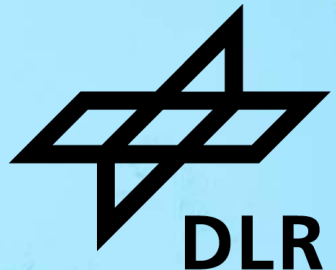


EXPLORING THE ACCESSIBILITY AND ACCEPTABILITY OF SHARED AUTONOMOUS TRANSPORT FOR VULNERABLE USERS

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Shared autonomous vehicles (SAVs)

- While technological development of shared autonomous vehicles (SAVs) is advancing rapidly, many questions are unanswered, among them questions addressing accessibility and inclusivity
- However, we know that *early user focus spares trouble*

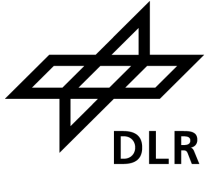


U-Shift vehicle, source: DLR (CC BY-NC-ND 3.0)

Shared autonomous vehicles (SAVs)

- Full automation (SAE level 5)
- Prospectively without on-board steward
- On-demand service

The role of the human operator for vulnerable users



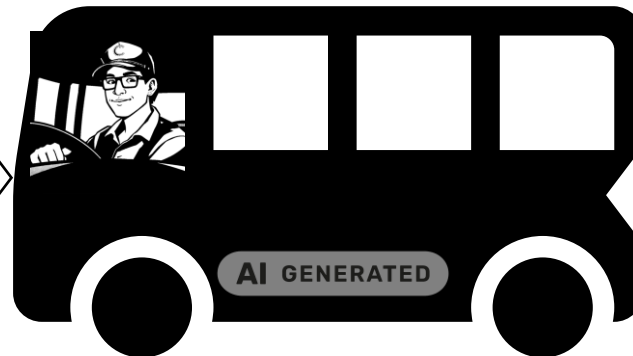
- A key difference between SAVs and nowadays public transport busses for people with mobility impairments is the absence of personnel onboard as these populations groups need more information and assistance (Miller, Chng & Cheah, 2022)
- Human operators of public busses assume multiple roles and tasks besides driving, such as:
 - communicating with and regulating other traffic participants
 - socio-emotional safety
 - information provision
 - monitoring function
 - assistance for boarding and disembarking
 - ...

(Bennett, Vijaygopal & Kottasz, 2019; Cordts et al., 2021; Kim, Anjani & van Lierop, 2024
Riggs & Pande, 2022)

Vulnerable users' ambivalent relationship with bus drivers

“Being treated like an actual person” (Das Neue et al., 2023)

Negative encounters due to demonstrations of ableist attitudes, discriminatory behaviour, lacking communication skills etc.

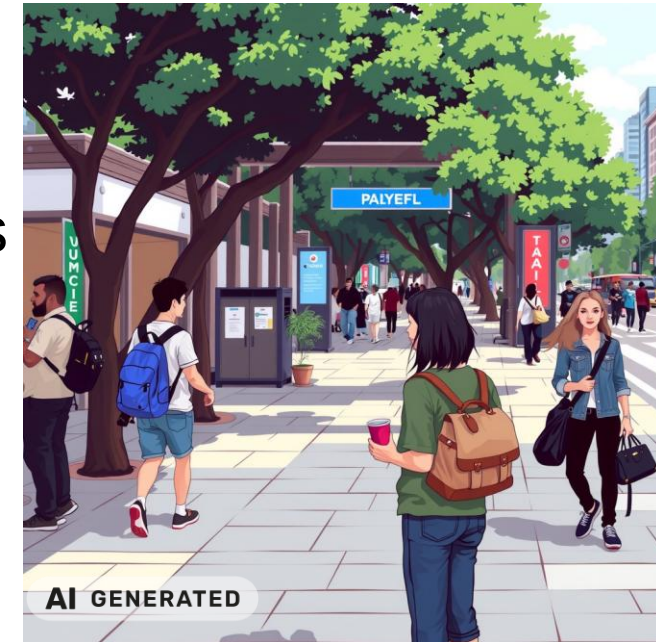


Dependency on bus drivers

Rely on assistance when boarding and disembarking, getting information etc. (Park & Chowdhury, 2018)

