the driving acceptance between participants using vehicles with integrated driving assistance systems and those of similar driving experience with retrofitted systems was investigated by Seter et al. [27]. Overall, higher acceptance was seen among users of the integrated driving assistance system, which achieved greater levels of satisfaction, convenience, and comfort [27].

2.2 The organizational and political levels of assisted drivings

At the organizational level, organizational structures, work design, and goal setting alter the course of digitalization. Looking at the relationship between organizational safety culture and unsafe driving behaviors, Mokarami et al. [28] found indications that improvements in organizational safety culture could reduce the number of accidents by lessening unsafe behaviors from drivers. On a larger scale, Nævestad et al. [29] examined the influence of national safety culture in addition to sector safety (e.g., differences in the road and maritime transport) and organizational safety culture. They found indications of a "[…] relationship between national road safety culture, road safety behavior and crash involvement" [29, p. 340].

Besides safety culture, managerial interventions should target organizational structures, which have an impact on the working environment, as well as on individual drivers [30]. For example, Kemp et al. [31] found that truck operators in the US are often placed in stressful situations where they must satisfy incompatible demands, forcing them to ignore hours of service rules and other regulations. Similarly, Miller et al. [32] reported that truck operators repeatedly break work-hour rules and drive poorly maintained trucks. In addition, Eskandarzahdeh et al. [33] reported that drivers are often forced to complete data entry during breaks, which in turn limits their ability to recover and has a negative impact on their recovery time and consequently their fatigue. Miller et al. [30] further endorse assistance systems for reporting and monitoring driver's fatigue, which are already in use in other transport sectors and show a positive impact on safety culture, helping to reduce the number of accidents caused by driver sleepiness.

At the political level, directive 2003/59/EC of the European Parliament, which had a decisive influence on the national legislation of the Member States, harmonized the initial qualification and periodic training of drivers and extended the legislation to improve the safety culture in road transport [34]. Since then, regular training of professional drivers in driving safety and fuel-efficient driving has been mandatory in the European Union. The periodic trainings, which are usually split into five modules covering related content, are offered to professional drivers through certified training centers. In addition, there have been initiatives to integrate new technologies for road safety improvement into the periodic training. Their focus is mostly on the training of instructors but also on the further development of the training modules' content [35].

According to Brock et. al. [36], however, such initiatives are very slow in the sector and rarely cause opportunities for drivers to test new driver assistance systems or learn about them as part of practical training. Nonetheless, Ebnali et. al. [37] have shown that practical trainings as well as the substantive examination and discussion of driving assistance systems provide for drivers a more realistic assessment of the systems' capabilities. They showed that trust in such systems is better calibrated and is neither over-enthusiastic nor negative. In addition, Loske and Klumpp [1] showed that the voluntary use of assistance systems for driving behavior by drivers leads to better results in terms of fuel consumption, lower variable costs and consequently to increased efficiency compared to management coercive interventions. Offering drivers the opportunity to try the assistance systems in order to explore and realize their capabilities is described as a vital contribution to increase acceptance. Elvebakk et al. [35] propose several measures to further develop training programs based on the Directive 2003/59/EC with the purpose to improve learning outcomes and thus enable the integration of new technologies into periodic training.

3. THEORETICAL BACKGROUND

Building on previous research, we employ the TAM and IDT to simultaneously tackle the individual and organizational levels of assisted driving. As a result, a theoretical framework is proposed to be tested with empirical evidence.

3.1 Technology acceptance and innovation diffusion in assisted driving

The TAM has been continuously studied and repeatedly expanded to determine under which circumstances new technology is accepted or rejected. The originally proposed TAM by Davis [10] highlights two determinants that are particularly important for technology application, perceived usefulness and perceived ease of use. The belief in the enhancing effect of a technology is thereby positively linked to the willingness to apply new technologies [10]. Even if users are convinced that an application is helpful, they may assume that successful use is too time-consuming or simply too difficult to accomplish such that perceived ease of use is important. In Davis' [10] model, strong correlations between behavioral intention and actual use of a system could be demonstrated while the perceived usefulness and perceived ease of use directly influenced the behavioral intention.

A review of empirical research on technology acceptance regarding driver assistance systems was presented by Isa et al. [38]. The researchers support the usage of the TAM for this particular specific research subject. Rahman et al. [5] came to a similar conclusion: TAM is an appropriate approach for exploring driver acceptance. At the same time, however, Isa et al. [38] emphasized the usefulness of including factors beyond the TAM model to complement and encourage further research. Yuen et al. [39], for instance, integrated some elements of TAM and Innovation Diffusion Theory (IDT) and stated: "IDT is well-synthesized with the TAM, supplementing each other and demonstrating high adaptability" [39, p. 11]. In addition to the TAM, accordingly, Rogers' [9] IDT is a recognized model that addresses the introduction, spread, and adoption of innovations by individuals in a social construct, such as the market or an organization.

Technology adoption within the context of IDT is defined as "[…] a decision to make full use of an innovation as the best course of action available" [9, p. 21]. Following IDT, innovation can bring improvements in various aspects, such as social prestige or relative advantage upon adoption. Similar to the TAM, IDT does not assume immediate adoption of mature technologies by users but instead assumes a life cycle of an object or product [9]. In this vein, IDT variables affect an innovation's rate of adoption and may explain 49% to 87% of the variance in the model [9]. Previous studies have already conducted research combining the TAM and IDT [39], but none of them for the context of advanced assistance systems for truck driving. Table 1 provides an overview on core attributes of the extended TAM and IDT relevant for the present context.

Table 1. IDT and TAM core constructs [9, 10].

Constructs	Description
Perceived usefulness	PU describes the extent to which potential users are subjectively convinced that the technology in question can increase their job performance.
Perceived ease of use	PEU describes the notion that "performance benefits of usage are outweighed by the effort of using the application" [10, p. 320].
Intention to use	Intention to use reflects a user's desire to use technology in the future and is a reliable predictor of actual technology usage [40].
Subjective norm	External norms are often called social, subjective, or perceived. A social norm refers to the perceived social pressure to perform or not perform a certain behavior [40].
Image	The degree to which use of an innovation is perceived to enhance the companies' status in its social system [41].
Functionality/ Compatibility	Compatibility examines the "degree to which an innovation is perceived as consistent with existing values, past experiences, and needs of potential adopters" [9, p. 224].
Trialability	The opportunity to try out the innovation is positively related to the adoption rate. Trialability is understood as "[…] the degree to which an innovation may be experimented with on a limited basis" [9, p. 243].

