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What Impressions Do Users Have after a Ride in an Automated Shuttle? An Interview Study

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ABSTRACT

In the future, automated shuttles may provide on-demand transport and serve as feeders to public transport systems. However, automated shuttles will only become widely used if they are accepted by the public. This paper presents results of an interview study with 30 users of an automated shuttle on the EUREF (Europäisches Energieforum) campus in Berlin-Schöneberg to obtain in-depth understanding of the acceptance of automated shuttles as feeders to public transport systems. From the interviews, we identified 340 quotes, which were classified into six categories: (1) expectations about the capabilities of the automated shuttle (10% of quotes), (2) evaluation of the shuttle performance (10%), (3) service quality (34%), (4) risk and benefit perception (15%), (5) travel purpose (25%), and (6) trust (6%). The quotes indicated that respondents had idealized expectations about the technological capabilities of the automated shuttle, which may have been fostered by the media. Respondents were positive about the idea of using automated shuttles as feeders to public transport systems but did not believe that the shuttle will allow them to engage in cognitively demanding activities such as working. Furthermore, 20% of respondents indicated to prefer supervision of shuttles via an external control room or steward on board over unsupervised automation. In conclusion, even though the current automated shuttle did not live up to the respondents' expectations, respondents still perceived automated shuttles as a viable option for feeders to public transport systems.

Keywords: Acceptance, expectations, automated shuttles, automated public transport, interviews

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1. Introduction

Various research projects are pursuing the development and introduction of automated shuttles (e.g., Transport Systems Catapult, 2016; WEpods, 2017). The public's acceptance of automated vehicles has been investigated in a number of questionnaire studies (e.g., Eden, Nanchen, Ramseyer, & Evéquoz, 2017a; Nordhoff et al., 2018a; Nordhoff, De Winter, Kyriakidis, Van Arem, & Happee, 2018b; Vöge & McDonald, 2003). Most studies involved respondents who were asked to *imagine* automated vehicles, while some studies asked respondents to rate *actual* automated vehicles after physically experiencing them.

In Nordhoff et al. (2018a), respondents rated an actual automated shuttle as positive but gave relatively low ratings to the effectiveness of the shuttle compared to their current mode of travel. Eden et al. (2017a) investigated respondents' safety and comfort before and after riding an automated shuttle. Before the ride with the shuttle, 4 out of 17 respondents expressed safety concerns because of news reports of an accident with an automated shuttle that ran into a parked delivery van. These respondents reported that the ride with the automated shuttle mitigated their safety concerns. However, most respondents also indicated that their safety concerns might increase if larger-sized automated buses without steward would operate on public roads at a regular speed. In Vöge and McDonald (2003), respondents indicated that the connection of automated transport systems to an external control room for emergencies, a door-to-door transport service, the option to order automated vehicles on demand via smartphones, and low waiting times are criteria that make automated vehicles attractive for users. In an online questionnaire study by Cyganski, Fraedrich, and Lenz (2015), respondents regarded the possibility of enjoying the landscape and talking to fellow passengers to be advantages of fully automated driving; the ability to work on the move was considered advantageous by only a small proportion of respondents. In another online study in which respondents were asked to imagine automated vehicles, respondents indicated that they would be more inclined to engage in non-driving tasks (e.g., resting, sleeping, watching movies, or reading) with higher automation levels (Kyriakidis, Happee, & De Winter, 2015).

Most studies that examined people's attitudes toward automated vehicles have been based on questionnaires (e.g., Bansal, Kockelman, & Singh, 2016; Kyriakidis et al., 2015; Regan et al., 2017), see Nordhoff et al. (2018a, 2018b) for an overview of prior acceptance studies. A weakness of questionnaires is that little in-depth information is obtained. The present study sought in-depth information from respondents who physically experienced an automated shuttle. Physically experiencing the shuttle is important given that in previous questionnaire studies on automated vehicles, respondents may have been "providing opinions based on a flawed understanding of the technology and its current state of development" (Hyde, Dalton, & Stevens, 2017, p. 3).

We conducted semi-structured interviews with 30 people after they had physically experienced the automated shuttle 'Olli' from Local Motors in Berlin-Schöneberg. The operation of this type of automated shuttle is representative of automated shuttle projects worldwide linked to public transport (Boersma, Van Arem, & Rieck, 2017; Eden, Nanchen, Ramseyer, & Evéquoz, 2017b; Van der Wiel, 2017), but not necessarily of prototype automated driving systems associated with private vehicles or taxi services (e.g., Google, Uber).

This research aimed to contribute to the literature on the acceptance of automated vehicles by acquiring information about respondents' expectations of automated driving technology and whether experiencing an automated shuttle fulfilled these expectations. In particular, factors that might affect respondents' intentions to use automated shuttles as feeders to transport systems were explored.

2. Method

2.1. Recruitment and Procedure

An invitation letter to take part in a test ride with the automated shuttle (Fig. 1) and participate in an interview was sent to 5 groups of people:

- Participants in former experiments of car-sharing or electro-mobility projects of the Innovation Centre for Mobility and Societal Change (InnoZ) in Berlin received the invitation letter via email (Group 1).
- Employees of the EUREF campus (where InnoZ is located) received the invitation letter as part of a newsletter sent on behalf of the EUREF campus (Group 2).
- Students and employees of the Geography department of the Humboldt University, Berlin, received the invitation letter via email on behalf of the department (Group 3).
- Students and employees of the Centre for Entrepreneurship of the Technical University of Berlin received the invitation letter via email on behalf of the centre (Group 4).
- People received the invitation letter from people of Groups 1–4, after which they expressed their interest in participating via email to the researchers of this study (Group 5).

The invitation letter informed the respondents that the ride and the participation in the interview would take around

90 minutes in total. The invitation letter also informed the respondents that the interview would be audio-recorded and that personal data would be treated anonymously. On the day of the interview, the respondents were asked whether they agreed with the conditions stated in the invitation letter and provided their verbal consent. They were offered no financial compensation for participation in the ride and interview.

Figure 1. Automated shuttle Olli by Local Motors at the EUREF campus in Berlin-Schöneberg

In total, 30 shuttle rides with corresponding interviews were performed between March and July 2017. There were 23 participants from Group 1, 1 from Group 2, none from Group 3, 2 from Group 4, and 4 from Group 5.

First, the respondent experienced the ride alone. After the ride, the first author of the present study interviewed the respondent individually in a quiet room at InnoZ. With 2 of 30 respondents, the interviewer held telephone interviews a few days after their test ride with the automated shuttle because a personal interview could not be arranged. Twenty-eight interviews were held in German, and two were performed in English. The interviewer guaranteed full anonymity to each respondent. The ride took on average 8 to 12 minutes per trip at an average speed of 8 km/h. The interview took on average 50 minutes per respondent.

The shuttle was fully electric and drove a 700 m route on the EUREF (Europäisches Energieforum) campus in Berlin-Schöneberg. The shuttle shared the road with pedestrians, cyclists, and occasionally with cars and trucks. It operated on 'virtual tracks' using lidar, radar, and geo-positioning technology. A steward was present in the shuttle to supervise its operation and intervene in situations that required manual intervention (e.g., use the joystick to overtake obstacles on the 'virtual tracks' of the shuttle, or apply an emergency brake in anticipation of approaching road users). In one test ride, an engineer from Local Motors was also present to check the functioning of the shuttle (see the quote of respondent R07 in Section 3.4.3). The shuttle provided space for 12 passengers in total (8 seated, 4 standing). An emergency button inside the shuttle could be used by passengers and the steward to halt the shuttle operation in cases of emergency.