Encounters and need for interaction

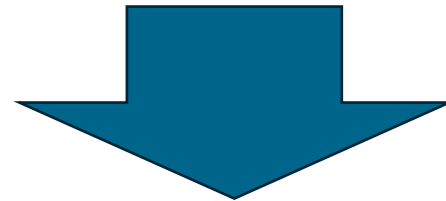
- Theory of *encounters* as social interactions between strangers with a common purpose in public places (Fincher & Iveson, 2007)
- Vulnerable users such as people with mobility impairments might have a higher need for personal contact with a human operator in SAVs
- Need for interaction (NFI) is defined as the importance of human interaction to the customer in service encounters (Dabholkar et al., 2002)
- Rational: The absence of onboard personnel might affect the acceptability of persons with mobility impairments with regard to SAVs more strongly



Research questions

1. How do people with mobility impairments assess SAVs with regard to the entire user journey in terms of their accessibility and acceptability?

2. How does the presence or absence of onboard personnel affect the accessibility and acceptability regarding SAVs of people with mobility impairments?



Suggestions for improving accessibility and acceptability of SAVs

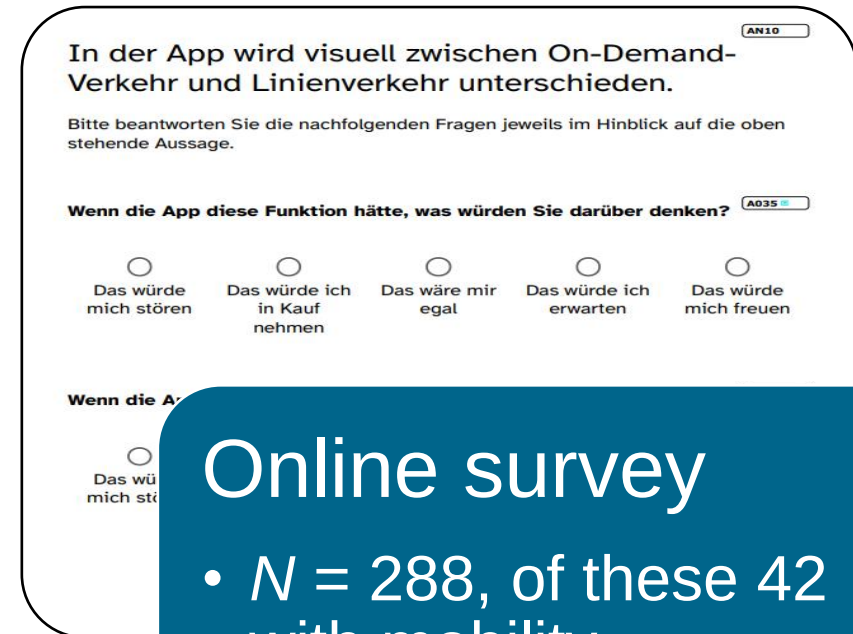
Methodology

Mixed-methods approach



Five focus groups

- In total 33 wheelchair users, senior citizens, care-givers, visually impaired persons and parents of young children



Online survey

- $N = 288$, of these 42 with mobility impairments (14,6%)
- Two scenarios: with and without onboard personnel