There exist further extensions of the TAM, such as the Unified Theory of Acceptance and Use of Technology (UTAUT) by Venkatesh et al. [42]. The UTAUT takes additional factors into account, including gender, age, experience, and voluntariness. To this end, multiple technology acceptance theories can be applied to predict the individuals' behaviors and measure the degree of acceptance, for instance the theory of reasoned action (TRA), the theory of planned behavior (TPB) [40], the TAM, and their extensions. While these models partially build on each other, the prediction of user acceptance is done from different viewpoints (individual, organizational, societal). With the aim of the present study to apply a multi-level perspective including the individual, organizational and political dimensions of assisted driving, we combine the TAM and IDT to provide further insights.

3.2 Hypotheses development

We apply the TAM as suitable, theoretical foundation for studying assistance systems and the information technology associated with them. First, constructs that directly influence a user's behavioral intention to use a novel technology and its actual use (AU) are considered. Both perceived usefulness (PU) and perceived ease of use (PEU) constructs influence a user's attitude toward utilizing driving assistance systems. PU is assumed to be the most important component, whereas PEU exhibits a lesser effect to predict intention (16). Additionally, the influence of PEU on PU is considered as observed in Ghazizadeh et al. [43] as well as Günthner and Proff [25]:

H1a: PU of assistance systems positively affects the behavioral IU.
H1b: PEU of assistance systems positively affects the behavioral IU.
H1c: PEU positively affects PU.
H1d: IU positively affects the AU.

Venkatesh and Davis's [17] extended TAM model 2 includes social influence variables (i.e., subjective norm, voluntariness, image) and cognitive instrumental constructs (i.e., job relevance, output quality, result demonstrability) that affect perceived usefulness and the behavioral intention to use a system. Particularly subjective norm (SN) "exerts a significant direct effect on usage intentions over and above perceived usefulness and perceived ease of use" [17, p. 198]. SN as a construct accordingly affects PU and is considered to be valuable in truck drivers' employer-employee relationship. Image (IMA) as a construct is included, too. The perception of assistant systems as restrictive and as a decision 'forced on drivers by management' has been observed; it is easy to assume that these beliefs might also impact the choice of employer. Thereby, the construct IMA is regarded in considerable connection with SN [17]. With regard to the use of assistance systems, we formulate the following hypotheses:

H2a: SN positively affect the PU of assistance systems.
H2b: IMA positively affects the PU of assistance systems.
H2c: IMA mediates the positive effect SN has on the PU.

Additional explanatory constructs are drawn from IDT. Trialability (TRIA) refers to how much people believe they need to try an invention before deciding whether to embrace it or not. The opportunity to try out new technologies beforehand can reduce uncertainty [9]. As a result, the experiences made contribute to performing a behavior such as using a driving assistant which indicates a positive effect of TRIA on PEU. To account for compatibility and observability of assistance systems, we introduce a last construct named as functionality (FUNC) which impacts the IU. Accordingly, the following hypotheses are formulated as follows:

H3a: TRIA positively affects the PEU of assistance system.

H3b: TRIA mediates the positive effect PEU has on PU.

H3c: FUNC positively affects the behavioral IU assistance systems.

Figure 1 depicts the theoretical framework containing all the proposed hypotheses.

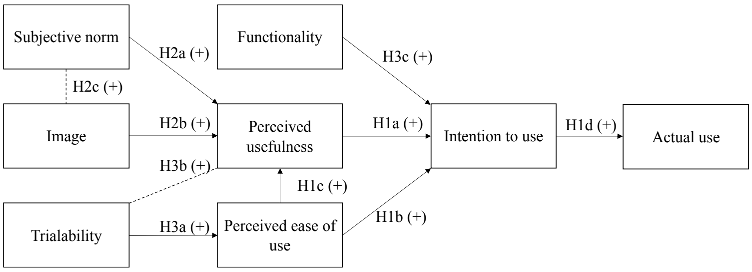

Figure 1. Theoretical framework.

4. RESEARCH DESIGN

4.1 Data collection and sample

The unit of analysis in this research is the individual truck driver. Survey research was applied to answer the proposed research questions regarding their acceptance of assistance systems in road freight traffic. The online questionnaire was distributed directly to freight forwarding companies. Respondents came primarily from Germany; the online questionnaire was answered voluntarily by the respondents (92%). Other respondents were residing in the European Union, namely Spain, Italy, Croatia, and Serbia, but working with German forwarders. A small margin of participants chose not to name their nationality. Being subject to European regulations [6, 7, 8]. Germany is a suitable national context for the present research. The data was collected in 2021. After eliminating severely lacking data sets and using Cook's Distance test to identify outliers, 142 truck driving respondents remained in the quantitative survey. Table 2 gives demographic information of the sample.

Table 2. Respondents.

	Item	Frequency	Percentage
Gender	Not specified	3	2.1
	Female	13	9.2
	Male	126	88.7
Age	Not specified	3	2.1
	18-29	9	6.3
	30-39	19	13.4
	40-49	41	28.9
	50-59	46	32.4
	60 and above	24	16.9
Company size	Not specified	8	5.6
	Up to 10 employees	20	14.1
	Up to 50 employees	45	31.7
	Up to 500 employees	53	37.3
	Above 500 employees	16	11.3
Vehicle age	Not specified	5	3.5
	Prior to 2000	2	1.4
	2000 until 2010	2	1.4
	2011 until 2019	80	56.4
	2020 and newer	53	37.3

The gender distribution is unequal, as expected [24]. 13 respondents reported themselves as female, three did not specify their gender. In comparison, 3.2 % of truck drivers are females in the US [24]. Most of the participants in the study report an age between 50 and 59 years, closely followed by the group of 40 to 49-year-olds with a total statistical mean of 48.5. The average age of German truck drivers is estimated at over 47 years [44]. Two-thirds of the participants are currently employed in companies with a workforce of between 50 and 500 employees. The vehicles' age matches the statistics for German road freight vehicles published by Eurostata [45] which estimated that around 40% of road freight vehicles in Germany are less than two years old.

