

I'm curious, I'm open to it, I test it, I trust it! A focus groups study to understand a-priori trust in automated buses

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1 *I'm curious, I'm open to it, I test it, I trust it!* A focus groups study to understand a-priori
2 trust in automated buses

3

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Abstract

Trust is regarded as one of the main predictors for adopting automated buses (ABs). However, theories about trust (development) in technology generally vary and an in-depths study about trust in ABs specifically is still outstanding. The present study fills this gap by presenting results from focus group interviews to trust (development) in shared automated buses prior to exposure. The objectives of this study are to contrast participants' naïve concepts of trust with theory and to identify underlying factors influencing a-priori trust in ABs. Results show that the $N = 21$ focus group participants use different strategies to familiarise themselves with the new technology of ABs, e.g., comparisons with familiar technologies, fundamental tendencies to approach or avoid, additional information seeking, or anthropomorphisation. These strategies largely support existing theories on trust (development) in technology. Differences between naïve interpretations of trust and its theoretical assumptions were found in focus group debates where more control over technology limited uncertainty and led to *more* trust. While theories suggest control and trust to be incompatible opposites, participants see control as a way to enhance trust. We provide starting points for further theory development and expansion and stress the importance of explanations in emerging technologies for trust and acceptance building.

Keywords: autonomous driving; trust in automated vehicles; automated buses; focus groups; theories on trust

43

1. Introduction

44 Automated buses (ABs) are an emerging technology for public transport being able to
45 move more than 10 passengers simultaneously on programmed routes without a driver
46 (Nordhoff et al., 2018; Zoellick, Kuhlmeier, Schenk, Schindel, & Blüher, 2019b). Those
47 ABs are “able to perform all driving functions under certain conditions” corresponding to
48 level 4 or above of the classification by the US-American National Highway Traffic Safety
49 Administration (NHTSA, 2017, p. 4). Fig. 1 depicts two examples of buses in use in pilot
50 projects in Berlin, Germany (Zoellick, Kuhlmeier, Schenk, Schindel, & Blüher, 2019a;
51 Zoellick et al., 2019b). Embedded in smart mobility systems, ABs promise societal and
52 environmental benefits, e.g. inclusive mobility (Pettigrew, 2017), reduced greenhouse
53 gas emissions (Greenblatt & Saxena, 2015; Wadud, MacKenzie, & Leiby, 2016), and a
54 positive change in urban spaces (Henderson & Spencer, 2016). Trust is regarded as one
55 of the most important concepts in explaining the degree of acceptance and thereby the
56 (non-)use of ABs (Choi & Ji, 2015; Kaur & Rampersad, 2018). Thus, trust is necessary
57 for the ABs to fulfil their promises.

(A)



(B)



58

59 Fig. 1. Electric, shared ABs at the Charité campuses. (A) EasyMile EZ10 at Charité
60 Campus Mitte. (B) Navya Arma at Charité Virchow Klinikum. Adopted from “Assessing
61 acceptance of electric automated vehicles after exposure in a realistic traffic
62 environment” by J.C. Zoellick, A. Kuhlmeier, L. Schenk, D. Schindel, and S. Blüher, 2019,
63 *PLOS One*, 14(5), p. 2.

64

65 However, little is known about trust in ABs. A first constraint is the dominance of
66 quantitative questionnaire studies within this research field (Versteegh, 2019) that share
67 the methodological limitation of focusing on breadth rather than depths of knowledge.
68 Many of the qualitative studies on trust in automated mobility conceptualise the vehicles
69 as privately owned passenger cars (Bazilinskyy, Kyriakidis, & de Winter, 2015; Buckley,
70 Kaye, & Pradhan, 2018; Li, Blythe, Guo, & Namdeo, 2019). The few studies reporting

71 results on ABs use trust as one outcome among many (Nordhoff, de Winter, Payre, van
72 Arem, & Happee, 2019; Nordhoff, Stapel, van Arem, & Happee, 2020; Zoellick et al.,
73 2019a). In their interview study after a ride in an AB, Nordhoff et al. (2019) coded 6% of
74 the material with the main category “trust” without sub-categories. Similarly, in the coding
75 scheme of Nordhoff et al. (2020), trust is operationalised as a sub-category of perceived
76 safety and discussed accordingly. Both of these studies collected their data on trust in
77 ABs *after* the ride, not a-priori trust before the ride. Thus, to our knowledge little is known
78 about the topic of a-priori trust in ABs.

79 The purpose of this paper is to investigate a-priori trust in ABs in depth using results from
80 focus group participants ($N = 21$) and interpretative methods (Kuckartz, 2016). Their
81 naïve conceptualisations of trust (development) are contrasted with theoretical
82 deliberations based on academic literature. Findings from these contrasts expand theory
83 and provide insights towards trust in newly induced automation processes generally.

