# Features of future autonomous cars: beyond interior design

## A global survey on user preferences

Felix Roeckle, M.Sc.
Institute of Human Factors and Technology Management
University of Stuttgart
Stuttgart, Germany
felix.roeckle@iat.uni-stuttgart.com

Raphael Hahn, M.A.
Institute of Human Factors and Technology Management
University of Stuttgart
Stuttgart, Germany
raphael.hahn@iat.uni-stuttgart.com

Dipl.-Wi.-Ing. Sebastian Stegmueller
Fraunhofer Institute for Industrial Engineering IAO
Stuttgart, Germany
sebastian.stegmueller@iao.fraunhofer.de

Dr.-Ing. Florian Herrmann
Fraunhofer Institute for Industrial Engineering IAO
Stuttgart, Germany
florian.herrmann@iao.fraunhofer.de

*Abstract* — **The product "car" as it is known since more than 100 years is going to change dramatically over the coming decades. Autonomous vehicles will enable an entirely new travelling experience. Accordingly, the interior concepts and equipment of vehicles are set to shift from a driver-oriented to a "quality of time"-oriented design. In a survey among 2,500 consumers from five different countries (CN, FR, GER, JP, US), this study examines five relevant use cases for autonomous individual transportation and identifies the desired car features correspondingly. The results indicate that "Sleeping & Relaxing" is the most accepted use case, and that a convenient seating/lying position and smooth driving dynamics are seen as key features.**

*Keywords — autonomous driving; extra equipment; interior design; in-car experience; user acceptance; vehicle concept; global survey*

## I. INTRODUCTION

### A. Motivation

No reference is needed to underpin one of the major trends in the automotive industry as of 2017: autonomous driving is coming, eventually. This development is going to reshape if not revolutionize the way cars are used in the future. Accordingly, the design of cars and their functions will change. Every major auto maker has recently presented futuristic car concepts: Audi Aicon [1], Mercedes-Benz F-105 [2], and VW Sedric [3], just to mention a few. All of these concepts emphasize the car's interior design, but do not entirely answer the question, what purpose they are made for. The authors are not aware of any study that, in detail, examined how different use cases of passenger activity during autonomous driving, desired car features and suitable trip purposes are related.

### B. Prior studies

Several works have analyzed how people would like to use their time in the car if they are dispensed from the driving task. A study by Bitkom Research [4] found that most respondents would talk to their co-driver (53%), read (34%) or, in fact, still focus on traffic (44%). Watching movies (24%), working (15%) and sleeping (7%) were ranked behind. Another recent survey came to a similar conclusion [5]: Looking out of the window and observing the environment was the most desired activity (73% of respondents), followed by relaxing (59%), reading (47%) and surfing the internet (39%). Again, working and sleeping (both 28%) are considered less attractive. Moreover, the study looked at the kinds of drives that are especially relevant for autonomous driving, i.e. long highway drives, overnight vacation drives and commuting. However, no connection was made regarding the relevant activities per trip purpose.

In a joint study ("The Value of Time", 2016), Fraunhofer IAO and Horváth & Partners have examined how people would like to spend their time during autonomous driving and what their general willingness to pay for user-centered services in the car was [6]. For this purpose, 1,500 car drivers from Germany, USA and Japan were queried by an online survey: In the first part of the questionnaire, the participants were presented with different service groups, such as "eating / drinking", "organization" or "wellness". For each of these service groups, one specific activity was provided as an example, e.g. "breakfast", "online banking" or "meditation". It was analyzed how relevant the different service groups were and how often the participants would use the corresponding activities while driving. In the second part of the survey, the willingness to pay for these services was assessed on the level

of "needs". Each of the six needs covered the service groups that are relevant to fulfil the respective need. For instance, the need "wellbeing" is fulfilled by the service groups "wellness", "beauty", "health" and "fitness".

The study has shown that a significant majority of participants is prepared to pay to freely make use of their time in the car by value-added services. The highest willingness to pay was indicated for the needs "communication", "productivity" and "basic requirements". The most relevant service groups were identified to be "private communication", "surrounding / route information", "online information search", "shopping for daily requirements" and "eating / drinking".

Findings were also made in relation to the extent to which the relevance and willingness to pay depends on other factors, such as the user's yearly mileage, the vehicle segment, or the age of the driver. This information was seen as extremely important for targeted development of new business models in the framework of autonomous driving. The analysis of users' willingness to pay, however, had certain limitations. In particular, it was predefined that the ability to do other activities while driving is connected to a monthly payment. This assumption implies a certain business model, i.e. that there is a periodic service fee rather than a one-time cost. This model is very different from how cars have traditionally been sold. Moreover, the willingness to pay was surveyed on the level of the six needs described above. Every need, however, covered several service groups that put very different demands on the equipment of the car. For instance, "eating / drinking" requires a very different set-up than "sleeping", although both service groups were assigned to the need "basic requirements". In turn, two service groups may pose the same requirements even if they meet different needs. For instance, a table is required for both "eating / drinking" and "organization". Thus, specific implications regarding the willingness to pay for distinct features of future cars are difficult to draw.