4.2 Questionaire

The central constructs of the theoretical framework derived from the TAM and IDT. The selection of items is based on previous studies and tested scales that have been adapted in wording for the context of driving assistance systems [17]. Participants' self-reported answers were applied to a five-point Likert scale (1 = 'strongly disagree' or 'never' to 5 = 'strongly agree' or 'always'). The questionnaire was administered in German. The translation of the questionnaire into German from the items proposed in literature was done through the back-translation technique; the questions were accordingly translated and then re-translated. Before data collection, a pretest was conducted to obtain participants' responses to the items as well as to identify any ambiguity and difficulty in understanding the questions [46]. Based on the pretest, the items with low scores were excluded, and the remaining items with unclear meanings were revised. Moreover, items were deleted to create a robust measurement model through exploratory factor analysis (EFA). The remaining 29 items are listed below in Table 3 including selected descriptive statistics.

Table 3. Survey items.

	Items	Code	Mn	Sd	Kurtosis	Skewness
Intention to use	I wish assistance systems will be used more often.	IU1	4.11	1.05	0.20	-0.97
	I plan to use the existing assistance systems in the next months.	IU2	4.44	0.86	3.03	-1.75
Perceived usefulness	The use of assistance systems avoids accidents.	PU1	4.39	0.69	1.57	-1.06
	The use of assistance systems increases safety.	PU2	4.44	0.70	2.19	-1.31
	The use of assistance systems increases job attractiveness.	PU3	3.49	1.20	-0.75	-0.38
	I consider assistance systems useful for my work.	PU4	4.25	0.75	1.07	-0.91
	Assistance systems make my work easier.	PU5	4.05	0.96	-0.25	-0.72
Perceived ease of use	The handling of assistance systems is clear and understandable for me.	PEU1	4.18	0.81	0.99	-0.92
	Dealing with assistance systems does not require great mental effort from me.	PEU2	4.02	0.98	1.08	-1.14
	I find assistance systems easy to use.	PEU3	4.12	0.79	-0.42	-0.52
Actual use	I use the emergency brake assistant…	AU1	3.98	1.42	-0.73	-0.94
	I use the lane departure assistant…	AU2	3.56	1.49	-1.07	-0.59
	I use the cruise control assistant…	AU3	4.31	1.09	2.98	-1.88
	I use the turning assistant…	AU4	3.36	1.82	-1.70	-0.40
Functionality/ Compatibility	Assistance systems worked flawlessly in the past.	FUNC1	3.72	0.89	0.11	-0.41
	Assistance systems technically fulfill their purpose.	FUNC2	4.17	0.73	-0.24	-0.50
	Assistance systems are compatible with other vehicle systems.	FUNC3	3.99	0.85	-0.08	-0.63
	Assistance systems are compatible with my work routines.	FUNC4	3.77	0.86	0.01	-0.44
	Assistance systems fit well to the way I work.	FUNC5	4.00	0.91	2.28	-1.07
Subjective norm	My company supports the use of assistance systems.	SN1	4.51	0.77	5.80	-2.19
	Colleagues who are important to me recommend the use of assistance systems.	SN2	3.41	1.22	-0.58	-0.47
	Supervisors who influence my actions think that I should use assistance systems.	SN3	4.14	1.15	1.22	-1.41
Image	The use of assistance systems improves the image of my company.	IMA1	3.13	1.38	-1.25	-0.12
	Assistance systems embody a status symbol in my company.	IMA2	2.83	1.41	-1.23	0.24
	Other drivers who do not work for my company see assistance systems as prestigious.	IMA3	2.54	1.15	-0.70	0.23
	Other drivers who do not work for my company would prefer to work for our company because of assistance systems.	IMA4	2.54	1.01	-0.40	0.21
Trialability	I was trained in the handling of assistance systems.	TRIA1	3.38	1.34	-1.04	-0.41
	Before I made my decision to use an assistance system, I was able to try it out.	TRIA2	2.80	1.41	-1.31	0.08
	Before the implementation of assistance systems, there was an elaborate trial phase.	TRIA3	2.42	1.19	-0.64	0.51

4.3 Data analyses

Structural equation modeling was used to find relationships between the study variables as "it permits statistical significance testing of factor loadings and correlations among factors and the computation of confidence intervals for these parameters" [47, p. 277]. As shown in Table 3, univariate normality assumption cannot be assumed as 15 items were above the threshold of ±1 for skewness and kurtosis, respectively [48]. Hence, performing PLS-SEM is judicious. PLS-SEM further has become a quasi-standard in business research to analyze the relations between latent constructs [48] being supported by the increasing number of publications in logistics and transportation management [49]. Before testing the proposed hypothesis as elaborated on in Section 3.2, several quality measures considering reliability and validity were applied to the measurement model, including scale reliability, convergent validity, and discriminant validity.

Regarding the unit of analysis of the individual truck driver and the use of single respondents for monadic constructs, respondent biases are not a major concern [12]. Nonetheless, common method biases (CMB) can occur due to the self-reported survey data. Therefore, careful attention was paid to the item wording to minimize ambiguity and accompanied the survey. Further, a cover letter was provided informing the respondents that the research would be conducted only for academic purposes and that their responses would be kept confidential and anonymous. In addition, Harman's one factor test was applied to avoid CMB by loading all items into an exploratory factor analysis (EFA) [50]. In the EFA, a Promax rotation was applied sorting out eight items showing only weak factor loadings or equally high cross-loadings on several factors.

In the next step, a confirmatory factor analysis (CFA) to purify the applied scales was conducted. In the structural model, the hypotheses are tested, and the main results are reported. Applying common latent factor analysis, the model fit indices of the structural model are evaluated with the minimum discrepancy (CMIN/DF = 1.557), Tucker-Lewis Index (TLI = 0.891), comparative fit index (CFI = 0.907), standardized root mean square residual (SRMR = 0.062), and root mean square error of approximation (RMSEA = 0.064) values. A high suitability of the model can be concluded from the measurements of the fit indices as the structural model meets all fit indices and thresholds as proposed in literature [47]. In the last step, possible mediations of the constructs were assessed [51].

