

VERIFIED USER NEEDS (FOCUS GROUPS)

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1 EXECUTIVE SUMMARY

The present deliverable describes the work performed in order to identify and verify user needs regarding the new vehicle concepts L3e and L5e developed within EU-LIVE. The aim is to gain a thorough understanding of targeted customers' requirements towards new L-category vehicle concepts considering today's infrastructural challenges and demographics. Identifying existing user needs as well as considering them in further product development is crucial in order to produce a product accepted and desired by the targeted customer groups.

Within focus groups of six to eight participants each, a total of 59 participants at three European locations were questioned on their current needs in different pre-defined traffic situations. As a result the participants named seven overall needs as the ones they have today: information, driving experience/pleasure, safety, comfort, cost-efficiency, time-efficiency and eco-friendliness.

A brief description of the work conducted is being explicated in section 3.

Section 3.1 describes the idea of an user-centred methodology used to question participants of small focus groups on their current needs within today's infrastructure.

Section 3.2 explains the approach of the user-centred methodology within the EU-LIVE project. It describes the exact procedure of the focus groups conducted as well as their participants.

Section 3.3 delivers a detailed report on the gained results. It describes all user needs collected as well as their corresponding prioritisations done by the participants. Furthermore, potential desired technical solutions fulfilling these needs as described by the participants of the focus groups are being reported.

Keywords: user needs, customer requirements, experience-centred methodology

2 OBJECTIVES

Objective of the present deliverable is to provide a thorough understanding of user needs towards vehicle concepts such as the L3e and L5e vehicles. Considering today's challenges of continuous urbanisation, target customers are questioned on their current unfulfilled needs. In focus groups at three different European locations, user needs are identified delivering insight into customer requirements in different countries representing target markets of the future L3e and L5e vehicles. The identified needs serve as crucial input for the subsequent definition of technical specifications of the L3e and L5e concepts.

This deliverable summarises the work performed on the following task:

T1.1.4 Exploration of user needs and definition of target markets, target price and production volumes for the vehicle concepts (L5e and L3e).

The results of this deliverable are directly linked to D1.1 [1] in which the target customer groups were defined. These user profiles were considered when selecting participants for the focus groups. Furthermore, this deliverable provides essential input to D2.1 [2] which specifies the overall vehicle requirements.

3 DESCRIPTION OF WORK

3.1 General concept of experience-centred focus groups in product development

Customers' increasing requirements towards individual mobility solutions as well as demographic changes challenge the automotive industry to develop new products that are not only economically justifiable but, furthermore, meet individuals' needs [3], [4]. Therefore, integrating the customer into the process of the development of innovations is becoming more and more crucial and should hence contribute to a larger extent to the overall product development process [5], [6].

Current approaches of development processes are mainly driven by the development stages of new technologies and, therefore, driven by already existing product ideas [7], [8], [9]. Customers' needs for the new product are assessed at a later stage when evaluating whether or not a product meets customers' requirements [10]. As opposed to this strategy, [11] propose the inverse approach: the fulfilment of customers' needs should be assessed by questioning the customer himself at the beginning of the product development phase.

However, asking the customer directly on what kind of product he or she desires might potentially cause issues. One problem most customers may have is naming an actual product as such, for instance a technical solution. This can be especially difficult for non-professionals since they may not be aware of possible technical options. A potential solution may be asking customers specifically about their requirements in a product i.e. their expectations towards a technical solution instead of the technical solution itself. This can lead to a set of specific requirements a product may have to fulfil. Subsequently, the developing engineers have to convert the requirements into potential technical solutions which may fulfil them. Defining these needs should be approached at the very beginning of the development process and should, therefore, already be part of generating the idea for a new product.

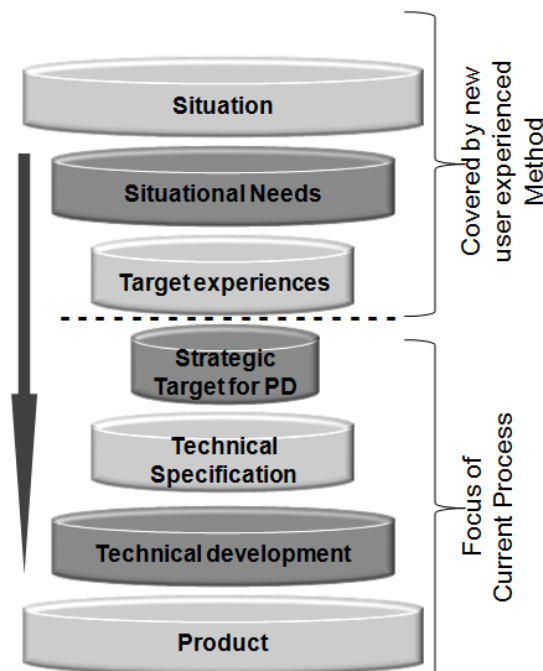


Figure 1: Product development process: current approach supplemented by potential further stages (source: fka)

An approach of a new process sequence in product development may be to start the development of ideas for new products by investigating situations in which customers may find themselves on a regular basis (see Figure 1). Each situation may bring specific challenges resulting in particular needs customers have in these situations.

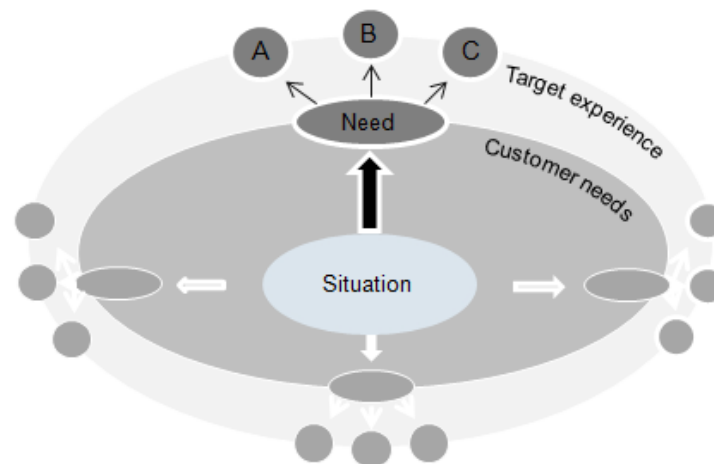


Figure 2: A situation experienced by a customer leading to needs and further to desired target experiences (source: fka)

The needs resulting from an experienced situation further lead to desired technical solutions, however, without any assessment of feasibility (see Figure 2). Therefore, the first step in the development process should be the identification of these customer situations.



Figure 3: Example of a potential customer situation: traffic jam (source: fka)

As an example, one situation a customers may find themselves in on a regular basis is a traffic jam on the motorway (Figure 3). The customers are stuck in traffic congestion with hardly any movement of the traffic, but, however, still have to focus on the traffic and the development of the congestion.

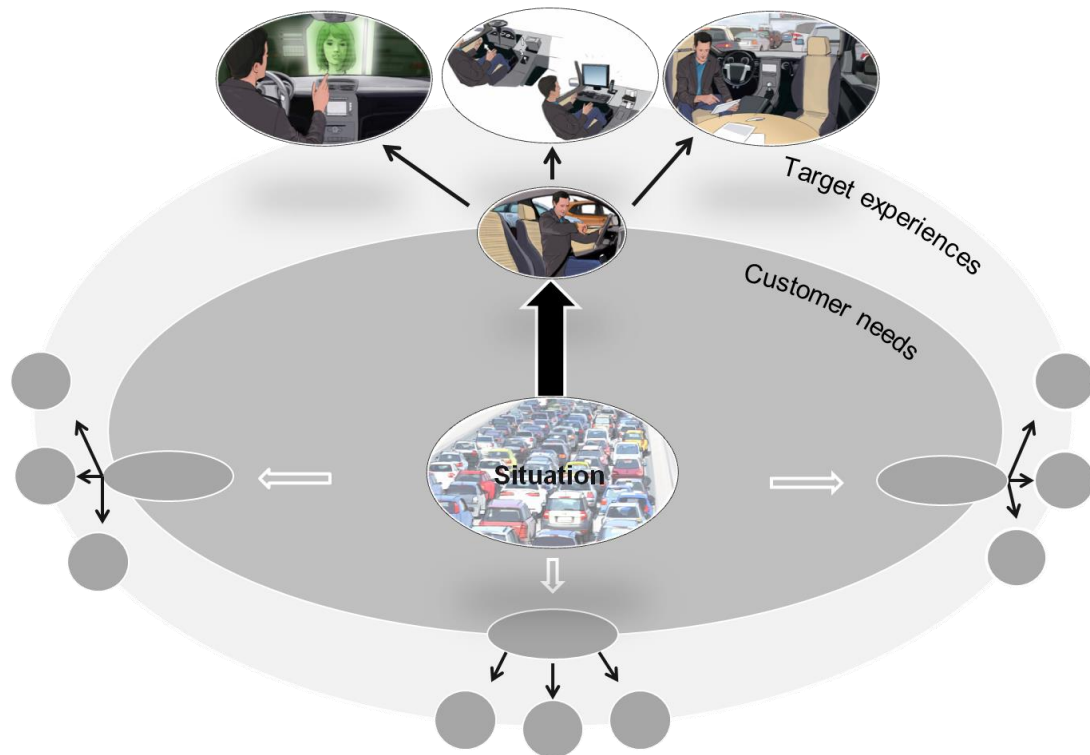


Figure 4: Example of a customer situation and its potential needs and desired target experiences
(source: fka)

A potential need of customers in such a traffic situation may be the efficient usage of their time due to the given situation (in this case the congestion) offering them time where they may not have to fully focus on the traffic situation itself since it is not as demanding. The need of the efficient usage of time, furthermore, may lead to the customers' desired target experiences being different options their vehicles may offer, which may then fulfil their need. One may be the windscreen functioning as a video conferencing screen, another may be dismantling the steering wheel and using the space as a workstation instead, as illustrated in Figure 4. However, it is essential to identify the customers' needs and target experiences regardless of any current technical advances or restrictions. Instead what is being aimed at are blunt customer desires resulting from a given situation serving as metaphors for potential future innovations.

