Proceedings of the Hamburg International Conference of Logistics (HICL) – 31

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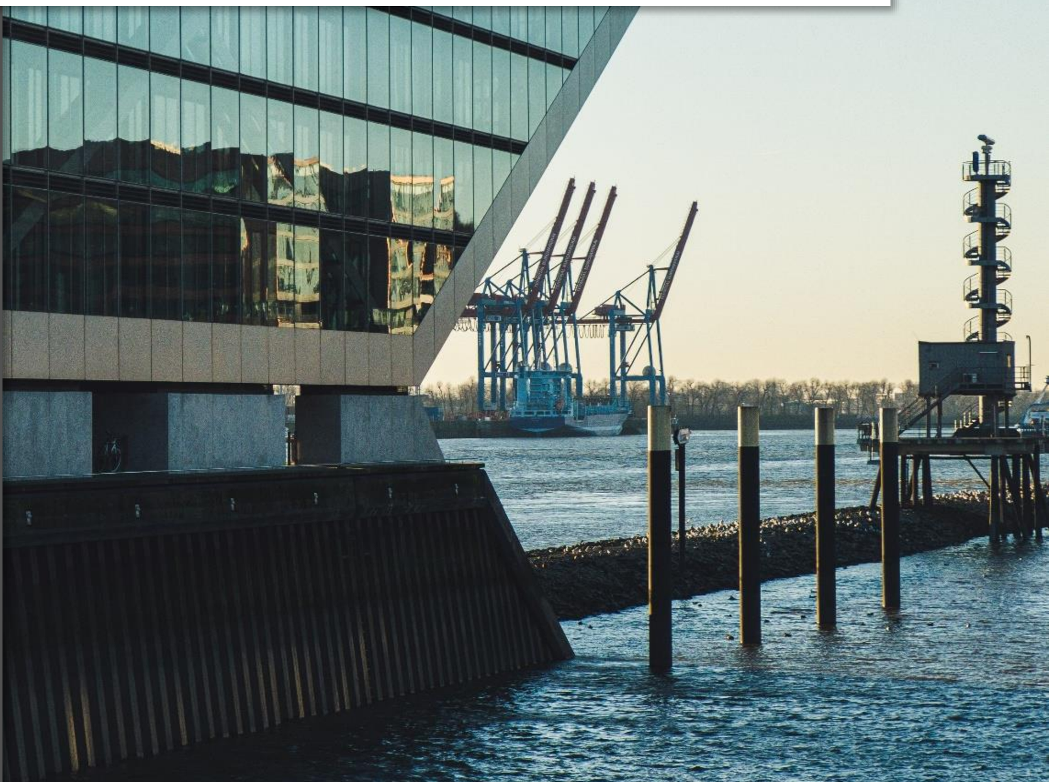
HICL



Published in: Adapting to the Future:
Wolfgang Kersten, Christian M. Ringle and Thorsten Blecker (Eds.)
ISBN 978-3-754927-70-0, September 2021, epubli

Bus driver’s technology acceptance for driving assistants

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Purpose: *According to recent studies, many road accidents could be avoided using driving assistance systems. However, the introduction of increased levels of technology in workplaces is often met with opposition. The paper, therefore, analyzes the bus drivers’ acceptance of assistance systems and provides recommendations for increasing acceptance.*

Methodology: *Using a mixed-method research approach of conducting interviews (N = 8) and an online survey among professional bus drivers (N = 81), we test a theoretical framework based on the Technology Acceptance Model (TAM) and Innovation Diffusion Theory (IDT) with qualitative content analysis and multiple regression analyses.*

Findings: *The interview findings suggest that TAM and IDT provide a suitable theoretical grounding for analyzing the bus driver's acceptance. The quantitative results confirm a positive attitude towards digital transformation processes at the bus driver's cab while, among others, the functionality and perceived usefulness experienced by the drivers can facilitate acceptance.*

Originality: *The paper analyzes the use of assistance systems in the workplace of professional bus drivers from various perspectives. Concerning technology acceptance, the present study contributes to a better understanding of underlying acceptance mechanisms in professional bus driving.*

First received: 20. Apr 2021 *Revised: 29. Aug 2021* *Accepted: 31. Aug 2021*

1 Introduction

New technologies offer opportunities for innovation in the logistics and transportation industry. In this context, the use of assistance systems by bus drivers not only plays a vital role in the prevention of traffic accidents and has an overall positive effect on occupational health and safety (Mokarami, Alizadeh, Pordanjani, & Varmazyar, 2019), but also helps to recruit and retain skilled workers. Extant literature found evidence that assistant systems mitigate CO_2 emissions while the related security also increases driver’s well-being (Zarkadoula, Zoidis, & Tritopoulou, 2007). However, assistance systems are not yet widely used and are sometimes rejected by drivers (Gruchmann, Demtschenko, & Salzmann, 2021). Besides economic and regulatory reasons, drivers’ negative attitudes toward them might be based on the mental and emotional stress levels generated by their use and the fact that the technology is not universally reliable (Tse, Flin, & Mearns, 2006). To gain more insights into the bus driver’s technology acceptance, the following research question guided our research: *Which factors significantly affect the bus drivers' attitudes towards using assistance systems?*