5. FINDINGS

5.1 Measurement model

First, several quality measures were applied to ensure satisfactory reliability and validity of the measurement model. All variables were inspected with Harman's one-factor test to avoid CMB [50]. In Harman's one-factor test, all items are loaded manually to a single factor in an exploratory procedure by fixating the possible number of factors. Since the one-factor model explained just 31.40% of the variable's total variance, CMB can confidently be rejected. The sampling adequacy of the data set was considered, too. The Kaiser-Meyer-Olkin (KMO) test is a goodness of fit criterion for factor analysis with a minimum value for an adequate sampling at 0.5 [47]. This study's data achieves a KMO measure of sampling adequacy of 0.877. Along with the KMO test, Bartlett's test of sphericity is performed to check whether the correlation matrix of the observed variables in the population is equal to the identity matrix. Bartlett's test of sphericity yielded an approximative $\chi 2$ of 2278.77, significant $p < 0.001$, and therefore showed that correlations between items are sufficiently distinct.

The JASP software was used to create the measurement model. Previously extracted factors from the EFA were accordingly checked for their suitability in the CFA. All items were assigned to constructs associated with the two theories that form the theoretical framework of this work. The latent factors were named after the observed variables that have the highest factor loadings on the respective latent factors. The confirmatory model depicted consists of the following correspondingly named factors: (1) intention to use (IU), (2) perceived usefulness (PU), (3) perceived ease of use (PEU), (4) actual use (AU), (5) functionality (FUNC), (6) subjective norm (SN), (7) image (IMA), and (8) trialability. Towards testing of the internal consistency of the study scales, Cronbach's alpha was employed. Most scales show good reliabilities with $\alpha > 0.7$ (see Table 4).

Further tests regarding constructs validity and factor reliability were conducted on the confirmatory measurement model (see Table 4). We computed the scorings for the composite reliability (CR) and give estimates on the average variance extracted (AVE). CR is a common alternative to Cronbach's alpha as the latter may underestimate scale reliability [52]. The AVE examines how much of the variation in items, on average, can be explained by an associated construct. Following Fornell and Larcker [53], however, the AVE is a more conservative measure and thereby the conventional thresholds may be too strict. If the AVE value is below the usual limits, but the CR reaches a higher value above 0.6, the conditions for subsequent examinations can be reached as well [53]. The square root of the respective AVE is taken to test for discriminant validity. If the AVE's square root of the construct is greater than the correlations of the construct with that of other constructs, discriminant validity is achieved [52]. Final values for reliability and validity are shown in Table 5. The AVE's square roots are illustrated in bold.

Table 4. Loadings of the applied scales.

Construct	No. of items	Std.lv	Std.all	Cronbach's α
Intention to Use (IU)	2 Items			0.625
IU1		0.874	0.816	
IU2		0.586	0.640	
Perceived Usefulness (PU)	5 Items			0.898
PU1		0.622	0.832	
PU2		0.646	0.853	
PU3		0.903	0.752	
PU4		0.667	0.841	
PU5		0.815	0.841	
Perceived Ease of Use (PEU)	3 Items			0.845
PEU1		0.716	0.881	
PEU2		0.690	0.711	
PEU3		0.663	0.845	
Actual use (AU)	4 items			0.625
AU1		0.494	0.349	
AU2		1.144	0.768	
AU3		0.969	0.533	
AU4		0.553	0.510	
Functionality (FUNC)	5 items			0.851
FUNC1		0.613	0.691	
FUNC2		0.561	0.768	
FUNC3		0.516	0.607	
FUNC4		0.620	0.724	
FUNC5		0.764	0.846	
Subjective Norm (SN)	3 Items			0.772
SN1		0.542	0.654	
SN2		0.987	0.800	
SN3		0.898	0.757	
Image (IMA)	4 Items			0.821
IMA1		1.029	0.738	
IMA2		0.971	0.689	
IMA3		0.952	0.822	
IMA4		0.743	0.721	
Trialability (TRIA)	3 Items			0.826
TRIA1		1.030	0.770	
TRIA2		1.115	0.789	
TRIA3		0.966	0.793	

Table 5. Constructs AVE, CR, and factor correlations.

	AVE	CR	IU	PU	PEU	AU	FUNC	SN	IMA	TRIA
IU	0.538	0.696	**0.733**							
PU	0.680	0.914	0.691	**0.825**						
PEU	0.665	0.855	0.314	0.315	**0.816**					
AU	0.314	0.630	0.472	0.484	0.168	**0.560**				
FUNC	0.535	0.850	0.652	0.649	0.404	0.437	**0.723**			
SN	0.547	0.782	0.487	0.576	0.136	0.331	0.438	**0.740**		
IMA	0.554	0.832	0.348	0.465	0.090	0.362	0.360	0.456	**0.744**	
TRIA	0.615	0.827	0.265	0.343	0.225	0.305	0.235	0.410	0.578	**0.784**

While the results across all constructs provide satisfactory results for composite reliability, there are a few things to note. First, the AVE of AU is below the traditional threshold which can be explained through the limited available of all assistance systems in the truck driver's cabin. Second, the square root of the AVE for IU is close to the absolute value of the correlation with the factor PU. These two central constructs of Davis' [10] TAM show a strong connection in this study on the acceptance of driving assistance systems among truck drivers. Such connection could already be observed in the previous step of EFA that IU and PU are detected as the same factor in some cases (e.g., change of extraction method, fixating the number of factors). The critical interplay between the constructs is stated from theory [10, 17] and has been demonstrated in previous studies referencing driving assistance and developments in the mobility of drivers [38, 41]. Given the robust CR value of 0.696 of the latent variable IU, a stronger correlation between IU and PU is tolerated in the succeeding analysis process.