## C. Research goal

Based on the results and key findings of the "Value of Time"-study, the goal of the present study was to understand the implications of autonomous driving for the interior design and the equipment of fully autonomous vehicles. And although shared autonomous vehicles (so-called robocabs or urban pods) may potentially gain a larger market share in the future, the authors assume that vehicles for exclusive, personal use will continue to play a significant role in the modal split of the future. Since this concept is also much more familiar to most respondents, the majority of the survey focuses on those "private vehicles". Only in the last part of the survey shared mobility and specifically designed robocabs play a role. Accordingly, the following five research questions are answered by this study:

1. What is the acceptance of different use cases for autonomous individual transportation?

2. Which use cases are best suited for different kinds of trip purposes and amounts of people in the car?

3. Which features are required to best fulfil the needs of different use cases?

4. How much are potential customers willing to pay for these (extra) features?

5. What is the acceptance of different specifically designed robocabs?

6. How do preferences differ with regard to socio-demographic criteria of the sample?

Thus, in order to distinguish from prior studies, it is the goal of this research to understand how much drivers are willing to pay for additional car features that help them better experience different use cases during autonomous driving, as well as to illuminate the relevance of said use cases.

## II. SURVEY DESIGN

### A. Assumptions

While fully automated vehicles will most likely not be available in the short term, they surely represent the most interesting development stage of automated driving. Therefore, the study only considers automated vehicles that correspond to the level five of the NHTSA/VDA classifications [7, 8]: The vehicle is autonomous and the human driver is not taking control of the vehicle at all. Moreover, it is assumed that every autonomous vehicle comprises at least the same features that a decently equipped 2017 middle-class car offers.

Respondents should assume that their (personal) autonomous vehicle already has basic equipment that is similar to a well-equipped midsize car by today's standards. Thus, in addition to the autonomous driving function, the special equipment of the vehicle also included:

- Air conditioning
- Internet and Wi-Fi
- Multimedia / navigation system input / input unit
- Navigation system
- Seats
- Speakers for multimedia, navigation and music
- 10-inch display for displaying multimedia content and information

This procedure ensured that study participants did not assume a completely "empty" vehicle.

### B. Use Cases

In the first part of the survey, it was analyzed how consumers assess different kinds of activities that could be possible during autonomous transportation in the future. For this purpose, activities that pose similar requirements to the car's equipment are grouped into five distinct use cases: Sleeping & Relaxing; Working & Being Productive; Eating & Drinking; Entertainment; Beauty, Wellbeing & Fitness. These use cases are based on the most relevant needs and service groups of the "Value of Time" study mentioned above:

- **Sleeping & Relaxing:** includes any form of rest, from dozing in a seated position to deep sleep in a lying position.

- **Working & Being Productive:** includes the private and professional office work e.g. the writing of documents, time scheduling or further education measures such as a language course.

- **Eating & Drinking:** includes the consumption of small snacks and drinks as well as the consumption of whole meals, which can be kept cool or warmed up in the vehicle.

- **Entertainment:** includes activities such as watching TV, playing video games, listening to music, reading books or playing board games.

- **Beauty, Wellbeing & Fitness:** includes activities such as body care and make-up as well as activities related to well-being and fitness such as gym exercises.

Survey participants were asked to rate the different use cases as well as the kinds of trips that were most suitable for the respective use case. The acceptance of the use cases was analyzed in accordance with the "Technology Acceptance Model" [9] and can be derived from the following three items:

- The use case … is useful.

- The use case … excites me.

- The use case … would I do regularly.

All statements should be rated on a 5-point Likert scale from "Disagree" (-2) to "Agree" (+2). The acceptance of each use case results from the proportion of respondents that indicated a clearly positive overall agreement score, i.e. a mean value of all three agreement scores that is greater or equal than 1.

Moreover, the use cases were examined in terms of their suitability for different kinds of drives. The study relies on trip purposes that were used in other scientific surveys before [10]:

- Long business trip (<1h)

- Short business trip (>1h)

- Short leisure trip (<1h)

- Long leisure trip (>1h)

- Bringing or picking up people

- Commuting (work or education)

- Shopping/grocery trip

- Vacation trip

Respondents were able to choose up to three suitable trip purposes per use case. The general suitability of a certain trip purpose for alternative activities during driving results from the total number of responses across all use cases.

Finally, it was examined which use cases are particularly well suited for only one person and which ones are particularly well suited for several passengers. For that purpose, respondents should select one to three well-suited use cases for both kinds of settings.

## C. Car features

The second part of the survey aimed at identifying the features that are most relevant for each use case. Therefore, equipment options that are conceivable to be useful for the different activities have been presented to the participants, and they should rate the importance of each option for the respective use case.