To systematically test factors influencing the acceptance of assistance systems, the present study proposes a theoretical model integrating Innovation Diffusion Theory (IDT) (cf. Roger, 1995) and the Technology Acceptance Model (TAM) (cf. Davis, Bagozzi, & Warshaw, 1989). The TAM is specifically designed to model user acceptance of technologies and information systems and has been widely used in information systems research, often in conjunction with social psychology questions. Also, IDT is a popular theory in a wide range of disciplines to study how people in a social system react to innovations and the processes that result from them. In this context, innovations are understood as various forms such as messages, objects, modern processes, and technical advances (Rogers, 1995). The fundamental question of the IDT is thereby why people make decisions for or against an innovation based on their convictions. For the present research context, an integrated research model of these two fundamental theories, TAM and IDT, is used. The constructs of the extended IDT (compatibility, demonstrability of results, and triability) can be found along with the two main dimensions of TAM (perceived ease of use, perceived usefulness, perceived behavioral control) as mediators for the intention to use or reject the technology (Yuen, Cai, Qi, & Wang, 2020).

Based on qualitative interviews (N = 8) and a quantitative questionnaire (N = 81) being administered in Germany, the factors influencing the use of legally mandatory assistance systems (e.g., emergency brake assist) and voluntary assistance systems (e.g., adaptive cruise control, turn-off assistant) are examined. These included, among others, the technical functionality and reliability of the systems. As a result, we found functionality and perceived usefulness as the strongest predictors for the intention to use assistance systems. Accordingly, technological innovations with assistance systems constitute an essential cornerstone for increased safety and job attractiveness (Gruchmann, Demtschenko, & Salzmann, 2021). Our study thereby contributes to improving the working conditions in the transportation sector, as well as the driver's perception and appreciation of the activities related to their occupational profile.

The remainder is structured as follows: Section 2 provides a brief literature background, while Section 3 describes the theoretical lens of IDT and TAM and related hypotheses. Section 4 describes the applied research design. Next, sections 5 and 6 present the findings of the qualitative and quantitative investigations. Finally, section 7 discusses the results against previous research, the limitations, managerial implications, and recommendations for future research.

2 Literature Background

Some important research has been published in recent years with a direct reference to bus drivers. In 2006, for example, a report by Tse, Flin, and Mearns (2006) summarized over 50 years of research on the health of bus drivers. Their report found that the most significant stressors for drivers today are the increased volume of traffic, aggressive and potentially violent passengers, and increasingly tight schedules. The studies also indicated that appropriate training, longer breaks, consistent and regular allocation of shifts, and appropriate assistance in road traffic (including assistance systems) could improve bus drivers' well-being as well as driver's and passengers' safety (Tse, Flin, &

Mearns, 2006). Supporting these results, an Australian study by Salmon, Young, and Regan (2011) found similar stressors and reasons for distraction.

A Greek project in 2007 investigated how bus drivers on Athens city routes could be trained to use more efficient driving styles and hence promote environmentally-friendly driving. In several phases, three bus drivers were trained by a Dutch training company and were taught how to drive more efficiently, thereby also using modern assistance systems. After completing the training, the bus drivers used 4.35% less diesel when driving in the city than before. In addition, they noticed that they could drive more economically without slowing down and hence did not risk running behind schedule. The findings showed that even in urban traffic, there need not be any time-related disadvantages for bus drivers when relying on assistance systems as long as appropriate training is provided.

More recently, Mokarami, Alizadeh, Pordanjani, and Varmazyar (2019) studied the relationship between organizational safety culture and unsafe driving behaviors. They particularly found that strategies for improving safety culture can reduce the number of accidents among bus drivers. Similar results were found by Nævestad, Phillips, Laiou, Bjørnskau, and Yannis (2019) for Norwegian and Greek bus drivers. Further, Miller, Filtness, Anund, Maynard, and Pilkington-Cheney (2020) found several factors contributing to sleepiness among London bus drivers. Assistance systems thereby can be seen as a potential means to positively influence safety culture and decrease accidents based on driver sleepiness.

