Karlsruhe Institute of Technology

Institute for Technology Assessment and Systems Analysis

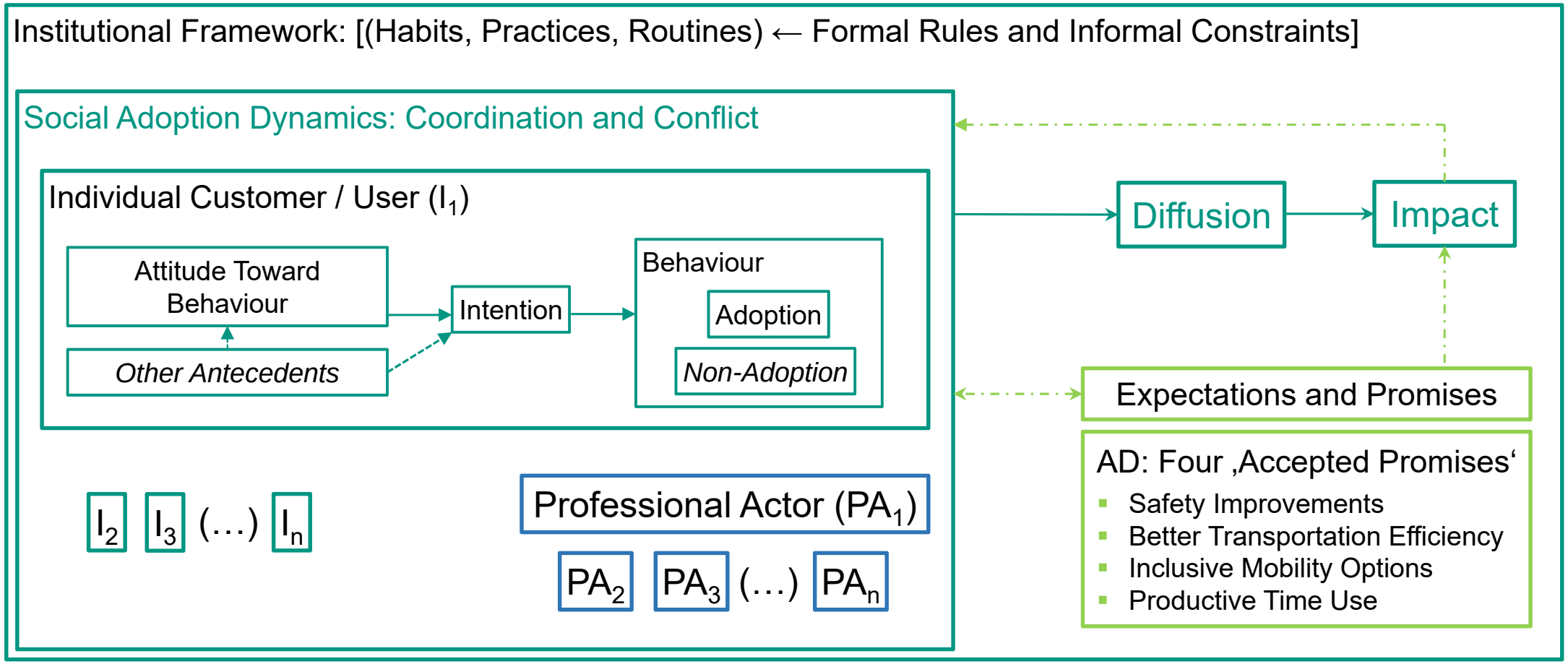
Warum ‚sicher sein' nicht genügt

Einsichten aus der empirischen Forschung zur sozialen Akzeptanz zu AF

Torsten Fleischer

TU Braunschweig
02.03.2022

A highly simplified model to understand S.A.



Why ‘Social Acceptance’ of CAD? (2)

- Public policy perspective: achieve related policy goals and avoid (potential, anticipated, …) societal conflicts
- Business perspective: achieve economic goals (new products and services, profits, avoid sunk cost, SLO/CSR,…)
- Ethics perspective: SA a metaphor for dealing with moral issues, value conflicts and acceptability
- Research perspective: Understanding all of the above (and more) and providing knowledge for orientation and action: structures and dynamics of sociotechnical change, conceptual and numerical models, empirical access,…

Insights from Qualitative Studies

- Lack of individual and collective experience with both new artefacts and new services based on them → statements based on imaginations rather than practice
- Temporality? Short-term, long-term, permanent?
- Four different (but not disjoint) argumentative frames
  - Technology-related factors: safety/risk perceptions, trust, usability, privacy,…
  - Situational behavior of mobile robots (aka AVs) in traffic: Social intrusion. Ambivalent expectations, including ‘ethical problems’ & moral intuitions
  - Mobility service-related factors: integration into everyday mobility needs and habits, constrained user flexibility, design, cost, quality
  - Diverse mobility futures – AV imaginaries as representatives of alternative visions of “good life” in societies of tomorrow

Der Weichensteller-Fall 4.0

Modifiziertes „Trolley-Problem“

Ein automatisiertes Fahrzeug gerät in eine Verkehrssituation, in dem es keine Trajektorie mehr identifizieren kann, die nicht zu einer potentiellen Schädigung von Personen führen könnte.
Das System entscheidet sich zu bremsen. Dennoch kann eine Kollision mit Personen alleine dadurch nicht abgewendet werden...

Frage 1: Sollte das System keine weitere Entscheidung treffen oder es sich **aktiv** für eine der Trajektorien mit potentieller Schadensfolge entscheiden dürfen?

38%: nicht entscheiden
58%: aktiv entscheiden
5%: keine Angabe

Frage 2: Wie sollte es im Falle einer aktiven Trajektorienwahl in bestimmten Fallkonstellationen entscheiden (dürfen)?

Fall	Variante 1	Variante 2	Zufall
A			
B			
C			
D			

Fall	Variante 1	Variante 2	Zufall
A	62%	3%	35%
B	4%	0%	96%
C	6%	36%	58%
D	7%	0%	93%

n = 125 (7 events)

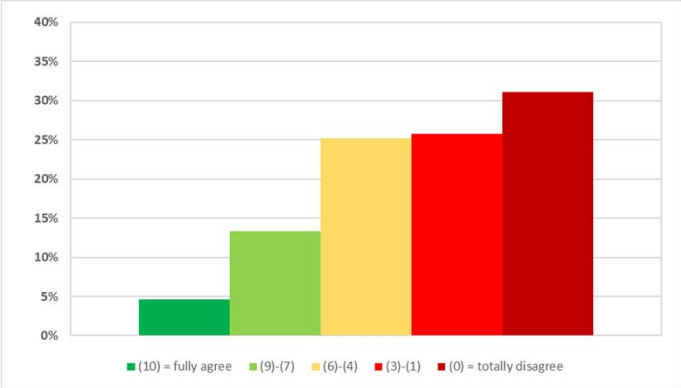
Sociotechnical imaginaries are “collectively held, institutionally stabilized, and publicly performed visions of desirable futures, animated by shared understandings of forms of social life and social order attainable through, and supportive of, advances in science and technology.” (Jasanoff 2015)

Stuttgart, Olgaeck heute (www.mapio.net)

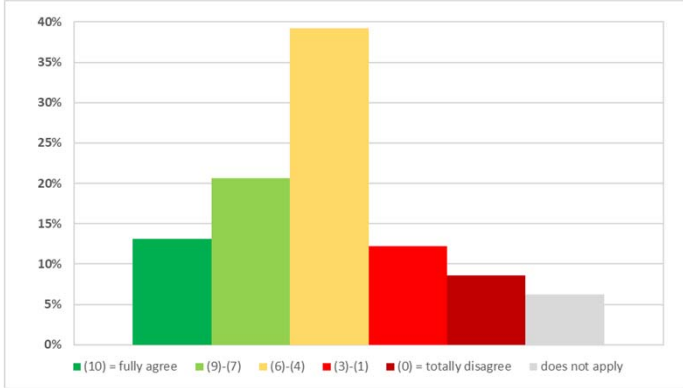
Stuttgart 2036 (Daimler AG 2017)