The three features „Quiet ride", „Isolation to the outside" and „Convenient atmosphere" were considered significant for all use cases and therefore queried for all use cases. The feature "virtual assistant" was also available in all use cases, but was individually described according to the respective activities (for example, "assistant who allows food delivery to the car"). Each functional equipment of a use case should be rated by respondents on a 5-point Likert scale from "not important at all" (-2) to "very important" (+2). The relevance of each equipment option (with regard to the respective use case) is determined by the proportion of clearly positive ratings ($\geq 1$).

## D. Ideal interieur of an allround vehicle

In the case of privately used vehicles, it is fair to assume that they are not going to serve only one single use case. Thus, the study looked at what an autonomous car would look like if it was configured for all potentially relevant use cases. Respondents were asked to review all of the previously requested equipment options and select the most important three to six options for them. For this purpose, similar equipment options (for example "Comfortable sitting position to working" and "Comfortable sitting position for relaxing") have been combined into one equipment option ("Comfortable sitting position for relaxing or working").

## E. Willingness to pay

The purpose of the study was not only to make statements about possible equipment options in particular use cases, but also to gain information about the willingness to pay for these equipment features. The willingness to pay for all present equipment options was queried in 15 steps from "0 €" to "more than 5000 €", referring to a one-time payment when buying the vehicle

## F. Specifically designed robocabs

Since not all types of use can necessarily be performed perfectly in one and the same vehicle, the idea of highly specialized, autonomous robocabs was developed. These special vehicles, offered as "mobility on demand"-service, are supposed to be ordered easily via smartphone and be paid for by use, just like the currently known ride hailing services (Uber, Lyft). Their special feature, however, apart from the autonomous driving function, is an interior that is specifically designed for a particular use case. The presented robocabs are based on the use cases described above (e.g. "Eatery Car"), but sometimes also go beyond (e.g. "Party Car"). Respondents should choose one to three robocabs that they would most

likely use. After the introduction of the concept, the respondents should also rate the acceptance of this concept in general, and how they would like to pay for it.

## III. DATA ACQUISITION & SAMPLE

### A. Selection of target group

In addition to the traditional triad markets Germany, USA and Japan, China and France were added in this study. China was chosen because it is and will remain one of the most important automobile markets in the world. France was added to this study in order to have another European market as a reference, besides Germany.

### B. Data acquisition

For this study, an online sampling company was assigned to provide 500 survey participants from China, Germany, France, Japan and the US each. By offering a financial incentive, the online sampling company insured that respondents finish the entire survey, which in turn enabled the analysis of a gapless dataset. As it was assumed that a proper completion of the survey would take at least 6.5 minutes, complete survey answers that have been finished within less than 6.5 minutes have been excluded from the sample. After some additional data clearing, a final sample of n=2,500 survey answers was used for the analysis.

### C. Demographic characteristics of final dataset

For the survey, 500 participants from each of the five countries China, Germany, France, Japan and the USA were interviewed. The average age was 46.3 years. The results show that the sample contains comparatively few Chinese participants that live in rural areas – which can at least partly be attributed to the comparably high urbanization in China.
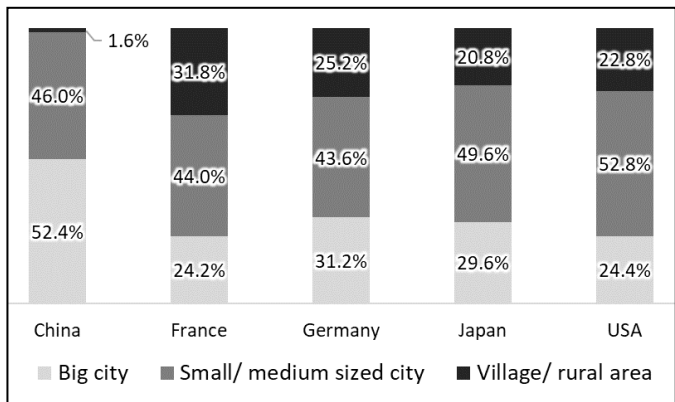


Fig. 1.  Distribution of residential environment per country (n=2,500)

## IV. DESCRIPTIVE STATISTICS

### A. Acceptance and suitability of use cases

The results show that "Sleeping & Relaxing" clearly is the most popular use case, while "Beauty, Wellbeing & Fitness" falls back a little (cf. Fig. 2). The remaining three use cases are rated on a similar level in between. This distribution does not change across different genders and age groups, even though

acceptance is generally a little bit higher for younger people. Also, differences between countries can be observed.
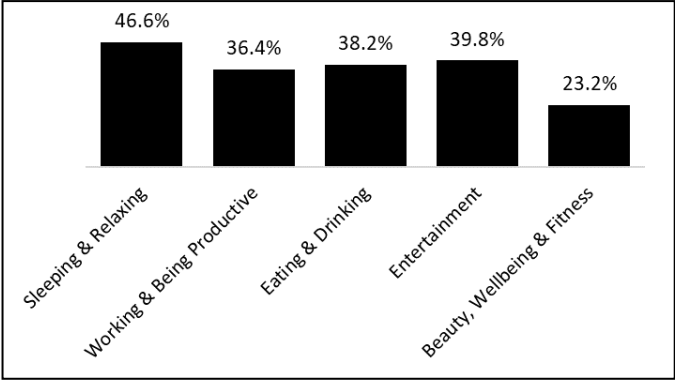