More broadly integrating assisted and autonomous driving technologies into the socio-technical context, the study by Yuen, Cai, Qi, and Wang (2020) examined the decisions made for or against automated vehicles. They found that an integrated model combining the TAM and the IDT is very well suited to carry out further research in this context. According to their study, the advantages of non-automated vehicles and providing targeted training for drivers are factors for the successful adoption of this innovation.

3 Theoretical Background

The TAM was initially developed by Fred Davis and published in 1989 (Davis, Bagozzi, & Warshaw, 1989). The TAM includes two specific constructs: "Perceived Usefulness" and "Perceived Ease of Use." Both dimensions directly influence an individual's attitude towards using a system and are determined by external variables such as demographic factors and personality traits. Attitudes, accordingly, directly influence the behavioral intention to use, which influences the actual system use (Davis, Bagozzi, & Warshaw, 1989). Considering the study's context, we can formulate the following hypotheses:

1. **H1a:** Perceived usefulness of assistance systems positively affects the intention to use.
2. **H1b:** Perceived ease of use of assistance systems positively affects the intention to use.
3. **H1c:** The intention to use assistance systems positively affects the actual usage.
4. **H1d:** The functionality of assistance systems positively affects the actual usage.

The TAM formulates the hypothesis that the potential users' mental assessment about how well work goals correspond to the results of carrying out a work task with the help of the technology serves as a basis for the development of assessments of the usefulness of the system (Venkatesh & Davis, 2000). In addition, subjective norms, following the basic idea that individuals are influenced by the ideas and attitudes of important people, were added as direct determinants of behavior (Venkatesh, Morris, Davis, & Davis, 2003). If personal norms and subjective norms do not match, people will be reluctant to engage with the technology. Davis and Venkatesh (2000, p. 187) explain this as follows: *"People may choose to perform a behavior, even if they are not themselves favorable toward the behavior or its consequences if they believe one or more important referents think they should, and they are sufficiently motivated to comply with the referents."* Regarding the use of assistance systems, we can formulate the following hypotheses:

5. **H2a:** Subjective norms positively affect the intention to use assistance systems.
6. **H2b:** Subjective norms positively affect the perceived usefulness of assistance systems.

7. **H2c:** Technology commitment positively affects the perceived usefulness of assistance systems.

In addition to the TAM, the IDT shall be considered. According to IDT theory, the decision-making process depends on five characteristics of the innovation: relative advantage, compatibility, complexity, experimentability, and observability (Poong, Eze, & Talha, 2009). In addition, the characteristic of observability can be divided into the two characteristics of demonstrability of results and visibility. Finally, the characteristic of voluntariness is introduced in conjunction with triability (Moore & Benbasat, 1991). Therefore, we formulate the following hypotheses:

8. **H3a:** Result demonstrability positively affects the perceived ease of use of assistance systems.
9. **H3b:** Triability positively affects the perceived ease of use of assistance systems.
10. **H3c:** Compatibility positively affects the perceived ease of use of assistance systems.

Figure 1 shows the theoretical framework to be tested.

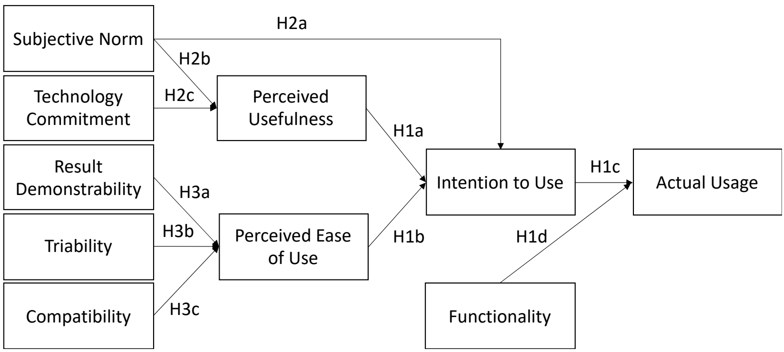

Figure 1: Integrated Theoretical Framework

4 Research Design

To answer the proposed research question, we applied a mixed-method research approach. A quantitative approach was conducted as an online survey among professional bus drivers in Germany (N = 81) to test factors influencing the acceptance of assistance systems statistically. To gain deeper and more exploratory insights into the bus drivers' personal perspectives and opinions with respect to assisted driving we additionally conducted qualitative interviews (N = 8). Mixed-method research designs are widely applied in logistics research, also including the blue-collar worker's perspective on workplace transformations (cf. Gruchmann, Mies, Neukirchen, & Gold, 2020).