In a further step these needs are to be prioritised by the customers and thus shedding light on which desires are to be targeted first. Furthermore, the collected target experiences are to be evaluated by experts in regard to technical feasibility. A comprehensive strategic market analysis can deliver crucial knowledge on 1) technical solutions already existing as such, 2) products satisfying customer needs being able to be developed within the next 3-5 years, 3) technical solutions for some needs not being possible at all using today's technical status and 4) technical solutions potentially already existing aiming at fulfilling certain needs, however, still struggling in accurately targeting them. The example situation above of being trapped in a traffic jam and having the need to efficiently use the time spent in the congestion is today already addressed by certain driver assistance systems such as the traffic jam assistant. These allow for the vehicle to manoeuvre itself automated through the traffic hereby allowing the customer to use the time efficiently for other activities. However, comparing the customer need of efficient time usage with this technical solution may show that the need is cannot fully be satisfied at the moment. In current systems customers may still be obliged to have one hand on the steering wheel depriving them from fully being able to perform secondary tasks. The comparison of current existing products and defined customer needs may give indications on remaining open issues which still need to be addressed technically (or legally) in order to completely fulfil customers' desires. Additionally, knowledge of those competitors' products which already are fulfilling certain customer needs may serve as a further indication when evaluating and defining future product planning.

This enables an evaluation of which innovative products (either already existing ones or ones that can be newly developed) can respond to customers' desires in the most efficient manner. This subsequently helps to strategically prioritise the manufacturer's own current technical product development foci and targets. As a result of several situations being analysed with respect to customer needs and target experiences, a so called

'customer journey' can be identified [12]. Different crucial situations which customers undergo with a product deliver individual needs with individual priorities. The aim is to deduce specifications for a product from grouping the situations and their corresponding needs. Examining such a customer journey can help understand a) different situations as such that are experienced and b) needs changing depending on the situation.

3.1.1 Procedure of the experience-centred focus groups

The here proposed experience-centred method consists of different qualitative and quantitative phases (see Figure 5).

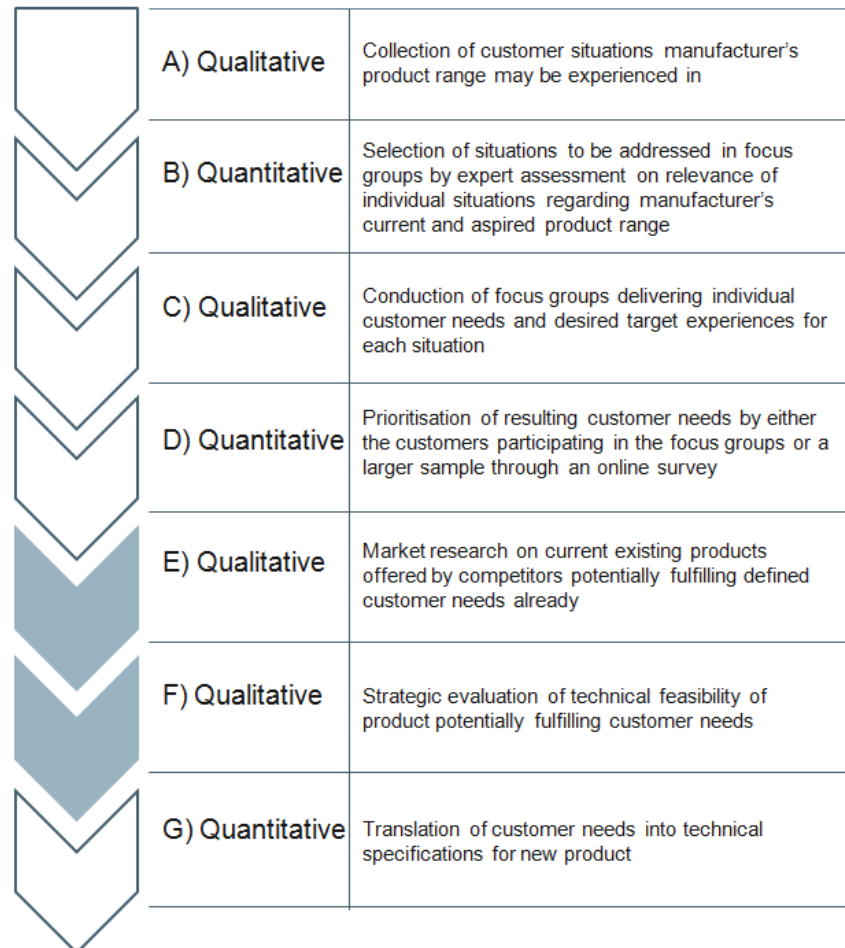


Figure 5: Procedure of experience-centred method (source: fka)

The first qualitative phase (A) is the general identification of situations a manufacturer's target customer group may experience with the brand's already existing products. Within the automotive industry, these may be situations around owning and driving a vehicle.

As a next (quantitative) step (B) manufacturers' experts prioritise the collection of situations in regard to selecting situations to be further elaborated. These situations should represent experiences their general customer group may have and in which they may face individual challenges, which are not yet overcome by the brand's current product range. The selection of the situations is an important step since they are the basis for the needs and target experiences and, therefore, serve as the basis for the ideas for a new product gained through the approach.

The subsequent qualitative step (C) is the conduction of small focus groups in which target customers are being actively questioned with respect to each situation. Ideally, these focus groups are conducted in different locations representing key market areas of the manufacturer with different groups of target customers representing people with different characteristics. The aim is to have the selected situations elaborated by different types of relevant customers in order to gain as much insight into potential needs and target

experiences of different customer groups as possible. Characteristics such as different nationalities may lead to differing customer desires and thus delivering essential input and feedback for the manufacturer aiming at identifying new product ideas.

In groups of around eight people, customers are given one individual situation at a time and are asked to discuss their potential needs in the particular situation. Furthermore, desired target experiences are discussed. Hereby it is essential to encourage customers to name needs and desires in a specific situation regardless of any technical restrictions.

A dedicated designer is to graphically illustrate different issues being named by the customers allowing for a more active discussion as well as an easier and more vivid illustration of complex customer desires.

Following the group discussion on a specific situation customers are, in a next quantitative step (D), asked to prioritise the desired target experiences they named regarding to how important they are to be fulfilled immediately.

In a subsequent qualitative stage (E), manufacturers can conduct strategic market research on their current positioning within the industry. The purpose is to obtain a comparison to competitors potentially already offering necessary technical solutions, as well as essential input on strategic prioritisation of current product development targets.

Furthermore, manufacturers are to evaluate in a further optional qualitative phase (F) to what extent customer needs can already be fulfilled using their current technological advances and which innovations could be developed further in order to fulfil the needs in an efficient manner. This will generate valuable input for strategic planning of future product development targets and options for short-term profits within the market.

Finally, if a product's development is feasible with the current status of technology, customer needs are to be translated into technical specifications for that product by a developing engineer (G).

3.1.2 Application in EU-LIVE

The approach of defining product requirements by evaluating customer situations together with real end-users with respect to their desires is being applied within EU-LIVE. The idea is to verify hypothesised user needs towards the new L3e and L5e vehicle concepts and identify crucial characteristics the new products should entail. In focus groups at different European locations, target customers described their needs and desired technical features of a vehicle in common traffic situations, leading to a collection of technical specifications which are essential for the subsequent technical development of the vehicle concepts.

3.2 Procedure

In order to verify user needs and derive desired technical requirements for the L3e and L5e concepts, individual quantitative and qualitative steps of the experience-centred method (section 3.1.1) were applied. First, a collection of all possible traffic situations (Figure 5, phase A), in which the new vehicle concepts may be fulfilling certain needs today's vehicles do not fulfil, were collected. These situations were then rated (Figure 5, phase B) according to their relevance for the particular vehicle concepts by the project's consortium in order to select six situations to be discussed with real end-users. Following this, focus groups were conducted (Figure 5, phase C) in which target customers were given a situation and asked which needs they usually have in such a situation and, moreover, which characteristics their vehicle should have in order to deal with the situation in the most satisfying manner. Customers were told not to consider technical or legislative restraints. They were asked to name all their needs and desires as well as all the things they would wish for their vehicle to be able to do in a completely open manner without doubting or questioning if what they were suggesting was possible or allowed at all. The aim was to gain insight into their real needs without blurring them with their thoughts on what was possible using today's technology. During the focus groups all needs and desired vehicle characteristics suggested by the participants were recorded and a mind map, centring the situation, was created. However, instead of, recording the participants' suggestions in writing, a designer (by Spirit Design GmbH) sketched all their ideas in order to allow for abstract suggestions to be illustrated in the most efficient manner. Each of the six traffic situations was sketched by the designer as well and thoroughly explained to the participants at the beginning of the discussion round using a standardized introduction for every situation allowing for every situation to be understood in the same way by every group discussing that situation.