Fig. 2.  Overall relevance of use cases

Regarding trip purposes, it is noticeable that "Sleeping & Relaxing" is especially relevant for long drives, such as long business trips, long leisure trips and vacation trips (cf. Fig. 3). These three trip purposes also do have the highest suitability for alternative activities during driving in general. In turn, the use case "Working & Being Productive" is considered especially relevant for all kinds of business trips including commuting, while "Eating & Drinking" is relevant for almost all trip purposes. There are no significant deviations across genders, age groups and countries.

| # of indications | Trip purpose | Top 3 Use Cases | | | | | |
|---|---|---|---|---|---|---|---|
| 7511 | Long leisure trip (>1h) | | 73% | | 72% | | 71% |
| 7120 | Vacation trip | | 71% | | 69% | | 68% |
| 4492 | Long business trip (>1h) | | 61% | | 36% | | 33% |
| 2308 | Commuting | | 35% | | 19% | | 14% |
| 1960 | Short business trip (<1h) | | 42% | | 11% | | 9% |
| 1764 | Short leisure trip (<1h) | | 19% | | 17% | | 14% |
| 1289 | Shopping/grocery trip | | 14% | | 11% | | 10% |
| 1109 | Bringing or picking up people | | 11% | | 10% | | 9% |

| | | | |
|---|---|---|---|
| ▨ | Sleeping & Relaxing | ⦂⦂ | Entertainment |
| ▨ | Working & Being Productive | ‖‖ | Beauty, Wellbeing & Fitness |
| | Eating & Drinking | | |

Fig. 3.  Relevance of use cases per trip purpose (up to 3 indications per resp.)

The suitability of use cases for a single person in the car pretty much equals the general acceptance of use cases as described above. However, looking at the suitability of use cases for two or more people in the car, it is noticeable that "Eating & Drinking" and "Entertainment" surpass the otherwise very well perceived use case "Sleeping & Relaxing". The latter in turn enjoys less popularity for multi person drives, just like "Beauty, Wellbeing & Fitness". Only "Working & Being Productive" is rated similarly for single and multi-person drives alike. This indicates that the participants could imagine to work in autonomous cars alone (e.g. writing a report) and in the group (e.g. having a meeting).
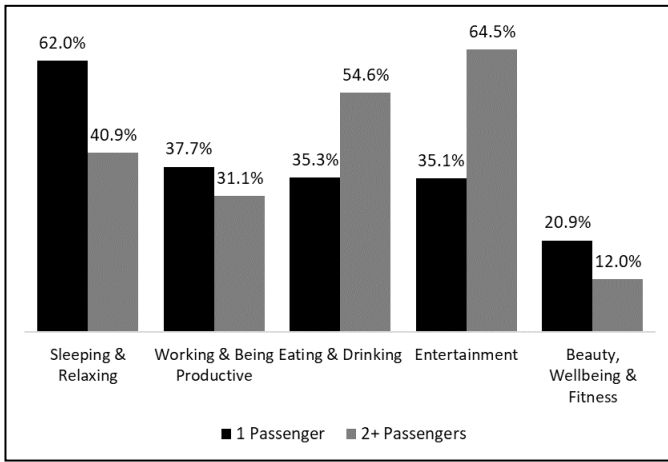
Fig. 4.  Relevance of use cases per occupancy (up to 3 indications per resp.)

## B.  Relevant car features per use case

To understand how future autonomous cars need to look like in order to enable the different use cases explained above, one needs to look at the relevance of different kinds of (additional) equipment options. In a first step, the relevance of specific features is analyzed for each of the five use cases.