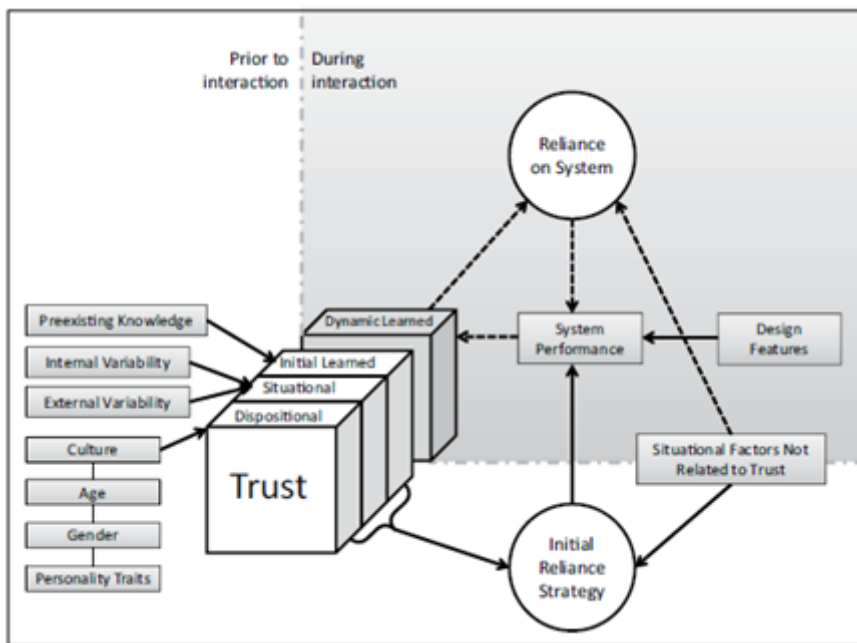
84 In the following sections, we will first present the concept of human-machine trust, which
85 differs from human-human trust, so that we can then discuss existing literature on trust
86 in automated vehicles in more detail. This will provide the theoretical basis for our
87 qualitative study on a-priori trust in automated buses.

88 **1.1. Theory on trust in ABs**

89 While authors generally agree that trust becomes relevant in human-machine interaction
90 and subsequent use (Parasuraman & Riley, 1997; Wu, Zhao, Zhu, Tan, & Zheng, 2011),
91 definitions vary in their emphasis on emotional (Plutchik, 2001), behavioural (Hergeth,
92 Lorenz, Vilimek, & Krems, 2016), situational (Goto, 1996), or attitudinal aspects (Lee &
93 See, 2004). Most commonly, trust is seen as “the attitude that an agent will help achieve
94 an individual’s goals in a situation characterized by uncertainty and vulnerability” (Lee &
95 See, 2004, p. 54). In that sense, trust in machines such as ABs is conceptually closely
96 related to interpersonal trust (Hoff & Bashir, 2015), but differs in its development and
97 reference point (Madhavan & Wiegmann, 2007). Interpersonal trust is linked to
98 (perceived) expertise of the other person and it typically increases from low default with
99 experience; whereas trust in machines is linked to performance and it decreases from
100 high default based on expectations of perfection with experience of errors (Madhavan &
101 Wiegmann, 2007).

102 Trust in machines and its development is influenced by several factors. Hoff and Bashir
103 (2015) proposed an empirically driven model that identified influencing factors on human

104 trust in automation. They suggest that there are four layers of trust (Fig. 2). The first layer
 105 consists of dispositional aspects such as demographic variables. Situational trust, the
 106 second layer, is characterised by the influence of environmental factors and the internal
 107 state of the operator. The third layer consists of knowledge and expectations prior to
 108 system interaction. Those three layers form initial expectations and the tenor of
 109 interaction. During interaction, trust evaluations can shift dynamically based on
 110 experiences with several aspects of the system (fourth layer). In contrast to other studies
 111 on trust in ABs, the focus of this article lays on the first three layers of a-priori trust as a
 112 baseline before interaction.



113

114 Fig. 2. Full model of factors that influence trust in automation. Adopted from “Trust in
 115 Automation: Integrating Empirical Evidence on Factors That Influence Trust” by Hoff &
 116 Bashir, 2015, *Human Factors*, 57(3), p. 427.

117

118 **1.2. Research questions**

119 The aims of this article are to discover underlying factors that influence the development
 120 of a-priori trust in ABs, and to contrast naïve trust conceptualisations of potential users
 121 with theoretical assumptions found in academic literature. Correspondingly, the research
 122 questions are formulated as follows:

- 123 1. Which underlying factors influence the existence and development of a-priori trust
 124 (and mistrust) in ABs?

125 2. What are similarities and differences of theoretical assumptions about human-
126 machine trust in comparison to naïve conceptualisations of a-priori trust in ABs
127 by potential users?

128 **2. Material and methods**

129 **2.1. Recruitment and participants**

130 The present case study was conducted in advance of introducing four ABs at two
131 campuses of a university clinic in Germany (Fig. 1), two Easymile EZ10 and two Navya
132 Armas, being employed on round courses with 0.8 and 1.2 km length and designated
133 stops (Zoellick et al., 2019b). Participants were recruited through notifications submitted
134 via the intranet of the university clinic and offered a compensation of 25€ for participating.
135 Forty-four clinic employees and university students responded to the call indicating their
136 role in the hospital and their main campus for work or studies. We selected $N = 21$
137 participants (9 women) for the four focus groups based on their location and role to reflect
138 the diversity of potential users within this case study. Characteristics of participants
139 included in this article are presented in Table 1. These were collected via interviewer
140 observations in the focus groups.