5.2 Structural model

Derived from the hypotheses, the structural model is formed and analyzed using JASP software, bootstrapping with 10.000 samples and a confidence interval of 95%. In the SEM, a variance of $R2 = 0.810$ is explained for the endogenous variable IU and a variance of $R2 = 0.509$ for AU. For PU, the coefficient of determination is found at 0.586. A considerably smaller variance for the endogenous variable PEU can be stated with $R2 = 0.081$. For the variable PU, there is a positive, significant associations with PEU (H1c), SN (H2a), and IMA (H2b) to be reported. A positive relationship of TRIA on PEU (H3a) can been seen. Among all present standardized effects, the impact of PU on IU is one of the strongest (H1a). Completing the model with a high significance is the effect of FUNC on IU (H3c). Surprisingly, the relationship of PEU to IU (H1b), as described in theory (Davis, 1989; 16), does not reach the required confidence level. Another highly significant effect is seen in IU on AU (H1d). Table 6 and Figure 2 summarize the results.

Table 6. Path coefficients of the PLS-SEM.

							95% Confidence Interval	
Outcome	**Predictor**	**Estimate**	**f²**	**Std. Error**	**z-value**	**p**	**Lower**	**Upper**
PEU	TRIA	0.325	0.088	0.085	3.808	< .001	0.162	0.488
PU	IMA	0.197	0.057	0.096	2.041	0.021	0.007	0.388
	SN	0.557	0.520	0.114	4.878	< .001	0.318	0.768
	PEU	0.250	0.148	0.093	2.677	0.004	0.066	0.430
IU	FUNC	0.272	0.170	0.144	1.883	0.030	-0.007	0.562
	PEU	0.045	0.005	0.098	0.453	0.325	-0.144	0.241
	PU	0.656	1.170	0.122	5.394	< .001	0.396	0.883
AU	IU	0.716	1.038	0.089	8.036	< .001	0.530	0.877

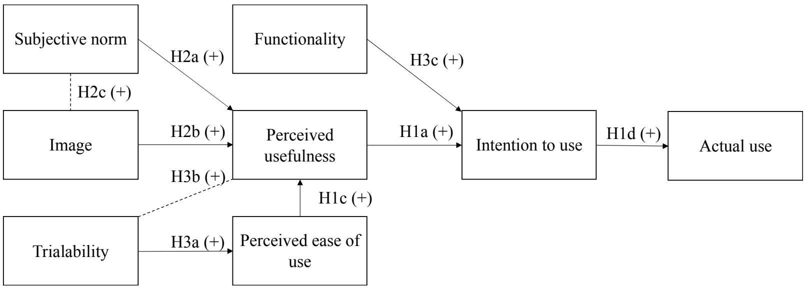

Figure 2. Confirmed theoretical framework.

5.3 Mediation analyses

Hayes' PROCESS macro version 4.0 [54] for SPSS was used to analyze possible mediation effects. Following established guidelines, bootstrapping with 5.000 samples and a confidence interval of 95% were used to evaluate the effects [51]. Effects were considered significant if the 95% bias-corrected and accelerated confidence intervals (BCa CI) did not include zero. Model 4 was selected for the mediation effects hypothesized in this study with one proposed mediator [55]. First, the effect of PEU on PU through TRIA was tested (H3b). A standardized significant indirect effect through the mediator trialability was found (B = 0,708, 95% BCa CI [0.0138 to 0.14]. Second, the effect of SN on PU through IMA (H2c) was assessed. In addition to the preceding analysis, partial mediation can also be observed here. Significant standardized indirect effect of through the mediator image is reported with B = 0,1369, 95% BCa CI [0.0620 to 0.2269]. Likewise, a highly significant direct effect is present ($p < 0.00$) being mediated through IMA. Accordingly, hypotheses H2c and H3b are supported. The results of the mediation analyses are shown in Figure 3.

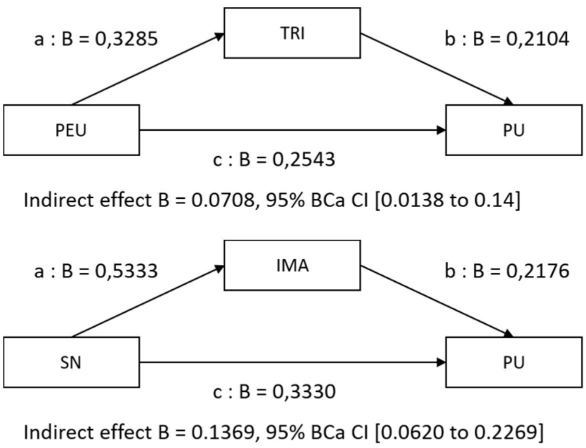

Figure 3. Mediation analyses.

6. Discussion

This study gained insights from the quantitative analysis of the trucker drivers' use of assistance systems in their work environment. By doing so, we responded to Ji-Hyland and Allen's [56] call for research on levers for improved job satisfaction and well-being of professional drivers, and Croson et al.'s [14] call for a deeper understanding of individual variances in behavioral operations. We thus position the present study in the social psychology domain of BeOM [13]. By combining multiple levels, the role of organizational factors and the legislative context is prevalent for the individual behavior [57]. Related interventions on the individual, organizational, and political level are discussed in the following, taking into account the theoretical grounding of the TAM and IDT.

While testing the hypotheses regarding the theoretical framework, overall, the collected data confirms the suitability of the TAM for the context of truck drivers. However, it must be mentioned that the well-established hypothesis H1b is rejected, deviating from the theoretical model of origin [17]. The relationship between PEU and IU only fails to meet the required criterion, whereas the smaller effect of PEU compared to PU corresponds to the TAM literature [10] and other studies on assistance systems [5, 25, 41]. Particularly looking at the results of Günthner and Proff's [25] study, independent of the age influence in relation to acceptance, the influence of PEU cannot reach a sufficient significance level in all cases and reveals only small effect sizes on the behavioral intention to use driver assistance systems.

Our study confirms that the social environment plays an essential role in the acceptance and subsequent successful use of driving assistance systems [17]. From the quantitative analysis, the SN can be cited as the single most crucial factor positively influencing the critical perceived usefulness. Thus, it can be inferred from the data in a theory-confirming manner that encouragement by managers, colleagues, and the company culture influences driver behavior and increases the likelihood that the systems will be used. Interestingly, the lowest mean value with the highest standard deviation is observed concerning the recommendation by fellow work colleagues (SN2). For practical purposes, supervisors need to continue the encouragement in relevant social surroundings of truck drivers. Another positive direct effect of IMA on PU from the structural model could be demonstrated. In the mediation analysis, the effect of SN on PU was found to be partially mediated through image.

