

Autonomous Driving 2019

**Driving Forces and Restrictions on the
Way to Autonomous Driving from the
Perspective of Drivers**

Research Report

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Content

Management Summary.....	3
1 Fact sheet.....	5
1.1 Design and scope of study	5
1.2 Aim and content of study	5
1.3 Sample	6
1.3.1 Age.....	6
1.3.2 Gender	6
1.3.3 Size of place of residence	7
1.3.4 School education.....	8
1.3.5 Yearly mileage.....	8
1.3.6 Propensity to spend on cars	9
1.3.7 General psychological user motivation.....	9
2 User typologization based on the requirements of the car.....	11
(Chapter 3 – not printed).....	11
4 Outlook: Desire for autonomous driving	12
4.1 Unaided positive associations	12
4.2 Unaided negative associations.....	14
4.3 Desire in total	16
4.4 Connection with brand preference.....	18
4.5 Desire for autonomous driving depending on sociodemographic and behavioural criteria.....	18
4.6 Desire for autonomous driving as a function of the requirements of a car ...	22
4.7 Desire for autonomous driving as a function of personality types.....	23

Management Summary

This report is an excerpt from a larger report on the assessment of driver assistance systems and autonomous driving from the perspective of the driver target group. The partial report on driver assistance systems is the property of a project sponsor, therefore the third chapter is not included in this publication. The study part on autonomous driving is made available to the public in extracts below.

The analyses are based on face-to-face interviews with 892 people aged between 18 and 88 years in Germany.

The report shows how autonomous driving is assessed and how great the desire is to use it. The query of unsupported, open associations without specifications provides an insight into which drivers and obstructive factors currently exist. Quantitative evaluations allow differences in a variety of sub-target groups to be identified. It also provides insights into the psychological motivational structure of drivers and its connection to the desire for autonomous driving.

The results can be used to derive indications of the need for action in the automotive and supplier industry to accelerate the diffusion process of the new technologies.

Key findings of this study

☞ So far, manufacturers and suppliers in Germany have not succeeded in creating a positive mood towards autonomous driving. A joint image or marketing campaign by the manufacturers does not exist.

☞ In the overall view, the known beneficial arguments do not have as positive an effect on the desire for autonomous driving as one would expect. This can only be explained by the fact that the entire automotive industry has lost credibility in recent years. The image of autonomous driving obviously suffers from this.

☞ Right now, skepticism towards autonomous driving is prevalent among drivers.

☞ If the car industry wants to pave the way for autonomous driving, special **campaigns are required in cities with 1 million inhabitants** or more.

☞ People of retirement age want more helpful driver assistance systems, but not autonomous driving.

Older people want to resume driving on their own and fear that autonomous driving will entail a loss of individual freedom.

☞ As was already the case with driver assistance systems, this confirms that it has not yet been possible to sufficiently convince drivers of the functional benefits of autonomous driving.

☞ Motorists do not expect autonomous driving to contribute to savings and environmental protection.

☞ There is still a great deal of educational work to be done by car manufacturers if the desire for autonomous driving is to become more widespread among the population. Generally speaking, people who are more "open-minded" are not surpassingly open to autonomous driving. The "doer" and "maker" types tend to be rather averse to autonomous driving.

1 Fact sheet

1.1 Design and scope of study

- Method: Face-to-face survey of car drivers aged 18 and over in Germany. Data collection in Germany, completion in the first quarter of 2019.
- Concept development: preliminary design involving real customers from the target group, explorative preliminary study to determine criteria relevant to buying behaviour in the target group, online research, pre-test.
- Sample composition: quoted sample with the following specifications: Interview partners aged 18 years and older, maximum one interviewee per family, driver or potential driver. Quotation according to age, gender and educational level according to the distribution of the total population.
- Data collection: 37 trained interviewers (21-29 years old, university degree) and five additional expert interviewers.
- Average interview duration approx. 20 minutes.
- Geographical distribution: The interviews were conducted at more than 20 locations throughout Germany, with a focus on southern Germany. The respondents come from over 100 different locations throughout Germany.
- Return: unedited stock of 973 interviews. Incomplete and obviously inconsistent questionnaires were eliminated, so that finally 892 interviews were included in the evaluation.
- Test quality: Extensive tests (split-half reliabilities, checks on interviewer reliability and expert judgements on content issues) prove the reliability and validity of the study results.

1.2 Aim and content of study

In the present study, drivers and inhibiting factors are analysed in comparison to autonomous driving in a primarily quantified form. The background is that both the automobile manufacturers and the supplier industry perceive reservations of automobile customers towards driver assistance technologies without knowing exactly what they are based on.

The new technologies on the road to autonomous driving are associated with high investments. The industry is therefore very interested in identifying the drivers and inhibiting factors for the new offers and, if necessary, to counteract them with suitable measures of development and communication in order to accelerate the diffusion process and thus ultimately to amortize the investments.

Optimizations in the context of the Human-Machine-Interface (HMI) could possibly help to prevent or counteract customer reservations. Individual customer opinions are likely to be repeated across many studies, but there is a lack of reliable, quantifiable data. And finally, there is no study available in which the motivational personality type of the target group is examined as an explanatory variable for adoption behaviour. The present study provides a first building block for closing this gap in knowledge.

1.3 Sample

The sample description serves the sole purpose of showing how the sample is composed and according to which criteria it is divided into subgroups for subsequent evaluations. The hurried reader can skip this chapter.