Table 1

Pseudonyms and descriptions of focus group participants in selected passages

Pseudonym	Age group	Mode of transport	Living conditions	Miscellaneous
B1m	40s	<i>Private car, annual ticket public transport; used to have a company car</i>	<i>Lives with family in the Brandenburg area</i>	<i>criticises prices of annual public transportation ticket</i>
C1f	<i>Mid-30s</i>	<i>Public transport user, previously car driver; owns rarely used car</i>	<i>Berlin suburb with husband and daughter</i>	<i>formerly excessive car driver in Bavaria</i>
D1f	<i>Mid-40s</i>	<i>Walking; public transport for long distances; owns 23-year-old car</i>	<i>Not disclosed</i>	<i>walks long distances, uses car only Sundays</i>
E1f	<i>End-30s</i>	<i>Cycling; former public transport user, because cycling was too dangerous</i>	<i>Not disclosed</i>	<i>enthusiastic cyclist (including shared bikes), has not driven a car for 16 years</i>
G2f	<i>Mid-50s</i>	<i>Private car, public transport (regularly)</i>	<i>Not disclosed</i>	<i>is keen on parking aids and technical development, wants better public transport clocking</i>
H2m	30s	<i>Private car exclusively</i>	<i>15-minute commute to work with nice route</i>	<i>Sports-affine</i>
I2f	<i>Mid-40s</i>	<i>Scooter; previously public transport that become fuller and chaotic</i>	<i>Not disclosed</i>	<i>Critical of corporations developing technology as business models</i>
J2m	<i>Mid-30s</i>	<i>Public transport; car rides are too stressful, but public transport is also increasingly stressful</i>	<i>Not disclosed</i>	<i>Fond of e-mobility and ride-sharing</i>
M3m	<i>Mid-40s</i>	<i>Private car and motorcycle enthusiast; public transport or cycling in the city</i>	<i>Not disclosed</i>	-
S4m	<i>End-40s</i>	<i>Private car; saves time compared to public transport</i>	<i>Not disclosed</i>	<i>Sceptical about e-mobility and low cost promises of automated public transport</i>
U4f	<i>Mid-30s</i>	<i>Bicycle; no driver's license</i>	<i>Not disclosed</i>	<i>Dreams of a car-free city with cheap and effective public transport</i>

141 Note. Pseudonyms consist of order of contribution (A to U; ascending alphabetically),
 142 focus group number (1 to 4), and sex (m = male; f = female). Participant characteristics
 143 were based on appearance and contributions during focus group discussions.

144 **2.2. Interviewing procedure and analysis**

145 All focus groups were conducted between February and March 2018 – prior to
146 introducing the ABs – using the same semi-structured guideline (supplementary
147 material) by the same team of two experienced researchers. Besides other topics such
148 as use, safety, or mobility generally, trust was included in the guideline with the stimuli
149 “to what extent do you trust the ABs?” and “what would increase your trust / mistrust?”
150 after describing the ABs and presenting pictures of the vehicles taken from the
151 manufacturers’ homepages. In one focus group the topic of trust emerged from the
152 participants themselves without the use of these stimuli. With this study design, we were
153 able to extract expectations of participants towards ABs generally and in their application
154 in this project particularly.

155 We analysed the qualitative material following qualitative content analysis by Kuckartz
156 (2016) using deductive and inductive categorisation of text. Here, the basic unit of
157 analysis is the so-called unit of meaning – a passage of the material that provides enough
158 context to stand for itself without further explanation. Such a unit of meaning can be a
159 sentence, but often times involves entire paragraphs or – particularly in the case of focus
160 groups – a back-and-forth between participants themselves and the interviewer. With
161 these characteristics, the same unit of meaning can be assigned to multiple categories
162 (one-to-many classification) which is particularly prevalent in longer passages. As in
163 other coding schemes, categories should be distinguishable and different from each
164 other, but do not need to be exclusive since the same passages can be assigned to
165 multiple categories. We refer to Kuckartz (2016, pp. 100-111) for a detailed description
166 of the method and its iterative processes in category development and coding.

167 In sum, all focus groups together lasted 401 minutes ($M = 100.25$ min; $SD = 14.55$ min),
168 and audio files were transcribed by an external transcription bureau into 74,887 words.
169 First, all material was coded deductively based on the topics of the interview guideline
170 as categories. One of those categories was trust and its passages were selected for
171 further analysis. Second, inductive categories emerging from the material were formed.
172 All categories were applied to the material again in an iterative process to clarify and
173 distinguish them. For the present article, all units of meaning with the deductive category
174 “trust” (4,799 words) were further analysed. Three experienced researchers analysed
175 this subset of material to identify inductive categories independently and merged them
176 into a shared set of categories in one meeting. This set was then used to classify the
177 material independently again and further adapted in an iterative process supported by

178 the institute's interpretation circle with eight experienced researchers as an additional
 179 measure for quality control.

180 **3. Results and discussion**

181 **3.1. Main categories of a-priori trust**

182 The final set of categories for analysing the focus groups can be found in Table 2. Their
 183 specifications, relationships to trust (development), and interplay are described and
 184 interpreted below. Following the methodological approach of qualitative content analysis
 185 by Kuckartz (2016), the results section is structured based on passages and their content
 186 rather than the categories, because the same passage can be assigned to multiple
 187 categories simultaneously. Structuring based on categories would require multiple uses
 188 of extensive passages. Selected passages below are either particularly representative
 189 for the category or show the variance within a category. Results are illustrated with
 190 exemplifying quotes from the focus groups and contrasted with findings from literature.