Technology Radar 2018 (field work Okt/Nov 2017)

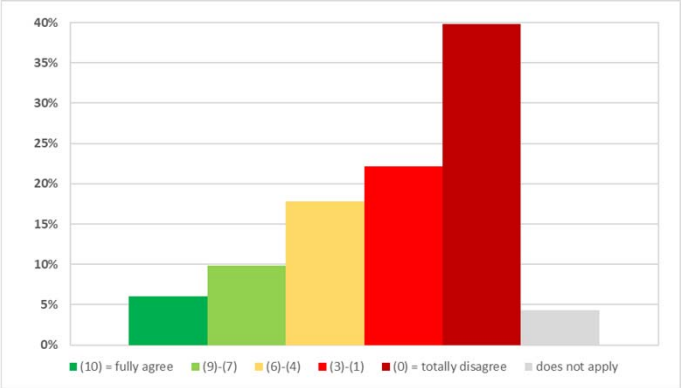
7.1.1 I have great confidence in the reliability of fully automated driving.
Ich habe großes Vertrauen in die Zuverlässigkeit des vollautomatischen Fahrens.



7.1.2 I can drive better than a computer-controlled car.
Ich kann besser fahren als ein computergesteuertes Auto.

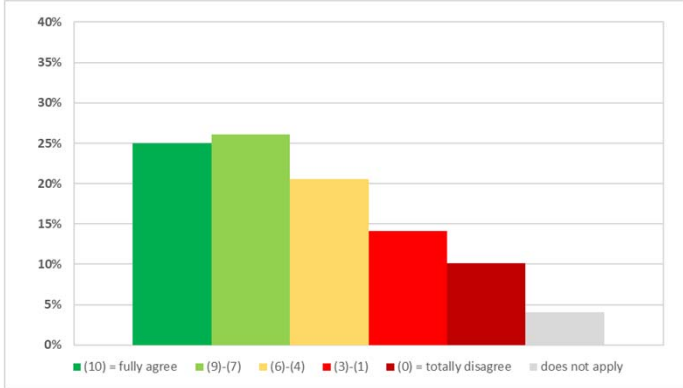


7.1.8 In principle, I am ready to completely hand over my responsibility to a fully automated car.
Ich bin grundsätzlich bereit, meine Verantwortung vollständig an ein voll automatisch fahrendes Auto abzugeben.



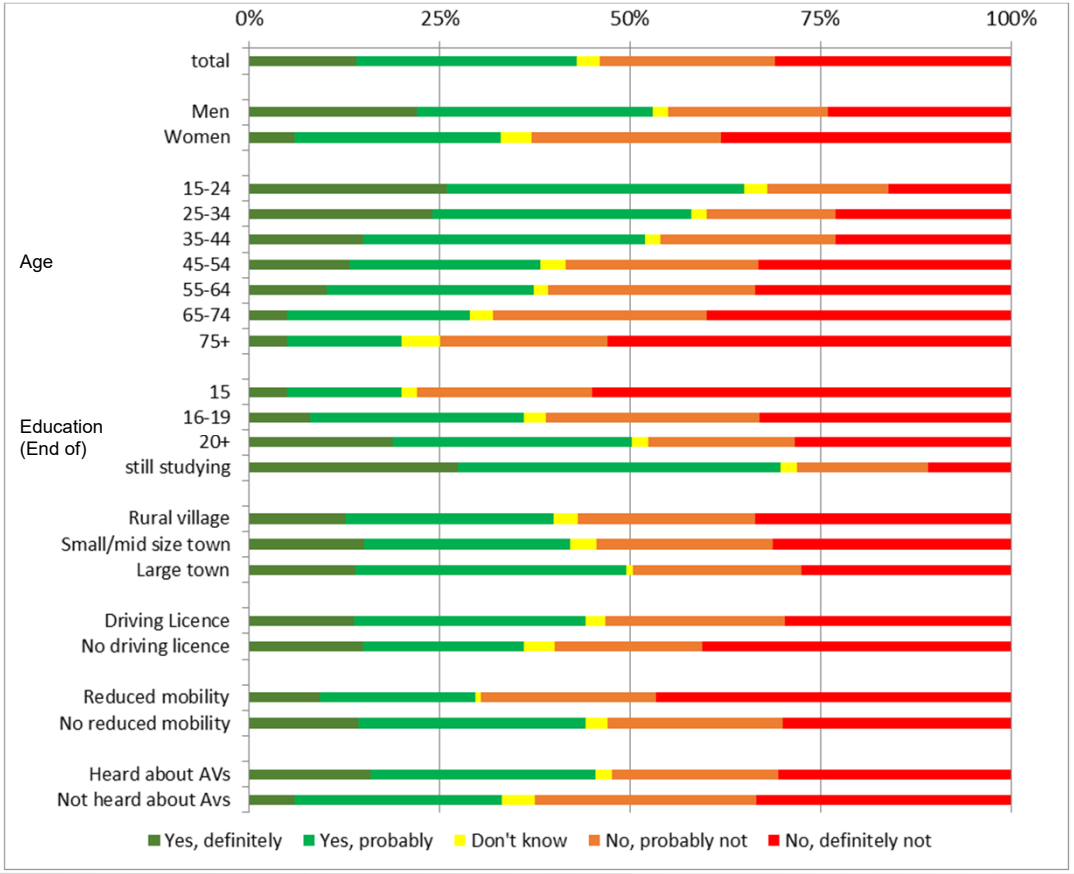
dread risk (Slovic 1987)
perceived lack of control, dread, (…), fatal consequences, inequitable distribution of risks and benefits
familiarity

7.1.7 What will bother me about fully AVs is not being able to drive the way I want to.
An voll automatischen Fahrzeugen wird mich stören, nicht so fahren zu können, wie ich es gerne will.



Attitudes towards AV: Germany (field work Sept 2019)

QB17.1: If you had the opportunity, would you be ready to use the following vehicle types? A) Fully automated



- Overall, the views are divided
  (Share of those who are skeptical did not change significantly between 2015 and 2019)
- More likely to say they would be ready to use:
  - Men compared to women
  - Younger respondents compared to older
  - Those who finished their education age 20 or older
  - Students compared to retired persons
  - Those without reduced mobility compared to respondents with reduced mobility

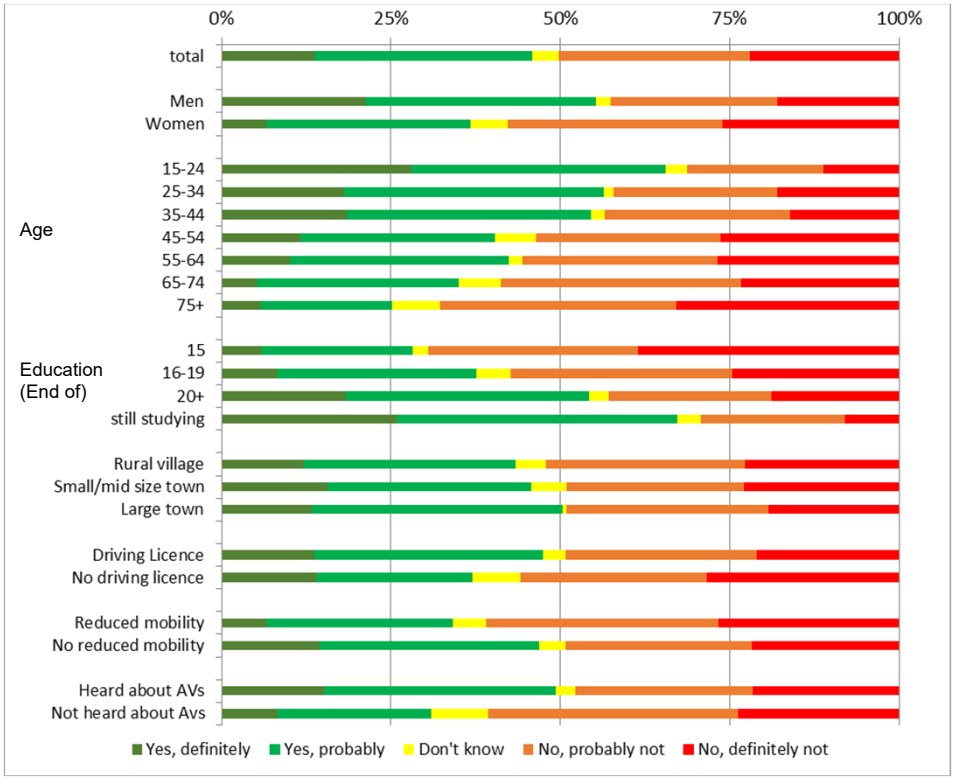
  (The first four points mirror well-known general patterns of attitudes towards new technologies)
- Rather small differences:
  - Subjective urbanization
  - Driving licence