Following the discussion of a particular situation, the participants were asked to prioritise their needs and ideas for potential technical specifications of a vehicle fulfilling their needs (Figure 5, phase D). These were numbered

and each participant was asked to rate each idea in a written way with respect to how important it was for them for this particular idea to be realised using a 5-point Likert scale ranging from 'not important at all' to 'very important'. This gave insight into how relevant each idea suggested by the participants was regarding the new vehicle concepts L3e and L5e allowing for a well-defined approach.

Three focus groups were conducted at each of the three different European locations, resulting in a total of nine focus groups. Each focus group, consisting of 6-8 participants, discussed two situations in a duration of about 2-3 hours each. This means that all six traffic situations were discussed once per location and three times in total.

3.2.1 Customer situations

As a first step potential traffic situations in which the new L3e and L5e vehicle concepts may be experienced or may offer solutions to challenges standard vehicles would raise, were collected. We identified situations which a) offer an everyday experience a customer using a standard vehicle may have in order to evaluate whether or not the new vehicle concept may offer solutions to potential needs in these situations; and b) situations which customers may experience using both, the new vehicle concept as well as a standard vehicle. The aim was to select six situations for discussion with target customers in the focus groups. In order to do so, the collection of situations was assessed within the project's consortium. In an online survey EU-LIVE partners were asked to rate each individual situation with respect to how important it is in their opinion, that the future vehicle concept will satisfy the customer in the presented situation. They were asked to rate this using a 5-point Likert scale ranging from 'not important' to 'very important'. This enabled us to select the situations offering the most relevant input regarding user needs for the L3e and L5e vehicles.

Customer Situations	Average Rating
Finding a parking space and parking the vehicle.	4.57
An exhausting city drive with bad traffic conditions (e.g. traffic jams, many traffic lights, narrow streets etc.).	4.48
Approaching a carsharing vehicle, entering it and preparing it for a short city drive (including planning the route and adjusting settings such as seat positioning etc.).	4.17
A city drive in adverse weather conditions (e.g. heavy rain, black ice etc.).	4.00
The vehicle requiring service (e.g. fixing of something, regular inspection etc.).	3.96
Approaching the vehicle, entering it and preparing it for a short city drive (including planning the route and minor adjustments e.g. temperature settings etc.).	3.91
Leaving the vehicle (e.g. locking it etc.).	3.87
A city drive with good traffic conditions (e.g. no traffic jams, good weather conditions, clear streets etc.).	3.83
Leaving the vehicle parked for several hours at home/at work (maybe expecting the vehicle to automatically perform updates/charge itself/clean itself etc.).	3.78
Having passengers in the vehicle.	3.65
A breakdown situation.	3.65
Driving on the motorway with bad traffic conditions (e.g. stop and go).	3.43
Reselling vehicle (maybe expecting the vehicle to value itself/clean itself/get rid of minor scratches itself etc.).	3.26
A total stop on the motorway, where the customer must linger for several hours in a long-lasting traffic jam (e.g. motorway closure).	3.26
Driving on a rural road in adverse environmental conditions (e.g. potholes etc.).	3.22

Customer Situations	Average Rating
Unloading the vehicle.	3.17
Driving on a rural road with good traffic conditions.	3.04
Cleaning the vehicle in- and outside (e.g. following an off-road drive, food scraps in the interior etc.).	3.04
The transportation of small goods (transporting sports equipment etc.).	3.00
Driving on the motorway with good traffic conditions.	2.78
A taxi ride, where the customer sits in the vehicle and is driven by someone else (e.g. chauffeur ride: use of vehicle as a taxi).	2.64
Preparing the vehicle for a holiday drive (including planning the route, loading baggage while leaving space on the backseats for the children etc.).	2.35
Remodelling of the vehicle (e.g. design changes of the interior and exterior etc.).	2.26

Table 1: Collection of potential situations to be discussed in focus groups and corresponding average ratings derived from the online survey

Table 1 shows an overview of all situations collected representing customer situations potentially relevant to be discussed in focus groups. Following the online survey in which N=26 consortium members participated, the six highlighted situations were chosen. The five situations rated as most important ones in which a customer should be satisfied by the new L3e and L5e vehicles and therefore most relevant to be used for discussion in the focus groups were: 'finding a parking space and parking the vehicle'; 'an exhausting city drive with bad traffic conditions'; 'approaching a carsharing vehicle, entering it and preparing it for a short city drive'; 'a city drive in adverse weather conditions' and 'the vehicle requiring service'. The sixth situation was 'the transportation of goods'. This situation was selected by the project's consortium relevant to be discussed with customers, since the aim was to include one situation that would challenge the vehicle concepts of L3e and L5e. The idea was to include one controversial situation where the new vehicle concepts may struggle to satisfy customers in order to fully understand which vehicle characteristics would, however, be important in such a situation.

3.2.2 Location

The focus groups were conducted at three different European cities: Bergamo in Italy, Vienna in Austria and Aachen in Germany. These locations represent target markets and therefore offered the most relevant results. In Bergamo, Italy, the focus groups were conducted on the grounds of Brembo S.p.A, in Vienna, Austria, in the localities of Spirit Design GmbH and in Aachen, Germany, at the fka mbH premises.

3.2.3 Participants

The criteria for selecting the participants of the focus groups were defined in D1.1 [1]. According to these, different participants were selected at the different locations. The overall aim was to group participants with different characteristics such as age, social and professional backgrounds so that each group represented the general public.

Bergamo, Italy:

- > Group 1, discussing the situations 'city drive in severe traffic' and 'vehicle requiring service', consisted of six participants (five male) with a mean age of 35.67 years. Only one person lived single in the household, all others had at least one more person living in their household. All six participants had a car available and none rode motorcycles or used public transport regularly. Four participants usually had no one else with them in their vehicle when they were driving and had an average annual mileage of 23,639 km.

- > Group 2, discussing the situations 'parking the vehicle' and 'collecting and entering a carsharing vehicle', consisted of six participants (four male) with a mean age of 34 years. All participants lived with at least one other person in their household and all of them had a car available. Two participants rode motorcycles regularly and none used the public transport. Three participants indicated to regularly have passengers with them in their vehicle and one participant regularly used car/bikesharing. The group drove an average annual mileage of about 24,167 km.
- > Group 3, discussing 'city drive in adverse weather conditions' and 'transportation of small goods', consisted of six participants (five male) with a mean age of 38.67 years. All participants had at least three people living in their household and all six had a car available. Four participants rode motorcycles regularly and none used public transport. Only one participant regularly had at least one passenger with him in the vehicle and one participant regularly used car/bikesharing. The group drove an average annual mileage of 23,333 km.

Table 2 gives an overview on the demographics of the participants in the focus groups in Bergamo (for more details see the Appendix).

Social Demographics

		Group 1	Group 2	Group 3
Mean age		36	34	39
Gender	Male	5	4	5
	Female	1	2	1
Number of persons in household	1	1	0	0
	2	1	1	0
	3	3	4	2
	4	1	1	4
A car available in household	yes	6	6	6
	no	0	0	0
Rides a motorcycle regularly (>125 cm ³)	yes	0	2	4
	no	6	4	2
Use of public transport regularly (>4 times a week)	yes	0	0	0
	no	6	6	6
Number of passengers >2	yes	2	3	1
	no	4	3	5
Use of car/bike/scooter sharing	yes	1	1	1
	no	5	5	5
Average total annual distance		23,333 km	23,417 km	24,167 km

Table 2: Demographic data of focus group participants in Bergamo, Italy

Vienna, Austria:

- > Group 1, discussing the situations 'city drive in severe traffic' and 'vehicle requiring service', consisted of seven participants (three male) with a mean age of 37.29 years. Two participants said to live by themselves and only five had a car available in their household. One participant drove a motorcycle regularly and five used public transport on a regular basis. Only one person said to have at least one passenger in their vehicle regularly and four people used car/bikesharing regularly. They drove an average annual mileage of 14,500 km.
- > Group 2, discussing situations 'parking the vehicle' and 'collecting and entering a carsharing vehicle' consisted of seven participants (six male) with a mean age of 48 years. Two participants said they were living by themselves and six had a car available in their household. Two participants rode motorcycles regularly and six used public transport on a regular basis. Four people said to regularly have at least one more passenger in their vehicle and two used car/bikesharing regularly. They drove an average annual mileage of 20,067 km.
- > Group 3, discussing 'city drive in adverse weather conditions' and 'transportation of small goods', consisted of seven participants (three male) with a mean age of 49.86 years. Five people lived by themselves and six had a car available in their household. Two participants rode motorcycles and three used public transport regularly. Three participants had at least one more passenger in their vehicle regularly and two used car/bikesharing on a regular basis. Their average annual mileage was 17,667 km.