From the perceptions of the participating truck drivers, assistance systems have not yet been perceived as attractive or associated with prestige. It seems reasonable that, to some degree, the feeling that one' competencies lose value due to the many supporting systems in the driver's cab and the impact on the driving sensation [26]. The encouragement to use assistance systems by supervisors and colleagues should be accompanied by comprehensive introduction programs to the systems. New technologies that can be tried out beforehand, or encouraged to be used under appropriate guidance, will positively affect the likelihood that the systems will be ultimately used [9]. From the theoretical model tested, a positive effect can be observed that the opportunity to experience assistance systems positively affects the judgment of using them (H3a).

Introductions to assistance systems or application training for drivers have already taken place to some extent, but on average, did not achieve sufficient agreement for a satisfactory assessment (TRI2). Conclusive potential for action can be derived from the last item, namely the assessment of an extensive test phases carried out before introduction to the driver's cabin contains the lowest mean value of all the items included in the analysis (TRI4, m = 2.42). These measures should ideally be framed by positive reinforcement through important referents from the driver's work environment. This results in a clear requirement to further develop the periodic driver training established under the Directive 2003/59/EC with the aim to include opportunities to test and engage with driver assistance systems [34] while costs for the mandatory trainings are not always covered by the employers. Overall, trainings and practical application of new technologies constitute a potential area to improvement in the current training system.

In Yuen et al.'s [39] study on factors leading to the adoption of autonomous vehicles, a positive effect of TRIA on PEU was identified, confirming the hypothesis that training and previous experience with the technology increases ease of use and the likelihood of technology adoption. Apart from this, elaborate introductory phases and training are also recommended as a measure for more mundane reasons. As Oviedo-Trespalacios et al. [58, p. 1] stated in their study, manuals on the proper use of driver assistance systems are inadequately written in that they "[…] require several years of education above the recommended for a universal audience." This results in potentially low readership in occupational groups that depend on driving assistance systems with a lower level of education, as can be seen to some extent in the group of truck drivers [58]. The use of low-threshold educational offers, such as explanatory videos that complement or substitute manuals, could be an incentive to reduce the inhibition threshold to use the driver assistance systems.

The observation that users of assistance systems perceive higher safety-related control over driving hazards and the probability of accidents was previously reported by Hagl and Kouabenan [59] and can be confirmed within this study. It can be deduced that truck drivers are well-aware of the benefits of driver assistance systems in terms of safety, which is in line with recent studies on general usage [26]. Despite high approval of the safety aspects offered by assistance systems, however, many drivers declared that systems should remain switched off if they are not legally mandatory (mean = 4.75, sd. 0.573). This observation points to tensions or even paradoxes in their application and provide potential for future research [60]. Such a better understanding of the paradoxical interrelations enables logistics managers to improve job design and working conditions, and policymakers to develop tailored regulation and incentives to counteract the present driver shortage.

7. MANAGERIAL IMPLICATIONS

The results of this study also provide guidance for managers in the process of prioritizing measures to generate acceptance and improvements in performance with respect to driving assistance systems and consequently addresses the need for further research outlined in this field [61]. Our research shows that efficient training and an extended time frame when implementing the assistance systems are essential factors for technology acceptance. The findings confirm that appropriate training and consistent use of specific assistance systems (in combination with an appropriate driving style) will lead to significant fuel savings benefitting the environment as well as improving security. The quantitative results also confirm a positive attitude towards digital transformation processes while, amongst others, the functionality and perceived usefulness experienced by the drivers can facilitate acceptance and should hence be taken into consideration for managerial measures.

Another recommendation would be to involve drivers when introducing new assistance systems to the fleet. This could be done by regularly obtaining feedback from drivers. This would result in practical improvements to the systems and thus increase acceptance and approval among drivers. It would also be essential to establish transparent communication between the drivers and the fleet managers. Ideally, this would allow drivers to follow precisely how their suggestions are implemented and, if they are not implemented, receive a reasoned explanation for the non-implementation, which would result in greater understanding. Finally, managers should have clear guidelines regarding the activation of and compliance with driver assistance systems.

Consistency in using the systems would lead to clarity among drivers. Even skeptical drivers could be quickly convinced by the consistent use of the systems, thus helping to ensure that the regularly obtained feedback is also well-founded.

8. CONCLUSION

The topic of driving assistance systems has been gaining momentum for some years now. Although more and increasingly advanced assistance systems can be found in the driver's cabin, this circumstance alone does not seem to make the profession of the truck driver more attractive. On the contrary, there is already a shortage of truck drivers in the European union, while in the coming years a further decrease is expected [44, p.7]. It is, therefore, relevant to examine how truck drivers engage with assistance systems, particularly concerning user acceptance as an essential factor for the success of a novel technology. For companies, it is also a matter of adapting to these changes and readying employees for new legislation in the European union. The aim of this study was consequently to analyze the various factors influencing the acceptance of assistance systems in road freight traffic as well as the functionality of truck assistance systems and the aspects of social norms, company image and trialability.

To achieve this research objective, the following two research questions were addressed: The first considers how social norms, the image of assistance system manufacturers as well as the trialability and functionality of truck assistance systems affect user behavior. The second asks what managerial recommendations can be derived to foster the acceptance and use of truck assistance systems. For the acceptance of driving with assistive technology, influential factors were confirmed through a PLS-SEM model in this study. In particular, the results of this work highlight the importance of PU towards the acceptance of driving assistance systems.

As a result, a positive outlook can be issued for the use of assistance systems and the associated digital transformation of the occupational profile of truck drivers. Assistance systems are seen as safety-promoting, helpful for the occupation, but so far as unattractive. With the potential to prevent or mitigate accidents, workers are exposed to lower risks. In the light of the truck driver shortage in Europe, it will be necessary to rethink the driver's role in the cabin. Here, organizations will have a special responsibility for recruiting and training the existing workforce find its way in a changing workplace. Clear starting points such as safety and comfort [26] should be utilized to ensure that a large majority in the coming future welcomes a gradually autonomous workplace with a multitude of assistance systems.