1.3.1 Age

Fig. 1: Sample composition by age		
Age groups	Quantity	Valid percentages
18 to 20	72	8.1
21 to 29	284	31.8
30 to 49	236	26.5
50 to 65	210	23.5
66 and older (max. 88)	90	10.1
Total	892	100.0

- Respondents ranged in age from 18 to 88, with an average age of 40.6 years (median 35). The average age is slightly lower than that of the overall population in Germany (44 years). This is in line with the quota target, as persons over 66 years of age were slightly underweighted, since from this age on, fewer and fewer cars are driven and purchasing behaviour has become more entrenched.

1.3.2 Gender

The sample contains 443 women and 449 men, which amounts to 49.7% female respondents.

1.3.3 Size of place of residence

Fig. 2: Distribution of sample by size of the respondents' place of residence		
Number of residents	Quantity	Valid percentages
Up to 4999	244	27.4
5000 to 24999	242	27.1
25000 to 99999	221	24.8
100000 to 999999	86	9.6
1 Mio and more (max. 3.5 Mio)	99	11.1
Total	892	100.0

- The respondents come from all sizes of towns and cities, with smaller town sizes being somewhat overrepresented. The average size of a town is 223,000 inhabitants (median 17,750).
- All sizes of residential areas are sufficiently represented in order to conduct reliable partial evaluations.

1.3.4 School education

Fig. 3: Distribution of sample by education		
Education level	Quantity	Valid percentages
Up to secondary general school	174	19.5
High School Diploma / GCSE	202	22.6
A-Levels (no studies)	148	16.6
Academic degree	355	39.8
Other	13	1.5
Total	892	100.0

- All four relevant educational levels are sufficiently represented in order to conduct reliable partial evaluations.

1.3.5 Yearly mileage

Fig. 4: Distribution of sample by yearly mileage		
Mileage by year, km	Quantity	Valid percentages
Up to 4999	139	15.6
5000 to 19999	445	50.0
20000 to 49999	256	28.8
50000 plus (max. 120000)	50	5.6
Valid mentions	890	100.0
Not specified	2	

- Respondents drive between 0 and 120,000 km per year themselves by car (mean 16,650 km, median 14,000 km).

1.3.6 Propensity to spend on cars

The question "If you had to buy a car in your current life situation in the next few months: what would be the maximum amount you would spend on it?" leads to a wide variation of answers between 500 and 175,000 euros. The willingness to spend includes both new and used car purchases.

Fig. 5: Propensity to spend on a car			
Amount (Euro)	Quantity	Percent	Valid percentage
Up to 4999	77	8.6	8.7
5000 to 9999	109	12.2	12.3
10000 to 19999	262	29.4	29.6
20000 to 49999	374	41.9	42.3
50000 and more (max. 175000)	63	7.1	7.1
Valid nominations	885	99.2	100.0
Not specified	7	0.8	

- The average propensity to spend is 21.340 Euro (Median 18.000).

1.3.7 General psychological user motivation

Consumer behaviour with regard to concrete issues such as the use of driver assistance systems is not only determined by the cognitive benefit expectations of the target groups, but also by their psychological disposition.

To survey the general psychological disposition of target groups, the so-called "Big Five" are an empirical standard instrument that was used in a shortened version with 10 individual questions.¹

¹ Cf. Rammstedt, B., Kemper, Ch., Klein, M., Beierlein, C., Kovaleva, A.: Eine kurze Skala zur Messung der fünf Dimensionen der Persönlichkeit, in: Methoden, Daten und Analysen, (7), 2013, p. 2.

The data set results in a factor structure with four meaningful personality dimensions, which deviates slightly from previous studies. These four dimensions can be described as "Extraversion", "Openness and imagination", "Do it yourself instead of criticizing" and "Work calmly and thoroughly" (see Fig. 6). The four dimensions can be examined below to determine their significance for the topic of driver assistance systems

Fig. 6: Psychological characteristics (self-assessment)					
Dimension	Description	Real scale values (0...100)²			
		Min.	Max.	Mean	Median
1 Extraversion	I'm not a reticent person, I'm a people person, I don't get insecure easily	7	100	62	63
2 Openness and imagination	I have artistic interests, I have imagination	0	100	54	52
3 Do it yourself instead of criticizing	I do not avoid effort, I do not tend to criticize others	0	100	53	53
4 Work calmly and thoroughly	I make it a point to complete tasks thoroughly, I do not let myself be distracted	5	100	71	70

- All four dimensions express "positively" assessed personality traits. Compared to the theoretical average (on a scale of 0 to 100, this would be 50), the self-assessments are all slightly positive, with the highest values in the dimensions "Working calmly and thoroughly" (71) and "Extraversion" (62).

² Based on the assignment of the individual variables to the dimensions, summary indices were calculated that have the same scaling as the output items (from 0 to 100) and are easier to interpret than z-transformed factor scores.

2 User typologization based on the requirements of the car

On the basis of previous studies and exploratory analysis, 11 essential general requirement criteria were defined (sportiness, low consumption, comfort, low price, low pollutants, modernity, safety, high-quality brand, reliability, lots of space, great design). These 11 criteria were supplemented by the criterion "innovative driver assistance systems".