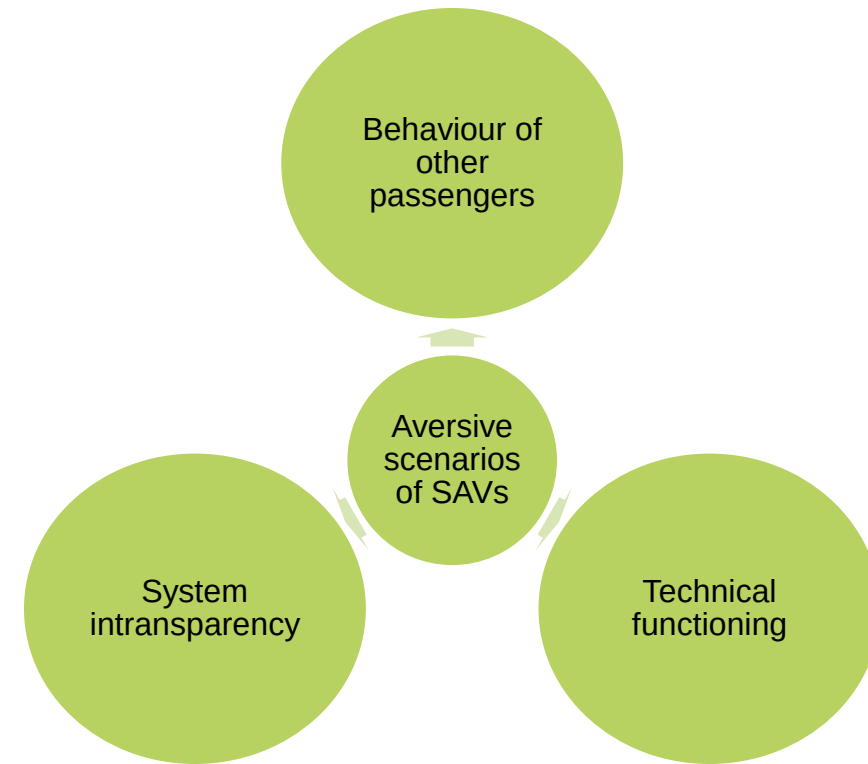
RESULTS OF FOCUS GROUPS

Results

Concerns and requirements based on focus groups

Concerns related to:

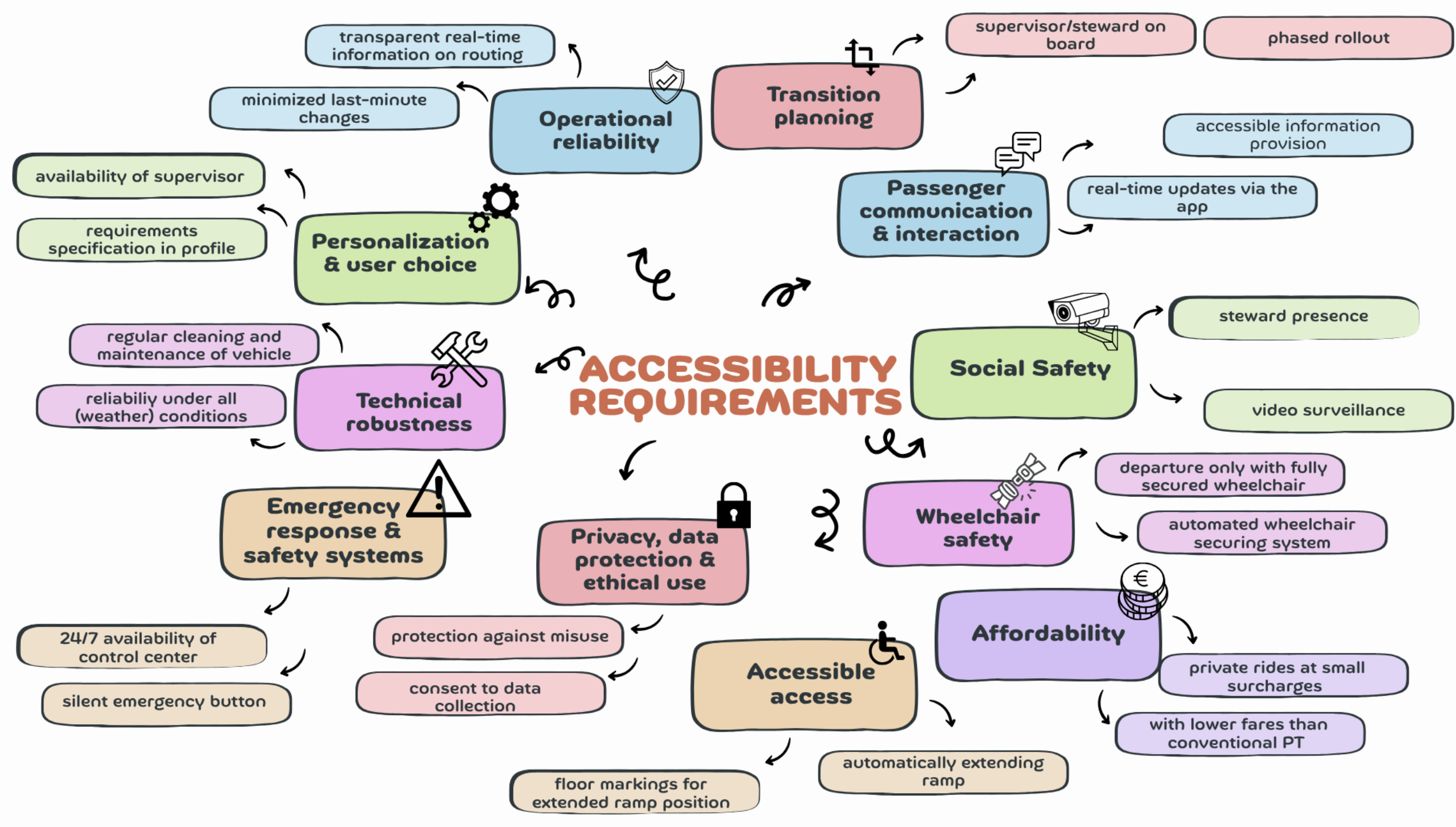
1. Lack of human supervisor: *“Consider what happens in the event of emergencies - it would be important for someone to step in.”* and *“But if you expect that kids will come up with really stupid ideas sooner or later and no supervisor is present, that worries me.”*
2. Safety of technology: *“When I'm driving and the rearview camera is dirty, I can't see anything. If the bus can't see you, it will run you over”*
3. Reliability due to flexibility of service: *“I could imagine it to work for fixed routes but not for on-demand services because there aren't as many contingencies and no driver available to communicate real-time information on route changes”*