Table 2

Final set of categories for qualitative analysis

Categories	Description	Frequency of occurrence
Comparisons of ABs to other (mobility) technologies	<i>Familiarisation through similarities and differences of the ABs to other (mobility) technologies.</i>	12
Curiosity vs. scepticism when approaching ABs	<i>Reactions of dealing with the unknown concept of ABs. Curiosity refers to inquisitiveness and tendencies to approach the ABs; scepticism refers to avoidance and retention.</i>	12
Maintaining of control over ABs	<i>Circumstances and features marked by the desire or exertion of control over (mobility) technology.</i>	7
Understanding the functionalities and processes of ABs	<i>The wish for more information and detailed knowledge about ABs and their role in developing trust.</i>	6
Ignorance and naivety as source of positive attitudes towards ABs	<i>Contrast to the wish for understanding. Ignorance refers to content with non-information; naivety refers to an unprejudiced, light-hearted view on ABs.</i>	3

Anthropomorphisation	<i>Attributing or desiring “human” features in the ABs.</i>	5
Habit and experience of other technology	<i>Description of past experiences with technology as well as habits that arose from the use of it. This includes the interplay between experience and habits.</i>	7
Perceived safety of the ABs	<i>Requirements that enhance a subjective assessment of protection from danger. Differentiated into the source of safety – human or machine.</i>	25
Reliability and error rate of the ABs	<i>Performance of a technical system in (repetitive) interaction with high (error-prone) or low (reliable) rates of malfunction.</i>	9

191 *Note.* Some categories depict a spectrum with opposing poles (e.g., curiosity vs.
192 scepticism) or cover closely related concepts (e.g., ignorance and naivety). With this
193 approach, we can capture, interpret, and discuss values and attitudes within categories
194 instead of contrasting opposing categories.

195 **3.2 Underlying factors of a-priori trust in ABs**

196 **3.2.1. Comparisons to other technologies and transmission of trust**

197 Participants compared the (unknown) concept of ABs to known mobility technologies
198 (e.g., subways, airplanes, cableway vehicles, lifts, or gondolas). This comparison can be
199 seen as a strategy to familiarise themselves with ABs and thus form a basis of trust. The
200 model by Hoff and Bashir (2015) suggests that there is initially learned trust that is based
201 on the pre-existing knowledge of a system. The comparison to other technologies can
202 therefore increase trust due to the knowledge gained. Passages 1 to 3 show a diversity
203 of comparisons and a way of approaching the concept of ABs through familiarisation.

204 Passage 1:

205 *M3m: I’m comparing this, for example, I’d be actually quite open-minded, without a*
206 *driver even, because, for example, I’m comparing that right now, when I’m sitting in*
207 *the back of the subway or something like that I have, yeah, I don’t actively think about*
208 *the driver and how he’s feeling right now, or whether he is feeling well, or whether he*
209 *can pay attention to things real quickly, emergencies or something like that or in*
210 *emergency situations, I don’t even know, I also have a certain basic trust in*
211 *technology. Well, I’m not even aware that the subway itself with its driver in that sense*
212 *still, I don’t actively think about it, that’s what I just noticed actually. Anyway...*

213 *Interviewer: A revelation!*

214 *M3m: Yes. Yes, because it’s also spatially so far apart from each other when I enter*

215 *somewhere in the back, I don't notice it in that sense. At the most, when the S-Bahn*
216 *or the U-Bahn (a/n: subway) passes me, that I still see the driver in the front. But*
217 *otherwise I have a certain basic trust in it. Get in, drive, and get out. So I could also*
218 *imagine it here.*

219 Passage 2:

220 *D1f: In a gondola, there is no one inside either – I'm just comparing it with a gondola*
221 *– when I'm sitting up there, then the interaction is through a push button. Well, I'm not*
222 *a pronounced gondola rider, but I go, well I do not, I don't ride it, but it's basically the*
223 *same. The thing drives without even having a person in there. And you have to trust,*
224 *that you can have contact immediately, like in a lift, if you get stuck, there is a button*
225 *through which you can call someone.*

226 Passage 3:

227 *S4m: And the sense of security, I mean you fly on the plane and you don't even know*
228 *if there is a pilot sitting at all in the cockpit or if automatic piloting is set and he is*
229 *sleeping or, I don't know, drinking coffee, or being on the toilet and nobody's there.*
230 *Anyhow, you don't know it. There is a closed door. So you're sitting in a plane and*
231 *you don't know if someone has the control...*

232 *U4w: But I know that there is someone, who could intervene in an emergency.*

233 *S4m: You don't know that either. You don't see it.*

234 *U4f: Yes I do. I do.*

235 The main topic of these comparisons is the subjective experience of being a passenger.
236 Direct control over one's own movement is relinquished to either an invisible person
237 whose presence becomes irrelevant (M3m and S4m), or to mere technology with a
238 button for human communication (D1f). In all instances, this loss of control necessitates
239 trust. Put differently, trust can only exist in a situation of uncertainty, vulnerability, and
240 the absence of control (Donick, 2019; Lee & See, 2004). Particularly M3m (passage 1)
241 presents an interesting case as his trust in the human U-Bahn driver is unknowingly
242 transferred to technology making both interchangeable. Passages 1 and 3 are exemplary
243 for how trust is often automatically generated (M3m) or reflexively denied (U4f) in routine
244 activities such as a flight or a subway ride. This supports the view on trust as routines
245 and norms about technology in general that are activated whenever engaging with
246 specific artefacts instead of explicit deliberations about the particular piece of technology
247 currently encountered (Wagner, 1994). Additionally, technology is not questioned as long
248 as it performs as expected demonstrated by the U-Bahn ("*get in, drive, and get out*",
249 M3m) or the plane's autopilot.