The respondents were asked to indicate how important the 12 requirement criteria are to them when buying a car. Based on the judgements, factor analysis can be used to determine how the individual criteria are grouped into dimensions (factors) in the perception of the target groups. Three factors can be distinguished:

Fig. 7: Requirements of the car					
Dimension of requirement	Content	Real scale values (0...100) ³			
		Min.	Max.	Mean	Median
1 Upmarket and modern	Sporty, high-quality brand, innovative driver assistance systems, modern, great design	0	100	60	63
2 Economical and environmentally friendly	Few pollutants, low consumption, favourable price	0	100	71	74
3 Functional	Safe, reliable, lots of space	30	100	80	83

- The result shows that driver assistance systems, together with aspects such as high quality and modernity, belong to an (image) dimension of automobile evaluation. This dimension is separated ("statistically independent") from the other two dimensions "economical and environmentally friendly" and "functionality".

(Chapter 3 – not printed)

³ Based on the assignment of the individual variables to the dimensions, summary indices were calculated that have the same scaling as the output items (from 0 to 100) and are easier to interpret than z-transformed factor scores.

4 Outlook: Desire for autonomous driving

4.1 Unaided positive associations

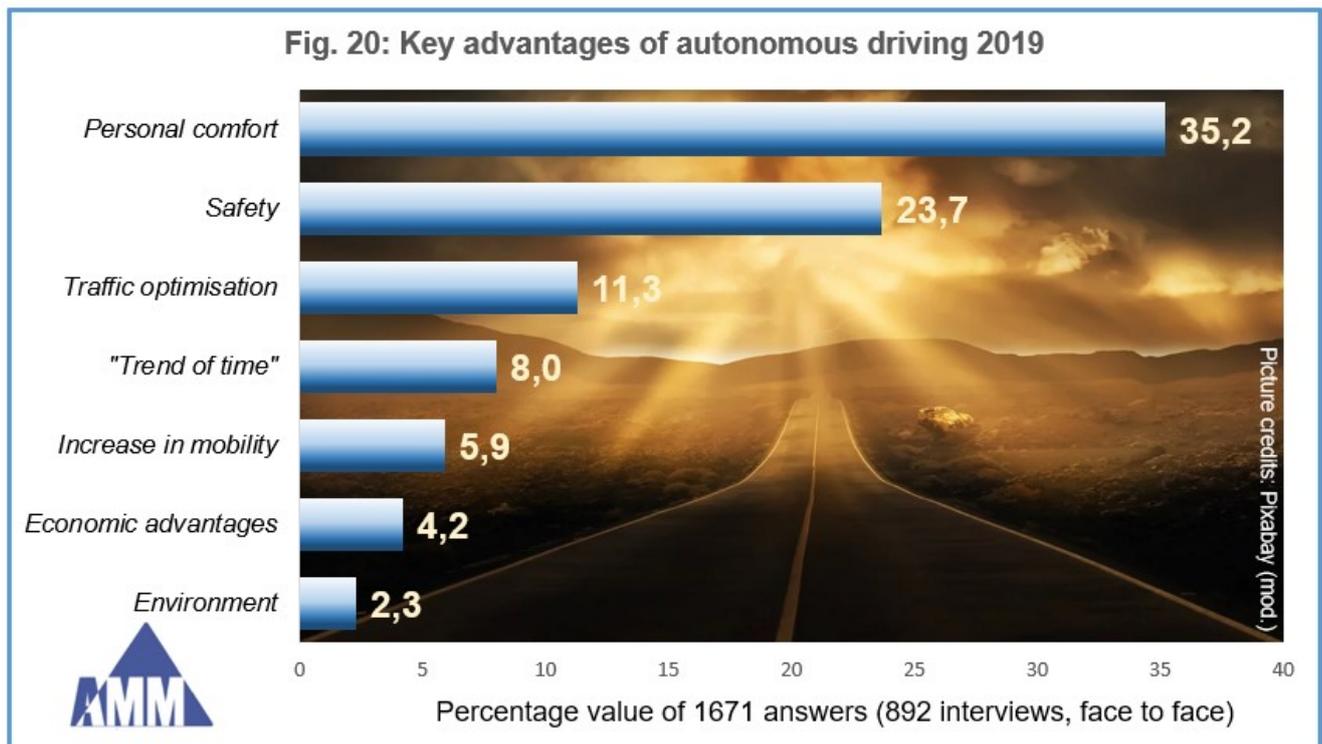
The motorists were asked without any help in terms of content; these are advantageous arguments that come to their mind spontaneously for autonomous driving.

Fig. 19: Unsupported associations with the advantages of autonomous driving
(only the most frequent statements are mentioned within categories)

Category	Single answers	n
Personal comfort (n= 491, 35.2%)	Relaxed driving, stress-free	142
	While driving it is possible to do other things	135
	Comfortable, convenient	71
Safety (n=331, 23.7%)	Prevention of accidents, no human mistake etc.	153
	Safety of traffic increases	135
	Issue with drowsiness solved, sleeping in car is possible	29
Traffic optimization (n=157, 11.3%)	Traffic jam prevention, optimization of traffic and navigation	81
	Positive for long rides	27
	Parking becomes easier to do, parking possibilities increased	11
Trend of time (n=112, 8.0%)	Future, technical advance, will establish itself	88
	Innovative, modern, digital age	24
Increase in mobility (n=82, 5.9%)	Positive for elderly, handicapped, while impaired etc.	75
	Positive when suffering from bad eyesight.	4
	Mobility is increased	3
Economic advantages (n=59, 4.2%)	Save money, economical driving, efficiency	40
	Positive for frequent drivers and business travels	10
	New business models and new jobs	5
General positive (n=57, 4.1%)	Good idea, awesome, cool, sensible etc.	38
	Handy, helpful	19
Environment (n=32, 2.3%)	Environmentally friendly	27
	Reduce consumption	5
Other (n=74, 5,3%)	Is being tested everywhere	26
	Tesla, Google and Uber are pioneers	23
	Technology offers lots of opportunities, is reliable	14
Total (multiple answers of 892 respondents)		1395

- The respondents primarily expect an increase in personal comfort from autonomous driving. 35.2% of the mentions are in this category, followed by an improvement in road safety (23.7% of the mentions) and optimization of traffic flow (11.3%).
- In contrast, economic benefits are mentioned in only 4.2% of the mentions - and only 2.3% of the mentions deal with positive environmental aspects.