As shown in the graphic below, the respondents indicate that the equipment option "Comfortable sitting position for sleeping and relaxing" is very useful for the use case "Sleeping and Relaxing". Also a "Quiet ride", a "Comfortable lying position for sleeping" and an "Isolation to the outside" are important equipment options. In contrast, the option "Full body massage" was rated as unimportant or only partly important.
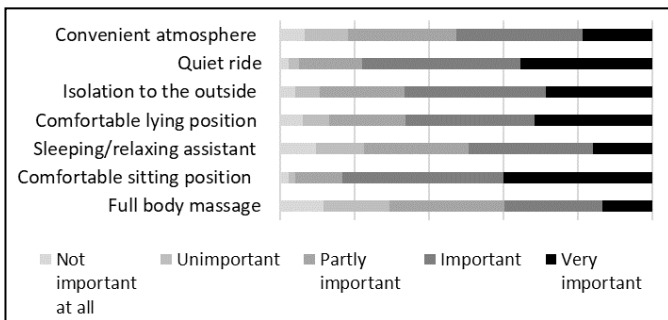


Fig. 5.  Relevance of equipment options for "Sleeping & Relaxing"

For the use case "Working & Being Productive" all queried equipment options were considered relevant by the respondents. Especially the options "Quiet ride" and "Comfortable sitting position for working" were rated very high by the respondents.
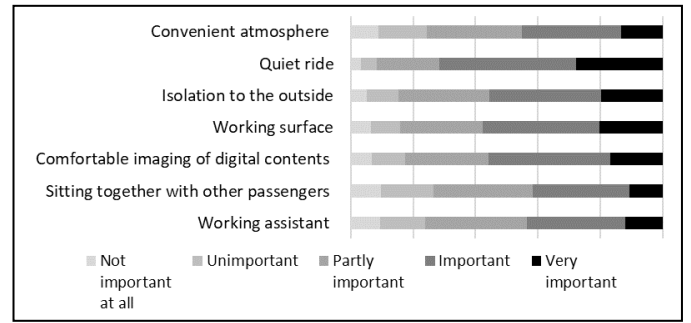


Fig. 6.  Relevance of equipment options for "Working & Being Productive"

The option "Quiet ride" is the most important equipment in the use case "Eating and Drinking". Also the opportunity to cool foods or beverages are considered as important by the respondents. In contrast, the "Food ordering assistant" was rated lowest. As well as the option "Heating opportunity", the respondents rated the possibility of "Sitting together with other passengers to have a joint meal" as not very important in comparison to the other equipment options.
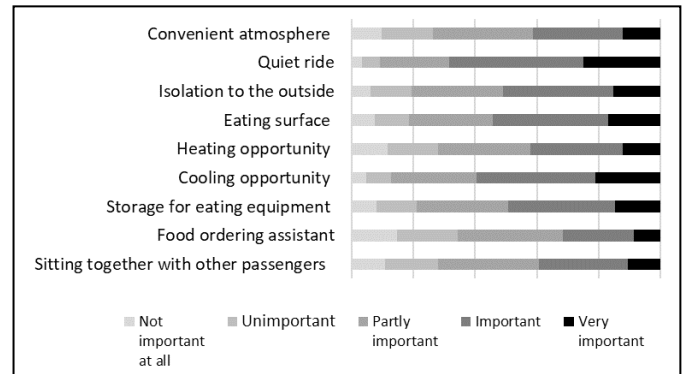


Fig. 7.  Relevance of equipment options for "Eating & Drinking"

In the "Entertainment" use case, the "Quiet ride" option achieves the highest rating of all. Additionally, the options "Isolation to the outside" and "Surface to place entertainment goods" were considered important, too.
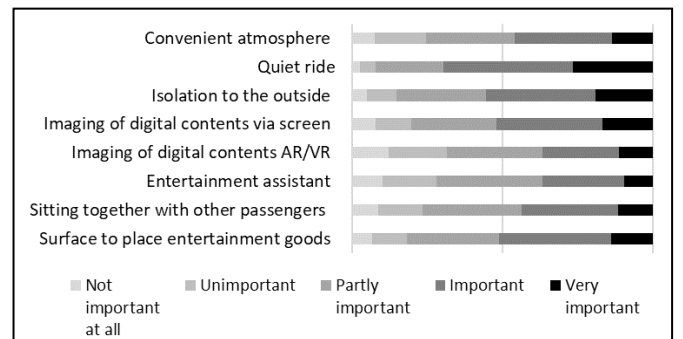


Fig. 8.  Relevance of equipment options for "Entertainment"

The use case "Beauty, Wellbeing & Fitness" got the lowest rating of all use cases. Regardless, the equipment options "Quiet ride" and "Isolation to the outside" were rated as most

important. The other options are rated as not so important by the respondents.
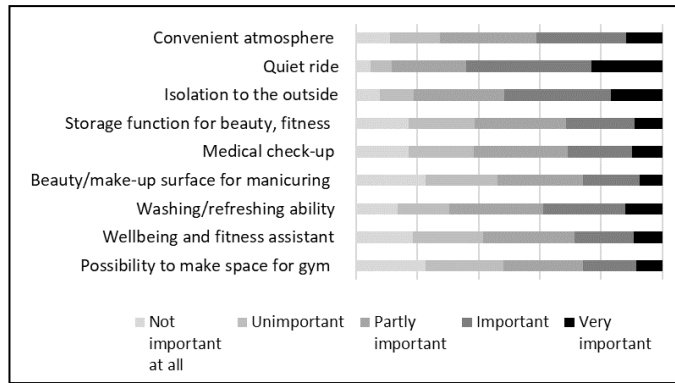