Dreßler et al., 2019, p. 3

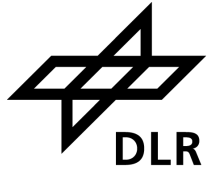
Requirements:

- 65 user requirements were extracted and clustered regarding to their content to 11 categories



RESULTS OF SURVEY

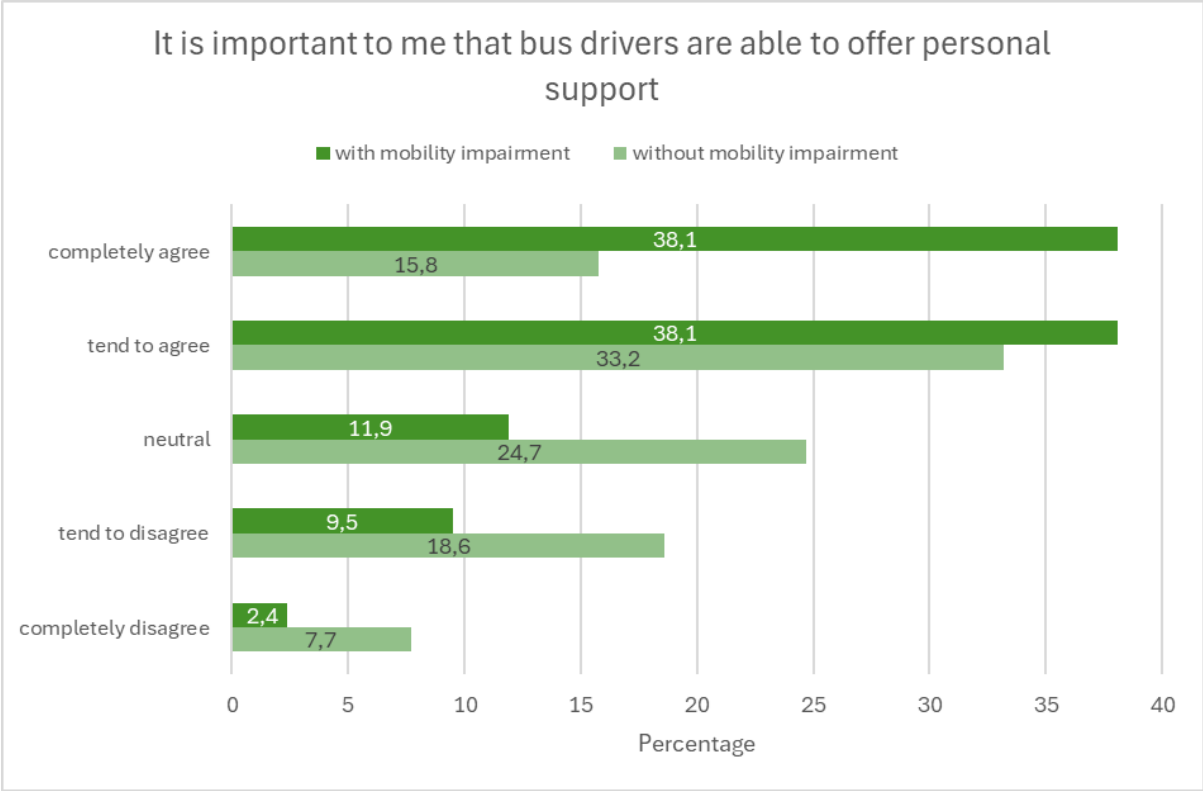
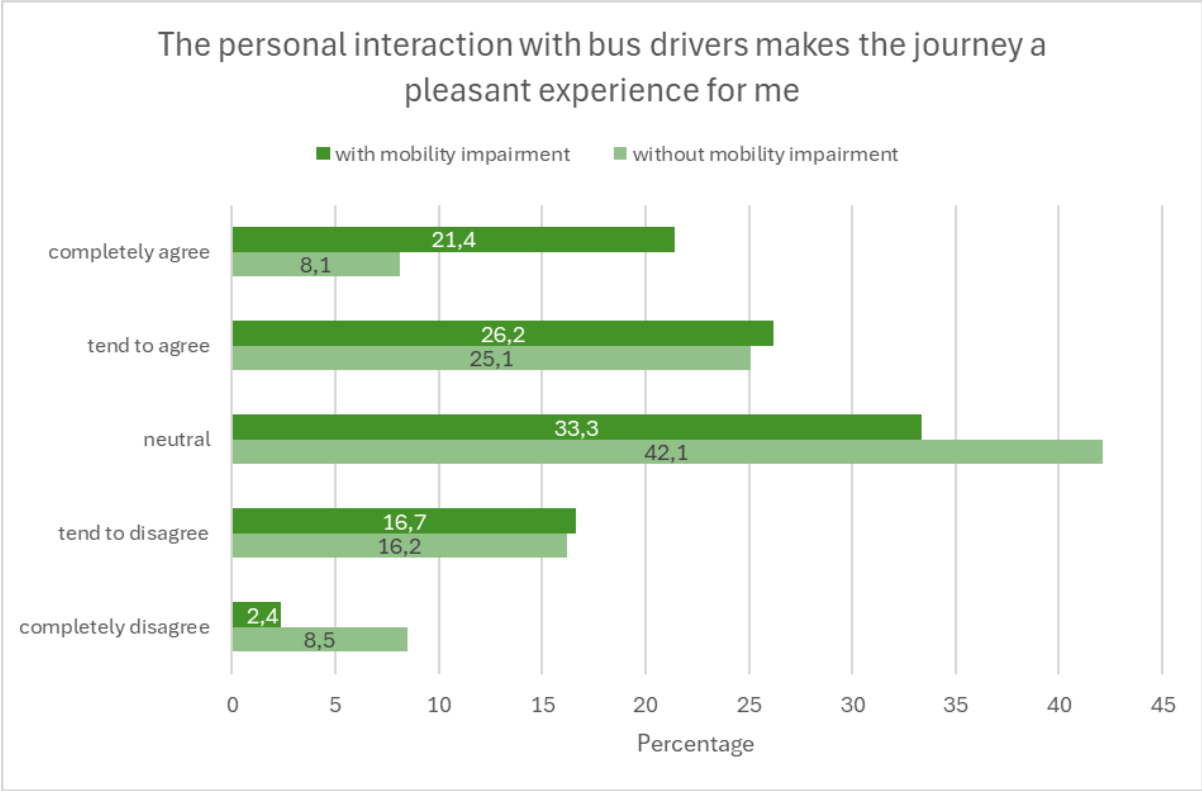
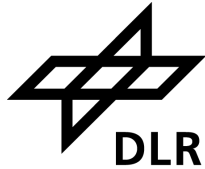
Sample



	Without mobility impairments (n = 246)	With mobility impairments (n = 42)
Mean age	39,7 years	55,0 years
Gender		
Female	98 (40,2%)	24 (58,5%)
Male	138 (56,6%)	14 (34,1%)
diverse	5 (2,0%)	2 (4,9%)
Public transport use		
daily	82 (33,6%)	14 (34,1%)
1-3 times/week	70 (28,7%)	14 (34,1%)
1-3 times/month	47 (19,3%)	6 (14,6%)
Less than monthly	43 (17,6%)	6 (14,6%)
never	2 (0,8%)	1 (2,4%)