2.2. Interviewing Procedures and Analysis

The interviews were semi-structured and based on a pre-defined protocol that consisted of open-ended questions to investigate the factors influencing the acceptance of automated shuttles as feeders to public transport systems. First, the respondents were asked with which mode of transport they travelled to the campus (Q1), and whether this mode of transport is representative of their daily travel mode choice (Q2). The interviewer asked the respondents about their perceptions and experiences during the ride (Q3), and their associations with automated driving before the ride (Q4). The central part of the interview concerned the identification of factors that influence respondents' acceptance and use of automated shuttles as feeders to public transport systems (Q5). Here the interviewer asked the respondents to think about their daily mobility needs and to what extent automated shuttles would correspond with their daily mobility as feeders. The interviewer encouraged respondents to assess the practicalities of using shuttles for their daily mobility. Respondents were asked how their close family members and friends perceive automated shuttles (Q6). In the last two questions, the interviewer asked respondents with which travel modes automated shuttles compete (Q7), and how they envisioned the future of mobility (Q8). For the sake of brevity, we will not report the results from Q1–Q2 and Q6–Q8 and concentrate on the examination of the acceptance of automated shuttles as feeders to public transport systems.

A questionnaire was sent to all respondents via email after the interview to obtain background information on their sociodemographic profile, such as age, gender, type of residential situation, labour status, education, having a driver license, and travel behaviour.

The interview was analysed in four steps, primarily performed by the first author, with regular discussions with the second author.

First, the interviews were recorded and transcribed verbatim. The coding process followed the principles of inductive category development (Mayring, 2000). Initial categories (i.e., content themes) were manually developed out of the interview material. The interview transcripts were scrutinized line-by-line applying common steps of text analysis, such as underlining/highlighting in the text, writing notes, searching for keywords in the text, and jumping to different text passages (Mayring, 2000).

In the second step, the transcripts were reread to refine the categories into main categories and subcategories. The categories that emerged from the data represent the factors influencing the acceptance of automated shuttles as feeders to transport systems. These categories were compared to theoretical concepts from the literature (e.g., Eden et al., 2017a, b; Meijkamp & Theunissen, 1996; Nordhoff et al., 2018a, b; Parasuraman, Zeithaml, & Berry, 1985; Parasuraman, Zeithaml, & Berry, 1988; Redman, Friman, Gärling, & Hartig, 2013; Vöge & McDonald, 2003).

In the third step of the analysis, the number of times a subcategory was mentioned per respondent was counted. Multiple mentions (i.e., quotes) of a subcategory by the same respondent equalled a frequency of 1. The difference between the number of respondents in a subcategory (as denoted by n in Table 2) and the total number of respondents ($n = 30$) equals the number of respondents who did not address that subcategory. Multiple mentions of a subcategory by the same respondent were not discarded from the analysis but clustered with the other quotes of this respondent. Therefore, some of the quotes presented here are clusters of sentences mentioned by the same respondent at different points in time during the interview. When the quote represented more than one subcategory, the quote was assigned to each of these subcategories. Topics quoted by fewer than five respondents were omitted from the analysis. We assumed that the more respondents spoke on a particular subcategory, the greater the importance of this subcategory as determinant of the acceptance of automated shuttles. Therefore, the number of quotes reported in this paper was decided to be proportional to the number of respondents mentioning the corresponding subcategory. To prevent that a sub-category is dominantly represented by a single respondent, a maximum of one quote per respondent was accepted for each of the subcategories.

In the last step of the analysis, illustrative quotes of each subcategory were selected for presentation in this paper. Here, we used the principle of "prototypical and outlier illustrations" for each subcategory (Graham-Rowe et al., 2012, p. 144). Illustrative quotes were selected as follows:

- Subcategories mentioned by 5 to 10 respondents are represented by a minimum of 1 and a maximum of 3 quotes.
- Subcategories mentioned by 11 to 20 respondents are represented by a minimum of 4 and a maximum of 6 quotes.
- Subcategories mentioned by 21 to 30 respondents are represented by a minimum of 7 and a maximum of 9 quotes.

3. Results

3.1. Sociodemographic Characteristics

Table 1 provides an overview of the respondents' sociodemographic characteristics. Most responses are based on 27 of 30 respondents because three respondents did not return their questionnaires. Information about age, gender, and being in possession of a valid driver license was available for all 30 respondents, as this information could be extracted from the interviews. Table S1 in the appendix provides a detailed overview of the socio-demographic information of each respondent.

Table 1.
Overview of respondents' sociodemographic profile. n represents the number of respondents

Personal characteristic	Response category	n
Age	21–25	2
	26–30	4
	31–35	4

	36–40	2
	41–45	5
	46–50	1
	51–55	3
	56–60	3
Gender	Male	24
	Female	6
Living situation	Outside the city in a house in the countryside	0
	In a house on the city outskirts	4
	Within a city, but outside the city centre in a purely residential area	8
	In an apartment in the immediate city centre	15
Highest education	School leaving examination	3
	Completed academic studies	20
	Pupil, student, apprentice	4
Valid driver license	Yes	26
	No	1
Walking >500 meters per trip	Daily or almost daily	17
	1–3 days per week	7
	1–3 days per month	2
	Less than monthly	1
	Never or almost never	0
Biking	Daily or almost daily	8
	1–3 days per week	7
	1–3 days per month	3
	Less than monthly	5
	Never or almost never	4
Moped or motorcycle	Daily or almost daily	0
	1–3 days per week	1
	1–3 days per month	1
	Less than monthly	1
	Never or almost never	24
Car as driver or passenger	Daily or almost daily	5
	1–3 days per week	5
	1–3 days per month	6

		Less than monthly	10
		Never or almost never	1
Public transport <100 km per trip		Daily or almost daily	15
		1–3 days per week	6
		1–3 days per month	4
		Less than monthly	2
		Never or almost never	0
Public transport >100 km per trip		Daily or almost daily	1
		1–3 days per week	2
		1–3 days per month	11
		Less than monthly	13
		Never or almost never	0

3.2. Main Categories and Subcategories

The data analysis resulted in the identification of 320 quotes. Nineteen quotes were assigned to two subcategories and one quote to three subcategories. The total number of classified quotes, therefore, equalled 340. The 340 quotes were assigned to the following six main categories that were regarded as relevant to the intention to use automated shuttles in public transport:

(1) Expectations about the capabilities of the automated shuttle (33 quotes)
(2) Evaluation of the shuttle performance (35 quotes)
(3) Service quality (115 quotes)
(4) Risk and benefit perception (52 quotes)
(5) Travel purpose (84 quotes)
(6) Trust (21 quotes)

Table 2 presents the extracted categories and subcategories, their meaning, and the number of respondents who spoke on a subcategory. A visual presentation of the main categories and their corresponding sub-categories is shown in Figure 2.

Table 2.
Overview of categories and their subcategories, and the number of respondents with a quote in that subcategory (n).

Category numbering	Main category	Subcategory	Sources	*n*
1.	Expectations about the capabilities of the automated shuttle	Full automation: Fully automated vehicle that drives in every traffic situation without human input	SAE International (2018)	17
		Comparison of automated shuttles to public transport systems	Newly created	10
		Automated driving as private and not as public transport	Newly created	6
2.	Evaluation of shuttle performance	Braking behaviour: Strong and abrupt braking	Newly created	15
		Incapability to overtake obstacles	Newly created	12
		Manual interventions by the steward	Newly created	8
3.	Service quality	Availability: Instant access to automated shuttles, high frequency of service operation, short waiting times	Shen, Zhang, & Zhao (2018)	20
		Convenience: Accessibility, information provision on routes and interchanges, uncomplicated booking and payment, inclusion in public transport ticket	Lai & Chen (2011), Redman et al. (2013)	20