4.1 Qualitative Interview Approach

To generate sound qualitative data, guided interviews with experts are particularly productive as a data collection method for identifying bus drivers' personal perspectives and opinions on a case-by-case basis (Riege, 2003). The interviewee selection is deliberately designed to ensure the heterogeneity of the research field under investigation by choosing interviewees from different areas of the industry. Thus, a sample of eight experts was compiled for the research process (see Table 1). An interview topic guide was used. All the interviews were recorded since this increases the accuracy of subsequent analyses and allows the researcher to refer to specific quotes from interviewees. Before the recording, the interviewees were informed that the interviews are recorded, transcribed, and analyzed anonymously.

The analysis of the interviews was carried out in two steps, first the transcription of the audio files and second, the evaluation of the data using qualitative content analysis (Mayring, 2015). First, the transcription process was carried out with f4transcript, a transcription software program. Any details subject to data protection were anonymized within the transcription process. The second step involved the process of evaluating the material obtained with qualitative content analysis. This evaluation process helps to structure the data via a systematic formation of main categories. By defining categories, it is possible to assign text passages to categories that match the content. The categories used were exclusively created by deductive means based on the underlying theoretical constructs of the TAM and IDT. According to the integrated model by Yuen, Cai, Qi, and Wang (2020), the theoretical dimensions that matched the content were applied as subcategories in the coding process. The entire coding process was carried out using the program f4analysis. It served as a database for the entire text material, allowing to list the main categories and subcategories and organize the coding process.

Table 1: Interviewees

Interviewee	Acronym	Length
Team bus driver for a premier league soccer team	B1	17 minutes
Bus driver for touristic coach travels and shuttle transport	B2	28 minutes
Public bus driver for scheduled bus services	B3	12 minutes
Bus driver for touristic coach travels and long-distance bus services	B4	31 minutes
Bus driver for school shuttle services	B5	22 minutes
Public bus driver for scheduled bus services	B6	42 minutes
Public bus driver for scheduled bus services	B7	32 minutes

Interviewee	Acronym	Length
Fleet manager for public bus operations	B8	22 minutes

4.2 Quantitative Survey Approach

Survey data were collected through a self-administered questionnaire based on the integrated theoretical framework (see Figure 1). The constructs of the questionnaire are displayed in Table 2. Table 2 also shows the measures used together with the descriptive data (mean value and standard deviation) and the code for each item. The participants (N = 81) for this survey were recruited through the Federal Association of German Bus Operators (BDO). The participants were mainly male (N = 73) and had an average age of 52.23 years (SD = 10.44). The majority of the companies employing the respondents can be categorized as small- to medium-sized. All constructs of the questionnaire were measured on a 5-point Likert scale with values from 1 to 5 (ranging from either "never" to "always" or from "strongly disagree" to "strongly agree"). All scales were already applied in other publications and altered for the context of bus driving assistants (e.g., Neyer, Felber, & Gebhardt, 2012). The questionnaire was administered in German. The translation of the questionnaire into English was done through the back-translation technique; the questions were accordingly translated and then retranslated.

Table 2: Constructs and Items

Constructs	Items	Code	Mean	SD
Actual Use	I use the emergency brake assistant	AU1	3.25	1.71
	I use the turning assistant	AU2	2.52	1.77

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Constructs	Items	Code	Mean	SD
	I use the lane-keeping assistant	AU3	3.46	1.43
	I use the adaptive cruise control	AU4	3.60	1.37
	In the past, I deactivated assistant systems.	AU5	1.81	0.95
Functionality	In the past, the emergency brake assistant worked error-free.	FC1	3.79	1.23
	In the past, the emergency brake assistant technically fulfilled its purpose.	FC2	4.05	1.09
	In the past, adaptive cruise control worked error-free.	FC3	4.02	1.22
	In the past, adaptive cruise control technically fulfilled its purpose.	FC4	4.15	1.23
Intention to Use	I wish assistance systems will be used more often.	IU1	4.21	1.03
	I plan to use the existing assistance systems in the next months.	IU2	4.21	1.13
	As long as assistance systems are not legally mandatory, they should remain switched off.	IU3	1.35	0.88
Perceived Usefulness	The use of assistance systems avoids accidents.	PU1	4.47	0.84
	The use of assistance systems increases safety.	PU2	4.54	0.67

Constructs	Items	Code	Mean	SD
	The use of assistance systems increases job attractiveness.	PU3	3.30	1.34
	The use of assistance systems improves my work performance.	PU4	3.54	1.21
	I consider assistance systems useful for my work.	PU5	4.21	0.95
	Assistance systems make my work easier.	PU6	3.99	1.16
	Assistance systems make me inattentive.	PU7	2.31	1.22
	In general, the signals from assistance systems offer me an added value.	PU8	3.93	0.96
Perceived Ease of Use	The handling of assistance systems is clear and understandable for me.	PE1	4.22	0.82
	Dealing with assistance systems does not require great mental effort from me.	PE2	4.17	0.97
	I find assistance systems easy to use.	PE3	4.1	0.89
	The system does what I want without any problems.	PE4	3.74	1.06
Subjective Norm	My company supports the use of assistance systems.	SN1	4.47	0.937
	Colleagues who are important to me recommend the use of assistance systems.	SN2	3.57	1.31