Results

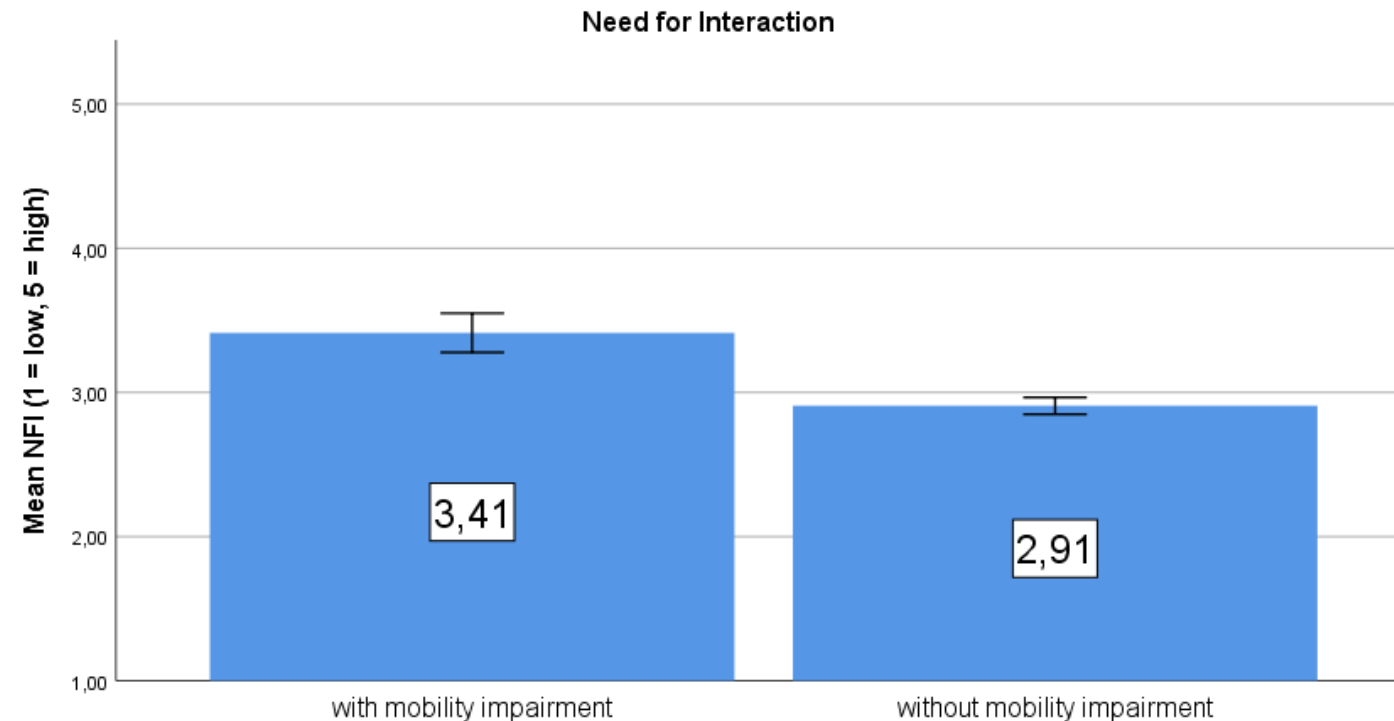
Need for interaction



Results

Need for interaction

- Persons with impairments reported a higher need for interaction (NFI) than persons without mobility impairments ($F(1) = 10,935, p = .001$)

