

Digital Appendix to:

MAY I SPEAK TO THE DRIVER? EXPLORING DESIGN PRINCIPLES FOR A VIRTUAL IN-VEHICLE ASSISTANCE SYSTEM APPLIED IN ROAD-BASED AUTONOMOUS PUBLIC TRANSPORT

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File Description

This file contains the digital appendix to the study, entitled "May I Speak to the Driver? Exploring Design Principles for a Virtual In-Vehicle Assistance System Applied in Road-Based Autonomous Public Transport."

Keywords: Public Transport, Autonomous Mobility, In-vehicle Assistance, Design Principles.

Appendix

Project	Location	Timeframe	Details	Source
Volkswagen ID.Buzz AD & MOIA	Hamburg, Germany	Since 2023	Autonomous minibuses for urban ride-pooling service.	Lauterbach, J. (2024, November 28). „Dieses Fahrzeug ist der Gamechanger“. Welt. https://www.welt.de/regionales/hamburg/article254570816/Autonomes-Fahren-Dieses-Fahrzeug-ist-der-Gamechanger.html
KelRide	Kelheim, Germany	Since 2022	Autonomous minibuses service in a rural setting.	Landkreis Kelheim (2023). KelRide - Weather-Proof Smart Shuttle. https://kelride.com/
Autonomous Bus (Deutsche Bahn & EasyMile)	Bad Birnbach, Germany	2017–2024	Autonomous minibuses integrated into public transport.	ioki GmbH (2022, August 5). Autonomous shuttles in Bad Birnbach – or why you find the future of public transport in rural areas. https://ioki.com/en/autonomous-shuttles-in-bad-birnbach-future-of-public-transport/
Swiss Transit Lab	Schaffhausen, Switzerland	2018–2019	Autonomous minibuses integrated into public transport.	Swiss Transit Lab (2025). Die Linie 12 des Swiss Transit Lab. https://www.swisstransitlab.ch/de/projekte/linie-12/
Navya & Keolis Shuttle Service	Châteauroux, France	Since 2020	Autonomous minibuses on predefined routes.	Navya (2020, October 19). Keolis and Navya take a new step in autonomous mobility with the entry into service of their first shuttle without an onboard safety operator, in Châteauroux, France. https://www.navya.tech/en/keolis-and-navya-take-a-new-step-in-autonomous-mobility-with-the-entry-into-service-of-their-first-shuttle-without-an-onboard-safety-operator-in-chateauroux-france/
Waymo & Cruise Robotaxis	San Francisco, USA	Since 2021	Autonomous taxis with no safety drivers.	Waymo LLC (2025). Redefine how you move around San Francisco. https://waymo.com/waymo-one-san-francisco/
Autonomous Shuttles (Navya & JTA)	Jacksonville, Florida, USA	Since 2018	Testing autonomous shuttles for public transport.	Jacksonville Transportation Authority (2025). Ultimate Urban Circulator. https://u2c.jtafla.com/
Autonomous Bus Pilot (ST Engineering & LTA)	Singapore	Since 2019	Public road trials of autonomous buses.	Government of Singapore (2025, January 27). Request for Proposals for the Pilot Deployment of Autonomous Buses for Public Bus Services. https://www.lta.gov.sg/content/ltgov/en/newsroom/2025/1/news-releases/request_for_proposals_for_the_pilot_deployment.html
Baidu Apollo Autonomous Vehicles	e.g., Guangzhou, China	Since 2021	Autonomous buses and shuttles services in smart city projects.	Silver. D. (2021, February 12). Baidu Launches Self-Driving Cars, Shuttles, Buses, Vending And Even Police Robots. Forbes. https://www.forbes.com/sites/davidsilver/2021/02/12/baidu-launches-self-driving-cars-shuttles-buses-vending-and-even-police-robots/

Table A.1: Exemplary real-world applications of autonomous public transport.