Constructs	Items	Code	Mean	SD
	Supervisors who influence my actions think that I should use assistance systems.	SN3	4.15	1.23
	I have the resources (time, nerves, attention, etc.) to be able to use assistance systems.	SN4	4.26	1.05
Technology Commitment	I am very curious about new technological developments.	TC1	4.59	0.67
	I enjoy new technical developments.	TC2	4.22	0.87
	I am always interested in using the latest technical equipment.	TC3	3.98	1.07
	If I had the opportunity, I would use technical products much more often than I do now.	TC4	3.84	1.08

To test the internal consistency of each scale, Cronbach's alpha measure of reliability was employed. In a meta-analysis on the Cronbach's alpha coefficient, Peterson (1994) provided evidence that a value below 0.60 is unacceptable, 0.60-0.70 is low, 0.80–0.90 is moderate to high, and above 0.90 is high. The results of the reliability analysis are shown in Table 3. If the α for a specific scale was found to be less than 0.60, correlation matrix analyses were done to identify and remove the item(s) contributing to low reliability.

Table 3: Cronbach's Alpha

Construct	Alpha	No.of Items
Actual Use	.675	3

Functionality	.804	4
Intention to Use	.717	3
Perceived Usefulness	.878	7
Perceived Ease of Use	.853	4
Subjective Norm	.827	4
Technology Commitment	.866	4

All items of the different constructs were entered into a principal component analysis (PCA) with orthogonal rotation (varimax). The Kaiser-Meyer-Olkin (KMO) measure verified the sample size adequacy for the analysis (KMO = 0.819). According to Field (2009), this is a "great" value for the overall KMO and well above the given limit of 0.50 for the individual items. Bartlett's test of sphericity yielded an approx. $\chi 2$ = 1648.06, $p < 0.001$, and showed that correlations between items were sufficiently large for PCA. The analysis showed inflections that would justify retaining eight components with an Eigenvalue above 1.0, explaining 75.42 percent of the variance. The results of the factor loadings after rotation are reported in Table 4. Therefore, the TAM, as elaborated by Venkatesh and Davis (2000), was only partly confirmed by the PCA.

Table 4: Rotated Component Matrix (values above .3 displayed)

Construct	Item	1	2	3	4	5	6	7	8
	AU1							.387	.592
Actual Use	AU3								.836
	AU4					.745			.359

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Construct	Item	1	2	3	4	5	6	7	8
Functionality	FC3					.888			
	FC4					.789			
	FC1							.859	
	FC2							.830	
Intention to Use	IU1	.449	.334	.583					
	IU2	.303		.524				.458	
	IU3			.707					
Perceived Usefulness	PU1			.802					
	PU2			.793					
	PU3	.639					.366		
	PU4	.731					.306		
	PU5	.711		.383					
	PU6	.790							
	PU8	.718	.336						
Perceived Ease of Use	PE1		.413		.642				.307
	PE2				.780				
	PE3				.784				

Construct	Item	1	2	3	4	5	6	7	8
	PE4				.714				
Subjective Norm	SN1						.687		
	SN2	.370					.528		
	SN3						.853		
	SN4	.399	.306				.524		
Technology Commitment	TC1		.823						
	TC2		.818						
	TC3		.672						
	TC4	.341	.690						

5 Findings of the Qualitative Content Analysis

In the following subsections, we qualitatively analyzed the effect of triability, compatibility, and result demonstrability on the perceived ease to use and perceived usefulness. Due to a lack of survey data, we could not test the relationships statistically. Nevertheless, a qualitative approach is well suited for a more exploratory analysis also considering bus drivers' perceptions and opinions. We found qualitative evidence that the IDT provides a suitable theoretical grounding for analyzing the bus driver's acceptance. Based on the qualitative data, we confirm the positive relationships between triability, compatibility, result demonstrability, and the perceived ease to use as hypothesized with the hypotheses H3a-H3c.