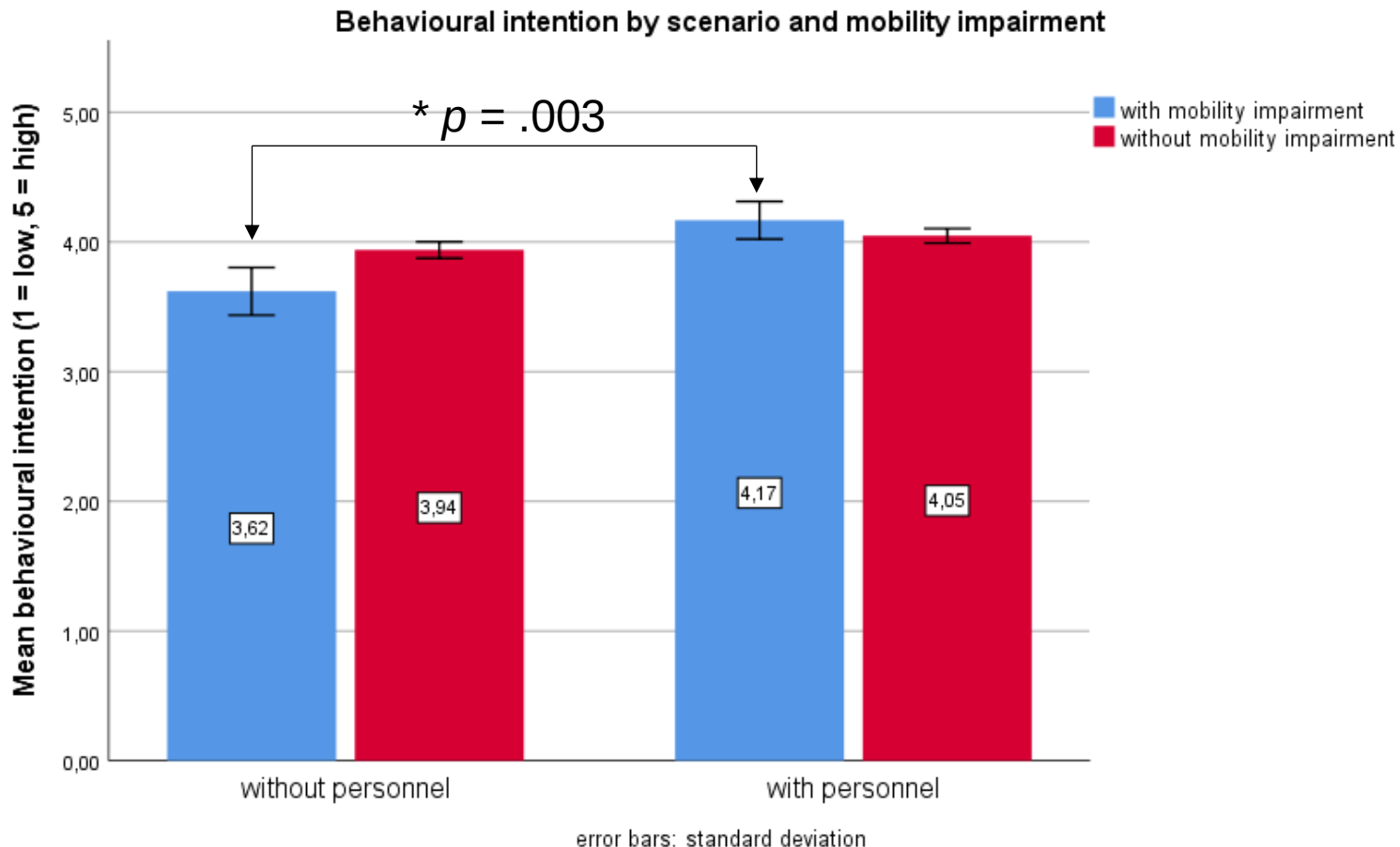


error bars = standard error

Results

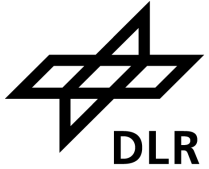
Intention to use SAVs depending on personnel presence

The interaction between impairment status and availability of onboard personnel was significant ($F(1,287) = 9,032$, $p = .003$, partial $\eta^2 = .031$) → persons with mobility impairments showed a lower use intention for SAVs without personnel



IMPLICATIONS

Implications and recommendations for practice



Stepwise approach

- Gradual transition is crucial, especially for vulnerable groups
- As technology matures and public trust increases, the presence of human personnel may be gradually reduced
- Facilitation of familiarization of users with the technology

Accessibility-per-default

- Automatic ramp should extend every time the door opens
- Two-channel principles as standard

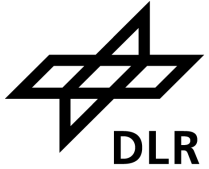
Private ride option

- A private ride option requesting a supplementary payment should be offered to avoid the onboarding of other passengers

Naturalistic wayfinding

- Navigation and wayfinding based on intuitive and naturalistic descriptions based on fotos, especially for young children or tourists

Implications and recommendations for practice



Stepwise approach

- Gradual transition is crucial, especially for vulnerable groups
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Accessibility-per-default

- Automatic ramp should extend every time the door opens
- Two-channel principles

→ Most of the suggestions for improvements would also benefit people without impairments

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Naturalistic wayfinding

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User state monitoring

- How can we assess and predict human perception, appraisal and behaviour and provide tailored support?
 - Sensor data analysis based on cameras or physiological sensors to learn about user states such as discomfort

Design approaches for substituting the operator

- How can the psychological functions fulfilled by driving personnel, such as reassurance, immediate support, and social presence, be effectively replaced?
 - smart companion (AI-based mobility buddy)
 - hologram
 - remote operation

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Topic: Exploring the Accessibility and Acceptability of Shared
Autonomous Transport for Vulnerable Users

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