Table 3 gives an overview on the demographics of the participants in the focus groups in Vienna (for more details see the Appendix).

Social Demographics

		Group 1	Group 2	Group 3
Age		37	48	50
Gender	Male	3	6	3
	Female	4	1	4
Number of persons in household	1	2	2	5
	2	5	3	0
	3	0	2	2
	4	0	0	0
A car available in household	yes	5	6	6
	no	2	1	0
Rides a motorcycle regularly (>125 cm ³)	yes	1	2	2
	no	6	5	4
Use of public transport regularly (>4 times a week)	yes	5	6	3
	no	2	1	3
Number of passengers >2	yes	1	4	3
	no	6	3	1
Use of car/bike/scooter sharing	yes	4	2	2
	no	3	5	3

Social Demographics

Average total annual distance	17,667 km	14,500 km	20,067 km
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Table 3: Demographic data of focus group participants in Vienna, Austria

Aachen, Germany:

- > Group 1, discussing situations 'city drive in severe traffic' and 'vehicle requiring service', consisted of eight participants (six male) with a mean age of 36 years. Two participants said they were living by themselves and five had a car available in their household. None rode motorcycles regularly and four used public transport on a regular basis. Two participants said to have at least one more passenger in their vehicle regularly and three used car/bikesharing. The group drove an average annual mileage of 14,800km.
- > Group 2, discussing situations 'parking the vehicle' and 'collecting and entering a carsharing vehicle' consisted of six participants (three male) with a mean age of 25 years. Three participants said to live by themselves and five had a car available in their household. Two participants rode motorcycles and five used public transport regularly. Five participants said to have at least one more passenger in their vehicle on a regular basis and two used car/bikesharing. Their average annual mileage was 9,000km.
- > Group 3, discussing 'city drive in adverse weather conditions' and 'transportation of small goods', consisted of six participants (three male) with a mean age of 30.67 years. Four people said to live by themselves and four had a car available in their household. One person rode a motorcycle and three used public transport regularly. None said to have passengers in their vehicle on a regular basis and one person said he was using car/bikesharing regularly. The group's average annual mileage was 14,600km.

Table 4 gives an overview on the demographics of the participants in the focus groups in Aachen (for more details see the Appendix).

Social Demographics

		Group 1	Group 2	Group 3
Age		36	25	31
Gender	Male	6	3	3
	Female	2	3	3
Number of persons in household	1	2	3	4
	2	1	2	2
	3	3	1	0
	4	2	0	0
A car available in household	yes	5	5	4
	no	3	1	2
Rides a motorcycle regularly (>125 cm ³)	yes	0	2	1
	no	8	4	5

Social Demographics

		Group 1	Group 2	Group 3
Use of public transport regularly (>4 times a week)	yes	4	5	3
	no	4	1	3
Number of passengers >2	yes	2	5	0
	no	6	1	6
Use of car/bike/scooter sharing	yes	3	2	1
	no	5	4	5
Average total annual distance		14,600 km	14,800 km	9,000 km

Table 4: Demographic data of focus group participants in Aachen, Germany

3.3 Results

The following section describes the results gained from the focus groups, first individually per situation (3.3.1) and in 3.3.2 overall combined.

3.3.1 Situational Results

In the following each idea named by the participants, referred to as 'items' and their corresponding needs are reported.

The items, i.e. the suggestions of participants on potential technical characteristics of their vehicle enabling them to experience a situation in the most satisfying manner, were clustered into groups, each representing a need that would be fulfilled by the items. The tables in the following subsections show the individual items and corresponding needs. The columns 'Bergamo', 'Vienna' and 'Aachen' display the mean values of the prioritisation of each item in each location (a 'X' refers to the item not having been mentioned in the particular location). As mentioned above, participants were asked to rate the items named in the focus groups at the end of discussing a particular situation. Using a scale ranging from one (not important at all) to five (very important) they were asked to assess the importance of the individual need to be met or of the potential technical solution to be fulfilled by a future product. Furthermore, the weighted mean value displays the combined mean value per item of all three groups/locations in which the particular situation was discussed considering mentioning in these. This means the mean value of each group (Bergamo, Vienna and Aachen) was multiplied by the number of participants in that particular group in which the item occurred. This number was then divided by the total number of participants of all three locations.

$$\bar{x}_{weighted} = \frac{(\bar{x} \text{ Bergamo} \times n \text{ Bergamo}) + (\bar{x} \text{ Vienna} \times n \text{ Vienna}) + (\bar{x} \text{ Aachen} \times n \text{ Aachen})}{N (\text{Bergamo} + \text{Vienna} + \text{Aachen})}$$

For example, if all three groups that discussed a situation consisted of six participants each and an item was named in only one of the locations (for example Bergamo) scoring a mean value of 5.0, the calculations would be the following:

$$\bar{x}_{weighted} = \frac{(5.0 \times 6) + (0 \times 6) + (0 \times 6)}{18}$$

By evaluating the weighted mean instead of the regular mean value the fact whether or not an item was suggested in only one group/location or if it was named by two or three groups gets taken into consideration.

This can lead to weighted means of ratings, originally having been relatively high in an individual group, being lower when the item was only named in one or two groups instead of all. Considering the number of occurrences in this particular context is important since the individual groups purposely represented a variety of social and professional backgrounds due to the target being the collection of opinions of the general public. Therefore, an equal distribution of different characteristics of participants is given and items can be expected to be suggested by all groups.

The 'overall mean' in the last column refers to the mean value of the group representing the needs, combining all mean values of individual items in the group.

3.3.1.1 City drive in adverse weather conditions

The situation 'city drive in adverse weather conditions' (see Figure 6) was explained to the participants using the following introduction: 'Imagine you are driving in a car through the city in adverse weather conditions. It is autumn, it is raining heavily and it is also quite stormy. Some pedestrians and cyclists are rushing around you. What is important to you in this kind of situation? What kind of desires do you have?'.

A city drive with bad weather conditions.



Figure 6: Customer situation 'a city drive in adverse weather conditions'

Table 5 summarises the suggestions (items) made by the participants of the focus groups as well as the corresponding needs they have in the given traffic situation.

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
Lift driver's mood	Imitation of nice weather conditions on windscreen.	3.33	3.00	1.83	2.74	2.11
	The vehicle is able to lift the mood of the driver by music, smell and light.	2.17	X	2.50	1.47	
Assistance	The tyres are adapting automatically to the prevailing weather conditions.	4.33	4.00	3.17	3.84	1.92

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
systems enhancing safety	Detection and display of other surrounding road users.	4.00	3.71	3.83	3.84	1.81
	The speed is adapted automatically to the prevailing weather conditions.	X	3.71	3.33	2.42	
	System warning driver about changing weather conditions.	4.00	2.86	X	2.32	
	The head-up display (HUD) provides lane assistance and important information for the driver.	X	X	4.67	1.47	
	Adaptive cruise control (ACC) adjusts speed and distance to the vehicle ahead.	X	4.00	X	1.47	
	The vehicle's system suggests speed and route.	4.33	X	X	1.37	
	On-board detection and warning system for aquaplaning.	4.17	X	X	1.32	
	Warning system for dangerous routes/ road conditions.	X	X	3.17	1.00	
	Automatic guidance to parking spot until weather improves.	X	1.86	X	0.69	
	The vehicle is able to assess risks on its own and adapt accordingly to the situation.	4.33	X	X	1.37	
Technical features enhancing safety	The A/C system ensures to have clear windows all around.	4.33	4.43	X	3.00	1.81
	Automatic activation of headlamps.	X	4.00	3.83	2.68	
	Side windows are equipped with windscreen wipers for better visibility.	3.67	X	4.33	2.53	
	Water drops are not causing reflections on glass surfaces anymore.	3.50	X	4.17	2.42	
	Mirrors are equipped with several features to compensate the lack of view (e.g. heating to prevent freezing, wipers against rain). A camera system is providing additional sight.	3.33	X	3.67	2.21	
	The rain sensor adapts automatically to rain intensity.	X	4.43	X	1.63	
	Light adapting to prevailing weather conditions (e.g. dim light incidence on strong sunlight).	X	3.86	X	1.42	
	Glaring effects (e.g. by other cars) are eliminated.	X	X	4.33	1.37	
	A third wheel improves the stability of the vehicle.	4.33	X	X	1.37	
	The vehicle has additional sideward and underbody illumination for better visibility.	X	X	3.83	1.21	