Fig. 20 shows the key advantages of autonomous driving.



4.2 Unaided negative associations

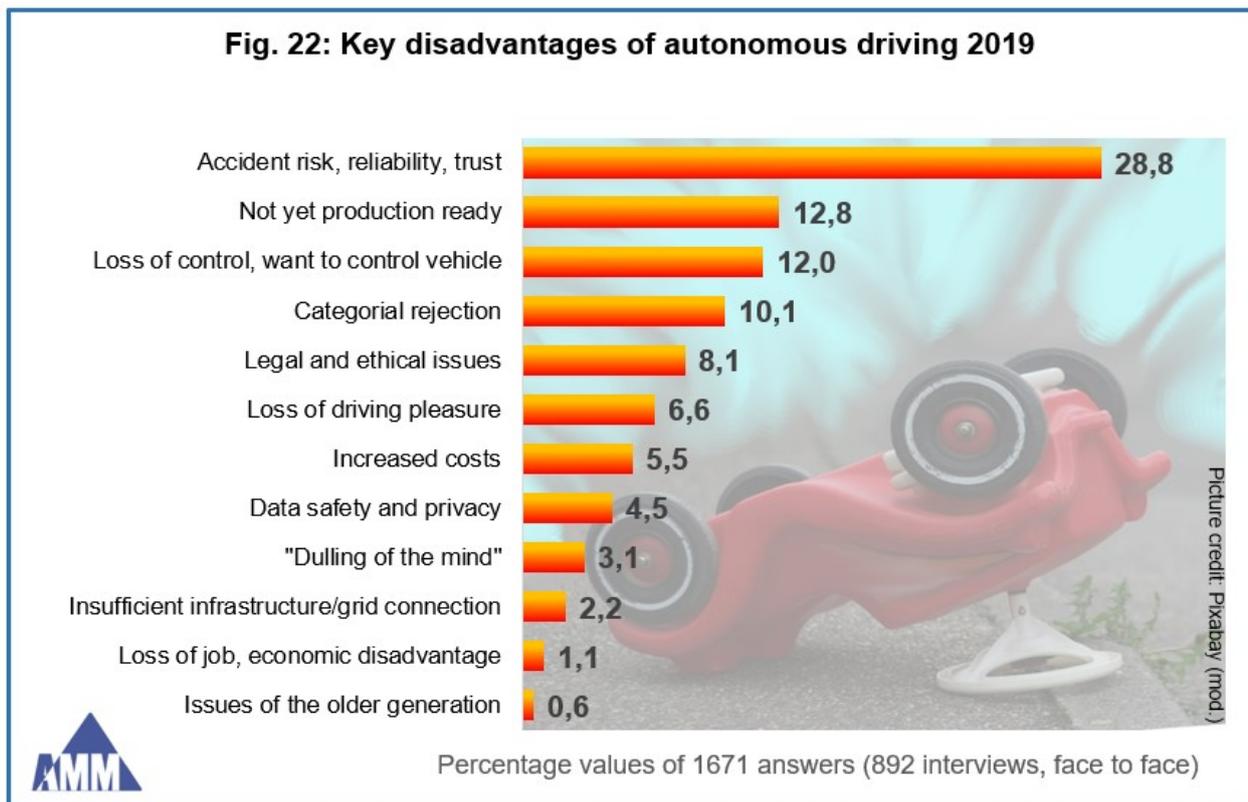
Fig. 21: Unaided negative associations against autonomous driving (only the most frequent statements are mentioned within categories)		
Category	Single answers	n
Accident risk, safety, reliability, trust (n=481, 28.8%)	No trust in technology, fear of malfunction	168
	Fear for safety of driving	106
	Accidents of Tesla, Google etc.	58
	Prone to failure, malfunctions of tech, software, sensors, network	55
Not yet production ready (n=214, 12.8%)	Not production ready, development still needs time	194
	Still in testing stage, level 5 not yet reached	12
	Infrastructure has not been built up yet to support this	4
	Issues are remaining in terms of working orderly	4
Loss of control, want to drive personally (n=200, 12.0%)	Loss of control, incapacitation, loss of independence	128
	One would want to drive and steer by oneself	32
	Dependence on technology, machines, computers	25
Categorical rejection (n=169, 10.1%)	I am opposed, no need, no interest, nobody needs it	38
	Frightening, scary, crazy, stupid	19
	Human is always better than a system	18
	Not conceivable, science-fiction	16
Legal and ethical issues (n=136, 8.1%)	Accountability in case of accident not evident	79
	Lots of unresolved legal issues	33
	Ethical discussions in case of accidents (trolley problem)	24
Loss of driving experience (n=111, 6.6%)	Driving pleasure is lost	75
	Boredom instead of driving pleasure	17
	Driving a car is fun, therefore no option	11
Costs (n=92, 5.5%)	Increased prices for cars and for driving	39
	Pricey, high price, expensive, only for the rich	39
	Maintenance and repairs are expensive	7
Data security (n=76, 4.5%)	Hacking, manipulation by third parties	42
	Data security and privacy unresolved, surveillance	21
	Big data-analysis, misuse of data	7
„Dulling of the mind“ (n=51, 3.1%)	Driving a car will be forgotten, loss of driving fun	23
	Attention to traffic is decreasing	16
	Laziness of people is being supported	4
Diffusion, grid connection (n=37, 2.2%)	Issues of mixing autonomous cars and non-autonomous cars	16
	Insufficient infrastructure in Germany	11
	Only in metropolitan areas, not possible in rural areas	6
Loss of jobs and economic disadvantages (n=18, 1.1%)	Jobs of truck drivers, taxi drivers etc.	13
	Losses in taxi business	4
	Losses for car dealerships and suppliers	1