		Comfort: (More) comfortable and larger number of seats, space for arms, legs, and luggage, having private space, driving in or against the direction of travel, air quality/ventilation, internet access, cleanliness, adequate shuttle size, design of interior	Eboli & Mazzulla (2011), Redman et al. (2013)	19
		Speed	Krueger, Rashidi, & Rose (2016), Redman et al. (2013)	18
		Flexibility: Direct, door-to-door transport or in proximity to respondents' destinations, flexible stop's and go's, no timetable dependence, demand-responsive or on-demand ordering via a smartphone app, being able to drive alternative routes, simple and seamless transfers	Brake, Mulley, Nelson, & Wright (2007), Chowdhury & Ceder (2016), Hine & Scott (2000), Redman et al. (2013)	15
		Creation of advantages through the use of automated shuttles compared to current travel	Rogers (2010)	12
		Reliability: Reliable matching of the actual service with the routing timetable, system reliability	Eboli & Mazzulla (2011), Parasuraman et al. (1985, 1988), Redman et al. (2013)	11
4.	Risk and benefit perception	Traffic safety: Higher traffic safety with automated vehicles than with manually controlled cars	Liu, Yang, & Xu (2018), Pettigrew, Talati, & Norman (2018), Ward, Raue, Lee, D'Ambrosio, & Coughlin (2017)	14
		Not having to drive: Manual driving as a stressful, unpleasant, costly, inefficient, tedious, or environmentally-unfriendly activity	Liu et al. (2018), Pettigrew, Talati, & Norman (2018), Ward et al. (2017)	13
		Environmental protection: Positive environmental effects of automated vehicles equipped with electric propulsion	Eboli & Mazzulla (2011), Liu et al. (2018), Pettigrew, Talati, & Norman (2018), Ward et al. (2017)	10
		Ethical programming	Newly created	5
		Job losses: Job losses will not stop the development of automated driving	Newly created	5
		No productive use of driving time in automated shuttle	Cyganski et al. (2015), Milakis, Van Arem, & Van Wee (2017), Singleton (2018)	5
5.	Travel purpose	Use of automated shuttles in severe weather conditions	Newly created	13
		Use of automated shuttles in suburban and rural areas	Nordhoff et al. (2018a), Vöge & McDonald (2003)	13
		Use of automated shuttles on closed areas	Vöge & McDonald (2003)	12
		Use of automated shuttles for transport of goods	Vöge & McDonald (2003)	11
		Use of automated shuttles in urban areas	Nordhoff et al. (2018a)	10
		Use of automated shuttles in touristic/unfamiliar areas	Vöge & McDonald (2003)	10
		Use of automated shuttles due to temporary physical impairments (e.g., pregnancy, exhaustiveness)	Newly created	5
		One-way trips currently covered by car	Newly created	5
		Suitability of automated shuttles on daily trips	Newly created	5
6.	Trust	Trusting automated vehicles	Choi & Ji (2015), Kaur & Rampersad (2018), Liu et al. (2018)	10
		Preference for supervision of shuttle (i.e., steward on board, external control room) & halting shuttle operation (i.e., emergency button)	Nordhoff et al. (2018a, b)	6

		Trialability: Putting automated shuttles to trial and expose the public to automated driving	Rogers (2010)	5
Total number of classified quotes				**340**
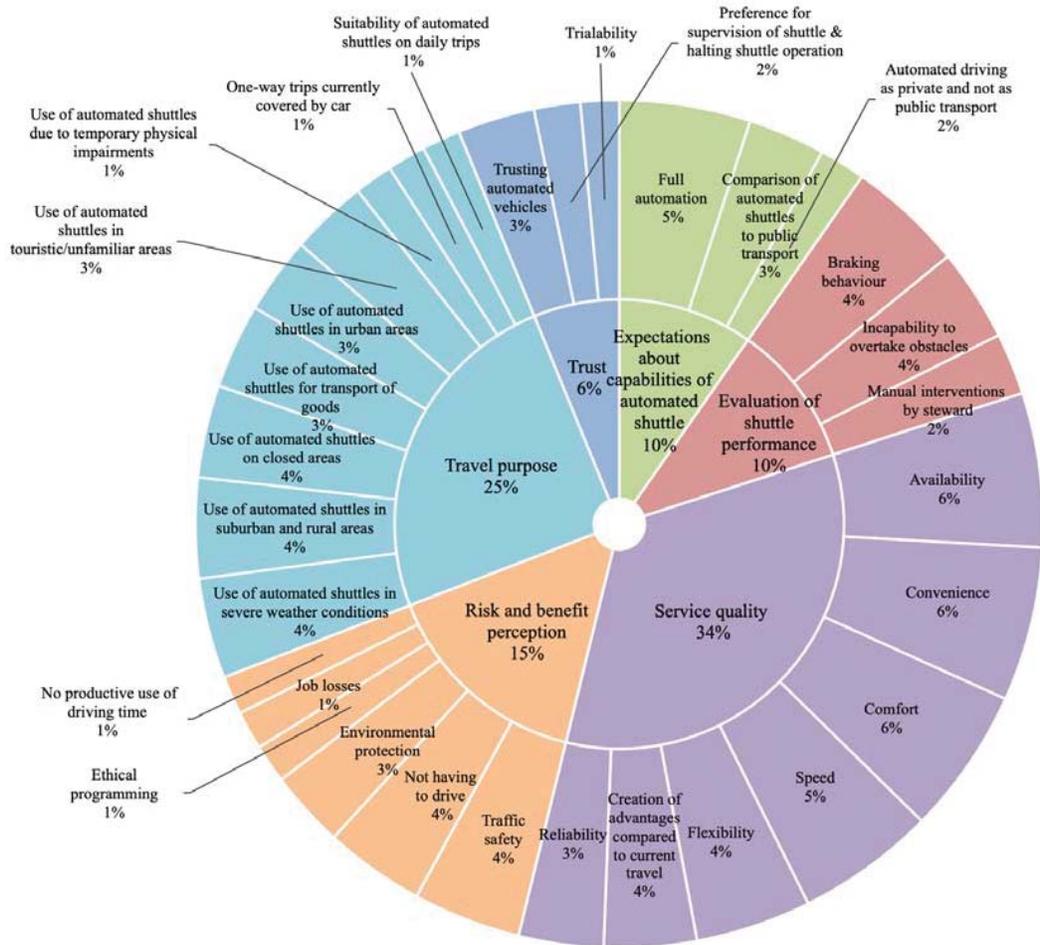
Figure 2. Pie diagram showing the six main categories and their corresponding thirty-one sub-categories.
Note: The arc length of the sectors corresponds to the number of quotes.

3.3. Main Category 1: Expectations about the Capabilities of the Automated Shuttle

3.3.1. Full automation

Seventeen respondents expected the automated shuttle to be in a more advanced state of technological development. They had an idealized idea of the technological capabilities of an automated vehicle that resembled SAE Level 5 automation (SAE International, 2018). As two interview respondents explained:

> „I find it rather strange that it is defined as automated driving when a steward is on-board who has to tell the shuttle that there is an obstacle on the road. And the shuttle does not know: Do I need to brake, avoid the obstacle now, or is the obstacle moving such as a car or pedestrian?" (R01)

> „I was a bit disappointed that the shuttle is not yet as advanced as I thought. I also found it interesting that the shuttle has to learn the route. I expected it to be much more autonomous." (R17)

Another respondent referred to the several press releases, technology showcases at exhibitions, and test rides by

prominent players in the field (e.g., Google, Tesla) that have contributed to the creation of unrealistic expectations. The respondent expected that automated driving is close to market launch with the technology already being there. The shuttle did not live up to the expectations of the respondent who expected a shuttle operating on every route and performing all driving manoeuvres in automated mode, with the steward intervening only on rare occasions. Instead:

> *„The shuttle was forced to run exactly on the route that was pre-programmed or on virtual tracks as they called it, which also meant that even the smallest deviation from the route prevented the system from continuing on the road in automated mode."* (R02)

Other respondents also blamed the media for creating unrealistic expectations:

> *„I would have expected Olli finding his own way like a private motor vehicle that picks me up from home and brings me to the station. This is the cliché of automated driving, the images of the Google cars which float in conventional traffic, that shape this idea."* (R03)