5.1 Triability

The bus drivers stated they enjoy testing out the systems. In addition to the training, there was enough time on the road to get to know the systems and learn how to use them efficiently (B3). In this context, person B5 mentioned that after a few hours of driving with the systems, a typical driver would have *"gotten used to"* them (B5). According to person B6, due to the triability, after some time, the problems with and reservations about the systems were *"no longer an issue"* among colleagues (B6). Persons B7 and B8 also stated that the drivers could learn how to use the systems well while on the job. After a few trips, *"at some point routine sets in"* (B7; B8). Person B5 sums up the drivers' comments with the following quote: *"And sure, you basically have to learn it, but you just do that, you know, step by step and try things out. And then you learn it if you're on the road day in and day out, then it's, I would say, like a day's training."* (B5)

5.2 Compatibility

The compatibility of the assistance systems refers to the extent to which the systems are compatible with the drivers' working environment and their everyday working lives. Here, the interviews illustrated that although the systems have many advantages, there are still a few situations in which the systems are not compatible with the working environment. For example, person B1 reported that the emergency brake assist would sometimes break when *"it was not necessary at all"* (B1). Person B4 added that there were situations in which it was unnecessary to use a particular assistance system. For example, he stated that there was no need to switch on cruise control in inner-city areas (B4). The main reason why assistance systems are compatible with the bus drivers' work goals and work environment is reflected in the following quote: "*The buses have an automatic transmission, after all, which means gear shifting is no longer necessary today, and this cruise control of course also reduces fuel, that is, diesel consumption, because it makes sure that the system always uses the ideal amount of fuel, so to speak."* (B2)

5.3 Result Demonstrability

The demonstrability of the results of the assistance systems, i.e., the direct results that arise from the use and activation of the systems, was a subject on which the respondents answered unanimously. They stated that it was clear that if the systems were used consistently and in combination with defensive driving, it was possible to avoid accidents and achieve considerable fuel savings, thus clearly demonstrating the usefulness of assistance systems (B4; B5; B6). Person B4 explains the bus drivers' perspective on the results of using the systems: *"And that's because of the cruise control – with the first cruise control, I don't remember exactly, but I would say at least ten percent, more like ten percent definitely. That was the reason why he had them put in everywhere after that – because you didn't need 33 liters anymore, but 30 liters or 29 liters."* (B4)

5.4 Perceived Ease of Use

Concerning the ease of using the most commonly used systems, the responses were mainly formulated quite unequivocally. Person B1, for example, did not think that "*you have to study it for 20 days"* (B1) to understand and handle the systems. He stated that there were not more systems installed in buses than in modern passenger cars (B1). Person B3 also stated that the systems are *"actually self-explanatory"* (B3), but he also pointed out that the drivers have to *"study them and try them out a bit"* (B3) to be able to use the systems to their advantage, especially if a driver is not very technically minded (B3). However, since most drivers had no problems with the systems, the following quote is a typical example of drivers' attitudes toward the ease of use of assistance systems: *"Everyone can grasp it right away. The systems are also pre-configured, which means I simply notice when I drive over into the wrong lane. I notice when I'm doing a hundred, and the, uh, and the bus slows down because, uh, 200 meters in front of me there's a vehicle, that, that's something I notice right away and so, it doesn't take long to get used to it."* (B2)

5.5 Perceived Usefulness

The respondents expressed their views on the usefulness of the installed systems very openly. Person B4, for example, said he was "*much more relaxed"* when using the assistance systems at work (B4). They also mentioned that the assistance systems, when used correctly, significantly reduce fuel consumption (B4; B5). According to persons B6 and B7, the systems additionally serve as an attention booster and prevent accidents, which in turn *"help the driver with his work"* both physically and mentally (B6; B7). Person B1 sums up the usefulness of the assistance systems from the driver's point of view: *"I mean there is a reason why they develop them. They are supposed to make the driver's job a little bit easier, which they actually do."* (B1)

6 Findings of the Quantitative Analyses

In the following subsections, we analyze the hypothesized relationships concerning the hypotheses H1a-H1d and H2a-H2c. As explained above H3a-H3c were analyzed by qualitative means only due to a lack of survey data. Except for hypothesis H2a, we found statistically significant results within the regression analyses, supporting the proposed theoretical framework. The quantitative results also support the mainly positive attitude towards using assistance systems.

6.1 Correlation Analysis

A multiple regression analysis was performed to analyze the relationships proposed by the TAM and IDT. Table 5 shows the intercorrelations among the measured constructs. Weak to strong correlations were evident between each of the variables. All constructs were positively correlated and significant. Technology commitment ($r = 0.592$, $p < 0.001$) and intention to use ($r = 0.750$, $p < 0.001$) were the most strongly correlated with perceived usefulness. Perceived usefulness and perceived ease of use were significantly ($p < 0.001$) and moderately correlated with the intention to use and the actual usage. Functionality was the most weakly associated with intentions to use ($r = 0.392$, $p < 0.001$) and perceived usefulness ($r = 0.357$, $p < 0.001$). Subjective norm, in general, had moderate to high correlation coefficients with the other constructs. As hypothesized by Venkatesh and Davis (2000), subjective norms were more strongly correlated with perceived usefulness ($r = 0.607$, $p > 0.001$) than with intention to use ($r = 0.435$, $p < 0.001$).