Dataset: Eurobarometer 92.1

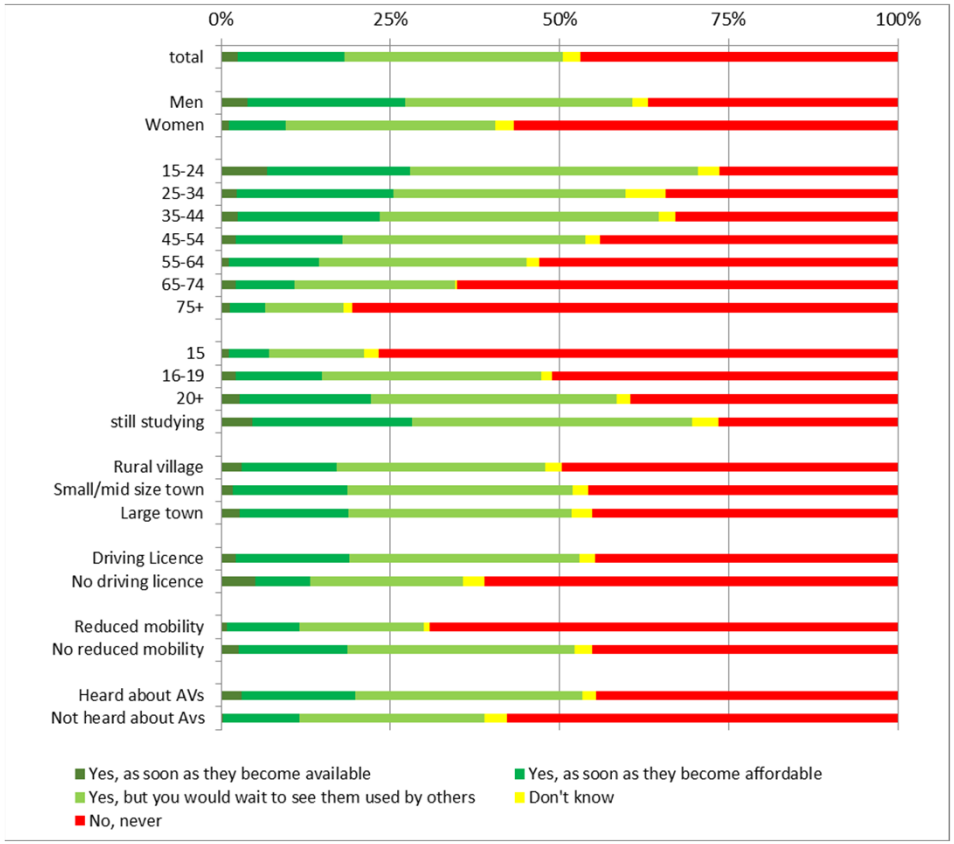
Patterns mirrored in similar questions

(Data for Germany, field work Sept 2019)

QB18.1: Please tell me to what extent are you in favour of or opposed to each of the following: The deployment of fully automated vehicles on our roads



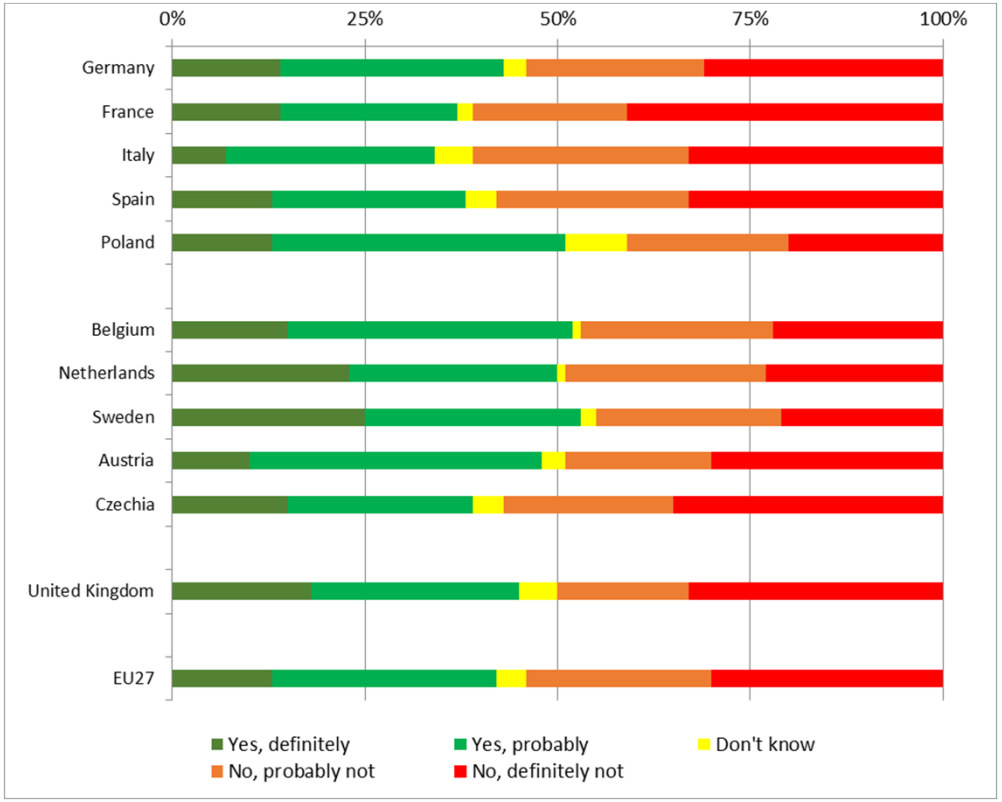
QB13: Would you ever consider purchasing an automated vehicle?



Dataset: Eurobarometer 92.1

Specific to Germany? Rather not. (field work Sept 2019)

QB17.1: If you had the opportunity, would you be ready to use the following vehicle types? A) Fully automated