Fig. 9. Relevance of equipment options for "Beauty, Wellbeing & Fitness"

### C. Overall relevance of autonomous car features and willingness to pay

If the survey participants were to configure an autonomous car for allround use, comfort features seem to be most relevant:



Fig. 10. Most relevant allround car features (6 indications per respondent)

Especially a comfortable sitting position, quite driving dynamics and a comfortable lying position are very popular (cf. Fig. 10). Interestingly, the "cooling opportunity", a feature that refers to only one use case ("Eating & Drinking"), ranks fourth, while the "retractable surface" that plays a role for several use cases only ranks sixth. The surprise continues when looking at the w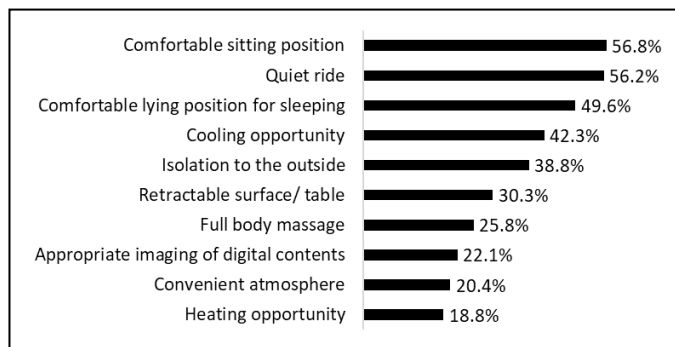illingness to pay: Only 18.3% of respondents would pay no more than 0€ for a cooling opportunity, i.e. 71.7% would in fact pay for this equipment option (cf. Fig. 11). In contrast, 22.2% would pay no premium for the feature "quite ride", indicating that this feature is seen as a basic equipment of autonomous cars. Comfortable seating and lying opportunities, however, attain the highest share of people that would pay more than 1,000€ for appropriate special equipment (3.9% and 4.0% respectively).

| Equipment option | Not more than 0€ | More than 100€ | More than 500 € | More than 1000€ |
|---|---|---|---|---|
| Comfortable sitting position | 18.6% | 42.8% | 9.2% | 3.9% |
| Quiet ride | 22.2% | 41.8% | 10.3% | 3.5% |
| Comfortable lying position for sleeping | 20.1% | 45.4% | 11.0% | 4.0% |
| Cooling opportunity | 18.3% | 31.2% | 4.2% | 1.3% |
| Isolation to the outside | 22.9% | 36.7% | 6.8% | 2.8% |
| Retractable surface/ table | 25.3% | 25.5% | 3.8% | 1.5% |
| Full body massage | 33.5% | 33.3% | 8.5% | 3.1% |
| Appropriate imaging of digital contents | 28.4% | 35.8% | 7.7% | 2.4% |
| Convenient atmosphere | 38.4% | 21.8% | 4.4% | 1.8% |
| Heating opportunity | 33.4% | 24.0% | 3.3% | 1.3% |

Fig. 11. Willingness to pay for Top 10 allround features (darker = less WTP)

### D. Acceptance of specifically designed robocabs

In general, this innovative mobility concept is highly accepted by 37.2% of respondents. Similar to the types of use in private vehicles, the "Sleeping Car" is also particularly popular here. Almost as popular is the "Sightseeing Car", a motto taxi that enriches the journey with information about the environment. The other robocabs with comparatively high acceptance are all relatives of the use cases mentioned above. Surprising here is that the "Wellness Car" performs relatively well, although the usage "Beauty, Wellbeing & Fitness" was previously rated with comparatively low acceptance. The "Beauty Car", the "Fitness Car" and the "Gaming Car" on the other hand are rated relatively weakly.

While only minor country differences can be seen, there is an interesting obversation for the age groups show an interesting observation: Particularly in the case of the "Wellness car" and the "Sightseeing car", the acceptance increases significantly with the age of the interviewees.
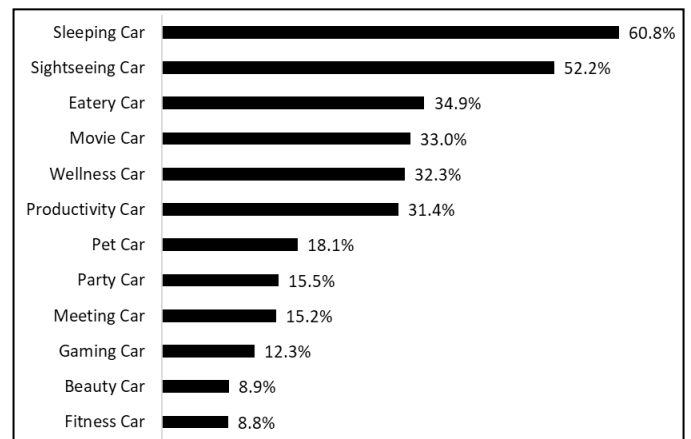