250 **3.2.3. Approaching ABs: Naivety, curiosity and scepticism**

251 The second way to approach ABs consisted of fundamental tendencies to approach and
252 avoid, or put differently, of curiosity and scepticism. In passage 4, scepticism is ascribed
253 to the potential user's attitudes towards the invention of the railway. Here, the
254 dispositional level of trust (Hoff & Bashir, 2015) can explain which factors play a role in
255 creating a positive or negative attitude towards ABs. Potential users of different age,
256 gender, or cultural background are likely to develop different attitudes towards
257 technology. Trust is therefore shaped by external factors that make it easier or harder to
258 approach ABs.

259 Passage 4:

260 *C1f: I think that, when the railway was introduced everyone made a big fuss out of it;*
261 *they just didn't understand it. When the first cars came there were people that resisted*
262 *and said I would never get into one and in the end they got driven to their own funeral*
263 *and well, they didn't make that experience, but yeah... Moreover, there are always...*
264 *especially with these kinds of cars (a/n: self-driving) I have the feeling that there will*
265 *always be difficulties. People just can't accept it straight away.*

266 In passage 4, scepticism towards new technologies as an anthropological constant is
267 addressed and transferred to ABs. Technological innovations seem to be accompanied
268 by an additional quality of trust necessary for adoption and acceptance. However, C1f
269 does not share the sceptical attitude, but rather ironizes it (the first ride being the one to
270 the own funeral). The trivialisation of scepticism can also be observed in passage 5 in
271 which the values curiosity (E1f) and scepticism (B1m) clash.

272 Passage 5:

273 *E1f: I believe that I am myself naïve enough to think that technology is like... functions*
274 *better than individuals behind the wheel. Well, actually I don't really know anything*
275 *about it, but I'm not worried, because I think someone will... the thing will learn and*
276 *manage it. And one day I will be able to save my cab money.*

277 *B1m: This will probably happen as you said with a probability of 99.8 percent. But I*
278 *mean probably due to my almost biblical age, as I said, one has witnessed events like*
279 *for example Chernobyl and those are things that have – well at least for me –*
280 *entrenched themselves deeply in my consciousness as something where because of*
281 *malfunxion technology got out of hand and eventually at a certain point became*
282 *incontrollable – regardless of what you do. And of course, it's not a bit comparable,*
283 *obviously, because this is a small bus that drives slowly around the place, but as I*
284 *said just as an example. So finally, my subliminal fear is that this technology fails and*
285 *this bus develops a malfunxion that leads to people's harm – either outside the buses*
286 *or inside the bus.*

287 *E1f: But I think it's madness that so many people trust in technology. So, technology*
288 *is applied in operating rooms; everybody has a computer at home; everybody lets*
289 *navigations systems navigate them. And then suddenly such a thing drives without a*
290 *driver and everybody gets anxious that something bad happens! I think we have so*
291 *much technology where we live and I personally do not understand this kind of...*

292 By her own account, E1f does not have enough knowledge about ABs cognitively, but is
293 affectively neither anxious nor afraid to use them. The result is unequivocal trust and the
294 belief in superiority of technology over humans (“functions better than individuals behind
295 the wheel”, E1f). B1m, on the other hand, is cognitively convinced of the vehicles’ safety
296 (“99.8%”), but affectively anxious. This is illustrated by his comparison between the
297 buses and Chernobyl as the maximum credible accident and reason for his scepticism
298 towards autonomous technology. In the situation of uncertainty because of autonomous
299 technology, E1f reacts “naïvely” and trusts unconditionally, while B1m wishes for a
300 controlling authority. Even if B1m rates the security level cognitively relatively high his
301 trust towards ABs is low because of affective concerns.

302 **3.2.4. Maintaining control, perceived safety, and reliability of the ABs**

303 The previous passage illustrated the tension between the concepts control and trust. If
304 uncertainty is a necessary premise for the definition of trust (Donick, 2019, p. 11; Lee &
305 See, 2004) then trust and control are incompatible counterparts. This wish for control
306 becomes more distinct in the following passages dealing with the presence of a human
307 operator (passage 6) and an openly accessible emergency button (passage 7).

308 Passage 6:

309 *B1m: Why don't I just as in a plane put a human inside instead? This is also a human*
310 *being who has a job who earns money. That doesn't even have to be, is not highly*
311 *qualified work, but as I said a good and solid job. And for all I care he is just sitting at*
312 *the wheel and looks around or babbles with the passengers and entertains them, but*
313 *I know he is there and for my salvation, like, if something evil happens: he is there! In*
314 *principle I would really like that, it'd be still autonomous, but, you know...*

315 [...]

316 *Interviewer: What I withheld so far is that in our test phase here at the campus for one*
317 *year a so-called operator rides along, a person, who is inside the car.*

318 *B1m: Thank God!*

319 B1m uses religious language (“salvation”, “evil”, “God”) to describe his relief about not
320 being solely dependent on technology. This underlines the strong desire for control, in
321 this case manifested through the professional human operator who metaphorically

322 arrives as saviour and practically serves as contact person and mediator between
323 technology and passenger.