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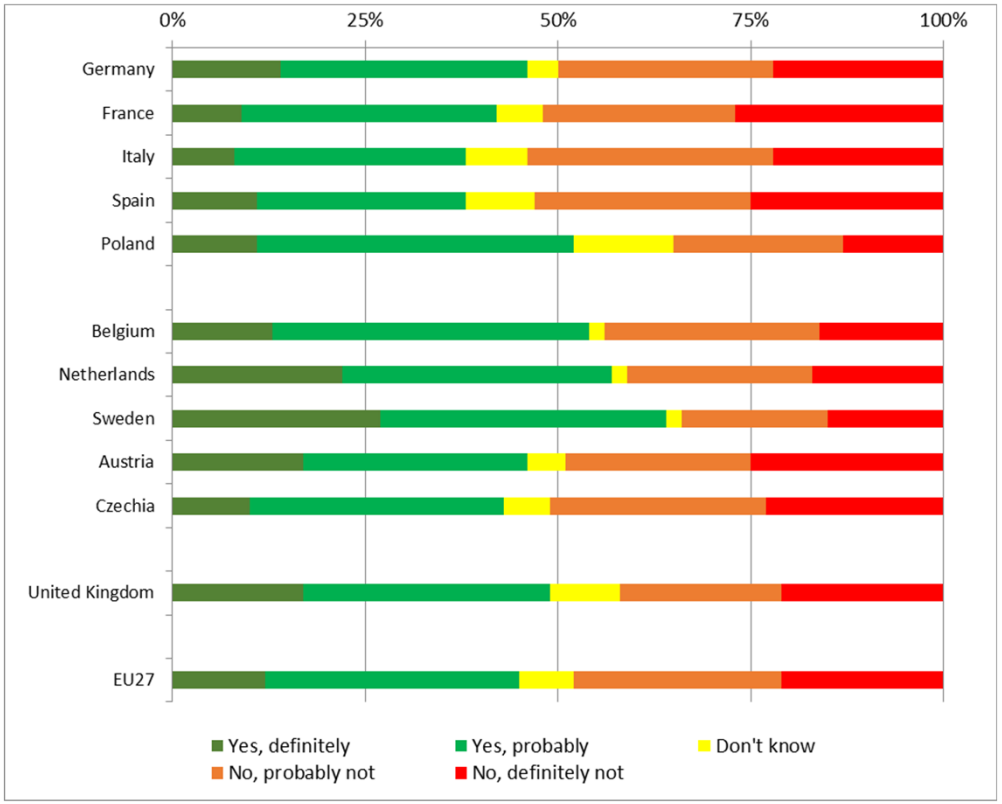

Dataset: Eurobarometer 92.1

Sample Characteristics

- German-speaking population aged 16 and over
- n = 2001
- Fieldwork: November 2021
- mixed-mode design: 1,001 CATI in dual-frame approach (50% mobile) & 1,000 CAWI
- Different topic areas:
  - own experiences with autonomous vehicles,
  - individual expectations on the longer-term effects of the use of AV,
  - perceptions of different AD use cases,
  - attitudes towards future framework conditions and regulations re wider use/deployment of AD/AV,
  - perceived potential of AV to fulfil individual mobility needs,
  - everyday mobility patterns and socio-demographics

female 51%
male 49%

age groups
16-25: 13%
26-35: 13%
36-45: 15%
46-55: 18%
56-65: 17%
66-75: 16%
76+ : 7%

education
15-: 17%
16-17: 49%
18-19: 17%
20+: 17%

employment
full time: 40%
part-time: 13%
self-empl.: 4%
studying: 9%
retired: 27%
other: 9%

subjective urbanization
city center: 25%
outskirts: 31%
suburban: 15%
rural: 29%

car in household
yes: 84%
no: 16%

subjective wealth
afford a lot: 10%
afford some: 29%
get along: 45%
limit a bit: 9%
limit a lot: 7%

main mode of tr.
car: 59%
urban PT: 11%
bike: 14%
walking: 12%
other: 4%

heard of AD: 84%
driven in AV: 8%
'not comfortable' in all AV use cases: 8%

Q4 Expectations

Q4: Stellen Sie sich bitte einmal vor, es gäbe in Zukunft autonome Straßenfahrzeuge, die in der Lage wären, am öffentlichen Straßenverkehr genauso selbständig teilzunehmen wie es heute Fahrzeuge mit menschlichen Fahrern tun. Was würden Sie von einer solchen Entwicklung längerfristig erwarten?

4.1 The number of traffic accidents will decrease. *(Die Zahl von Verkehrsunfällen nimmt ab.)*

4.2 The severity of traffic accidents (the number of people killed and seriously injured in them) will decrease. *(Die Schwere von Verkehrsunfällen (die Zahl der dabei getöteten und schwer verletzten Personen) nimmt ab.)*

4.3 Road traffic will run more smoothly overall, and there will be fewer traffic jams. *(Der Straßenverkehr läuft insgesamt flüssiger, es gibt weniger Staus.)*

4.4 There will be fewer parked cars than today. *(Es gibt weniger parkende Autos als heute.)*

4.5 Children will travel more distances independently, i.e. without being accompanied by their parents or other adults. *(Kinder werden mehr Wege selbständig, d.h. ohne Begleitung durch ihre Eltern oder andere Erwachsene, zurücklegen.)*

4.6 Elderly people and people with limited mobility will make more trips independently. *(Ältere Menschen und mobilitätseingeschränkte Personen werden mehr Wege selbständig zurücklegen.)*

4.7 Public transport services will improve, especially in less densely populated areas (such as on the outskirts of cities, in small towns and in rural areas). *(Das Angebot des öffentlichen Verkehrs verbessert sich, vor allem in weniger dicht besiedelten Gebieten (etwa am Stadtrand, in Kleinstädten und auf dem Land).)*

4.8 Mobility services will become cheaper for customers overall. *(Mobilitätsdienstleistungen werden für die Kunden insgesamt billiger werden.)*

4.9 There will be more traffic on the roads. *(Es wird mehr Verkehr auf der Straße geben.)*

4.10 The competitiveness of the German economy will be strengthened as a result. *(Die Wettbewerbsfähigkeit der deutschen Wirtschaft wird dadurch gestärkt.)*

4.11 Climate gas emissions from transport will be reduced. *(Dadurch kann der Klimagasausstoß des Verkehrs reduziert werden.)*

4.12 I will use the time I spend on the road for productive purposes (such as working, doing homework, or attending meetings). *(Ich werde die Zeit, in der ich unterwegs bin, für produktive Zwecke nutzen (etwa Arbeiten, Hausaufgaben machen oder Gesprächstermine erledigen.))*

4.13 Mobility services will become cheaper for me overall. *(Mobilitätsdienstleistungen werden für mich insgesamt billiger werden.)*

Q4 Expectations

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- 4.1 Number of accidents decreases
- 4.2 Severity of accidents decreases
- 4.3 Road traffic more smoothly, fewer traffic jams
- 4.4 Fewer parked cars
- 4.5 Children travel more independently
- 4.6 Elderly people and impaired travel more independently
- 4.7 Public transport services will improve in less densely populated areas
- 4.8 Mobility services cheaper for customers overall
- 4.9 More traffic on the roads
- 4.10 Competitiveness of the German economy strengthened
- 4.11 Climate gas emissions reduced
- 4.12 Time in traffic used more productively
- 4.13 Mobility services cheaper for me

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	Averages			Top 2 Box		Top 3 Box		*n/a*[a]
	ArithMean	*StdDev*	*Median*	*Top 2*	*Bottom 2*	*Top 3*	*Bottom 3*	
4.1	5,95	3,136	6	23%	12%	37%	16%	5,2%
4.2	5,99	3,084	6	23%	11%	35%	15%	6,7%
4.3	6,33	3,104	7	28%	11%	43%	14%	4,1%
4.4	6,11	3,193	7	25%	12%	41%	16%	6,1%
4.5	4,86	3,022	5	12%	16%	21%	24%	5,5%
4.6	6,58	3,029	7	30%	9%	47%	12%	3,8%
4.7	6,16	3,057	7	24%	10%	41%	14%	4,2%
4.8	5,10	3,122	5	15%	16%	26%	22%	6,4%
4.9	4,78	2,929	5	11%	13%	19%	22%	6,7%
4.10	5,50	3,002	5	16%	12%	27%	16%	9,5%
4.11	6,10	3,210	7	26%	12%	39%	16%	6,6%
4.12	5,54	3,354	6	22%	17%	34%	22%	4,1%
4.13	4,88	3,185	5	14%	19%	24%	25%	6,7%

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	F4.2	F4.3	F4.4	F4.5	F4.6	F4.7	F4.8	F4.9	F4.10	F4.11	F4.12	F4.13
F4.1	,778**	,705**	,503**	,476**	,509**	,525**	,525**		,477**	,490**	,477**	,536**
F4.2		,699**	,512**	,480**	,505**	,533**	,499**		,494**	,478**	,443**	,493**
F4.3			,581**	,470**	,558**	,568**	,549**		,512**	,516**	,519**	,538**
F4.4				,450**	,470**	,546**	,460**		,466**	,500**	,471**	,478**
F4.5					,522**	,506**	,451**	,121**	,472**	,408**	,452**	,479**
F4.6						,568**	,461**	,121**	,485**	,431**	,515**	,436**
F4.7							,525**	,079**	,530**	,500**	,490**	,521**
F4.8								,102**	,488**	,491**	,431**	,734**
F4.9									,175**		,086**	,087**
F4.10										,506**	,489**	,489**
F4.11											,407**	,486**
F4.12												,451**

** Correlation is significant at the 0.01 level (2-tailed)

Q6 Changing regulations and institutions

Q6: Um eine solche Entwicklung hin zum autonomen Fahren möglich zu machen, müssten eventuell einige Rahmenbedingungen des heutigen Verkehrs geändert werden. Angenommen, das würde die folgenden Veränderungen umfassen: Würden Sie diese eher begrüßen oder eher ablehnen?