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
Features preventing wetness	Windows are coated to prevent them from steaming.	3.83	X	X	1.21	1.67
	The helmet needed by motorcyclists is equipped with wipers.	X	X	2.00	0.63	
	Provision of a rain protection between closing umbrella and vehicle boarding.	3.83	3.43	3.50	3.58	
	The vehicle comes with a protective cover to avoid getting wet.	X	3.43	4.33	2.63	
	Extra storage compartment for wet umbrella to prevent the interior from getting wet.	4.17	X	3.17	2.32	
	A flexible rain cover for motorcyclists which can be easily de- and attachable at the handlebar.	4.50	X	X	1.42	
	The umbrella holder ensures that both hands are left free (e.g. for putting goods into car).	4.17	X	X	1.32	
	Windows and sunroof are closing automatically in case of rain.	X	3.57	X	1.32	
	The ability to open the windows not only vertically but also sideways (to prevent rain from coming in).	4.00	X	X	1.26	
	The seat is waterproof.	3.83	X	X	1.21	
Features dealing with wetness	Rain equipment (e.g. raincoat) is always on board.	3.67	X	X	1.16	1.66
	Waterproof storage compartment for wet coat.	3.33	X	X	1.05	
	A detachable umbrella is integrated in the vehicle.	X	2.86	X	1.05	
	The windscreen has a lotus effect so that water and dirt drip off.	X	4.43	3.00	2.58	
	The vehicle is equipped with a different solution to clean the windscreen (e.g. air blower instead of wipers).	4.00	X	3.83	2.47	
	Possibility to dry the shoes on board.	X	3.29	3.00	2.16	
	The motorbike's seat dries itself automatically.	4.17	X	X	1.32	
	Possibility to dry the driver's clothes.	X	3.14	X	1.16	
	Possibility to dry the hair on board.	3.17	X	X	1.00	
	The vehicle automatically dries the interior and cleans itself while parked.	3.00	X	X	0.95	
Comfort	Vehicle is sound insulated (e.g. rain on roof).	3.50	2.14	2.50	2.68	1.54

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
	The vehicle can avoid splashing pedestrians.	X	2.86	3.00	2.00	0.79
	The vehicle has only one entrance from where every seat can be accessed for flexible arrangement of passengers.	4.33	X	X	1.37	
	The satnav system is able to calculate delays reliably.	X	X	3.17	1.00	
	The steering wheel has automated heating integrated.	X	X	2.00	0.63	
	Ability to change interior equipment into cinema when driving autonomously.	X	X	2.50	0.79	
	Ability to make hot drinks inside the car.	2.50	X	X	0.79	
Entertainment						

Table 5: Items and corresponding needs for the situation ‘city drive in adverse weather conditions’

Table 5 displays all desired vehicle’s features named by the participants regarding the situation ‘city drive in adverse weather conditions’ as well as corresponding prioritisations of these, grouped with respect to summarising needs.

Needs, overall rated as most important to be fulfilled by future vehicle concepts potentially utilizing suggested technical characteristics, were ‘lifting the driver’s mood’ (2.11), ‘assistance systems enhancing safety’ (1.92) as well as ‘technical features enhancing safety’ (1.81). Furthermore, ‘comfort’ (1.54) and ‘entertainment’ (0.79) were needs participants would have in the given situation, however, rated as not as important to be fulfilled.

3.3.1.2 City drive in severe traffic conditions

The situation ‘city drive in severe traffic conditions’ (see Figure 7) was described with the following introduction: ‘Imagine you are driving a car on your way home from work. It is rush-hour time and you are stuck in traffic. Although the traffic lights are changing from red to green it is not improving the slow-moving traffic. What do you need in this kind of situation to feel better? What kind of demands do you have?’

An exhausting city drive
with bad traffic conditions.

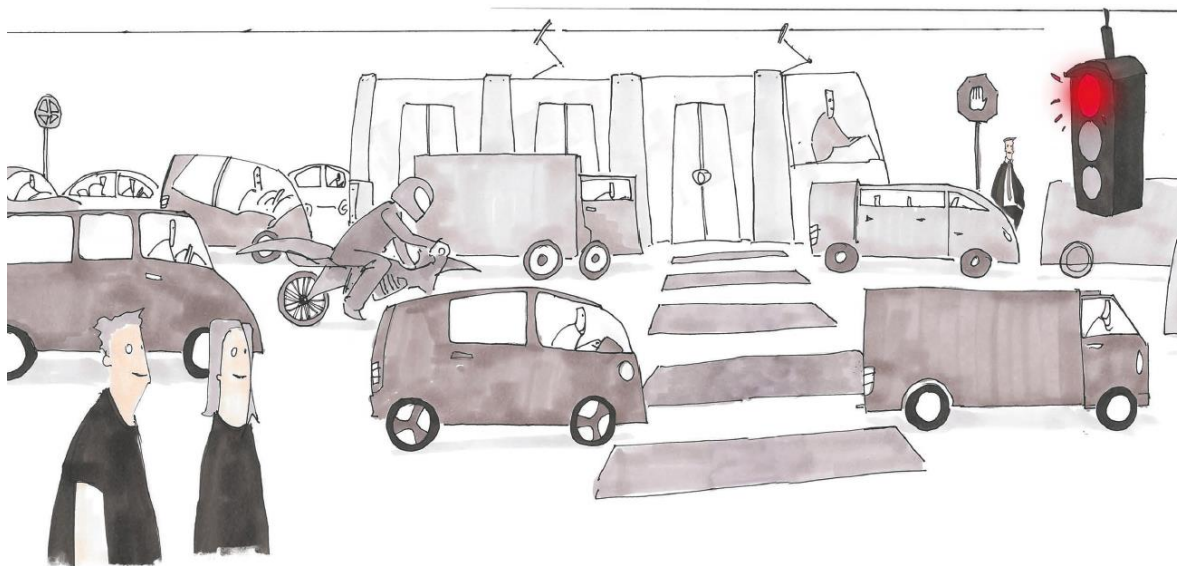


Figure 7: Customer situation ‘a city drive in severe traffic conditions’

Table 6 summarises the suggestions (items) made by the participants of the focus groups as well as the corresponding needs they have in the given traffic situation.

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
Adaption of technical propositions of vehicle	The vehicle is able to drive autonomously in traffic jam situations.	4.83	4.86	4.25	4.62	2.21
	Ability to change the driving mode (e.g. from combustion engine to electric motor).	4.50	X	X	1.29	
	Ability to change from manual to automatic transmission.	X	X	1.88	0.71	
Efficient usage of time	Ability to use the windscreen as a multimedia display for entertainment.	X	4.43	4.63	3.24	1.56
	Possibility to do activities (e.g. play console games) while there is no need to focus on traffic.	4.83	X	3.50	2.71	
	Ability to charge the vehicle inductively without the need of a power cable.	4.50	X	3.38	2.57	
	Using the time efficiently by execution of lessons (e.g. language courses).	3.83	X	3.88	2.57	
	Ability to communicate with surrounding drivers in traffic jam (e.g. via rear window).	X	3.00	2.50	1.95	

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
	Car-to-Home (C2H) communication: The car's system can be used to control home automation systems.	X	X	4.63	1.76	1.42
	Possibility for sports exercises in the vehicle.	3.83	X	1.63	1.72	
	Vehicle has an integrated wireless access point that provides internet access.	X	X	3.50	1.33	
	The vehicle provides free moving space inside the car.	3.83	X	X	1.09	
	Information about the surrounding area (e.g. sights).	3.67	X	X	1.05	
	Communication options (e.g. with friends, other people in traffic jam).	3.67	X	X	1.05	
	Vehicle suggests activities while stuck in traffic jam.	3.50	X	X	1.00	
	The vehicle is able to autonomously carry out small maintenance services.	X	X	2.63	1.00	
	The interior is transformable (e.g. possibility to change the steering wheel for a table, seat for bed).	X	X	2.63	1.00	
	Swivel chairs for communication enhancements with other passengers.	X	2.71	X	0.90	
	Ability to consume food and drinks.	2.83	X	X	0.81	
	Possibility to shower and change clothes (e.g. between work and going out).	2.50	X	X	0.71	
Possibility to leave traffic situation instantly	Possibility to leave the car and walk or cycle instead.	3.67	2.14	3.63	3.14	1.44
	Efficient guidance system for autonomously finding parking lots.	4.67	X	X	1.33	
	Car without wheels for alternative routing.	4.33	X	X	1.24	
	Vehicle drives and parks autonomously without the need of a driver.	X	3.29	X	1.10	
	A service person takes over the vehicle and drives it to specified destination.	3.50	X	X	1.00	
	The vehicle is capable of using alternative tracks (e.g. rails instead of roads).	X	2.57	X	0.86	
Traffic jam avoidance	Car-to-Car (C2C) communication: vehicles are connected with each other and use swarm intelligence to optimise movement flow.	3.83	4.14	X	2.47	1.42
	Intelligent adaption of the route ahead according to prevailing traffic situation.	X	X	4.63	1.76	

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
	Car-to-Infrastructure (C2I) communication: intelligent communication between cars and traffic lights.	4.50	X	X	1.29	
	A signalling system on the rear of the vehicle indicates following drivers congestion ahead.	X	3.71	X	1.24	
	A system which is prohibiting the vehicle from driving onto a non-free junction.	X	3.71	X	1.24	
	The vehicle can change its size by foldability mechanism.	4.33	X	X	1.24	
	The vehicle recognises driving behaviour potentially causing traffic jams and prevents it.	4.17	X	X	1.19	
	Usage of car pooling to minimise the number of vehicles on the road and prevent traffic jam occurrence.	3.17	X	X	0.91	
Safety	Automatic formation of an emergency corridor among all vehicles.	X	X	4.38	1.67	1.39
	Automatic distance adaption among vehicles according to the traffic condition.	X	4.14	X	1.38	
	The vehicle is equipped with sensors to prevent collisions.	4.67	X	X	1.33	
	Display on the rear window showing the vehicle behind what's in front.	X	3.71	X	1.24	
	Visual and acoustic warning that prevents potential collisions with other road users.	X	X	3.50	1.33	
Comfort	An air filtering system is keeping out exhaust gases.	X	4.00	4.63	3.10	1.29
	The vehicle is cold- and heat insulated.	X	X	4.50	1.71	
	Integrated massage function in vehicle's seats.	X	2.14	2.38	1.62	
	The vehicle's sound insulation is absorbing all external noises.	X	X	4.13	1.57	
	The vehicle collects and saves personal interests (e.g. favourite radio station, preferred volume).	X	X	3.75	1.43	
	Acoustical warning signal if other vehicles continue driving and the traffic jam dissolves.	X	X	3.50	1.33	
	Various forms of mood lifting by music, smell and light.	X	X	3.50	1.33	
	Presence of a cooling possibility in the central console or in the glove box	X	3.14	X	1.05	
	The vehicle has a toilet integrated.	X	2.71	X	0.90	
	The vehicle has a microwave oven on board to heat up food or beverages.	X	1.43	1.13	0.90	