324 Passage 7:

325 *C1f: Well, if the car drives and we see a cat, is there a possibility to press stop*
326 *somewhere, as a passenger, to by ourselves make the thing...*

327 *Interviewer: That exists, yes.*

328 *C1f: Yes, that's good. That's good. It is good, right?*

329 *D1f: Yes, I don't have a problem getting in there. I don't have a problem with that thing*
330 *at all. I think it's rather funny.*

331 *Interviewer: What if it would not exist? What would you think about it then?*

332 *C1f: Let's put it that way: I would, I'll try it, because I think it is interesting. It's not my*
333 *means of transportation, but I would definitely try it. But it will be fun-, well, it will be*
334 *interesting. Well, it would be thrilling, I think. And that I have the possibility to control*
335 *it – maybe I am a control person, could be – that comforts me a lot. I would first of all*
336 *look where this button is.*

337 *D1f: This now worries me that there is a button with which everybody sitting inside*
338 *can live out their own sensitivities. No.*

339 *C1f: No, well, only in an emergency.*

340 *D1f: Well, the emergency... If there is a cat, someone gets a fright, because he loves*
341 *cats. But the thing already recognises the cat.*

342 *C1f: Yes, he recognises it.*

343 *D1f: But if everyone has access to this button, and has a problem, well, have fun with*
344 *it. Then I am not riding along.*

345 *C1f: Oh ok.*

346 *D1f: No, if everybody has access to it, I don't like it so much.*

347 C1f is relieved by the possibility to exercise procedural control over the autonomous
348 machine and describes herself as a control person. D1f, on the other side, sees this kind
349 of control through humans as a threat that lowers her willingness to ride the AV. This
350 signifies a sceptical attitude towards the human (unprofessional, arbitrary, and affect-
351 driven) element in the human-machine interaction. Accordingly, the question who should
352 control whom – humans the technology or the technology humans – is answered quite
353 differently. On the one hand, technology supposedly performs better than humans never
354 being sleepy, drunk, or in a bad mood (M3m, passage 1; E1f, passage 5) becoming an
355 ideal corrective for human inadequacy (Gehlen, 1978). On the other hand, uncontrolled

356 technology produces devastating results (B1m, passages 5 and 6). However, humans
357 as control mechanisms seem also inadequate if responsibilities are not clearly assigned
358 (passage 6).

359 The debate about the button in passage 6 resembles the theory of Madhavan and
360 Wiegmann (2007) who argue that humans are initially met with scepticism until they have
361 proven their trustworthiness. This is contrasted by passage 8, in which technology must
362 prove its trustworthiness as well. Here, participants differ in their extent to grant a-priori
363 trust. For H2m, trust is not granted a priori when dealing with ABs. Instead, trust has to
364 be earned through experience. J2m on the other hand describes a generally high a-priori
365 trust that is however based on conditions of safety. Particularly, different speeds are
366 discussed and a categorical difference between slow ABs and fast ABs is introduced.

367 Passage 8:

368 *Interviewer: Do you trust the vehicles?*

369 *G2f: Yes.*

370 *H2m: I think trust is something that has to be proven first, something you have to get*
371 *used to. I would not go as far and say I'm getting into this vehicle and trust it right from*
372 *the start. Instead, I would rather gradually gain trust by driving it more often.*

373 *J2m: Well, up to this speed I'd trust it, because I'm just imagining with my naïveté that,*
374 *if there is any mistake, they'll stop anyway, yeah. Well, that's just what I'm talking*
375 *myself into believing. As such, up to the speed they are driving now, 20 or 45 even, it*
376 *would not be an issue for me. Higher up, I would get careful, because that is a whole*
377 *new ball game.*

378 *G2f: No, absolutely, at 20 I would also get in and say, yes, I'm curious, I'm open to it,*
379 *I test it, I trust it.*

380 Contrary to theoretical conceptualisations of trust (Madhavan & Wiegmann, 2007), trust
381 is not the default for H2m when dealing with technology. Instead, repeated interaction
382 builds trust similar to how Madhavan and Wiegmann (2007) conceptualise interpersonal
383 trust. In the rest of passage 9, “naïve” curiosity is embedded in cognitive restrictions
384 about safety. The “whole new ball game” (J2m) presents a categorical change of
385 perceived risk from acceptable to unbearable. Trust is therefore not expressed
386 unconditionally, but in a clearly defined spectrum of conditions.

387 **3.2.5. Understanding the black box and anthropomorphisation**

388 The technology of ABs is increasingly attributed to be equipped with human agency
389 (Brand, 2018), because it changed from being trivial and predictable towards complex

390 and connected configurations outside the realm of understanding. In its effectiveness,
391 technology becomes opaque; like a black box with observable inputs and outputs of the
392 machine, but hidden mechanisms in between (Latour & Venn, 2002). In passage 9,
393 participants express the wish to understand the “black box” by visualising the actions of
394 the machine. Participants humanise the process of AV decision making and thereby
395 translate the machine’s algorithms into human categories to experience the world. This
396 approach can be seen in the context of the development of technology from trivial to non-
397 trivial (Donick, 2019). If the technology is non-trivial, more human agency is credited and
398 trust is defined by repetition and transparency about intentions. Therefore, the proposed
399 separation of the concepts of trust towards machines and trust between humans is
400 challenged (Madhavan & Wiegmann, 2007). Passages 5, 7, and 8 are consistent with
401 the view of trust and control as opposites in situations of uncertainty and self-efficacy. A
402 contradicting viewpoint is presented in passage 9, which expresses that participants are
403 more willing to trust ABs the more they have control over them, e.g. in the form of
404 information.