> *„In the media, automated vehicles are almost on the verge of a breakthrough and that it is great to drive alone in every situation, but we are still a long way away from that. The state of technology tends to be communicated in an exaggerated form. Many are not aware that fully automated driving is not available yet and have different ideas. A common notion is that of being driven; that people give up the largest part of driving, but they do not have sufficient information about what can be technically realized and to what extent. We are far away from a vehicle that can drive 130 km/h on its own and where people can put their feet up."* (R04)

Another respondent described the ride with the shuttle as disillusioning, yet still considered the ride as a valuable experience:

> *„I had a glorified idea and thought that the shuttle could drive alone, and then in the rain, it did not work properly, but I like it now to be aware of this and to come down to earth again. Now I have a more realistic idea. The ride was important for me to discover how far we are on the timeline of this technological development. This has not worsened my impression of this technology; it just helps me to position it more realistically."* (R06)

3.3.2. Comparison of Automated Shuttles to Public Transport Systems

Ten respondents compared automated shuttles to current public transport systems, with three respondents explaining:

> *„In the end, the trip in the train also happens almost in automated mode. When I get on the train, that's a kind of automated driving. That a human being does this is not transparent to me. In public transport, I am already traveling in automated mode. Covering the last mile with the shuttle would be completely okay for me."* (R15)

> *„If you disregard all the unintentional braking, then that would have been a ride as with the Sky Train at Frankfurt Airport from Terminal 1 to 2."* (R22)

> *„Somehow Olli does not differ from a normal bus except for the fact that no driver is inside. From the user perspective, I do not mind at all whether there is someone in the front or not. If you disregard all the technical details, all the automated parts, then this is a normal bus that needs to drive like every normal bus. The same criteria apply."* (R29)

3.3.3. Automated Driving as Private and not as Public Transport

Six respondents stated that the idea of automated shuttles was new to them as they mainly perceived automated driving as private and not as public transport, with two respondents explaining:

„When I think about automated driving, I think about a car just driving itself. I have not thought about it in the context of like a shuttle. Whenever I think about an automated vehicle, it is a Tesla or a Chevy Volt." (R08)

„It was new to me that it was a large vehicle for many people. I rather expected a Google vehicle or passenger vehicle, an individual vehicle rather than a mass vehicle that you need to share with others." (R21)

3.4. Main Category 2: Evaluation of Shuttle Performance

3.4.1. Braking Behaviour

Fifteen respondents mentioned the strong and abrupt braking behaviour of the shuttle, with three of them saying:

„I would not dare using the shuttle on public roads after the test ride now. During the ride a few minutes ago, the shuttle abruptly braked, and this is not something that is trustworthy. Before the test ride, I would probably have said yes to testing the shuttle on public roads without a steward on board. Now I would say: Rather not!" (R13)

„There was an abrupt braking, which was very uncomfortable." (R15)

„Not much was provided; the speed, the thing was not functioning consistently. Even on straight roads, the shuttle would slow occasionally. At this low speed, there is no reason for Olli to panic. At this speed, Olli could easily slow down and start again."
(R19)

3.4.2. Incapability to Overtake Obstacles

Twelve respondents referred to the incapability of the shuttle to overtake obstacles on its trajectory, with five of them saying:

„And maybe because of the growing pains, that it couldn't react to obstacles at the moment. There were obstacles in the way, and the shuttle did not know: 'Do I have to brake or dodge now, or is this a moving obstacle, such as a car or pedestrian?'"
(R01)

„A container in the middle of the road, which could have been easily overtaken, but the overtaking was not done autonomously. This is actually the opposite of automated driving." (R11)

„When I imagine that the thing stops every five meters in inner city traffic, then that would definitely be too annoying. If you are already driving at a low speed, then this is not convenient. There should be a smart way to deal with obstacles that is tolerable and adaptive in such a way that you do not have the feeling that everything comes to a standstill when a fly is blowing through." (R16)

„There were some obstacles on the road and the system was really lost. For example, there was a vehicle from the delivery company. I thought the shuttle would recognize this, identify it as a temporary obstacle and be programmed in a way that the chances are high that the vehicle will also move away soon because it is from the delivery company." (R23)

„I was a little bit disappointed by Olli. That he had to be controlled by hand to overtake every little obstacle, I would not have thought that." (R24)

3.4.3. Manual interventions

Eight respondents referred to the manual interventions by the steward, with two of them saying:

„Most of the time, the trip with the shuttle did not work. If you start with the expectation that I had before taking a ride with the shuttle: 'A self-driving thing, you sit inside, have no control, don't know exactly what it will do next.' This was not the case, because the shuttle was super slow, and there were two people there. That is, you were not alone, so to speak. They always made sure that nothing happened and that's why it wasn't as stressful of a situation as it could have been." (R07)

„The trip was very nice, but I had the feeling that it was not so autonomous because the system consistently crashed." (R10)

3.5. Main Category 3: Service Quality

3.5.1. Availability

Twenty respondents considered the instant availability of automated shuttles, high frequency of service operation, and short waiting times as factors that could positively affect the acceptance of automated shuttles in public transport. Five respondents explained:

„It is also a question of availability. Like, my car sits there, and I can take it and just get in immediately. Sure, I can order Olli with a mobile phone an hour before, and it's there, and that works if I can estimate approximately when I finish work. But when I am spontaneously going out or if my plans change, I think that the car is simply more flexible." (R02)

„Availability; that these things are available. What good is it to me if such a thing is basically there, but I have to wait an hour? If I have an appointment at 1 pm, and I don't order the vehicle 3 hours before, but maybe 15 or 5 minutes before and it isn't there, then that's not practical. This means that before I switch from my private car, I expect the vehicle to arrive within a period of 15 minutes. If it takes more than 15 minutes, then I can also easily walk to the next bus stop." (R07)

„I would use Olli from the station if I know that Olli is always available and is running every few minutes or when I need it." (R16)

„When I know upon arrival at the station that there is always a shuttle when I need it, then I would like using it more. Here we talk about waiting times of less than 5 minutes. When it takes the shuttle more than 5 minutes to arrive, I will not use it but try to find a different mode such as the bike or my feet. Assuming that the shuttle would always be available and arrive in less than 5 minutes, then the likelihood is very high that I would use it." (R18)

„Waiting times are all the more important on the last mile because you can also walk the last part of the route easily." (R26)

3.5.2. Comfort

Having a comfortable journey was mentioned as important by nineteen respondents. Comfort was equated with comfortable seating, travelling in or with the back to the driving direction, access to seating including a place for luggage, free Internet, outside visibility, cleanliness, air conditioning, an attractive interior room, and the size of the shuttle. Three respondents explained:

„To increase the attractiveness, of course, cleanliness and comfort are important. So, if the vehicle really did look like this vehicle here on the campus, but if I take a look at reality, in the train, I'll think: „Oh, I'd rather take the bike because I simply find this uncomfortable. If I have to decide between the underground train and the Olli, I would rather choose the automated shuttle as it makes a more comfortable and cleaner impression if this state corresponds with the real practice." (R01)

„Of course, you also want to sit comfortably, but you do not have to sit like in the car now. If it's similar to the current train, that's fine too. For longer trips, the seats might be too uncomfortable. It can be a bit

more comfortable, where you can lean on. I find the seats in our current trains more comfortable." (R20)

„The question is simply how to bring a higher quality in public transport systems today. The higher the quality, the higher the acceptance." (R24)

It was also mentioned that automated shuttles could improve seating space and comfort compared to current public transport, making traveling more convenient, with one respondent explaining:

„I live 300 meters away from the train station; then I would need to travel 3 stops with the train and then I would need to walk 400 meters from the station to my workplace. Actually, it would not be a problem at all traveling by train, but I still take the car because of humans on the train. Hobos lying on the seats. Getting in an automated shuttle of this size will be more comfortable than taking the train." (R11)