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
	The vehicle's system has the ability to order drinks from nearby stores/point-of-interests (POIs)	X	X	2.00	0.76	
	The vehicle is able to change its colours (e.g. according to mood).	1.92	X	X	0.55	
	Storage for shoes and possibility to change them within the vehicle.	1.83	X	X	0.52	
Provision of information on traffic situation	Precise information about the additional time required to reach destination.	4.67	X	X	1.33	1.05
	Information about the incident occurred and if people were harmed.	2.67	X	X	0.76	

Table 6: Items and corresponding needs for the situation ‘city drive in severe traffic conditions’

Participants rated the need for the ‘ability to adapt technical propositions of the vehicle’ (2.21) as most important to be considered in a future vehicle concerning driving it in a city drive in severe traffic conditions. ‘Provision of information on traffic situation’ (1.05) was rated as not as important to be fulfilled.

3.3.1.3 Parking the vehicle

The situation ‘parking the vehicle’ (see Figure 8) was introduced by the following: ‘Imagine you are on your way to a doctor’s appointment in the city centre. You are getting there by car and as usual the parking situation is fairly difficult. The doctor’s office is located on a busy road and parking spaces are rare and usually quite small. What would you wish for in this kind of situation? What kind of demands do you have?’

Finding a parking space and parking the vehicle.

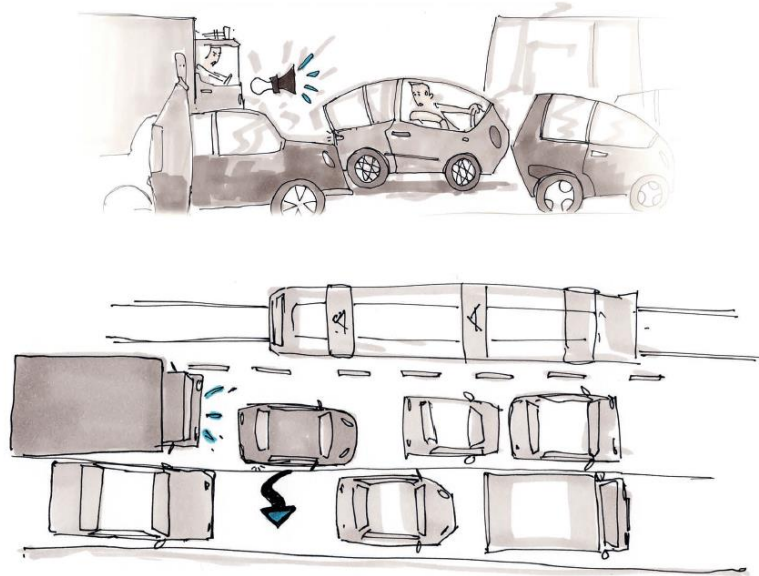


Figure 8: Customer situation 'parking the vehicle'

Table 7 summarises the suggestions (items) made by the participants of the focus groups as well as the corresponding needs they have in the given traffic situation.

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
Simplified payment systems	Simplified parking payment system (e.g. with mobile phone or periodically subscription) that deducts charges automatically from bank account/credit card.	4.17	4.71	3.50	4.16	4.16
Mechanical adaptations facilitating parking manoeuvre	The vehicle can reduce its size while not needed.	4.17	4.43	2.33	3.68	2.96
	Rotation of wheels by 90° allows to use very small parking lots.	X	4.43	3.17	2.63	
	Vertical parking possible in order to fit into small parking spaces.	3.17	2.86	1.67	2.58	
Adaption of parking spaces	Vehicles can mechanically connect to each other in order to offer more parking space.	3.17	4.00	X	2.47	2.74
	Optimised use of space by the ability to rearrange the position of surrounding parked vehicles.	4.17	4.57	X	3.00	
Efficient usage of parking time	The vehicle's battery is charged automatically by implemented induction coils in the ground of the parking lot.	3.83	X	4.33	2.58	2.58

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
Reservation of available parking spaces facilitating search	Real-time information on free parking lots, retrievable within the vehicle and on mobile devices.	4.83	4.57	4.67	4.68	2.37
	Provision of real-time information on soon to be free parking lots, reserve them for arriving vehicles and considers vehicle dimensions.	X	X	4.50	1.42	
	Car-to-Car (C2C) communication: vehicles inform each other about the duration of the allocation of parking lots.	X	X	3.17	1.00	
Alternative transportation options if search for parking not successful	The car can be parked in the surrounding area while the electric bike on board guarantees a fast and sweat-free ride to reach the destination.	3.17	3.57	X	2.32	1.89
	Satnav recommends nearby Park and Ride (P+R) facilities if finding a suitable parking lot takes too long.	X	4.00	X	1.47	
Autonomous parking manoeuvre (including search)	The driver exits at the desired destination while the car searches autonomously for a parking lot in the surrounding area.	X	4.14	4.00	2.79	1.88
	The car is able to fully park itself autonomously.	3.67	X	4.50	2.58	
	The external access to features related to autonomous functions is prohibited.	X	X	4.67	1.47	
	The vehicle gives driver feedback on autonomously found parking lot.	X	X	4.67	1.47	
	Car exits the parking lot autonomously and drives to driver on phone call.	3.50	X	X	1.11	
Efficient planning of route/ destination times	The vehicle takes all available information (time of appointment, traffic- and weather conditions, free parking lots etc.) into account and provides precise and efficient trip information.	4.33	3.29	X	2.58	1.84
	Overall trip time calculation considers also parking and walking time.	3.50	X	X	1.11	
Mechanical support during parking manoeuvre by vehicle	The vehicle gives parking manoeuvre instructions on display and by electromechanical assistance (e.g. steering wheel turns automatically).	X	X	4.67	1.47	1.47
Safety	Warning system informs other road users of an upcoming parking manoeuvre.	X	3.57	X	1.32	1.32
Provision of information regarding the parking space	Information on prices and terms and conditions.	4.00	X	X	1.26	1.05
	Provision of information regarding the safety of the parking area.	X	X	2.67	0.84	
Designated	Reserved parking lots for micro cars.	3.33	X	X	1.05	0.84

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
parking areas for particular types of vehicles	Special area for vehicles that are able to park themselves autonomously.	X	X	2.00	0.63	

Table 7: Items and corresponding needs for the situation ‘parking the vehicle’

The need for ‘simplified payment systems’ was rated highest (4.16) in regard to importance of fulfilment. ‘Provision of information regarding the parking space’ (1.05) and ‘designated parking areas for particular types of vehicles’ (0.84) were rated as least important.

3.3.1.4 Transportation of small goods

The situation ‘transportation of small goods’ (see Figure 9) was described to the participants using the following introduction: ‘Imagine you have just been grocery shopping for the upcoming week. You are now loading the shopping in the car with a box of drinks, e.g. water and a few shopping bags. What would you wish for concerning the loading as well as the transport? What kind of demands do you have?’.

Transportation of goods.

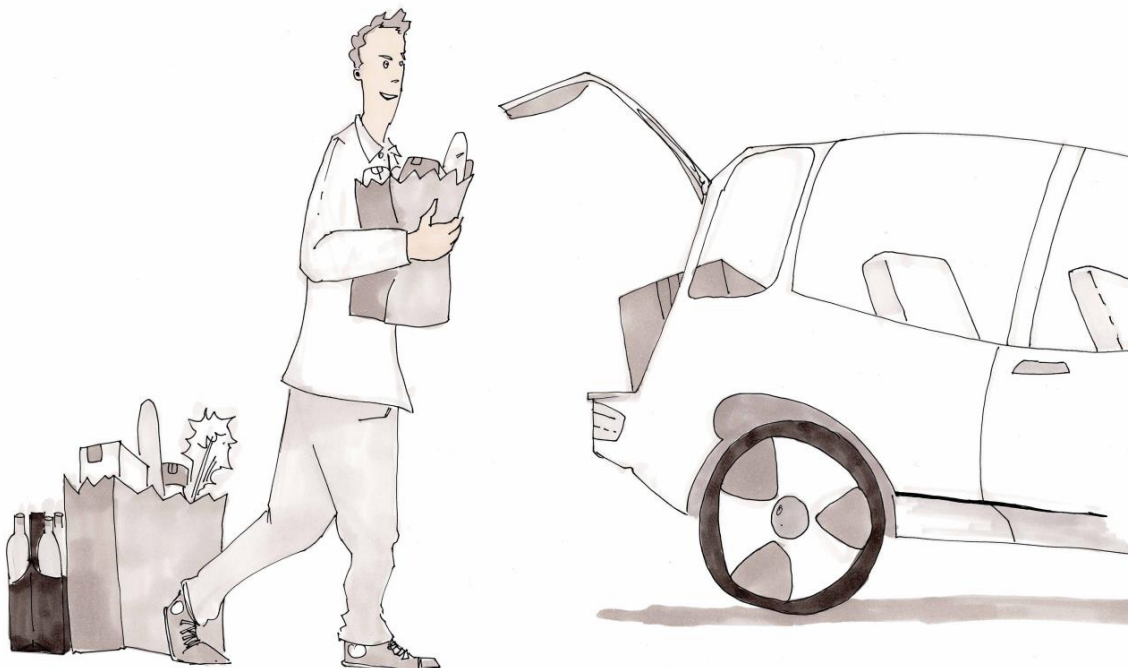


Figure 9: Customer situation ‘transportation of small goods’

Table 8 summarises the suggestions (items) made by the participants of the focus groups as well as the corresponding needs they have in the given traffic situation.