6.1 The government should provide financial support for private individuals to purchase autonomous vehicles. *(Der Staat sollte Privatpersonen bei der Anschaffung von autonomen Fahrzeugen finanziell unterstützen.)*

6.2 The existing regulatory framework for the type approval of motor vehicles should be relaxed to make it easier to offer new mobility services with autonomous vehicles. *(Die bestehenden Regelwerke für die Zulassung von Kraftfahrzeugen für den Straßenverkehr sollten gelockert werden, damit neue Mobilitätsangebote mit autonomen Fahrzeugen einfacher möglich werden.)*

6.3 If autonomous vehicles are involved in an accident, their *manufacturers* should assume liability for damages. *(Wenn autonome Fahrzeuge in einen Unfall verwickelt werden, sollten deren Hersteller die Haftung für Schäden übernehmen.)*

6.4 If autonomous vehicles are involved in an accident, their *owners* should assume liability for damages. *(Wenn autonome Fahrzeuge in einen Unfall verwickelt werden, sollten deren Halter die Haftung für Schäden übernehmen.)*

6.5 Data protection regulations should be relaxed. *(Vorschriften zum Datenschutz sollten gelockert werden.)*

6.6 Users should also be able to intervene in autonomous driving if accidents are imminent. *(Nutzer sollten auch beim autonomen Fahren die Möglichkeit haben, bei sich abzeichnenden Unfällen eingreifen zu können.)*

6.7 Autonomous vehicles should only be allowed to drive in their own lanes, which must be structurally separated from other road traffic. *(Autonome Fahrzeuge sollten nur auf eigenen Fahrspuren, die vom übrigen Straßenverkehr baulich getrennt sein müssen, unterwegs sein dürfen.)*

6.8 It should be easy for every road user to recognize at all times whether a vehicle is driving autonomously. *(Es sollte für jede/n Verkehrsteilnehmer/in jederzeit leicht erkennbar sein, ob ein Fahrzeug autonom fährt.)*

6.9 Autonomous vehicles should be allowed to violate traffic rules if this could prevent accidents. *(Autonome Fahrzeuge sollten gegen Verkehrsregeln verstoßen dürfen, wenn dadurch Unfälle vermieden werden könnten.)*

6.10 Autonomous vehicles should be allowed to be tested in transparent field trials on public roads. *(Autonome Fahrzeuge sollten in transparenten Feldversuchen auf öffentlichen Straßen erprobt werden dürfen.)*

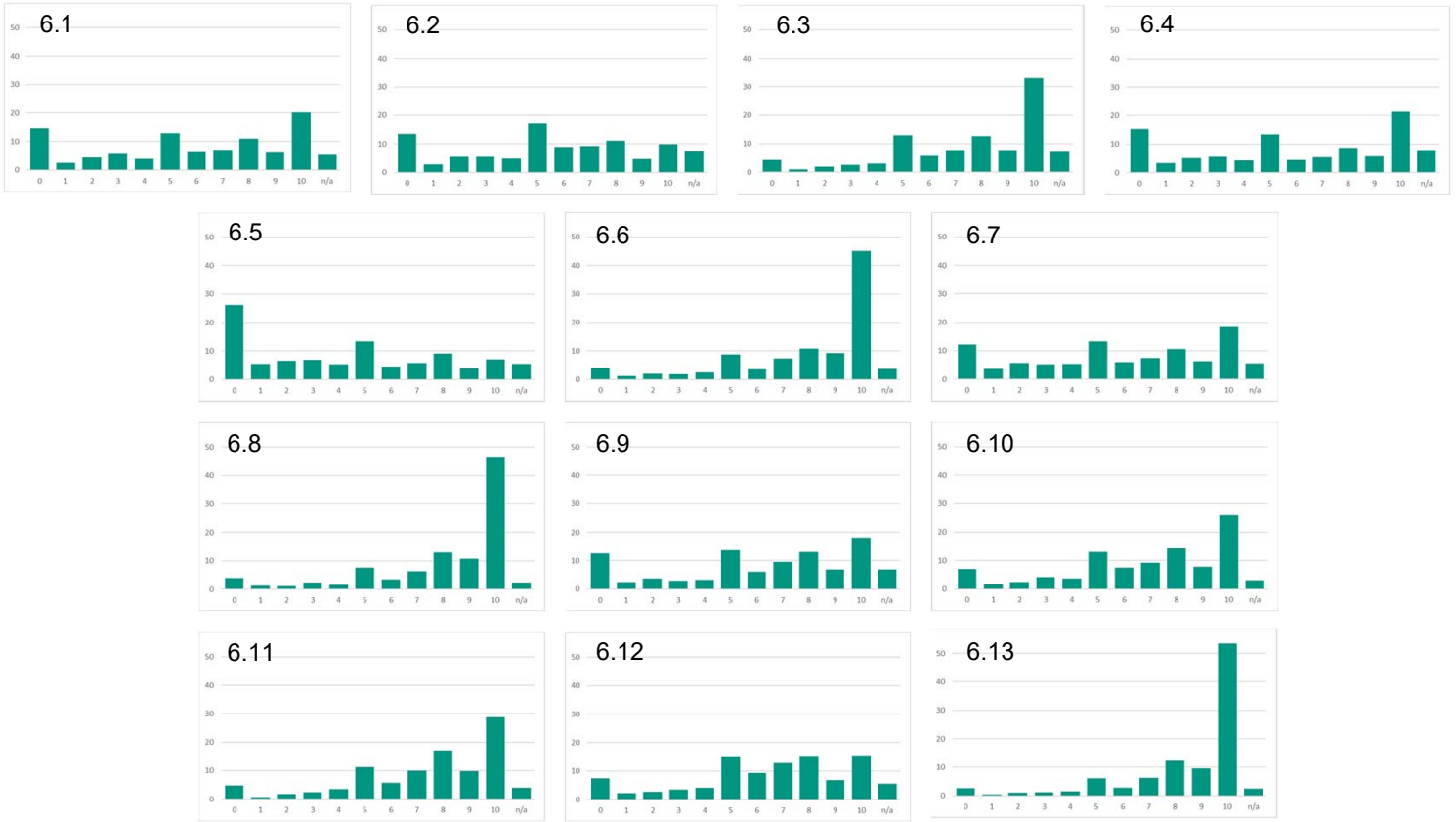
6.11 Citizens should be involved in planning and conducting field trials of autonomous vehicles. *(Bei der Planung und Durchführung von Feldversuchen mit autonomen Fahrzeugen sollten Bürgerinnen und Bürger beteiligt werden.)*

6.12 Private mobility providers should be given generous opportunities to test new services with autonomous vehicles. *(Private Mobilitätsanbieter sollten großzügige Möglichkeiten erhalten, neue Dienstleistungen mit autonomen Fahrzeugen zu erproben.)*