Despite these contributions, this study features some limitations. First, the study must account for a limited number of constructs. Thereby, the categories used were exclusively created deductively based on the underlying theoretical constructs of the TAM and IDT. Additional dimensions can be added, of which future work might use inductive means to discover new patterns with respect to promoting assistant driving. Second, the sample size can be enlarged. The data collected is based on one country (Germany) and, thus, can be extended to other countries. An extension to other geographical regions could also consider cultural factors which influence further the acceptance of driving assistants. While the conceptual model offers a sound comprehension, the sample size, which is adequate to test the conceptual model, poses certain empirical limitations. Finally, the analysis is restricted to the evaluation of prior defined relationships rather than discovering unexpected patterns. However, the preliminary analyses did not indicate a structure inherent in the data that departs from the present model.

ACKNOWLEDGEMENTS

The authors would like to thank the editor and reviewers for their valuable and constructive comments, which have led to a significant improvement in the manuscript. Moreover, we would like to express our sincere gratitude to Maximilian Girnus from the Westcoast University of Applied Sciences in Heide for supporting the research activities.

REFERENCES

1. Loske D, Klumpp M (2021) Intelligent and efficient? An empirical analysis of human–AI collaboration for truck drivers in retail logistics. The International Journal of Logistics Management 32(4): 1356-1383.
2. Winkelhaus S, Grosse EH, Glock CH (2022) Job satisfaction: An explorative study on work characteristics changes of employees in Intralogistics 4.0. Journal of Business Logistics 43(3): 343-367.
3. John LM, Flin R, Mearns K (2006) Bus driver well-being review: 50 years of research. Transportation Research Part F: Traffic Psychology and Behaviour 9(2): 89-114.
4. Miller JW (2017) A multivariate time-series examination of motor carrier safety behaviors. Journal of Business Logistics 38(4): 266-289.
5. Rahman MM, Lesch MF, Horrey WJ, Strawderman L (2017) Assessing the utility of TAM, TPB, and UTAUT for advanced driver assistance systems. Accident Analysis & Prevention 108: 361-373.
6. European Council (EC) (2009) EUR-Lex - 32009R0661 – EN. https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009R0661.
7. European Parliament (EP) (2017) EUR-Lex - 52017IP0423 – EN. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52017IP0423.
8. European Union (EU) (2019) EUR-Lex - 32019R2144 – EN. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32019R2144.
9. Rogers EM (1995) Diffusion of Innovations. Modifications of a Model for Telecommunications. In Stoetzer MW, Mahler A (Eds.) Die Diffusion von Innovationen in der Telekommunikation. Springer, Berlin, Heidelberg, Germany.
10. Davis F (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. MIS Quarterly 13(3): 319–340.
11. Gruchmann T (2022) Theorizing the impact of network characteristics on multitier sustainable supply chain governance: a power perspective. The International Journal of Logistics Management 33(5): 170-192.
12. Flynn B, Pagell M, Fugate B (2018) Survey research design in supply chain management: the need for evolution in our expectations. Journal of Supply Chain Management 54(1): 1-15.
13. Bendoly E, Croson R, Goncalves P, Schultz K (2010) Bodies of knowledge for research in behavioral operations. Production and Operations Management 19(4): 434-452.
14. Croson R, Schultz K, Siemsen E, Yeo ML (2013). Behavioral operations: the state of the field. Journal of Operations Management 31(1-2): 1-5.
15. Gino F, Pisano G (2008). Toward a theory of behavioral operations. Manufacturing & Service Operations Management 10(4): 676-691.
16. Lee JD, See KA (2004) Trust in automation: Designing for appropriate reliance. Human Factors 46(1): 50-80.
17. Venkatesh V, Davis FD (2000) A theoretical extension of the technology acceptance model: Four longitudinal field studies. Management Science 46(2): 186-204.
18. Salmon PM, Young KL, Regan MA (2011) Distraction 'on the buses': A novel framework of ergonomics methods for identifying sources and effects of bus driver distraction. Applied Ergonomics 42(4): 602-610.
19. Roberts SC, Ghazizadeh M, Lee JD (2012) Warn me now or inform me later: Drivers' acceptance of real-time and post-drive distraction mitigation systems. International Journal of Human-Computer Studies 70(12): 967-979.
20. Lyu N, Deng C, Xie L, Wu C, Duan, Z (2019) A field operational test in China: Exploring the effect of an advanced driver assistance system on driving performance and braking behavior. Transportation Research Part F: Traffic Psychology and Behaviour 65: 730-747.
21. Son J, Park M, Park BB (2015) The effect of age, gender and roadway environment on the acceptance and effectiveness of Advanced Driver Assistance Systems. Transportation Research Part F: Traffic Psychology and Behaviour 31: 12-24.
22. Li G, Eben Li S, Cheng B (2015) Field operational test of advanced driver assistance systems in typical Chinese road conditions: The influence of driver gender, age and aggression. International Journal of Automotive Technology 16: 739-750.
23. Ervin R, Sayer J, LeBlanc D, Bogard S, Mefford M, Hagan M, Bareket Z, Winkler C (2005) Automotive collision avoidance system field operational test report: methodology and results. National Highway Traffic Safety Administration, UMTRI-2006-9-1, Washington DC.
24. Scott A, Davis-Sramek B (2023) Driving in a man's world: examining gender disparity in the trucking industry. International Journal of Physical Distribution & Logistics Management 53(3): 330-353.
25. Günthner T, Proff H (2021) On the way to autonomous driving: How age influences the acceptance of driver assistance systems. Transportation Research Part F: Traffic Psychology and Behaviour 81: 586-607.