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
Protection of goods	Load can be secured on integrated fastening hooks.	3.67	4.29	4.33	4.11	1.85
	Rain cover for shopping goods.	4.33	X	1.67	1.89	
	Possibility to hide valuables efficiently inside the vehicle.	4.00	X	X	1.26	
	Camera surveillance to protect goods from getting stolen.	3.83	X	X	1.21	
	Handbag can be attached to a holder on the passenger seat.	X	2.14	X	0.79	
Ability to regulate temperatures in order to carry load adequately	Insulated storage to cover long distances.	3.67	4.00	X	2.63	1.80
	Possibility to cool things on board in a refrigerator.	3.83	2.86	X	2.26	
	Cooling of boot with remote operability.	3.83	X	X	1.21	
	Provision of a cooling ability in the centre console.	X	3.00	X	1.11	
Simple and easy loading	System that simplifies the loading of heavy things into the vehicle (e.g. rear is lowerable).	3.67	4.43	2.67	3.63	1.73
	The vehicle leaves parking space autonomously and picks me up from door to avoid having to carry heavy goods.	X	4.86	4.50	3.21	
	The boot floor is able to move forwards, backwards and sideways.	4.67	X	3.50	2.58	
	Automatic tailgate opening and closing mechanism.	X	4.71	X	1.74	
	Special seat for dogs at the rear seats to have more space in the boot.	X	4.14	X	1.53	
	The boot is accessible from the driver's seat.	X	X	4.33	1.37	
	Ability to load the vehicle from all around.	4.00	X	X	1.26	
	Automatically opening and closing of doors.	X	X	3.83	1.21	
	The boot is illuminated.	3.83	X	X	1.21	
	Provision of a possibility to attach the shopping cart to the vehicle.	X	X	3.33	1.05	
	Boot closing mechanism prevents locking if key is still inside it.	X	2.86	X	1.05	
	Availability of an electrically assisted trolley on board that supports bringing back the shopping goods to the car.	2.83	X	X	0.89	
Protection of driver	The driver is protected by a barrier from the goods.	X	3.43	3.00	2.21	1.61
	Camera system that restores rear view vision if fully loaded.	4.33	X	X	1.37	

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
Simple organisation of goods	On board umbrella that is detachable from the car to prevent getting wet while loading goods into the vehicle.	4.00	X	X	1.26	1.45
	Detachable bag or box for storing things (e.g. shopping goods).	X	3.57	4.17	2.63	
	The vehicle has an integrated rack system for improved loading.	3.33	X	3.17	2.05	
	Automatic sorting of shopping into different categories e.g. cooled items (enhancing an easy unloading at home).	X	X	5.00	1.58	
	Available transport boxes in the boot ensuring that nothing falls over.	X	4.14	X	1.53	
	The boot has several levels for storage.	X	3.86	X	1.42	
	Availability of shopping bags in the vehicle.	X	X	4.17	1.32	
	Seat is replaced by a drawer system that simplifies storage of smaller objects.	3.67	X	X	1.16	
	The vehicle's integrated dividers are removable.	3.33	X	X	1.05	
	The interior of the boot is organised in drawers.	X	X	2.83	0.89	
Additional storage spaces	Provision of a storage system to arrange objects in categories	2.67	X	X	0.84	1.43
	Undertray storage for equipment (e.g. child safety seat).	3.83	X	4.33	2.58	
	Additional boot under the bonnet, whereof one is cooling, the other one is keeping things hot, while the engine is attached to the wheels.	3.50	X	X	1.11	
	The doors offer an increased amount of storage space.	X	2.86	X	1.05	
	Shopping goods are attachable to the vehicle exterior.	X	X	3.17	1.00	
	Ability to store things in the engine compartment of the vehicle.	X	1.29	X	0.47	
	Space to drop things in the centre console of the vehicle.	X	4.00	4.00	2.74	
	Ability to store things on the roof of the vehicle.	X	1.43	3.83	1.74	
Easy adjustability of vehicle	Paddle box as additional storage space.	X	2.00	X	0.74	1.36
	Rear seats move forward while loading the boot of the vehicle.	4.33	X	2.00	2.00	
	Mechanism to fold down the rear seat is simple to operate.	X	4.86	X	1.79	
	Depending on the required loading space, the vehicle is able to adjust its size.	X	X	4.33	1.37	

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
	The boot compartment adjusts itself automatically to the size of the shopping.	X	X	4.17	1.32	
	Rear seats are folding themselves into a cavity floor to create an even surface.	X	3.29	X	1.21	
	The storage space is adjustable. For motorcycles: engine can be moved elsewhere.	3.33	X	X	1.05	
	The vehicle height is adjustable to create more room inside.	X	2.14	X	0.79	
Protection of vehicle	Availability of different surfaces for the boot floor.	2.83	X	3.83	2.11	1.32
	The boot cleans itself automatically.	3.50	X	X	1.11	
	Availability of a back seat cover with mounting option.	X	2.86	X	1.05	
	Possibility to seal smelly objects.	3.17	X	X	1.00	
Mechanical adjustments of vehicle in accordance to goods	The tyre pressure adjusts itself in accordance with the load weight.	X	X	3.50	1.11	1.08
	Attachable supporting wheels for single-track vehicles when moving heavy goods.	3.33	X	X	1.05	
Alternative doors	Big boot lid aperture angle.	X	3.14	X	1.16	1.05
	The boot has a rolling door (=rolls up and down) instead of a lid.	3.33	X	X	1.05	
	Availability of sliding doors (e.g. boot door) to ease loading.	3.17	X	X	1.00	
	Ability to open the doors only partially for small objects.	3.17	X	X	1.00	
Comfort	The vehicle assists in reminding needed shopping.	2.00	X	X	0.63	0.63

Table 8: Items and corresponding needs for the situation ‘transportation of small goods’

The situation ‘transportation of small goods’ triggers most importantly for the needs ‘protection of goods’(1.85), ‘ability to regulate temperatures in order to carry load adequately’ (1.80), ‘simple and easy loading’ (1.73) and ‘protection of driver’ (1.61) to be fulfilled. The needs ‘alternative doors’ (1.05) and ‘comfort’ (0.63) were rated as less important to be fulfilled by a new vehicle concept.

3.3.1.5 Collecting and entering a carsharing vehicle

The situation ‘collecting and entering a carsharing vehicle’ (see Figure 10) was introduced by the following: ‘Imagine you booked a carsharing vehicle. You now want to pick it up, what is important to you in this kind of situation? What kind of demands do you have?’

Approaching a carshare vehicle,
entering it and preparing it for a drive.

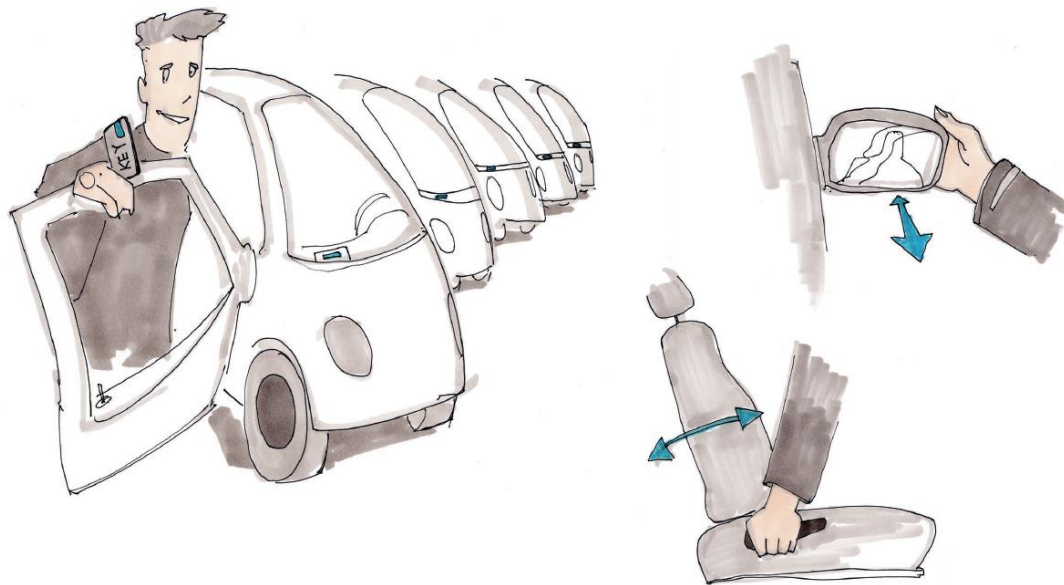


Figure 10: Customer situation ‘collecting and entering a carsharing vehicle’

Table 9 summarises the suggestions (items) made by the participants of the focus groups as well as the corresponding needs they have in the given traffic situation.