6.13 Autonomous vehicles should drive carefully when they perceive children or elderly people in their vicinity. *(Autonome Fahrzeuge sollten vorsichtig fahren, wenn sie Kinder oder ältere Menschen in ihrem Umfeld wahrnehmen.)*

Q6 Changing regulations and institutions

6.1 financial support for private individuals
6.2 existing regulatory framework should be relaxed
6.3 AV manufacturers should assume liability for damages.
6.4 AV owners should assume liability for damages.
6.5 Data protection regulations should be relaxed.
6.6 Users should be able to intervene if accidents are imminent.
6.7 AV only in their own lanes
6.8 every road user can recognize AVs at all times
6.9 AV can violate traffic rules if this prevents accidents.
6.10 AV to be tested in transparent field trials on public roads.
6.11 Citizens should be involved in field trials
6.12 Private mobility providers should be given generous testing opportunities
6.13 AVs should drive carefully when they perceive vulnerable road users



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Karlsruhe Institute of Technology

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	Averages			Top 2 Box		Top 3 Box		*n/a*[a]
	ArithMean	*StdDev*	*Median*	*Top 2*	*Bottom 2*	*Top 3*	*Bottom 3*	
6.1	5,70	3,503	6	26%	17%	37%	22%	5,3%
6.2	5,20	3,147	5	15%	16%	26%	22%	7,3%
6.3	7,33	2,852	8	41%	5%	54%	7%	7,2%
6.4	5,55	3,618	5	27%	19%	36%	24%	7,9%
6.5	3,96	3,390	4	11%	32%	20%	38%	5,5%
6.6	7,88	2,801	9	54%	5%	65%	7%	3,7%
6.7	5,65	3,407	6	25%	16%	35%	22%	5,6%
6.8	8,01	2,730	9	57%	5%	70%	6%	2,3%
6.9	5,96	3,354	7	25%	15%	38%	19%	6,9%
6.10	6,74	3,044	7	34%	9%	48%	11%	3,2%
6.11	7,29	2,767	8	39%	6%	56%	7%	4,0%
6.12	6,27	2,912	7	22%	10%	38%	12%	5,5%
6.13	8,44	2,405	10	63%	3%	75%	4%	2,5%

Q5 Use Cases

Imagine that in the future there would be autonomous road vehicles that would be able to participate in public traffic just as independently as vehicles with human drivers do today. In which constellation would you feel comfortable driving such a vehicle?

5.1 alone in my private autonomous vehicle on a highway at recommended speed
5.2 alone in my private autonomous vehicle in city traffic
5.3 alone in a hired autonomous vehicle in city traffic
5.4 alone in a hired autonomous vehicle in city traffic, where the journey is constantly monitored by a tele-operator
5.5 together with two to five other passengers in an autonomous mini-bus in city traffic
5.6 in a half-full autonomous bus the size of today's city buses in urban traffic
5.7 in a half-full autonomous streetcar in urban traffic

Stellen Sie sich bitte einmal vor, es gäbe in Zukunft autonome Straßenfahrzeuge, die in der Lage wären, am öffentlichen Straßenverkehr genauso selbständig teilzunehmen wie es heute Fahrzeuge mit menschlichen Fahrern tun. In welcher Konstellation würden Sie sich denn bei einer Fahrt damit wohlfühlen?

5.1 allein in meinem eigenen autonomen Fahrzeug auf der Autobahn bei der heute geltenden Richtgeschwindigkeit
5.2 allein in meinem eigenen autonomen Fahrzeug im Stadtverkehr
5.3 allein in einem gemieteten autonomen Fahrzeug im Stadtverkehr
5.4 allein in einem gemieteten autonomen Fahrzeug im Stadtverkehr, bei dem die Fahrt ständig durch einen Tele-Operator überwacht wird
5.5 zusammen mit zwei bis fünf anderen Fahrgästen in einem autonomen Mini-Bus im Stadtverkehr
5.6 in einem halbvollen autonomen Bus in der Größe heutiger Linienbusse im Stadtverkehr
5.7 in einer halbvollen autonomen Straßenbahn im Stadtverkehr

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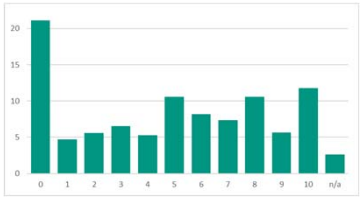
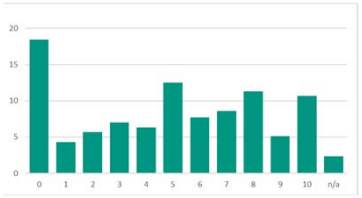
	Averages			Top 2 Box		Top 3 Box		*n/a*[a]
	ArithMean	*StdDev*	*Median*	*Top 2*	*Bottom 2*	*Top 3*	*Bottom 3*	
5.1	4,76	3,508	5	17%	26%	28%	31%	2,6%
5.2	5,26	3,475	5	22%	21%	33%	26%	2,9%
5.3	4,86	3,365	5	16%	23%	27%	28%	2,3%
5.4	5,07	3,272	5	16%	20%	28%	25%	3,4%
5.5	5,10	3,143	5	14%	18%	27%	23%	2,2%
5.6	5,34	3,140	6	16%	16%	28%	21%	2,5%
5.7	5,66	3,189	6	20%	15%	34%	20%	3,5%