26. Richardson N, Doubek F, Kuhn K, Stumpf A (2017) Assessing truck drivers' and fleet managers' opinions towards highly automated driving. In Advances in Human Aspects of Transportation: Proceedings of the AHFE 2016 International Conference on Human Factors in Transportation (pp. 473-484), Springer International Publishing.
27. Seter H, Hansen L, Arnesen P (2021) Comparing user acceptance of integrated and retrofit driver assistance systems–A real-traffic study. Transportation Research Part F: Traffic Psychology and Behaviour 79: 139-156.
28. Mokarami H, Alizadeh SS, Pordanjani TR, Varmazyar S (2019) The relationship between organizational safety culture and unsafe behaviors, and accidents among public transport bus drivers using structural equation modeling. Transportation Research Part F: Traffic Psychology and Behaviour 65: 46-55.
29. Nævestad T, Phillips RO, Laiou A, Bjørnskau T, Yannis G (2019) Safety culture among bus drivers in Norway and Greece. Transportation Research Part F: Traffic Psychology and Behaviour 64: 323-341.
30. Miller KA, Filtness AJ, Anund A, Maynard SE, Pilkington-Cheney F (2020) Contributory factors to sleepiness amongst London bus drivers. Transportation Research Part F: Traffic Psychology and Behaviour 73: 415-424.
31. Kemp E, Kopp SW, Kemp Jr EC (2013) Take this job and shove it: Examining the influence of role stressors and emotional exhaustion on organizational commitment and identification in professional truck drivers. Journal of Business Logistics 34(1): 33-45.
32. Miller JW, Golicic SL, Fugate BS (2018) Reconciling alternative theories for the safety of owner–operators. Journal of Business Logistics 39(2): 101-122.
33. Eskandarzadeh S, Fahimnia B, Hoberg K (2023) Adherence to standard operating procedures for improving data quality: An empirical analysis in the postal service industry. Transportation Research Part E: Logistics and Transportation Review 176: 103178.
34. European Parliament (EP) (2003) EUR-Lex - 32003L0059 – EN. https://eur-lex.europa.eu/legal-content/DE/ALL/?uri=CELEX%3A32003L0059.
35. Elvebakk B, Nævestad TO, Lahn LC (2020) Mandatory periodic training for professional drivers: A Norwegian study of implementation and effects. Transportation Research Part F: Traffic Psychology and Behaviour 72: 264-279.
36. Brock JF, McFann J, Inderbitzen RE, Bergoffen G (2007) Effectiveness of commercial motor vehicle driver training curricula and delivery methods. Transportation Research Board, Washington D.C.
37. Ebnali M, Hulme K, Ebnali-Heidari A, Mazloumi A (2019) How does training effect users' attitudes and skills needed for highly automated driving?. Transportation Research Part F: Traffic Psychology and Behaviour 66: 184-195.
38. Isa MH, Deros B, Abu Kassim, KA (2015) A Review of empirical studies on user acceptance of driver assistance systems. Global Journal of Business and Social Science Review 3(3): 39-46.
39. Yuen KF, Cai L, Qi G, Wang X (2021) Factors influencing autonomous vehicle adoption: An application of the technology acceptance model and innovation diffusion theory. Technology Analysis & Strategic Management 33(5): 505-519.
40. Ajzen I (1991) The theory of planned behavior. Organizational behavior and human decision processes 50(2): 179-211.
41. Venkatesh V, Bala H (2008) Technology acceptance model 3 and a research agenda on interventions. Decision Sciences 39(2): 273-315.
42. Venkatesh V, Morris MG, Davis GB, Davis FD (2003) User acceptance of information technology: Toward a unified view. MIS Quarterly: 425-478.
43. Ghazizadeh M, Peng Y, Lee JD, Boyle LN (2012) Augmenting the technology acceptance model with trust: Commercial drivers' attitudes towards monitoring and feedback. In Proceedings of the human factors and ergonomics society annual meeting 56(1): 2286-2290.
44. International Road Transport Union (IRU) (2019) Tackling Driver Shortage in Europe. https://transport-online.de/sites/default/files/public/data-news/tackling-european-driver-shortage-iru-report.pdf.
45. European Statistical Office (Eurostata) (2021). Road accident fatalities - statistics by type of vehicle. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Road_accident_fatalities_-_statistics_by_type_of_vehicle.
46. Schwarz NE, Sudman SE (1996) Answering questions: Methodology for determining cognitive and communicative processes in survey research. Jossey-Bass/Wiley.
47. Fabrigar LR, Wegener DT, MacCallum RC, Strahan EJ (1999) Evaluating the use of exploratory factor analysis in psychological research. Psychological Methods 4(3): 272.
48. Hair J, Black W, Babin B, Anderson R (2013) Multivariate data analysis. Pearson Education Limited, Harlow, 7th Edition.
49. Ali AH, Gruchmann T, Melkonyan A (2022) Assessing the impact of sustainable logistics service quality on relationship quality: Survey-based evidence in Egypt. Cleaner Logistics and Supply Chain 4: 100036.

50. Podsakoff PM, MacKenzie SB, Lee JY, Podsakoff NP (2003) Common method biases in behavioral research: a critical review of the literature and recommended remedies. Journal of Applied Psychology 88(5): 879.
51. Baron RM, Kenny, DA (1986) The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. Journal of Personality and Social Psychology 51(6): 1173.
52. Garson GD (2016) Validity & Reliability. Statistical Associates Publishers, Asheboro.
53. Fornell C, Larcker DF (1981) Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research 18(1): 39-50.
54. Hayes AF (2021) The PROCESS macro for SPSS, SAS, and R. https://www.processmacro.org/index.html.
55. Hayes AF (2017) Introduction to mediation, moderation, and conditional process analysis: A regression-based approach. Guilford Press, New York City.
56. Ji-Hyland C, Allen D (2022) What do professional drivers think about their profession? An examination of factors contributing to the driver shortage. International Journal of Logistics Research and Applications 25(3): 231-246.
57. Saikouk T, Fattam N, Angappa G, Hamdi A (2021) The interplay between inter-personal and inter-organizational relationships in coordinating supply chain activities. The International Journal of Logistics Management 32(3): 898-917.
58. Oviedo-Trespalacios O, Tichon J, Briant O (2021) Is a flick-through enough? A content analysis of Advanced Driver Assistance Systems (ADAS) user manuals. Plos one 16(6): 1-17.
59. Hagl M, Kouabenan DR (2020) Safe on the road–does advanced driver-assistance systems use affect road risk perception?. Transportation Research Part F: Traffic Psychology and Behaviour 73: 488-498.
60. Gruchmann T, Mies A, Neukirchen T, Gold S (2021) Tensions in sustainable warehousing: including the blue-collar perspective on automation and ergonomic workplace design. Journal of Business Economics 91(2): 151-178.
61. Klumpp M (2018) Automation and artificial intelligence in business logistics systems: human reactions and collaboration requirements. International Journal of Logistics Research and Applications 21(3): 224-242.