405 Passage 9:

406 *I2f: Well, I could imagine running in its way, just to see what happens.*

407 *G2f: To test it?*

408 *J2m: Is he knocking me over?*

409 *I2f: Well, with a safe distance. Then I would like to know how they work exactly and*
410 *to what they actually react. And that would probably at least strengthen my trust, if I*
411 *understood it better.*

412 *Interviewer: Yeah, what else would increase trust? Understanding the behaviour of*
413 *the vehicle, I'd say.*

414 *G2f: Just write more about how safe they are, that a vehicle has been used again,*
415 *this and this many people have used it, it is usable around the clock. Well, that's*
416 *something I'd say, oh great, sounds good, it works, so you can use it. And, yeah,*
417 *people with prejudices might be convinced too. Yeah, if that many use it I can get in*
418 *as well.*

419 *H2m: Maybe also reviews of rather older people who trust the vehicle. I feel like young*
420 *people are more open to such things and will do it right away. And when I read that*
421 *an 80-year-old elderly lady gets in there and writes 'great' and that everything went*
422 *well, then I'd rather trust the whole thing.*

423 *J2m: Another point for visually perhaps, well, those information, that's all already kind*
424 *of happened. However, if you're sitting in there live, maybe some kind of visualisation*
425 *would be, when he drives, just projected into the windowpane, like a head-up display:*

426 *these are my lines and I'm driving there. So, it's not totally unexpected, I say in*
427 *quotation marks, 'what he does'. And if there is a car parking, then there should be*
428 *like a red circle around it, so that you simply project into the windowpane what he*
429 *thinks, what the computer thinks. Well, and then one has a sense of security, I say,*
430 *or suggesting it. Such a, somehow such a visualization of like, what he does.*

431 *G2f: Or a voice that says, well, in five minutes we reach the station, I don't know,*
432 *Virchowweg, corner, or here, I don't know, maybe that's important in the beginning.*
433 *So, you have elderly, right, that they have the feeling, yes, there is someone who is*
434 *watching all of this somehow.*

435 *J2m: Exactly, well, that... Also, in live operation as well, when you're sitting inside,*
436 *not only that you've read a newspaper before and that means, yes, there was an 80-*
437 *year-old woman in there, she thought it was great. But that, I say, yes, I call it live*
438 *operation again, it helps me when I see something that's visually orientated and that's*
439 *why I would say that would help me too. When I can sit there and then there are two*
440 *yellow lin-..., like, similar to a backup camera, there is sometimes, a picture, a ...*
441 *camera projected inside, that would be, yeah, stuff like that.*

442 Additionally, passage 9 describes different trust-building mechanisms. Information about
443 the functioning of the vehicle is discussed on different levels – in direct experience, when
444 and why the AV stops, or through visualisations of the route or the AV's "thinking" (J2m).
445 Information reduces uncertainty of the situation and trust is less necessary than without
446 information. Therefore, the desire for information can be interpreted as desire for control
447 that is, theory-driven, contrary to trust (Lee & See, 2004). However, participants see
448 information as helpful in building *trust*. This contradiction can be resolved by interpreting
449 the feeling described as trust rather as a feeling of *comfort*. Trust itself is a strategy to
450 feel comfortable in a situation of uncertainty and to give up responsibility.

451 Furthermore, anthropomorphisation of technology is used as strategy to reduce
452 discomfort and as a third way to approach the ABs. In the participants' imaginations, the
453 AV is capable of thinking (J2m), perceiving through senses, and it should be able to
454 speak (G2f). For the passengers this anthropomorphisation of technology creates
455 (imagined) transparency or simplicity of the machine and thus ensures greater trust in
456 the ABs. This is underpinned by other evidence on anthropomorphisation and trust
457 (Verberne, Ham, & Midden, 2012, 2015).

458 Lastly, this passage draws a line to behaviour or function (of humans and machines) and
459 its communication. The participants realise that, similar to a human brain, the processes
460 of the intelligent, non-trivial technology are not easily traceable. J2m and G2f both desire
461 communication of the AV to elicit certain functions and rationales. While humans use
462 language, gestures, etc. to explain behaviour, machines need another way of

463 communicating their functions. Participants imagine ways for ABs to communicate and
464 thus understand the ABs' "intentions". This shows similarities in human-to-human and
465 human-to-machine interaction. The will to avoid mysterious errors and malfunctions
466 through communication to gain more trust also resembles the theory that a-priori trust in
467 technology is high and decreases rapidly if errors occur (Hoff & Bashir, 2015; Madhavan
468 & Wiegmann, 2007).