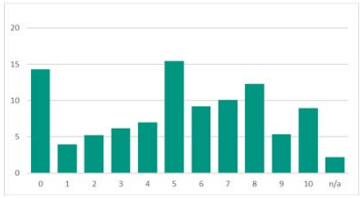
5.1



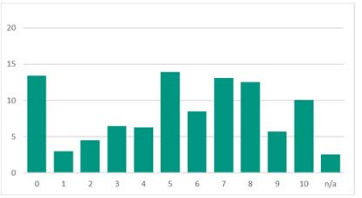
5.3



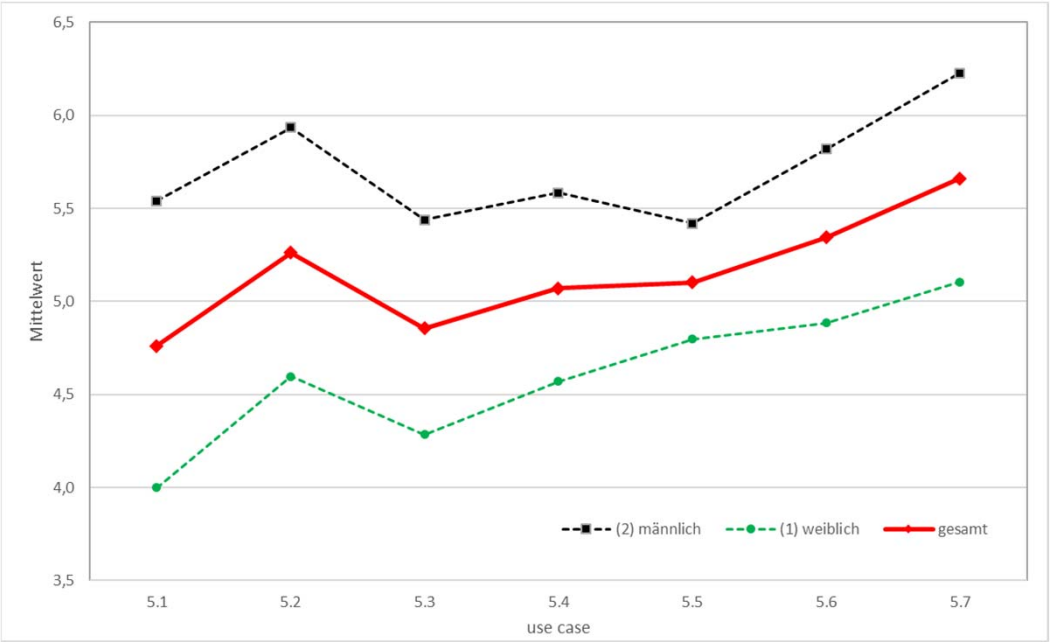
5.5

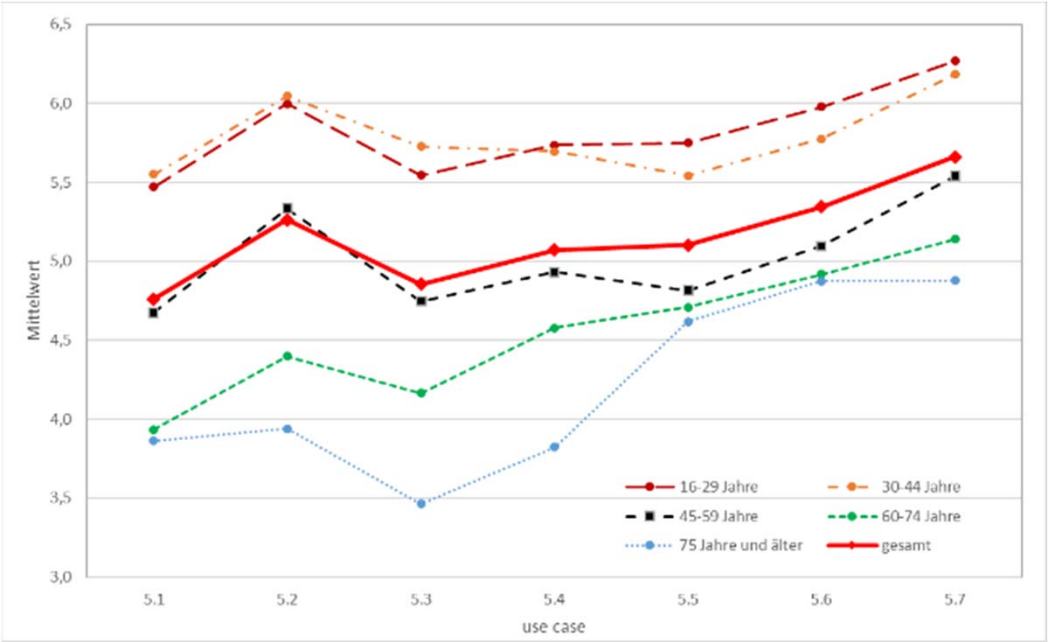


5.6



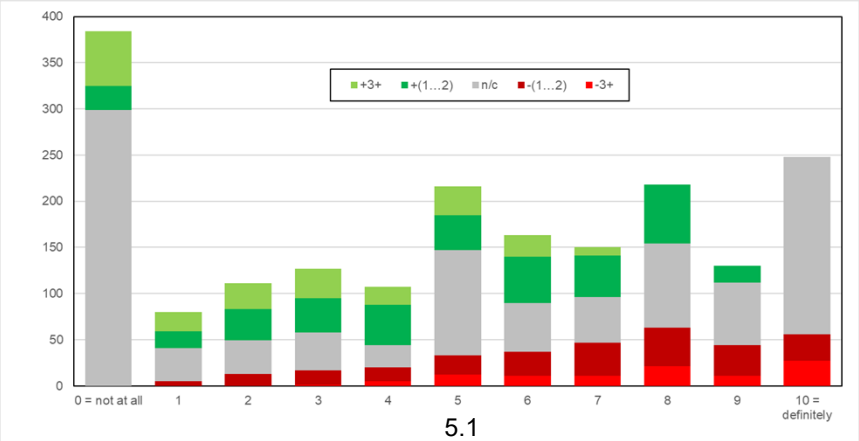
Q5 Use Cases


6,5
6,0
5,5
5,0
4,5
4,0
3,5
Mittelwert
5.1
5.2
5.3
5.4
5.5
5.6
5.7
use case
(2) männlich
(1) weiblich
gesamt

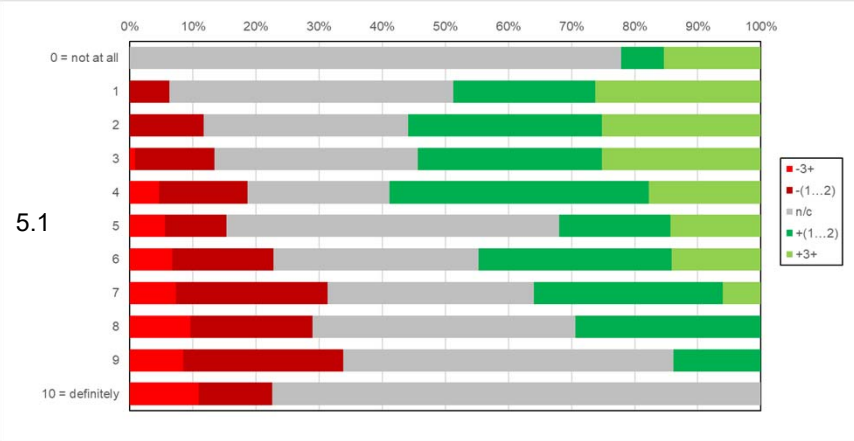

6,5
6,0
5,5
5,0
4,5
4,0
3,5
3,0
Mittelwert
5.1
5.2
5.3
5.4
5.5
5.6
5.7
use case
16-29 Jahre
30-44 Jahre
45-59 Jahre
60-74 Jahre
75 Jahre und älter
gesamt