Fig. 12. Acceptance of specifically designed robocabs

Asked how they would like to pay for these specialized robocabs, most respondents (39%) prefer a "pay per ride"-model (cf. Fig. 13). Billing per time or per mile, as well as a monthly flat fee are less popular.
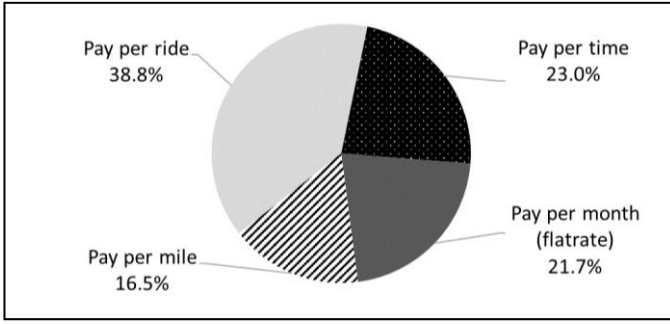
Fig. 13. Acceptance of specifically designed robocabs

## V. Observed Correlations

### A. Daily driving time, frustration and acceptance of autonomous driving

About 25% of respondents indicated a high level of agreement to the statement "I spend too much time in my vehicle". In addition, a particularly high affirmation towards this statement was observed in the age groups 25-34 and 35-44. Noticeable is the fact that the group of drivers who have agreed to the statement also estimate their daily travel time to be 95 minutes, which is 25 minutes longer than the estimated travel time of all other participants. Moreover, the results show that consumers who believe that they spend too much time in their vehicle, have a higher pleasant anticipation to autonomous driving than other respondents (74% vs. 40%).

### B. Nationality, virtual assistants and willingness to pay

On average, only about one third of the respondents find virtual assistants uninteresting, with more than three quarters showing an interest in for the use cases "Working & Being Productive" and "Sleeping & Relaxing". Basically about 60% of the respondents, i.e. only slightly less than those who express a consumption intention at all – are willing to pay for such equipment. However, about one third of all people across the country have a willingness to pay of up to € 100. On the other hand only very few of the respondents would pay more than € 500. China, where more than four-fifths of respondents are willing to pay for virtual assistants, was identified as the country with the highest levels of willingness to pay. Japan and Germany have similar distributions, which also roughly correspond to the average of all respondents. Interesting are the results of the French market, which has the lowest willingness to pay. Thus, only half of the interviewed French would be willing to pay for virtual assistants at all. On the other hand, the interest of French respondents in virtual assistants is on average, and even higher than average for "Working & Being Productive" and "Eating & Drinking". The Chinese respondents, who also show the highest willingness to pay in general, indicate the highest interest in all activities. While the Japanese respondents showed an above-average interest, especially in the use case "Sleeping & Relaxing", the US and German respondents showed a below-average interest in all activities. This is particularly noticeable in the case of the Germans, as the second highest willingness to pay for virtual assistants was shown for the German market, closely followed by the Japanese.

### C. Business traveleres and use cases

While there is no clear preference for all other driving purposes, "Working and being productive" is by far the best use case for work related purposes. For example, working on long business trips is the most suitable use case for 61% of respondents, while "Sleeping & Relaxing" and "Eating and Drinking" are far behind with 36% and 33% respectively. Even with short business trips and commuting, productive activities are always at the top with at least 20 percentage points ahead (see Fig. 14).
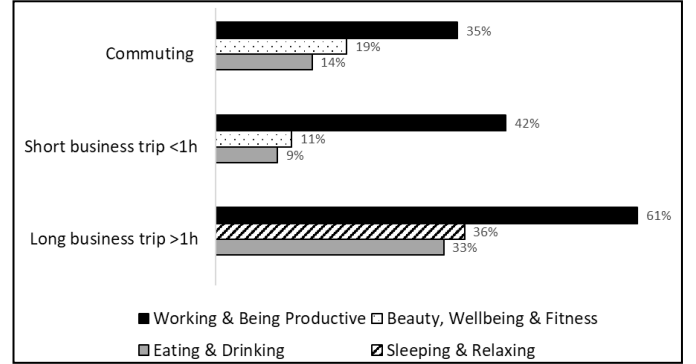


Fig. 14. Most suited use cases for work-related trip purposes

These findings will not surprise anyone using business trips for phone calls already today. However, with autonomous driving, far more complex productive activities in the vehicle will become possible in the future. The desired future use of business trips in the car thus converges to the behavior of business travelers in rail transport: they mostly spend their time working [11]. However, where not all business activities can be carried out without problems in a train car, e.g. due to a lack of privacy, the private space within an autonomous vehicle opens up completely new possibilities. In the car of the future, not only can confidential telephone numbers be kept undisturbed, but also the creation of complex CAD models on large-format displays could become possible due to the larger available space.