Workshop Insights					
Information	What information do users need in an emergency?	What information do users need at the end of the journey?	How should the information be?	What information do users need before travelling?	What information do users need during the journey?
	<div>Special exit (problem solution)</div> <div>Emergency assistance (fall detection, conflict detection, etc.)</div>	<div>Hints: Don't forget your umbrella</div> <div>Weather information</div> <div>City map</div> <div>Destination guidance after exit</div> <div>Local tips: nearest pub, nearest supermarket</div>	<div>Trustworthy</div> <div>Intensität / Menge</div> <div>Consistent</div> <div>Multilingual</div>	<div>Onboarding: 'Are you [name]?'</div> <div>'Please secure your bike as follows'</div> <div>'Please fasten your seatbelt'</div>	<div>Travel information</div> <div>Route information</div> <div>Location (Where am I?)/ GPS</div> <div>Journey time (traffic jam, delay)</div> <div>What time will I be there?</div> <div>Passengers (detours, how many passengers)</div> <div>Connection information/ Changeover time</div> <div>Disruption info: why, when will it continue</div>
Communication / Interface	What should the contact form be?	What should the form of communication be?	What level of individualised support do the users need?	How should communication be presented?	
	<div>Communication triggers ('Hey Google', button, 'Hello Siri')</div> <div>Make the contact room recognisable (push button/ screen)</div> <div>Contact (several options)</div> <div>Connection for headphones</div> <div>Accessible interface</div> <div>Avatar necessary for communication?</div>	<div>Multilingual</div> <div>Facial expressions, gestures, non-verbal communication</div> <div>General loudspeaker for announcements (defensive)</div> <div>Customised user support</div>	<div>Personalised user support</div> <div>Selectable supervision intensities</div> <div>Subscription model (extra service)</div>	<div>Text-based passenger information</div> <div>Main display</div> <div>App (smartphone)</div> <div>Individual display</div> <div>Bus stop - display with departure times</div> <div>Customised avatar and subtitles</div>	
Safety / Well-being	How are problems detected in the vehicle?	How do the VIVA react to problems in the vehicle?	What requirements must the system fulfil during interaction?	How can barrier-free communication with the vehicle be achieved?	What environmental factors can be influenced by the autonomous driver that could lead to greater passenger well-being?
	<div>Diagnostics</div> <div>Perception of interpersonal tensions</div> <div>Monitoring vs. data protection</div> <div>Clarify the threat situation</div>	<div>Emergency assistance interface</div> <div>Emergency reaction</div> <div>Emergency assistance</div> <div>Automatic emergency call</div> <div>Fastening and securing the seat belt</div>	<div>Recognise special needs</div> <div>Personalised support from AI</div> <div>Gaining trust vs. loss of control</div>	<div>Simulating empathy</div> <div>Dialogue with the avatar</div> <div>Recognition of the language</div> <div>Clear feedback</div> <div>Possibility of communication from outside the vehicle</div> <div>Use of hearing aids</div>	<div>Customised room climate</div> <div>Voice Cancelling</div> <div>Climate control</div> <div>Olfactory: room fragrance</div>

Figure A.1. Workshop insights.

Literature Reviewed	
[Number]	Short reference
1	Hollebeek et al. 2024
2	Boffi 2020
3	Lawson-Guidigbe et al. 2020
5	Lang et al. 2024
6	Riedl 2022
7	Clark et al. 2024
9	Kaufman et al. 2024
11	Burggraf et al. 2022
12	Li et al. (2019)
13	Lugano 2017
14	Tenhundfeld et al. 2022
15	Liu et al. 2024
17	Gao et al. 2023
18	Macrae 2022
21	Large, Harrington, et al. 2019
22	Knutzen et al. 2019
23	Wang et al. 2021
24	Detjen et al. 2020
26	Flohr et al. 2021
27	Wang et al. 2022
28	Detjen & Schneegass 2022
29	Cunningham 2023
30	Wallner et al. 2022
31	Premstaller et al. 2023
34	Kaplan et al. 2023
37	Yue und Li 2023
38	Lawson-Guidigbe et al. 2023
41	Kong et al. 2021
43	Kuberkar & Singhal 2020
46	Bawack & Desveaud 2022
51	Renner et al. 2021
55	Heinbach et al. 2021
58	Seeger et al. 2018
59	Voinescu et al. 2018
60	Uzan et al. 2023
63	Williams & Breazeal 2013
64	Koo et al. 2015
65	Large et al. 2017
66	Waytz et al. 2014
68	Du et al. 2019
70	Antrobus et al. 2019
73	Forster et al. 2017

75	Ekman et al. 2018
77	Cramer et al. 2008
78	Eyssel et al. 2012
79	Hock et al. 2016
80	Kraus et al. 2016
81	Tanaka et al. 2017
82	Frison et al. 2019
85	Large, Clark, et al. 2019
86	Large, Burnett, et al. 2019
88	Verberne et al. 2015
89	Dong et al. 2020
90	Ruijten et al. 2018
91	Antrobus et al. 2018