Table 5: Correlation Coefficients for the Measured Constructs

Item	1.	2.	3.	4.	5.	6.	7.
1. Actual Usage	--						
2. Functionality	.523**	--					
3. Technology Commitment	.204	.454**	--				
4. Intention to Use	.407**	.392**	.456**	--			
5. Perceived Usefulness	.394**	.357**	.592**	.750**	--		
6. Perceived ease of use	.460**	.525**	.438**	.509**	.489**	--	
7. Subjective norm	.456**	.600*	.566**	.435**	.609**	.537**	--

** Pearson correlation is significant at 0.01 level (2-tailed).

6.2 Regression Analysis

To predict actual usage, the intention to use and functionality variables were entered in the regression analysis. The results are shown in Table 6. The predictor variables explained 32.2 percent of the variance in the actual use. Intention to use and functionality had significant beta weights in the regression equation ($\beta = 0.239$, $p < 0.05$ and $\beta = 0.429$, $p < 0.001$, respectively).

Table 6: Regression Analysis to Predict Actual Usage

Variables	R2	R2 change	B	SE B	β
	.322	.322***			

Variables	R2	R2 change	B	SE B	β
Intention to use			.346	.146	.239*
Functionality			.532	.126	.429***

* p < 0.05; ** p < 0.01; *** p < 0.001.

In a stepwise regression analysis to predict intention to use, the perceived usefulness and perceived ease of use variables were entered first, followed by the subjective norm construct. The regression analysis results are shown in Table 7. The predictor variables explained 59.7 percent of the variance in the intention to use. Perceived usefulness and perceived ease of use had significant beta weights in the regression equation ($\beta = 0.713$, $p < 0.001$ and $\beta = 0.225$, $p < 0.05$, respectively). Subjective norm was not significant and had a much smaller, negative effect.

In the regression analysis to predict perceived usefulness, the subjective norm and technology commitment variables were entered. The regression analysis results are shown in Table 8. The predictor variables explained 46.1 percent of the variance in perceived usefulness. Subjective norm and technology commitment had significant beta weights in the regression equation ($\beta = 0.403$, $p < 0.001$ and $\beta = 0.364$, $p < 0.001$, respectively). Figure 2 gives an overview of the tested relationships.

Table 7: Regression Analysis to Predict Intention to Use

Step	Variables	R2	R2 change	B	SE B	β
1		.589	.589***			
	Perceived Usefulness			.680	.086	.658***
	Perceived ease of use			.195	.087	.187*

Step	Variables	R2	R2 change	B	SE B	β
2		.597	.597***			
	Perceived Usefulness			.737	.097	.713***
	Perceived ease of use			.234	.092	.225*
	Subjective norm			-.106	.086	-.120

* p < 0.05; ** p < 0.01; *** p < 0.001.

Table 8: Regression Analysis to Predict Perceived Usefulness

Variables	R2	R2 change	B	SE B	β
	.461	.461***			
Subjective Norm			.344	.086	.403***
Technology commitment			.362	.100	.364***

* p < 0.05; ** p < 0.01; *** p < 0.001.

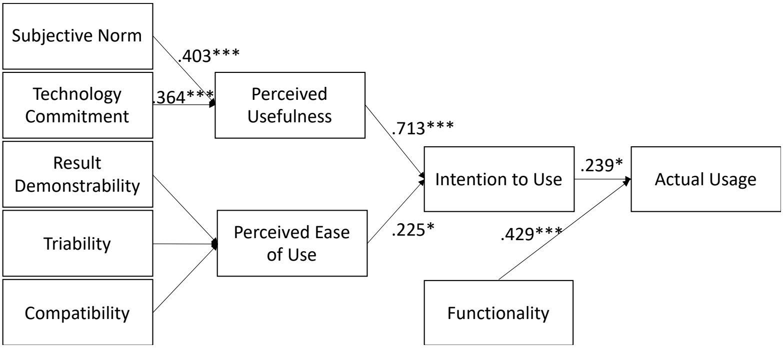

Figure 2: Significant Beta Weights of the Tested Theoretical Framework

7 Discussion and Conclusion

By comparing the qualitative and quantitative results with the integrated model of the TAM and the IDT, as shown in Figures 1 and 2, it becomes evident that the theoretical dimensions do indeed impact driver acceptance of the assistance systems. For example, the results indicate that the perceived usefulness of the assistance systems plays a significant role in implementing and accepting driving with assistive technology ($\beta = 0.713$). The collected data thereby confirms the TAM for the context of bus driving assistants except for hypothesis H2a. Further, the demonstrability of the results of the assistance systems can be seen as essential for their success following IDT. For example, bus drivers are much more open to using assistive technology if they do not only have "perceived" advantages from using the systems but can equally experience the benefits of using the systems on a measurable level. Here, the measurable advantages of saving fuel and reducing traffic accidents are most important.