469 **3.3. Summary**

470 Our analysis revealed that a-priori trust (development) in automated buses is
471 characterised by several factors as presented in the focus group discussions answering
472 our first research question. First, participants used several comparisons to other mobility
473 technologies (e.g., gondola, lift, or subway) to grasp the concept of ABs and familiarise
474 themselves with its characteristics. Second, participants differed in their fundamental
475 tendencies to approach or avoid the concept of ABs demonstrating curiosity or
476 scepticism. This tendency is shaped by pre-existing knowledge (e.g., Chernobyl) or
477 situational aspects (e.g., speed of the ABs) supporting the model by Hoff and Bashir
478 (2015). Some participants desire more understanding of the black box behind the ABs
479 while others are satisfied with their nescience. In either case, anthropomorphisation is
480 used to feel comfortable with the "learning", "thinking", or otherwise perceiving ABs.
481 Lastly, participants differ in their desire for control exerted on the ABs either in the form
482 of emergency stop buttons or human operators. Here, technology is seen by some to
483 surpass human performance in traffic and thus they see ABs as a solution to human
484 errors (e.g., tiredness or drunkenness) while others desire human control at all times.

485 Our second research question addressed the fit between theoretical conceptions of trust
486 and naïve conceptions by participants. Here, the model of Hoff and Bashir (2015)
487 described three layers of a-priori trust, namely dispositional factors, situational variance,
488 and pre-existing knowledge. We found evidence for all three factors in the focus group
489 discussions. However, theoretical deliberations suggest that people grant machines a-
490 priori trust whilst expecting perfect functioning; when experiencing errors trust
491 deteriorates (Madhavan & Wiegmann, 2007). Particularly the inductive categories
492 "ignorance and naivety" and "curiosity vs. scepticism" suggest that for many of the
493 participants this is the case. Even those initially critical of ABs because of traumatic error
494 experiences (e.g., Chernobyl, B1m) are willing to cognitively grant a-priori trust in the
495 functioning of ABs ("99.8%" safety, B1m). In contrast, for H2m trust is inextricably linked
496 to experience, i.e., trust has to be earned regardless whether the agent is human or

497 mechanic. Thus, we demonstrate that the assumption of high trust granted a-priori
498 (Madhavan & Wiegmann, 2007) does not apply for all potential users. Lastly, trust
499 defined as an attitude towards another agent in an uncertain situation (Lee & See, 2004)
500 suggests that trust and control are opposites. Participants in the focus groups were
501 ambiguous about this assumption. Some suggested an increase of control to *enhance*
502 their trust. This supports theories about the demand for explanations of automation
503 (Janssen, Donker, Brumby, & Kun, 2019), but stands in contrast to theories about
504 uncertainty (Donick, 2019; Lee & See, 2004). This contradiction could be explained by
505 diverging definitions of trust between theory and laypeople. In this case, participants
506 might consider trust (because of reflexive inaccessibility) as a positive feeling of comfort
507 with the ABs, for which control and information are beneficial.

508 **3.4. Strengths, limitations, and future research**

509 The qualitative approach in this study enabled an in-depth understanding of
510 preconceptions about trust in ABs, and factors relevant for trust development. Our results
511 suggest that at least for some participants trust assessments might not be only partially
512 cognitively accessible. This finding questions the informative value of attitudinal trust
513 conceptions in quantitative measures. Those measures arguably provide superficial
514 information on a cognitive, reflexive *kind of trust*. They however disregard inaccessible
515 parts such as the fundamental tendencies curiosity or scepticism as well as the level of
516 information necessary to trust or feel comfortable with ABs. We thus enrich the corpus
517 of predominantly quantitative academic literature on trust in automated mobility
518 (Versteegh, 2019) with a qualitative study on a-priori trust in ABs.

519 However, the results of this study need to be interpreted considering limitations. One
520 limitation is the sampling bias due to self-selection: although participants represented a
521 broad spectrum of potential users in this use case, they may be particularly interested in
522 ABs. At the same time, they are all hospital-associated persons with a centre of life in
523 (the outskirts of) a large city. The use case represented a very specific scenario before
524 ABs were employed in a protected environment. Hence, the results might not be
525 generalisable to other forms of automated vehicles or trust after experience.

526 For future research, a focus could lie on other influences on a-priori such as media
527 coverage. Reports, particularly those about the two deadly accidents involving a
528 pedestrian and a Volvo XC90 on 18 March 2018 in Arizona and involving a Tesla Model X
529 and a concrete barrier on 23 March 2018 in California which became caesuras in
530 automated driving in USA (Boudette, 2018; Griggs & Wakabayashi, 2018) possibly affect

531 trust in ABs through additional knowledge about their safety (layer 3 in Hoff & Bashir,
532 2015). Our focus groups were conducted before these accidents occurred and thus could
533 not capture this effect on a-priori trust.

534

4. Conclusion

535 This study demonstrates that qualitative methods enable a critical reflection to approach
536 the question of a-priori trust in ABs and produce promising results that support and
537 extend theories on trust (development). Our results suggest that potential users can build
538 trust towards a previously unknown concept through different trajectories. Here, previous
539 experiences, fundamental tendencies to be curious or cautious towards new
540 technologies, or the degree of understanding the black box influence the level of a-priori
541 trust between potential users. Providing similarities with existing technologies helps to
542 grasp the concept of ABs. Many of those mechanisms were supported by theories of
543 trust in automation, but none of the models includes all factors. Thus, we see a need in
544 revisions of trust theories to include, e.g., affective components of trust. On the one hand,
545 trust seems to be a combination of control beliefs, information, and cognitive
546 assessments; on the other hand, it apparently includes affective components as well as
547 dispositions to approach or avoid new technologies.

548

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