(Table continues on the following page)

Issues of the elderly (n=10, 0.6%)	Elderly do not understand the technology	4
	Elderly people already mistrust the technology of today	4
	Older generations will encounter problems in using the system	2
Other (n=76, 4.5%)	Personality and human interaction is lacking	5
	Driver still has to remain attentive	4
	Human is rendered obsolete by technology	4
Total (multiple answers of 892 respondents)		1671

- The large number of possible points of criticism, some of which are formulated in drastic language, illustrates the majority of motorists' hostile attitude at the present time. Media reports on accidents in the USA, legal dilemmas, insurance issues, etc. have become entrenched in the minds of German motorists long before autonomous driving became a reality.
- The playful interest in new technologies, as can be found in Asia and to some extent in the USA, is found in Germany among only a few people. While the assumed advantages of autonomous driving are rather seen in a vague promise of increasing comfort, German motorists can imagine the possible disadvantages very concretely. Pronounced fear of loss (control, independence, driving pleasure, data security, etc.) is manifest.

Fig. 22 shows the key disadvantages of autonomous driving



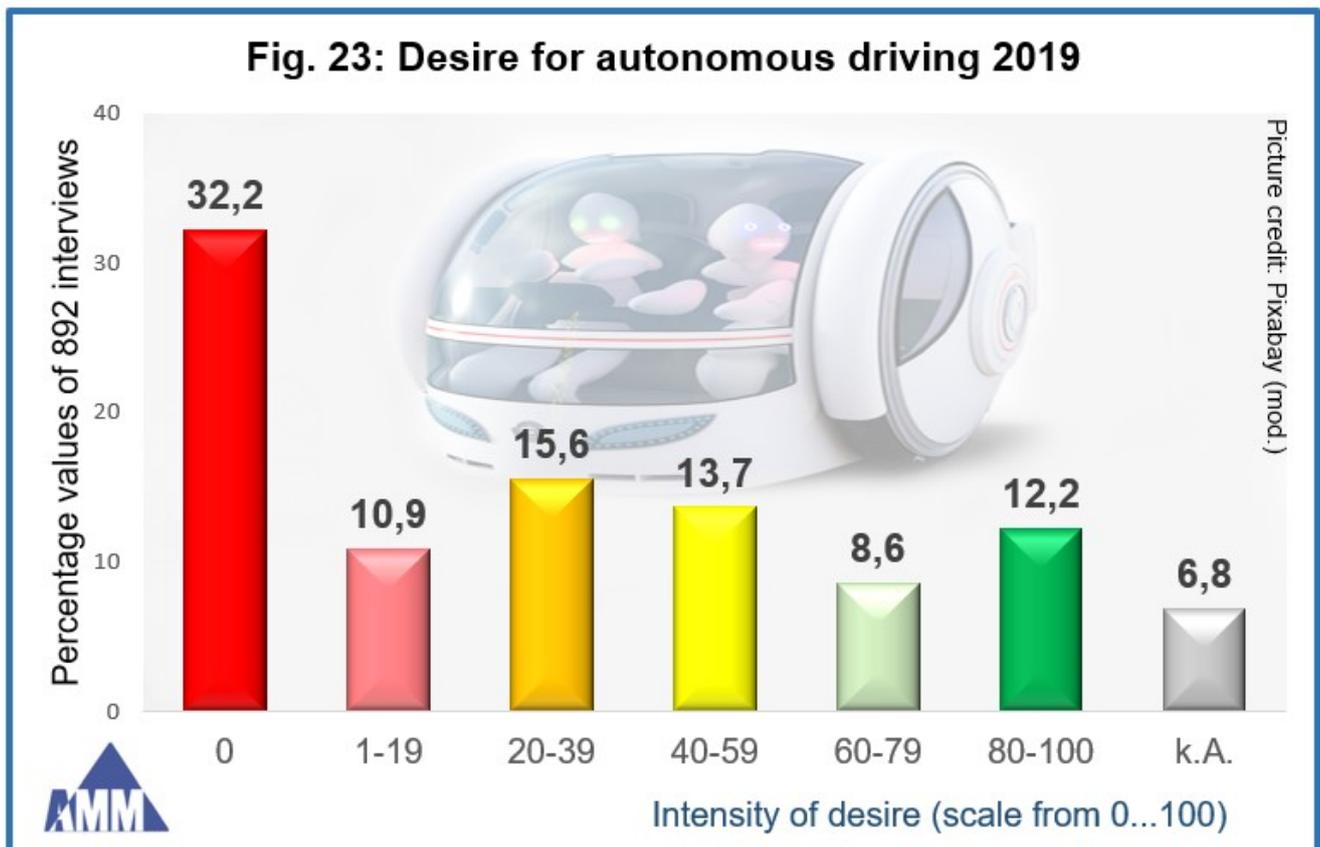
Juxtaposition of positive aspects and critical issues:

- A numerical comparison of the benefit arrangements mentioned unsupported by 892 respondents (1395) and the critical points (1671) shows that the worries predominate.
- The particularly critical aspect "safety/accidents" is mentioned 331 times as a possible advantage, but 481 times as a problem.
- A general agreement of 57 people (6.4 percent of the sample) is contrasted by a general rejection of 169 people (18.9 percent).