3.5.3. Speed

Eighteen respondents mentioned the importance of travel time for the use of automated shuttles, with four of them saying:

„For me travel time is decisive. If I travel longer with Olli than with another travel mode such as the bike or bus, then I would choose the fastest travel mode. Even if the use of Olli were for free, I would not use it if it takes me longer than alternative travel modes." (R01)

„I was disappointed by the low speed. If I can travel faster than walking speed, I would use it. If not, I would rather walk." (R15)

„When I compare it with the bus, the bus is much faster. If I was to imagine travelling from A to B in the inner city, then the shuttle would be too slow. But when I'm at the airport and drive from the terminal to the gate, then speed does not matter. It has to be faster than walking. It does not have to be as fast as the car, but if it's going to be fast like, say cycling speed. When I think about riding from Friedrichshain to Schöneberg to visit a friend on a regular basis and the thing is jerking along the road at this tempo and I need 90 minutes to get there, then I would do it once, because I would find it exciting and funny to see the vehicle working, but only once and never again. The train would be faster in all situations." (R16)

„My expectations were largely fulfilled. I thought it would go faster. I could imagine using it if it drove faster and was more reliable. I will never get into the Olli if it drives 10 km/h or 30 km/h and that's how fast I get to work. It would definitely have to drive 50 km/h to match normal traffic." (R25)

3.5.4. Convenience

Twenty respondents mentioned that convenience is a factor that would encourage them to use automated shuttles in public transport. Convenience refers to the provision of information about routes and interchanges, as well as functionality, accessibility for people with (temporary) physical impairments, and the ease of booking and payment of the shuttle. Five respondents explained:

„Explaining all the different parts of it, the stewards explaining where the sensors are and what they do and what they are supposed to do and what will happen, so giving all this context information really helps. Maybe if there is an obstacle, it could say „obstacle ahead", this is why it is stopping, more context and more explanations about how it generally works would be cool." (R08)

„Sort of monthly ticket because if I just have the option not to think about the price, I would just buy it for convenience." (R08)

„Its use has to be predictable. It should fit as seamlessly as possible into my driving behaviour, and I have to know when Olli is where.

If I use the Olli as a shuttle, I need a certainty that I'm really getting on with it. Either there is a large number of Ollis around, so that a schedule is no longer necessary, or I get real-time travel information about departure times. I think I would use it very extensively, regardless of the weather." (R15)

„What I have not seen so far was the interaction with the passenger. Where does the shuttle go to, what happens next? I want to know where the shuttle is driving to, how long will it take, will there be detours? Simply getting in and relying on it that it works would be difficult. Even though I order the shuttle via an app and if I get all the information over this channel or another channel, I think I would still miss a kind of display such as the one we have in trains today saying what comes next."
(R16)

„It has to be easy to use. My mother has a smartphone and uses apps on the smartphone. She would be able to do it. Someone without a smartphone should be able to order the shuttle by phone. It has to be orderable." (R23)

„Obstacle-free access; the payment has to be uncomplicated. Its use has to be included in the public transport ticket." (R29)

3.5.5. Flexibility

Fifteen respondents mentioned the provision of door-to-door transport as a positive factor that could enhance the acceptance of automated shuttles. Four respondents explained:

„If the shuttle drives a direct route instead of driving detours and is more flexible, demand-oriented, and if you can determine your own destination, this will be very nice." (R11)

„If you can order it there must be a certain flexibility. If you have to wait two hours, that's bad. At best, it ensures that the shuttle takes over the flexibility offered by the private car." (R23)

„If the Olli were to be used now and stops 3 times rather than 30 times like the normal bus, then maybe I drive 5−10 minutes longer than with my car, but that's okay. But if I need twice as long as the public bus. Olli would have to pick me up from home or pick me up nearby, 5 minutes of walking is okay." (R25)

„If I have to decide between automated shuttles and my private car, I would opt for the shuttle if it picks me up at home and if I don't need to walk to the nearby bus stop. But I think it will never completely replace the car unless it works in the same way as my car. Then I do not need to go farther than in front of my doorstep, Olli picks me up exactly there where my parking space would be and drives me at the same speed to my destination. Okay, then I don't need to drive, but I don't mind whether I drive on my own or not. It is mainly a financial issue; the contingency costs are so high with a car. If I could do without it, this would be beneficial." (R29)

3.5.6. Relative Advantages of Automated Shuttles Compared to Current Travel

Twelve respondents mentioned that the use of automated shuttles has to create advantages in comparison with the respondents' current travel. Three respondents explained:

„Usage depends on the benefits offered to you. If I have shorter waiting times, or if I get off where I can directly get the connection. You have to do it right, add value to how it works now." (R11)

„It has to be better than the bus. This may mean shorter waiting times or shorter transport routes. Then it may not be more expensive than a cab; a cab is also around the station. The shuttle may take a longer route if it is cheaper than the cab.

*It should not be more expensive than the cab because the cab brings me to the door.
In the worst case, the car smells, and the cab driver is rude."* (R21)

*„There have to be very clear advantages compared to the status quo. If such a
vehicle offers a timely and monetary advantage, then this would certainly help. But
if it ends up in the same traffic congestion as the individual private car, then it
barely has an advantage."* (R23)

One respondent predicted that automated shuttles would be accepted if their use generates the same advantages as the use of conventional cars:

*„If I don't need to drive my own car anymore but have the same advantages as with
my car and it does not cost me more, then it would be accepted."* (R29)

3.5.7. Reliability

The reliability of automated shuttles was mentioned as an important criterion for the choice of automated shuttles by eleven respondents. Four respondents explained:

*„Assuming that the current M29 will be replaced by an automated shuttle, then I
would also take the shuttle. But I would only consider the shuttle superior to the bus
if it was more reliable than the M29."* (R18)

*„The faster and the more reliable it drives, the higher its attractiveness is.
The thing has to work, no showstopper like today."* (R22)

*„The system needs to be developed in a way that it works reliably and is safe. This
has to be taken for granted."* (R23)

*„Reliability: That a bus is coming when it should come, and I do not have to
wait 20 minutes for the bus. That is one of the biggest factors. Taking the bus
to work instead of the car takes me twice as long; I have to walk to the bus,
then the bus does not come, then I stand in the rain, that's also an issue of
reliability, which is usually not so great in my experience."* (R25)

3.6. Main Category 4: Risk and Benefit Perception

3.6.1. Traffic Safety

Fourteen respondents expected automated vehicles to be safer than manually controlled cars, with five of them explaining:

*„There will always be a few people who want to drive their own car, but in the end,
it will be like: ‚What? You still drive your car? That's so dangerous. You are not
allowed to drive your own car in the city. I don't want my child to be run over by a
crazy driver.' At some point, those who want to control their car themselves are
socially looked down on, which will eventually encourage them to stop driving. I like
technological progress and feel positive about automated driving because once the
software works, then accidents can be avoided because accidents are caused by
100% human error and if we can reduce that to 10% human error, then many lives
would be saved."* (R06)

*„I am pretty sure that computers are more trustworthy than humans because we
have delayed reactions and can't really process things. And I am sure the computer
also doesn't have these things: ‚Oh, my girlfriend broke up with me, and now I am
feeling a little bit distracted.' It is really focused on one thing."* (R08)

*„Sure, driving a car is fun, but when I have the feeling that the automated vehicle
can do it, or can do it better, then it can do the driving for me. Giving this up is not
the big thing."* (R12)

„And if the autonomous vehicles are really good, I think manual driving will be prohibited within the next 5-10 years for safety reasons because autonomous vehicles are substantially safer than human drivers." (R17)

„If traffic is automated, the frequency of accidents will certainly decline. There would not be such a chaotic driving on the streets anymore. That's why I think the trend is quite good." (R28)

3.6.2. Not Having to Drive

Not having to drive and being able to pursue non-driving tasks was considered an important aspect of automated vehicle acceptance by thirteen respondents. They considered driving as a stressful, unpleasant, costly, inefficient, tedious, and environmentally harmful activity, given the time lost while driving, the need to look for a free parking place, or the waste of resources that results from the large number of cars being unused. Three respondents said:

„For me, driving a car is not fun. I was already involved in a car accident, and it is simply stressful for me. Accordingly, I prefer to travel using public transport rather than owning a car, also because the high costs are unappealing to me. I find it harmful for the environment; I would not like the constant search for a parking space. There are so many reasons that completely rule out private car use." (R04)

„In private transport, automated driving is extremely useful, because it offers those people who now have a car the same possibilities. I order the vehicle, input a destination, and have my peace without having to drive myself." (R10)

„My dream is not to drive a car anymore. In fact, I like driving a car, but I don't like physically controlling it because it is stressful and I lose time. I would like to drive everywhere with automated busses and cars, and give up control. It is a desirable goal for the city and society that you can prevent accidents, release the driver and avoid traffic congestion." (R20)

One respondent pointed to his visual impairments and explained:

„I am really looking forward to self-driving cars. I can hardly wait for it because I hate driving cars and I hate owning cars. Driving on the road is stressful for me. Needing to change lanes constantly is stressful for me. I have bad vision because I am almost blind in my left eye, which makes it difficult to estimate the distance to the next car properly. Driving a car gives me no pleasure at all." (R07)

3.6.3. No Productive Use of Driving Time

Five respondents stated that they could not imagine working in an automated shuttle given the lack of anonymity and privacy, the difficulty to perform cognitively demanding tasks and the necessity to trust the automated driving system. The short trip length, motion sickness, the general liking of driving a car, and the conscious separation of working and private life are also factors. Regarding the short trip length, one respondent explained:

„When it comes to Olli, it would make me feel like being in the passenger seat as I would monitor the environment too much rather than being able to sit back and read a book. For this, I will reach my destination too early. I can only imagine doing small things on the smartphone such as replying to emails such as 'Are you attending the meeting on time?' – 'Yes, I will be there', but 'I do not take the bike but instead use Olli, because I can do some reading there' – this I don't see at the moment." (R03)

One respondent pointed to difficulties to trust the system, and would monitor its operation:

„I would prefer more active safety systems in cities to autonomous driving as there won't be a break for the driver if you need to be attentive the whole time anyway. When I imagine using one of these Google cars, I couldn't imagine taking a newspaper because I would watch the road the whole time anyway. I think people would always be attentive because they don't trust the technology 100 percent. With man-made technology, there are always mistakes. I would always feel uneasy about it. It will take generations for people to trust the concept of a driverless car, and not pay attention anymore. As a passenger, you drive in the spirit of watching the road." (R21)

3.6.4. Environmental Protection

Ten respondents stated that they liked that the automated shuttle had electric propulsion. Two respondents explained:

„I like it that Olli has an electric propulsion. I think that private car use in cities should be restricted because of air pollution. If we want to continue living in large cities, then we need to restrict car use because otherwise, these cities will not be liveable in the long run. When you think about how some countries like China look like in terms of air pollution. I do not want to live here in Germany in such a city. This is why I find it extremely important to develop alternative propulsion systems." (R04)

„In the long run, it is better for all people involved, because these cars produce fewer emissions because they are electric; they make no noise, and there will only be five percent of the current number of vehicles on the roads. Karl Marx Allee would be fantastic. (R17)

3.6.5. Ethical Programming and Job Losses

Five respondents mentioned the ethical programming of automated vehicles, as well as job losses that may arise due to road vehicle automation. These issues were not considered influential enough to halt the development of automated driving technology. Concerning the ethical programming of automated vehicles, two respondents said:

„A little girl is crossing the street. Killing the girl or driving against the wall and being killed? How does the vehicle decide? First, we need to realize that these events will occur less frequently because the sensors will definitely react faster than the human being who would definitely kill the girl. It is often overlooked that discussions such as these will occur less frequently because the human driver would definitely kill the girl. Until (s)he reacts, it is already too late. The car has at least the chance to react." (R07)

„The question of acceptance is also related to ethical issues, that's a big point. The ethical and moral question is: A child jumps in front of the car. What should the computer decide? Can you do that at all? Is that morally justifiable? The ethical question is a question that has to be discussed, but it is no reason for me to reject automated vehicles." (R24)

Concerning possible job losses, one respondent said:

„Of course, jobs will be lost. This is a bit critical, but will not stop this trend." (R05)

3.7. Main Category 5: Travel Purpose

Respondents envisioned the use of automated shuttles for different trip purposes. Thirteen respondents expressed their intent to use automated shuttles in severe weather conditions, and in suburban and rural areas or areas that are generally unserved by public transport. Twelve respondents indicated they would be willing to use shuttles in

closed areas (e.g., exhibitions, large factories, airports, university campuses, retirement homes, hospitals). Eleven respondents indicated to be willing to use shuttles for the transport of goods, ten respondents expressed their interest in using automated shuttles in urban areas, and in touristic/unfamiliar areas. Three respondents explained:

„I would use the shuttle when it would be available, in areas where transit is not really good and where the walking distance to public transit is far so that you add mobility.” (R08)

„I would want to use it. For example, we had very bad weather on the second day of our tour, and it had soaked me completely. A shuttle like this would fix that. Sometimes I ride a bike in combination with taking the train, and I would actually use the bike less often if I then had the opportunity to use shuttles, especially in rainy weather.” (R15)

„If an automated shuttle like Olli is transporting me from where I live in an independent and regular way to the supermarket, I get in and drive five to eight streets to the supermarket, and the way back is equally independent, then I would probably always do this. This would be a very purpose-oriented and practical tool, and this would be a great thing.” (R16)

Another respondent posited that getting to and from the station generally discourages the use of public transport:

„Because then I don't need to take the tram to get to the station, the train from the station and from the station I still need to walk to my destination. Taking the direct route through the city is more direct, and it is usually quicker by a factor of 1.5.”
(R16)

Five respondents expressed their interest in using automated shuttles because of physical impairments (e.g., pregnancy, early motherhood) or for one-way trips that are currently covered by the car. Five respondents questioned the suitability of automated shuttles on their daily trips. It was explained:

„With a travel time of 6 minutes, I would use Olli if I have something difficult to carry, or when I'm exhausted, but these are exceptional cases.” (R06)

„I would guess this is suitable for one-way routes. If I go by car to the station, I have to leave the car there somewhere, or if I want the car, it must be there somewhere. So I see it more as a comfortable variant of what I am using now when I arrive with a lot of luggage and use a car2go or drive now or anything else.” (R03)

„I was very positive towards automated shuttles in general, but when I think about it, I can't envision at all how I could use these shuttles on my daily trips as I live today in Berlin. Then I realized, I would not use them. The bike and underground system are simply quicker, and it is more practical in daily life. And I have my routines, and my daily trips are already routinized to a large extent; a shuttle would not be able to beat this.” (R18)

3.8. Main Category 6: Trust

3.8.1. Trusting Automated Vehicles

The relevance of trust for the use of automated shuttles was emphasized by ten respondents, with two of them saying:

„You also need to trust the system, but I also think that this develops over time. It is simply a habitual issue. In Copenhagen, there is also an automated underground train, and the passengers are not afraid anymore that the train is not properly driving or not stopping somewhere as planned.” (R10)

„I think the most important factor is trust, especially with the elderly generations, who are afraid of fully or partially automated driving. I believe the most important point is to create trust that the vehicle works. During our ride, the shuttle stopped on

the middle of the route and braked abruptly. This is something that does not build trust." (R13)

Trust might be contingent on the type of environment in which automated vehicles are being trialled, as emphasized by the following respondent:

„What has not been properly tested here is the driving in normal traffic. The driving experience will likely be different in a normal traffic situation compared to a closed campus situation where the feeling of safety is likely to be higher." (R01)