## VI. Discussion

### A. Conclusion

The present survey mostly confirms the findings of prior studies. Moreover, it provides additional insights regarding the practical implementation of different use cases in autonomous driving as well as the relevance and willingness to pay for specific car features. Across the sample of 2,500 car drivers from five countries, "Sleeping & Relaxing" has been identified as the most relevant use case for autonomous individual transportation. Taking previous research into account [5], one would assume that especially "relaxing" is a very relevant activity to be done in future cars. Accordingly, special equipment options that provide a comfortable relaxing position (both sitting and lying) are considered important and also rated with a comparably high willingness to pay. Smooth driving dynamics, in turn, are considered relevant as well, but willingness to pay is restricted.

The survey also shows that not all use cases are equally suitable for all kinds of trips. Most notably, "Working & Being Productive" is particularly relevant for business trips and commuting – without major differences regarding the number of people in the car. In contrast, "Sleeping & Relaxing" is clearly seen as a one-person activity and it is relevant for any long-distance trip. "Eating & Drinking" and "Entertainment", however, are clearly seen as group activities, with high relevance for all kinds of trips, especially private ones. With an overall low acceptance, "Beauty, Wellbeing & Fitness" is only considered relevant for shorter trips, particularly commuting.

The previously determined high popularity of "looking out of the window" (cf. prior studies) is confirmed by the high acceptance of a robocab specifically designed for this use case ("Sightseeing Car"). Other innovative mobility concepts that got high acceptance values are the "Sleeping Car", the "Eatery Car", the "Movie Car", the "Wellness Car" and the "Productivity Car". These results indicate that some use cases are rather less accepted within privately used cars, but are indeed interesting if implemented via specifically designed on demand vehicles (e.g. the "Wellness Car").

## B. Implications for industry

For automakers, suppliers and new mobility companies, there are several lessons to learn from this survey. This relates to the equipment of future cars as well as to their marketing:

1. Smooth driving dynamics are an important feature, but the willingness to pay for it is limited. This feature can thus be seen as mandatory for every autonomous vehicle and engineers should not treat the development of the required technologies lightly. Otherwise, it will be hard to positively experience the envisioned use cases in the cars of the future.

2. Comfortable seats, potentially transformable to a bed, could provide considerable potential for revenue from additional equipment in the sale of privately used autonomous vehicles.

3. Different trip purposes may require different equipment set-ups. When commuting, people want to work and satisfy their basic needs (eating, drinking, beauty), when travelling long-distance, they want to relax, and when travelling for business, they want to work, either alone or in the group. Thus, targeted offers could be a solution to maximize both user value and business revenue. For instance, commuters may be happy with a simple one-person pod for their everyday mobility, but require a full-size long-distance vehicle whenever they go on vacation.

4. Frequent business travelers require a company car that combines a work environment with an opportunity to relax occasionally. As company cars are typically replaced within 2-3 years, this segment could provide potential for a fast diffusion of work-related equipment in (partly) automated cars.

5. Specifically designed robocabs that are booked on demand are appreciated by more than one third of the sample. Thus, this innovative mobility concept could become a viable business model at some point in the future. Especially the dedicated "Sleeping Car" and the "Sightseeing Car" promise potential for revenue.

## C. Limitations and further research

As every other survey on user acceptance of future technologies, this study has its limitations. Specifically, it may be hard for people to imagine how autonomous driving will be like and how they would use autonomous vehicles if they were available. Moreover, an online questionnaire can only capture a certain portion of future user needs and preferences. Thus, to study user acceptance in detail, further working prototypes and demonstration vehicles are required to investigate how people actually behave and what they really need.

The revenue potentials indicated above are not only contingent on further technology development, but also on the legal situation. It may very well be that, in the short-term, automated driving will only be allowed while moving on the highway. Thus, it could be worthwhile to take a deeper look at use cases and the corresponding equipment that are relevant for these kinds of trips.

In fact, further research could investigate the relationship between use cases and trip purposes in detail. For the German market, it could be an idea to bring together the results of this survey with the results of large-scale study on actual mobility behavior in Germany ("MiD – Mobilität in Deutschland"). Based on the combination of the two data sources it would be possible to generate further insights about the frequency as well as attractiveness of certain use cases. Another relationship that needs to be studied is between use cases, trip purposes and the occupancy of the car. For instance, while "Sleeping & Relaxing" turned out to be the most popular use case for long leisure trips and vacation trips, the high rating dropped when there were more people in the car. Thus, it should be analyzed how often these trips are done with only one passenger. Again, "MiD" could be helpful. Furthermore, it is obvious that e.g. the use case "Sleeping & Relaxing" does not have the same attractiveness at each hour of a day. It could be assumed that features to enable "Sleeping & Relaxing" will not be as relevant during mid-day as it may be in the morning or evening hours, or at night.

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