☞ The manufacturers and suppliers working intensively on assistance systems have not yet succeeded in creating a positive mood. A joint image campaign by the manufacturers does not exist.

☞ The fact that the well-known arguments for advantages do not have the expected positive effects in the overall view can only be explained by the fact that the entire automotive industry has lost credibility in recent years, which obviously also affects the image of autonomous driving.

4.3 Desire in total



- On the "desire scale" from 0 to 100, a theoretical average value would be 50, but in fact the wish to drive autonomously is significantly lower, namely only 30.0 (median 20.0) on the average of the valid answers of the sample.
- Many motorists cannot yet imagine driving autonomously, and about a third reject the idea completely (wish "0").

In grouping German drivers according to their desire for autonomous driving, four main groups can be identified:



- Currently, only one in eight drivers (12.2 percent) can be considered a staunch advocate of autonomous driving. Another 22.3 percent are at least open to this future technology.
- In contrast, 32 percent are "objectors" and 26.5 percent are "sceptics".

☞ Overall, German motorists are currently clearly sceptical about autonomous driving. Even before this technology of the future has become available, many reservations and concerns have already become entrenched in the minds of motorists.

4.4 Connection with brand preference

As expected, the desire for autonomous driving shows clear differences when car drivers with different brand preferences are surveyed. For example, the desire for autonomous driving among drivers who intend to buy a Porsche or an Alfa Romeo is only 24 (median 5) and thus significantly below the overall average. This value corresponds to unsupported statements such as "loss of driving pleasure", loss of control and loss of competence.

4.5 Desire for autonomous driving depending on sociodemographic and behavioural criteria

The following analyses show that there are numerous differences in sub-target groups when it comes to the desire for autonomous driving (fig. 24, next page).

- Men are significantly more open to autonomous driving than women.
- Increasing educational levels correspond to a greater desire for autonomous driving. Drivers with a university degree express a significantly above-average openness to taking advantage of autonomous driving as soon as it becomes available.
- The desire for autonomous driving also increases with greater size of place of residence. However, this no longer applies to metropolitan areas with 1 million inhabitants or more. The individual analysis of the open answers shows that their inhabitants increasingly refer to the use of public transport or demand its further expansion instead of autonomous driving. This is significant because precisely metropolises shape the development of opinion, as the media, NGOs and political decision-makers are mostly based there.

☞ If the car industry wants to pave the way for autonomous driving, special campaigns are required in cities with 1 million inhabitants or more.

- With increasing annual mileage, the desire for autonomous driving tends to grow.⁴
- With increasing willingness to spend money on a car, the desire for autonomous driving tends to enhance.

⁴ Contrary to the overall trends, the drivers with the lowest mileage, the youngest and those with the least willingness to spend, mention an increased desire for autonomous driving. Probably this reflects a basic attitude "I can desire it, even if it is not very realistic that I can afford it". This does not change the significant correlations identified overall (increasing desire with increasing age, increasing driving performance and increasing willingness to spend).

Fig. 24: Desire for autonomous driving in several partial target groups

Split criterion	Desire for autonomous driving (scale 0-100)	
Gender⁵	Female	28
	Male	32
Education level⁶	Up to secondary general school	25
	High School Diploma / GCSE	25
	A-Levels (no studies)	29
	Academic degree	37
	other	25
Age (years)⁷	18 to 20	36
	21 to 29	33
	30 to 49	32
	50 to 65	24
	66 and older (max. 88)	24

(Table continues on the following page)

⁵ Group differences statistically significant, p=0.023.

⁶ Group differences statistically significant, p=0.005.

⁷ Group differences statistically significant, p=0.005.

Size of place of residence (Residents)⁸	Up to 4999	27
	5000 - 24999	27
	25000 - 99999	30
	100000 - 999999	43
	1 Mio. and more	33
Jearly mileage (km)⁹	Up to 4999	31
	5000 to 19999	27
	20000 to 49999	32
	50000 and more (max. 120000)	37
Propensity to spend on a car (Euro)¹⁰	Up to 4999	35
	5000 to 9999	28
	10000 to 19999	28
	20000 to 49999	30
	50000 and more (max. 175000)	39

- Although older people in particular see a benefit in letting themselves be driven, the desire for autonomous driving decreases steadily and significantly with increasing age. Obviously, the majority of older people do not see the potential benefit; rather, they cannot or do not want to imagine the new technology of completely autonomous driving. This is all the more remarkable since it was noted above with regard to the individual driver assistance systems that the desire *increases* with age.
- Individual answers indicate that the older target group fears that they will give up part of their self-determination by driving themselves. This issue is already known to be socially unenforceable, as the elderly are opposed to compulsory driving tests for older people

⁸ Group differences statistically significant, p=0.001.