3.8.2. Supervision and Control

Six respondents indicated to prefer supervision of automated shuttles via an external control room or a steward on board over unsupervised automation or to halt the actions of automated shuttles via an emergency button inside the vehicle. According to three respondents:

„It needs a human being at the beginning inside the shuttle, who is explaining the system. First, to create trust and second, to provide explanations and understanding and thus dismantling fears because I can imagine that people are still insecure and do not trust the system if they do not have any possibility to control it. I can imagine that some people feel powerless then. The system is driving against the wall. What can I do? Maybe an emergency button would help, but experience also shows that these buttons are often used and misused. I also saw the emergency button and wondered whether I would be able to react in time if sitting in the back seat when the emergency button is at the door in the front." (R03)

„Having the option to control the vehicle, for example, by pressing an emergency button if there is an obstacle that the car can't see. Having the option there would be really nice. There is perhaps always the concern that the sensors don't see something, but the human eye does. Having a steward in the beginning is a good way, without it would be kind of weird because you don't know what is going on and having a steward there is probably reassuring because I would perceive it like: 'Oh this person knows a lot more about the vehicle than I do, I could ask him stuff about it, it is like asking a human.'" (R08)

„The automated shuttle can be supervised by an external control room. I would not like it if the shuttle isn't being supervised at all anymore, but if an external control room supervises it, this would not be a problem for me. One person, for example, could control ten shuttles at the same time." (R20)

3.8.3. Trialability

Five respondents mentioned the importance of putting automated shuttles to trial, and to expose the public to automated driving technology to reduce fear and scepticism, with one of the respondents motivating his view as follows:

„Lots of people cannot imagine it. If you have more demos, then more people try it and then more people will probably accept it." (R09)

4. Discussion

The aim of this interview study was to acquire in-depth knowledge of people's expectations about automated driving technology and the alignment of those expectations with actual experiences with the automated shuttle during the ride. Also, the factors that affect respondents' intentions to use automated shuttles as feeders to transport systems were explored. Based on the interview quotes, we identified six categories that are relevant to the intention to use automated shuttles in public transport: (1) expectations about the capabilities of the automated shuttle (10% of 340 quotes), (2) evaluation of the shuttle performance (10%), (3) service quality (34%), (4) risk and benefit perception (15%), (5) travel purpose (25%), and (6) trust (6%).

4.1. Expectations about the Capabilities of the Automated Shuttle and Shuttle Performance
Respondents expected a higher level of autonomy of the shuttle in reacting to obstacles and in finding its route independently without the reliance on pre-programmed routes. The majority of our respondents had an idealized expectation of the technological development state and were disappointed by the prototype shuttle they physically

experienced during their ride. These findings correspond to Fernández Medina and Jenkins (2017), who found that respondents who took a ride in a driverless shuttle reported that the driverless vehicle/journey did not meet their expectations and had disappointed them, as the vehicle operated at a limited speed and was supervised by a steward on board.

The results of the interviews suggest that the respondents' idealized expectations were, in part, the result of an ambitious portrayal of automated vehicles in the media. This notion is consistent with Parkhurst and Lyons (2018), who pointed to the existence of positive expectations and a hype about the adoption of automated vehicles and their capabilities. Contrastingly, Shariff, Bonnefon, and Rahwan (2017) mentioned the disproportionate media coverage of crashes involving autonomous vehicles, which may amplify people's fears. The development of incorrect expectations can be harmful to long-term acceptance (Nees, 2016). Incorrect expectations may be mitigated by an accurate portrayal of the benefits and risks of driverless transportation in the media, for example, by emphasizing the safety advantages of automated vehicles compared to manual drivers, while avoiding claims about infallibility (Shariff et al., 2017).

4.2. Service Quality
The service quality category received a large number of mentions by respondents, which suggests that service quality is an important determinant of the acceptance of automated shuttles. Among the service quality aspects, respondents appreciated the provision of a flexible door-to-door service, which current public transport systems are unable to offer. This finding corresponds with Shen et al. (2018), who postulated that a door-to-door service would make automated vehicles attractive. The positive outlook of respondents is conditional on requirements of speed and reliability: A large number of respondents indicated that the current shuttle speed was too slow to be of real use on their daily mobility trips.

4.3. Risk and Benefit Perception, and Travel Purpose
Our results showed that respondents supported the idea of using automated shuttles in public transport. They appreciated the idea of not having to drive and the potential of automated vehicles to reduce traffic accidents, which mirrors the literature (e.g., Bansal et al., 2016; Daziano, Sarrias, & Leard, 2017; Portouli et al., 2017).

Studies have shown that passengers perceive the interaction with other people in public transport both positively (e.g., a way for passengers to be entertained) and negatively (e.g., as noise, disturbance) (Beirão & Cabral, 2007; Carreira, Patrício, Natal Jorge, Magee, & Van Eikema Hommes, 2013). Because automated shuttles accommodate passengers in a smaller space compared to conventional public transport (e.g., bus, train), automated shuttles could magnify privacy issues. A number of respondents pointed out that lack of personal privacy in shuttles may discourage them from engaging in cognitively demanding tasks. This finding contradicts the commonly held assumption that travellers will use automated vehicles to make productive use of their travel time (König & Neumayr, 2017; Robertson, Meister, Vanlaar, & Hing, 2017). However, our finding is consistent with Singleton (2018), who argued that users of automated vehicles might not use their newly available travel time for productive in-vehicle activities (see also Cyganski et al., 2015; Milakis et al., 2017). Of course, passengers may still tolerate the lack of privacy and the inability to engage in cognitively demanding activities (e.g., work), if the automated shuttle improves the efficiency of their transport. Kyriakidis et al. (2015) found that there are national differences in public opinion towards automated driving. Their results suggest that people in higher-income countries are more concerned with data privacy of automated vehicles. Future research should investigate the effect of travelling with fellow travellers on the perception of privacy and pleasure of the ride across different cultures and income regions.

Issues related to adverse socioeconomic outcomes (e.g., job losses), and the ethical programming of automated vehicles were addressed by a relatively small number of respondents. Respondents may have found it difficult to speculate on the long-term socioeconomic implications of automated shuttles. Cavoli, Phillips, Cohen, and Jones (2017) pointed out that the long-term effects of automated vehicles are currently unclear. Adnan, Nordin, Bahruddin, and Ali (2018) assumed that ethical questions have not been sufficiently and transparently discussed, and that ethical issues related to accidents are still hypothetical, given that highly or fully automated vehicles are not yet available on the market. Following the recommendations of Adnan et al. (2018), future research should more closely investigate the relationship between the ethical implications of automated driving and user acceptance of automated driving technology.

4.4. Trust
Twenty per cent of the respondents (6/30) indicated to prefer supervision of the shuttle from an external control room or steward on board over unsupervised full automation. The desire for human control corresponds to questionnaire studies, where few people were comfortable without any type of supervision. Similarly, Liljamo, Liimatainen, and Pöllänen (2018) reported that 90% of respondents preferred that automated vehicles should also be manually driveable, while 92% of respondents would also like to determine where, when, and which automated functions to use. In this regard, research on automated vehicle acceptance would profit from drawing analogies to

other domains, such as driverless trains and even pilotless aircraft. Fraszczyk and Mulley (2017) found that respondents rated having a driver on driverless trains as (very) important and preferred to include a driver cab on driverless trains. Rice et al. (2014), who investigated opinions about autonomous auto-pilots for commercial flights, found that respondents were more comfortable/trusting/willing to use the aircraft with the human pilot in comparison to the auto-pilot (fully autonomous machines that operate without interference with human pilots), or a human pilot in a ground station remotely controlling the aircraft. Control mechanisms inside (e.g., an emergency button to halt the shuttle's operation, S.O.S. button to connect the shuttle to a technical cite centre) or outside the shuttle (e.g., remote supervision of shuttle) could be deployed to compensate for the perceived loss of control and the negative perception of safety.