Example: Variations 5.1 vs. 5.2

5.1 → 5.2

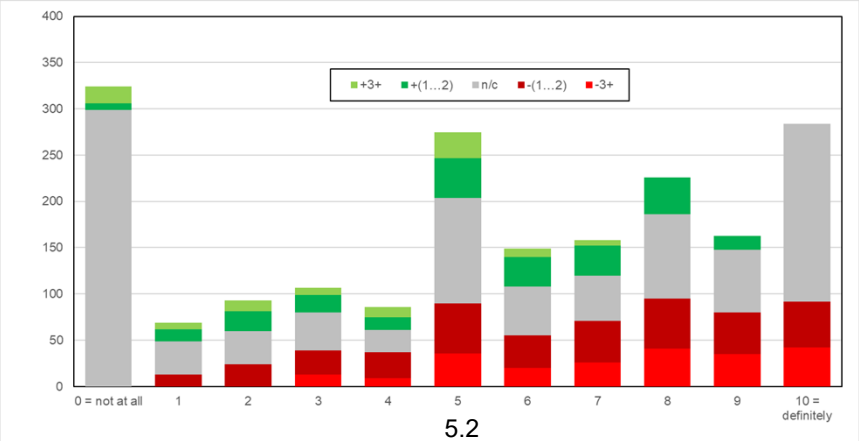


5.1

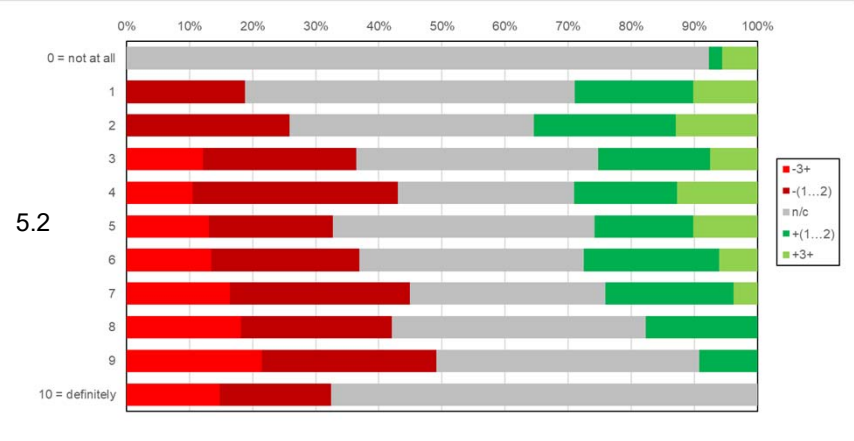


5.1

5.2 → 5.1



5.2



5.2

5.1 alone in my private AV on a highway at recommended speed

5.2 alone in my private AV in city traffic

Example: Variations 5.2 (private car in city) vs. 5.x

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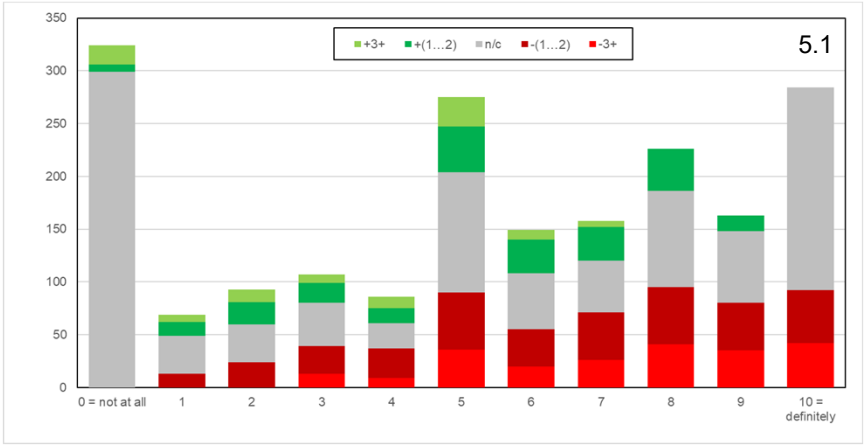
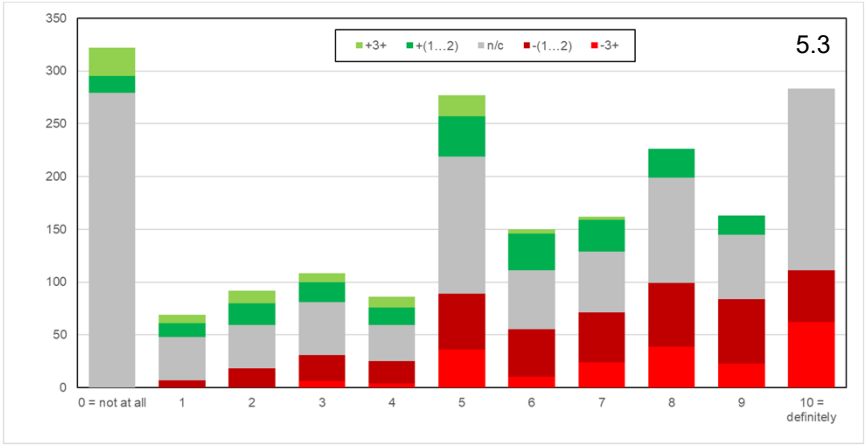
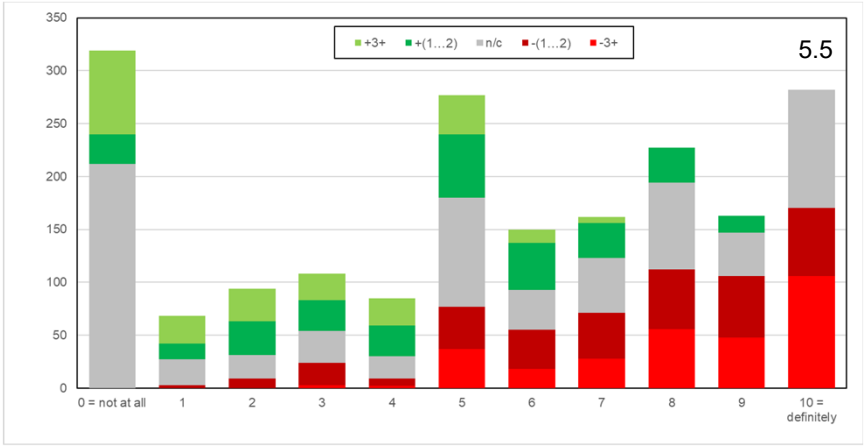
5%
12%
51%
19%
11%



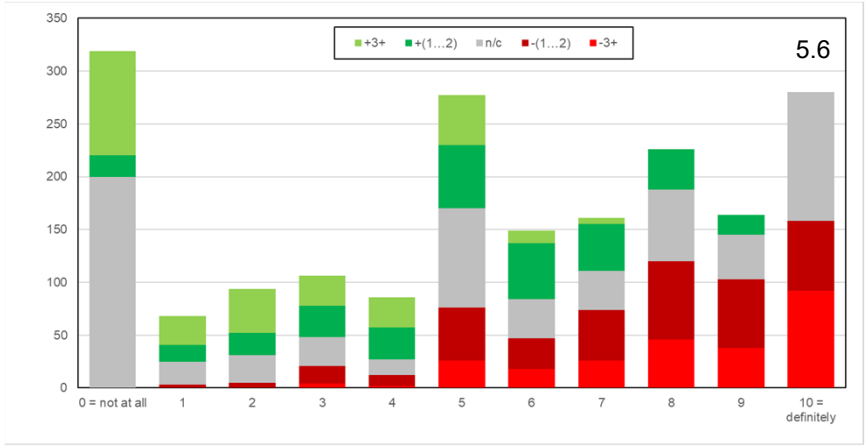
5%
12%
52%
20%
10%



12%
16%
37%
17%
15%



15%
17%
35%
19%
13%



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Share of all

current main means of transport		most suitable AV mobility option					
	share	private car	robo-taxi	shuttle	bus	none of these	n/a, DK
total		**36%**	**10%**	**13%**	**19%**	**18%**	**4%**
car	*59%*	26%	6%	7%	9%	9%	2%
bike	*14%*	4%	2%	2%	3%	2%	
urban PT	*11%*	2%	1%	2%	4%	1%	1%
walking	*12%*	3%	1%	2%	2%	3%	1%
other	*3%*	1%	1%		1%	1%	
not mobile	*1%*					1%	

Share of respective current main means of transport

current main means of transport		most suitable AV mobility option					
	share	private car	robo-taxi	shuttle	bus	none of these	n/a, DK
total		**36%**	**10%**	**13%**	**19%**	**18%**	**4%**
car	*59%*	43%	10%	12%	15%	16%	
bike	*14%*	27%	14%	16%	25%	17%	
urban PT	*11%*	22%	7%	19%	36%	10%	
walking	*12%*	27%	6%	13%	21%	28%	
other	*3%*						
not mobile	*1%*						

First lessons for innovation / deployment strategies (1)

- Modern societies are diverse and plural. Their members may hold widely different (sometimes disparate and conflicting) self-understandings, beliefs, and practices across a wide range of areas in everyday life, including human mobility.
- AD aims at modifying an existing, highly regulated socio-technical system („conversion instead of construction"). The introduction of AD is a social program.
- 'Social acceptance' can be read as a metaphor for attempts to capture (and shape?) the social dynamics preceding the or induced by the development and/or deployment of AV/AD.
- Risk reduction (defined as reduction of exposure to danger, harm or loss) is both societal expectation and innovators' promise. It is a necessary but not a sufficient condition for 'social acceptance' and wider diffusion of AV/AD.

First lessons for innovation / deployment strategies (2)

- AD will change socio-technical arrangements, either deliberately, as a consequence of its diffusion/adoption, or both. This will affect multiple actors.
- Actors are embedded on order structures in the social world. AD-induced changes in these structures should be anticipated, systematically mapped and analyzed.
- Citizens, e.g., are more than just (passive) customers; they are also movers and shakers.
- Communities and society need time to familiarize, learn and build trust.
- AD technologies and services should be tested in real-world labs: inclusive, long-term, transparent, mission-oriented.
- AD diffusion is embedded in broader policy contexts: climate change, livable cities, ageing populations, ‘forced mobility’. AD needs to offer persuasive solutions.

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