⁹ Group differences statistically significant, p=0.085.

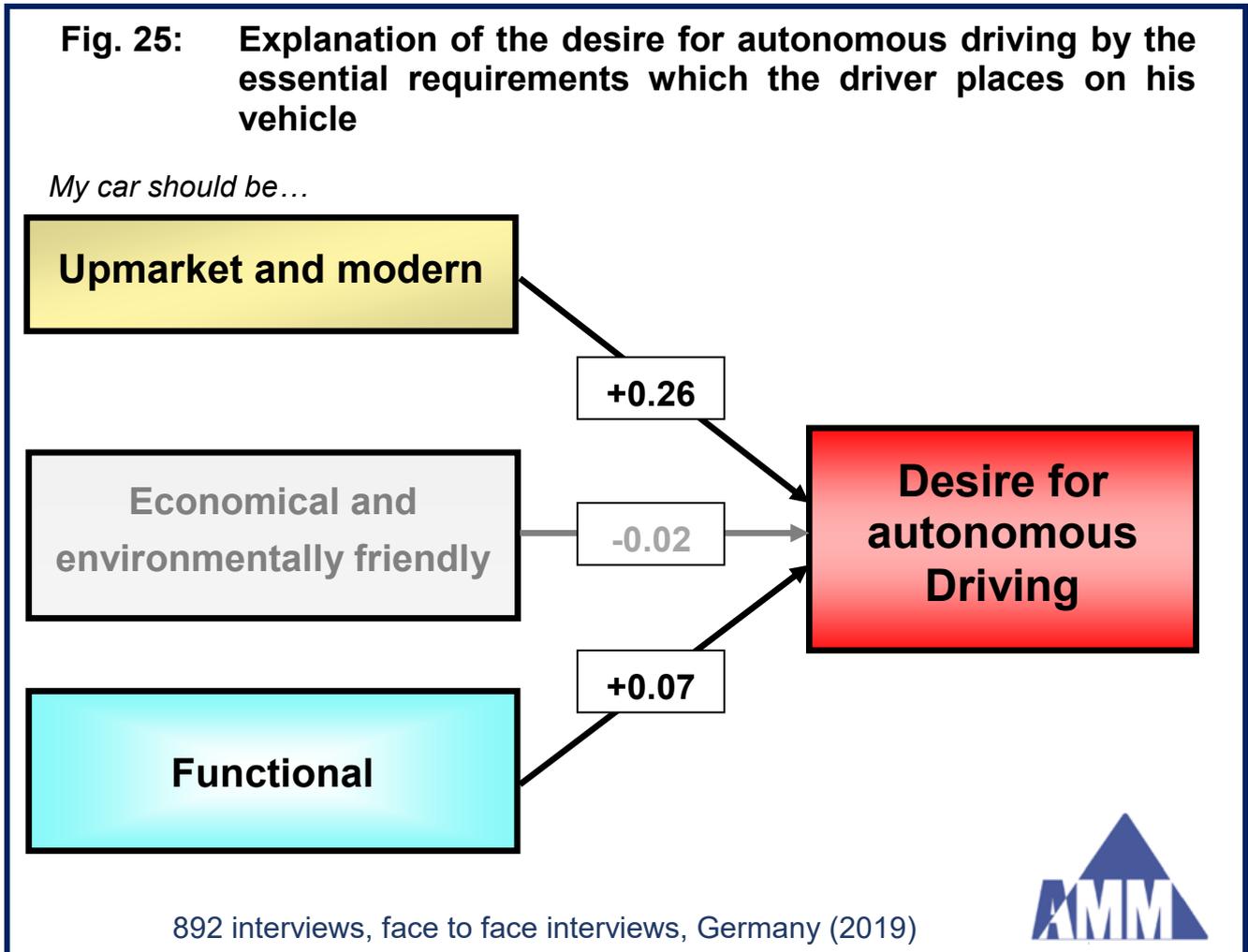
¹⁰ Group differences statistically significant, p=0.096.

and politicians are anxious to lose votes if they take up the issue. Press reports about the "Trolley Problem" (if an accident is unavoidable, the autonomous vehicle should then choose who is more likely to be injured, e.g. are older people more likely to be run over than younger ones? etc.) may also have contributed to the fact that the older generation is rather hostile to autonomous driving.

☞ People of retirement age want more helpful driver assistance systems, but not autonomous driving. Older people want to be allowed to continue driving on their own and fear that autonomous driving is not a gain but a loss of individual freedom.

4.6 Desire for autonomous driving as a function of the requirements of a car

It was deduced above (cf. chapter 2, fig. 7) that there are currently three main demands on the car from motorists. Fig. 25 shows the connection between these main requirements for the desire for autonomous driving among car customers.



Interpretation of the values: So-called beta values of regression analysis can range between 0 and 1. The higher the value, the greater the influence on the dependent variable (here: the desire for autonomous driving).