4.5. Comparison with Previous Questionnaire Research
The findings obtained in this interview study are in line with a previous questionnaire study with 384 respondents experiencing the same shuttle ride as in the current study (Nordhoff et al., 2018a). That is, both in the questionnaire study and the interview study, respondents were least satisfied with the shuttle speed. However, in the previous questionnaire study, respondents were overall more positive towards using automated shuttles, as shown by their strong agreement with general questions on their intended use of automated shuttles as feeders to public transport (e.g., "I would use an electric driverless vehicle from the train station or some other public transport stop to my final destination or vice versa"). The questionnaire items may have elicited a so-called "yea-saying behaviour" (Kiesler & Sproull, 1986, p. 404; Nordhoff et al., 2018b) among respondents due to lack of time or willingness for critical reflection. In the present interviews, respondents were given the opportunity to reflect on their experiences and provide insights into their needs and the way automated shuttles should be commercialized. This opportunity for in-depth reflection may explain their critical, albeit still positive, stance toward automated shuttles in public transport.

4.6. Study Strengths and Limitations
So far, there was limited knowledge of the public about automated vehicles (Sanbonmatsu, Strayer, Zhenghui, Biondi, & Cooper, 2018) and an uncertainty of what the public understands about driverless technology and how the technology can form part of their lives in the short- and middle-run (Langdon et al., 2017).

Our interview study is one of the few studies which explored respondents' critical in-depth reflections on their direct experiences with automated shuttles, their ideas and expectations about automated driving technology, as well as the factors affecting automated vehicle acceptance. Qualitative studies are particularly effective in exploring relatively new or unknown phenomena such as automated vehicles (Fernández Medina & Jenkins, 2017). The knowledge offered by the present interview study improves the understanding of the public's attitudes towards automated vehicles and inform future quantitative research.

A limitation of our study is that the respondents rode the shuttle alone, and were asked to reflect on using automated shuttles as feeders to transport systems on their daily trips. Thus, respondents were asked to imagine a hypothetical use of shuttles that has not formed a part of their daily mobility lives. Second, the 8–12 minute test ride may have been insufficient for establishing familiarity and stable attitudes. Some of our findings are thus of a preliminary nature, reflecting initial beliefs around automated vehicles. Third, face-to-face interviews have the risk of producing specific forms of bias, for example, due to the tone of the questions asked and facial expressions of the interviewer (Bowling, 2005). Future interview research could be conducted using a higher degree of anonymity. For example, anonymous telephone interviews could be performed (Knox & Burkard, 2009). A fourth limitation of the present study is its use of a convenience sample that overrepresents males with an academic background, who travel with environmentally-friendly modes of transport (e.g., public transport, walking), and already participated in former experiments of carsharing or electro-mobility projects of the InnoZ (see Table 1). Their attitudes may not be representative of the general population, but of the specific group of early adopters and innovators with a high interest in progressive technologies. We recommend future research using larger gender-balanced samples that are representative of the entire population.

4.7. Conclusions
This interview study classified people's quotes concerning the acceptance of a driverless shuttle in terms of technological expectations, shuttle performance, service quality, risk and benefit perception, travel purpose, and trust. People had idealized expectations regarding the technical capabilities of an automated shuttle, which did not correspond with the actual technological capabilities of the shuttle. A large number of respondents indicated that the current shuttle speed was too slow to be of real use on their daily mobility trips. The interviews further suggest that respondents' idealized expectations were the result of the ambitious portrayal of automated driving in the media. Respondents regarded service quality as a particularly important determinant of the acceptance of automated shuttles. In general, respondents were positive towards the future use of automated shuttles in public transport. A number of respondents indicated to prefer having a steward on-board or in a control room and did not think that the shuttle allows them to engage in cognitively demanding tasks such as working. We recommend to

improve the technical capabilities and service quality of automated shuttles in order to be accepted. The present results provide a sobering outlook on the current hype that surrounds automated public transport and provides various important leads regarding how to make driverless shuttles acceptable to the public.

Appendix A. Supplementary material

Table S1.

Overview of selected socio-demographic information of respondents R01–R30

Respondent ID	Gender	Age	Living situation	Highest educational qualification	Type of daily transport modes	Access to valid driver license
R01	Female	31–35	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Biking	Yes
R02	Male	26–30	Within the city, but outside the city centre in a purely residential area	Pupil, student, apprentice	Biking, walking > 500 meters per trip	Yes
R03	Male	41–45	Within the city, but outside the city centre in a purely residential area	Completed academic studies (university, technical college, academy)	Biking, walking > 500 meters per trip	Yes
R04	Male	21–25	In an apartment in the immediate city centre	Pupil, student, apprentice	Public transport < 100 km per trip, walking > 500 meters per trip	Yes
R05	Male	31–35	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Biking, walking > 500 meters per trip	Yes
R06	Male	21–25	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Public transport < 100 km per trip	Yes
R07	Male	36–40	Within the city, but outside the city centre in a purely residential area	Completed academic studies (university, technical college, academy)	Public transport < 100 km per trip, conventional car, walking > 500 meters per trip	Yes
R08	Female	26–30	Within the city, but outside the city centre in a purely residential area	School leaving examination/qualification	Public transport < 100 km per trip	Yes
R09	Male	56–60	Within the city, but outside the city centre in a purely residential area	Completed academic studies (university, technical college, academy)	Biking, walking > 500 meters per trip	No
R10	Male	41–45	Within the city, but outside the city centre in a purely residential area	Completed academic studies (university, technical college, academy)	Biking	Yes
R11	Male	26–30	In an apartment in the immediate city centre	Pupil, student, apprentice	Public transport < 100 km per trip, walking > 500 meters per trip	Yes
R12	Male	46–50	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Conventional car	Yes

R13	Male	31–35	In a house on the city outskirts	Completed academic studies (university, technical college, academy)	Public transport < 100 km per trip, walking > 500 meters per trip	Yes
R14	Male	51–55	In a house on the city outskirts	School leaving examination/qualification	Public transport < 100 km per trip	Yes
R15	Male	41–45	In a house on the city outskirts	Completed academic studies (university, technical college, academy)	Public transport < 100 km per trip, walking > 500 meters per trip	Yes
R16	Male	–	–	–	–	–
R17	Male	41–45	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Public transport < 100 km per trip, walking > 500 meters per trip	Yes
R18	Female	31–35	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Public transport < 100 km per trip, biking, walking > 500 meters per trip	Yes
R19	Male	51–55	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Biking, walking > 500 meters per trip	Yes
R20	Male	36–40	Within the city, but outside the city centre in a purely residential area	Completed academic studies (university, technical college, academy)	Biking, public transport < 100 km per trip	Yes
R21	Male	51–55	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Public transport < 100 km per trip, walking > 500 meters per trip	Yes
R22	Male	–	–	–	–	–
R23	Male	–	–	–	–	–
R24	Male	56–60	In an apartment in the immediate city centre	School leaving examination/qualification	Public transport < 100 km per trip, walking > 500 meters per trip	Yes
R25	Female	26–30	In a house on the city outskirts	Completed academic studies (university, technical college, academy)	Conventional car	Yes
R26	Female	–	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Conventional car, walking > 500 meters per trip	Yes
R27	Male	31–35	Within the city, but outside the city centre in a purely residential area	Completed academic studies (university, technical college, academy)	Public transport < 100 km per trip, walking > 500 meters per trip	Yes
R28	Male	56–60	In an apartment in the immediate city centre	School leaving examination/qualification	Biking, walking > 500 meters per trip	Yes
R29	Male	41–45	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Public transport < 100 km per trip	Yes
R30	Male	–	In an apartment in the immediate city centre	Completed academic studies (university, technical college, academy)	Conventional car, walking > 500 meters per trip	Yes

Note: The questionnaires on the socio-demographic information of the respondents R16, R22, and R23 were not returned. Respondents R26 and R30 did not provide information on their age.

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