Table A.2. *Literature Reviewed including consecutive numbers.*

TAP no.	Area of expertise	Professional title	Experience	Evaluated subject
1	Automotive, software engineering company	Site manager	18 Years	MRs (Contentual)
2	Design science research, university	Associate professor	10 Years	DPs (Method)
3	Design science research, university	Research associate	7 years	DPs (Method)
4	Mobility, data analytics company	Senior developer	13 Years	DPs (Contentual)
5	Mobility, public transport authority	Project engineer	7 Years	DPs (Contentual)
6	Mobility research, non-profit company	Project manager	11 Years	DPs (Contentual)

Table A.3. *Details of the experts involved in the think aloud sessions.*

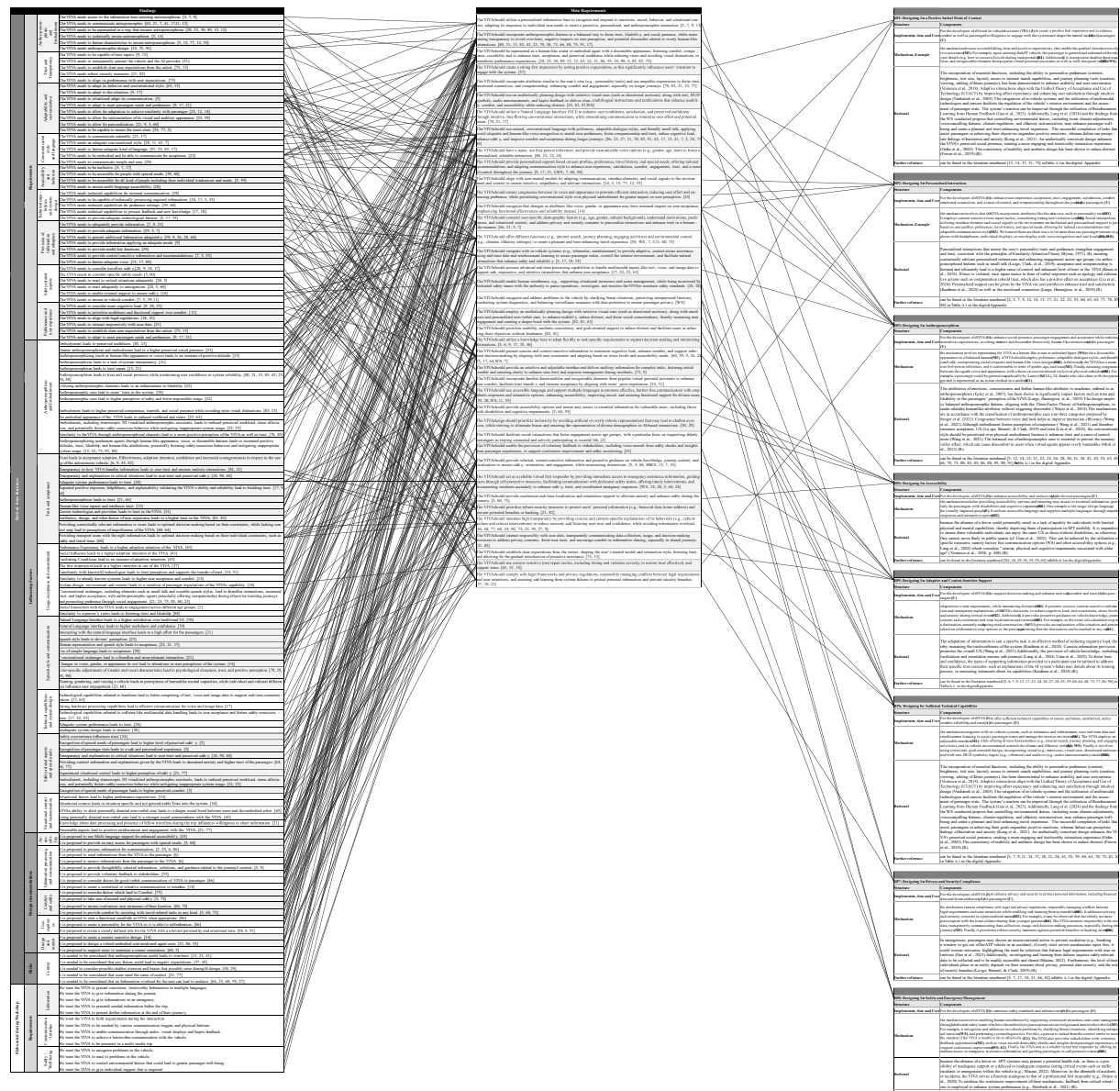


Figure A.2. Visualisation of the derivation process.

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