- The desire for a "high-quality and modern vehicle" is most closely related to the desire for autonomous driving.¹¹

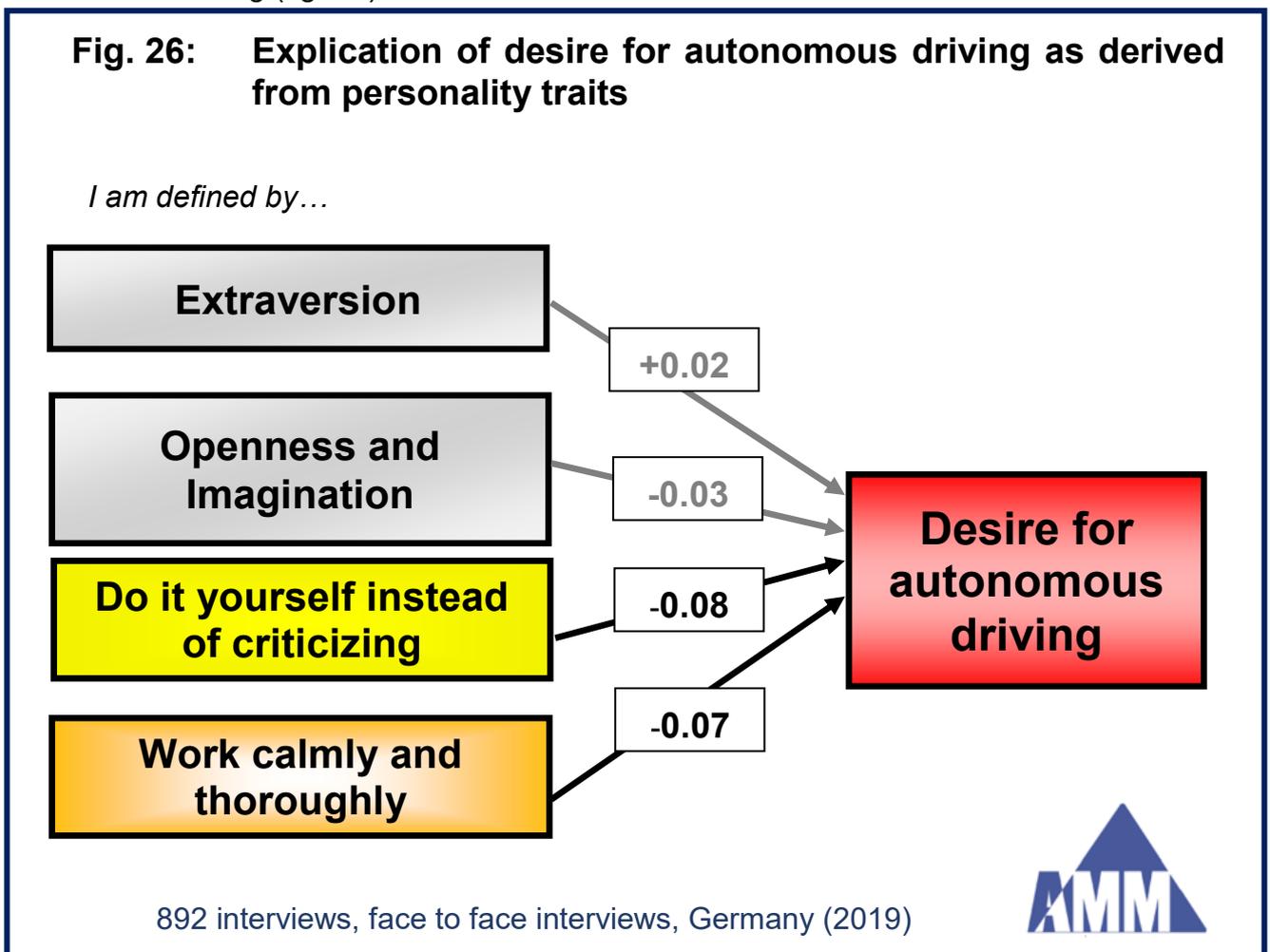
¹¹ Significances for the three factors: F1/upmarket and modern: $t=7.742$, $p<0.001$, F2/Economical and environmentally friendly: $t=-0.569$, $p=0.569$ (not significant), F3/Functional: $t= 2.127$, $p= 0.034$.

- The desired "functionality" of a car is only slightly related to the desire for autonomous driving.
- There is no significant connection between the requirement "economical and environmentally friendly" and the desire for autonomous driving.

☞ As with driver assistance systems, this confirms that it has not yet been possible to convince drivers of the functional benefits of autonomous driving. Neither is a benefit for the environment identifiable.

4.7 Desire for autonomous driving as a function of personality types

Four general personality dimensions have been derived above. Weak but statistically significant negative correlations can be found for two of the dimensions with the desire for autonomous driving (fig. 26).



- The more a person is characterized by "doing it yourself instead of criticizing", the less he or she tends to be interested in autonomous driving.
- The more a person is characterized by "working calmly and thoroughly", the less he or she tends to be interested in autonomous driving.
- The personality dimensions "extraversion" and "openness and imagination" have no measurable connection with the desire for autonomous driving.

In view of the small number of correlations, it is impossible to draw any harsh conclusions. Unsurprisingly, the two personality dimensions associated with active motivation to act have a tendentially negative relationship with the desire for autonomous driving. The "doers" literally do not want to give up the wheel.

It is disappointing that for the other two dimensions, especially for "openness and imagination", no positive connection with the desire for autonomous driving can be established. It is to be noted that the reluctance of drivers towards the topic of autonomous driving prevails across all personality types, and that not even consumers with a greater tendency towards fantasy (with the characteristic openness and fantasy) are more open to the topic.

☞ There is still a great deal of educational work to be done by car manufacturers if the desire for autonomous driving is to become more widespread among the population. Contrary to expectations, people who are generally more "open-minded" are not particularly open to autonomous driving. It is also surprising that "doer" or "maker" types even tend to be averse to autonomous driving.