The compatibility and triability of the assistance systems also impact drivers' attitudes toward the assistance systems. Triability is very important for drivers, as it allows them to gradually adapt to using assistive technology while at the same time developing a driving style that is environmentally friendly as well as comfortable for the passengers. On the other hand, many drivers still see compatibility as a weakness of current assistance systems. The drivers acknowledge problems in the interaction of the assistance systems with new phenomena, such as the increasingly heavy and aggressive traffic on the roads (Nævestad, Phillips, Laiou, Bjørnskau, & Yannis, 2019). Under optimal driving conditions (empty roads, for example), compatibility is valued positively (e.g., through fuel savings). Under less-than-optimal driving conditions (e.g., busy roads), this dimension can still be seen as an obstacle to successful interaction.

Despite these contributions, this study is not free from limitations. First, the analysis is restricted to evaluating prior defined or assumed relationships by testing hypotheses rather than discovering unexpected patterns. Although the qualitative approach applied is more exploratory, the categories used were exclusively created by deductive means based on the underlying theoretical constructs of the TAM and IDT. Future work might use inductive means to discover new patterns with respect to acceptance of assistant driving. Furthermore, the sample size could be enlarged. The data collected is based on one country (Germany) only and thus, could be extended to other countries, hence also taking into account cultural factors influencing the acceptance of driving assistants.

In the following, the findings of this study will be discussed against previous research and recommendations for future research will be provided. In contrast to the study by Banks, Eriksson, O'Donoghue, and Stanton (2018), who found that drivers of automated vehicles tend to rely on the technology overly, the findings of the present study suggest that this is not the case for bus drivers. While bus drivers trust the assistance systems' operational capability and technical functionality, they are also convinced that drivers should not have blind faith in the systems. The bus drivers believe that the systems should only be perceived as a form of support and should continue to alert them. The difference in results may, to some extent, be explained by the fact that drivers in the study by Banks, Eriksson, O'Donoghue, and Stanton (2018) referred to driving in their private vehicles during leisure time, while the current study is focused on bus drivers in their work context. Hence, an increase in the drivers' perceived responsibility may lead to a change in their willingness to rely upon assistive technology versus staying in control themselves. Comparing our results with the studies by Hoff and Bashir (2014), which states that people's trust in machines develops similarly to their trust in people, could explain why bus drivers do not immediately fully embrace new forms of assistive technology. Similar to trust between people, it has to grow and flourish over time. The role of trust and how it can be developed with respect to human-machine interaction in the context of bus driving assistants might be a future research question to explore.

In line with the research results of Tse, Flin, and Mearns (2006), we were able to confirm the stress factors of an increased volume of traffic and the associated disadvantages. In contrast to their study, however, the bus drivers we interviewed report that the assistance systems were of little help in these situations and, in some cases, even entirely useless. This adds a further indicator that increased traffic volume can become an obstacle to using assistant systems. However, some bus drivers felt significantly calmer and more relaxed at work due to using the systems, which again supports the study's findings. Future research might hence explore the conditions under which driving assistants are considered a support or an obstacle when traffic volume increases.

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 bus driving assistance systems: Our research shows that efficient training and an extended time frame when implementing the assistance systems are essential factors for technology acceptance. The drivers interviewed were able to confirm that appropriate training and consistent use of specific assistance systems such as cruise control (in combination with an appropriate driving style) will lead to significant fuel savings benefitting the environment as well as improving driving quality for passengers. This is in line with the results of the study conducted by Zarkadoula, Zoidis, and Tritopoulou (2007). The quantitative results 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.

In conclusion it can be stated that the paper analyzed the use of assistance systems in the workplace of professional bus drivers from various perspectives, hence contributing to a better understanding of underlying acceptance mechanisms in professional bus driving. The qualitative findings suggest that TAM and IDT provide a suitable theoretical grounding for analyzing bus drivers' acceptance, while the quantitative results confirm a positive attitude of bus drivers towards digital transformation processes. Thereby, among others, especially the functionality and perceived usefulness experienced by the drivers can facilitate acceptance.

Acknowledgements

We like to express our sincere gratitude to Gunther Mörl, former managing director of the BDO, and Vincent Beul from FOM University of Applied Sciences for supporting the data collection and analysis.

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