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
Simple, fast and secure identification process	The vehicle is able to identify different drivers by their mobile phone.	3.50	4.57	4.17	4.11	2.74
	Biometric identification (e.g. fingerprint) to aggravate stealing.	4.33	X	X	1.37	
High-class technical basic configurations	Alco lock prohibits starting the engine if limit exceeded.	3.33	3.57	X	2.37	1.56
	Signalling system informs the driver about the technical status (e.g. green light means everything is okay).	4.67	X	X	1.47	
	The vehicle delivers itself autonomously.	X	3.71	X	1.37	
	Availability of a park pilot on board of every vehicle.	X	3.57	X	1.32	
	The vehicle is equipped with satnav by default.	4.00	X	X	1.26	
Comfort	Individual preferences (e.g. favourite radio station, seat settings) will be saved and loaded on next hire.	3.83	4.71	2.83	3.84	1.51

	Vehicle provides hands-free module that allows Bluetooth pairing with driver's mobile phone.	X	4.43	X	1.63	
	The vehicle cleans itself autonomously after each usage.	4.17	X	X	1.32	
	Provision of charging devices for mobile phones.	X	3.57	X	1.32	
	On board provision of cleaning- and hygiene (e.g. disinfection spray) equipment.	X	3.43	X	1.26	
	Loaded goods are monitored to remind the driver to unload them when returning vehicle.	3.83	X	X	1.21	
	Additional equipment that is available for order is integrated in ordering process (e.g. child seat) to avoid having to deal with it when picking vehicle up.	3.67	X	X	1.16	
	The vehicle's interior is heated up before entering it.	X	X	3.67	1.16	
	Home and work addresses are preset in the satnav.	X	X	3.50	1.11	
	Vehicle will be provided with full fuel tank. Billing is based on the fuel difference.	X	X	3.33	1.05	
Broad area of availability	Service will be provided in coordination with public transport (e.g. pick up station at railway station).	X	4.00	X	1.47	
	Prevention that cars accumulate all in one area.	4.50	X	X	1.42	
	No restrictions regarding the area of use.	4.17	X	X	1.32	1.26
	Deployment system according to events in the city or alignment to commuter hours.	3.83	X	X	1.21	
	Availability of car sharing services in rural areas outside large agglomerations and city centres.	X	X	2.83	0.89	
Simple use/drive of vehicles	Text-to-speech engine allows to explain technical features acoustically while driving.	3.50	X	2.50	1.89	
	Mobile phone able to function as an interface by providing valuable information if the car is unknown to driver.	3.17	X	X	1.00	1.25
	Vehicles' functionalities within the same class should be as homogeneously as possible.	X	X	2.67	0.84	
Alternative fuels	The built-in solar roof charges automatically the battery of the electricity powered vehicle.	4.17	X	X	1.32	1.24
	Car sharing is only available with e-cars.	X	3.14	X	1.16	
Broad range of vehicle types	Provision of cars for people that have a disability.	X	4.00	X	1.47	1.14
	Variety of different available vehicle categories (e.g. van, convertible).	X	X	4.50	1.42	

Provision of cars for people that smoke while driving.	X	X	2.67	0.84
Provision of cars for people that carry along their pets.	X	X	2.67	0.84

Table 9: Items and corresponding needs for the situation ‘collecting and entering carsharing vehicle’

The most important need to be fulfilled for customers is the ‘simple, fast and secure identification process’ (2.74). The need rated as least important to require fulfilment was ‘broad range of vehicle types’ (1.14).

3.3.1.6 Vehicle requiring service

The situation ‘vehicle requiring service’ (Figure 11) was described to the focus group participants by the following introduction: ‘Imagine your car requiring its next regular service due to it coming up to the usual amount of kilometres indicating service being needed (e.g. 20,000 km). You therefore take it to your usual garage. Also, you expect a few smaller repairs having to be done which would mean having to leave the car at the garage for some time. What would you wish for in this kind of situation? What kind of demands do you have?’

The vehicle requiring service.

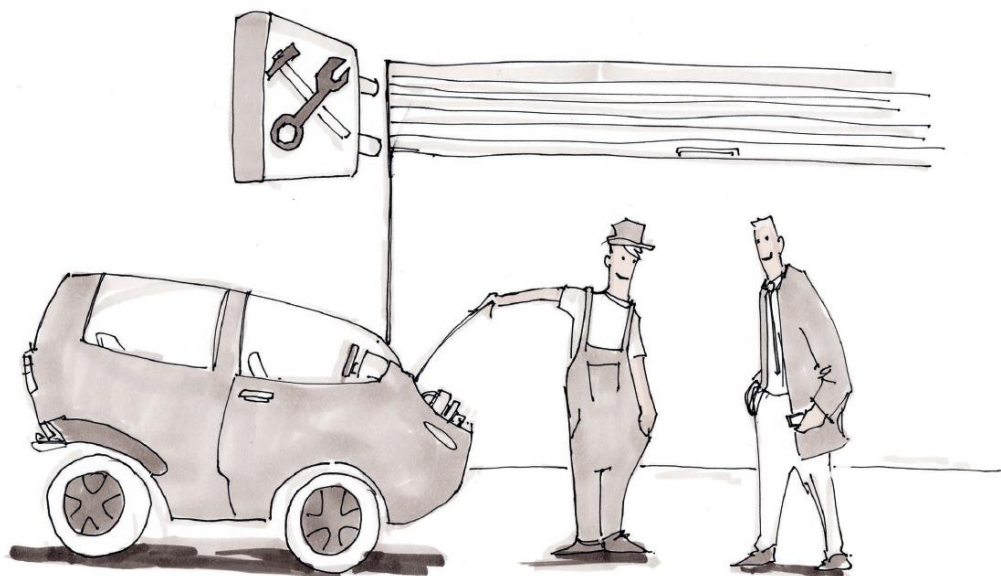


Figure 11: Customer situation ‘the vehicle requiring service’

Table 10 summarises the suggestions (items) made by the participants of the focus groups as well as the corresponding needs they have in the given traffic situation.

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
Comfort	The vehicle drives itself autonomously to the garage and back.	4.83	3.71	3.50	3.95	2.26
	Mobile execution of maintenance service at the customer's residence.	4.17	3.86	3.13	3.67	
	The garage provides a pick up and return service for their customers if the car has to be left there for repair.	3.67	3.43	3.38	3.48	
	The vehicle is able to diagnose technical difficulties autonomously and enables independent comparison to garage diagnosis.	4.83	X	4.75	3.19	
	Provision of a rental car while the owner's car is at service.	X	4.14	4.50	3.09	
	The car gives an overall status on technical components which can simplify decisions regarding further investment.	4.83	4.29	X	2.81	
	Information on estimated prospective overall maintenance costs with option to select an all-inclusive service package at purchase.	4.33	4.57	X	2.76	
	The modular approach allows for parts to be repaired individually.	X	X	4.63	1.76	
	Mobile execution of maintenance service while car is loaded onto a lorry.	X	3.43	X	1.14	
	A garage key for mechanics prevents from opening the boot and glove box and maintains privacy.	X	3.29	X	1.10	
	Autonomous quality check by vehicle regarding the performed service.	3.67	X	X	1.05	
	Parts indicate their (technical) condition by adjusting their colour.	3.00	X	X	0.86	
	Detachable on-board vehicle to cover distances (e.g. return home from garage where the car is serviced).	X	X	1.38	0.52	
Supporting DIY approach	The way to replace parts (e.g. light bulbs in headlamps) is kept simple.	X	3.29	X	4.43	1.79
	The engine is technically simplified to have less parts and variant diversity.	3.67	X	X	2.81	
	Poka-yoke (zero-error principle) mechanisms to prevent mixing up individual parts and making errors (e.g. light bulb fits only in one direction).	3.00	X	X	1.62	
	Assistance for Do-It-Yourself maintenance work on the vehicle.	X	X	3.75	1.43	
	A guide recommending which parts should be replaced and how this is conducted.	3.67	3.43	3.38	1.33	

Need	Item	Bergamo	Vienna	Aachen	Weighted Mean	Overall Mean
	The spare parts are standardised and fit for several brands.	X	3.29	X	1.10	
	The aggregates in the engine compartment can be moved flexibly to enhance accessibility.	4.83	X	4.75	0.81	
	Problems related to the vehicle are explained in an understandable manner to the driver.	4.83	4.29	X	0.81	
Ability to avoid/postpone services	The vehicle is maintenance-free, not requiring any service.	4.83	X	3.00	3.05	1.56
	Collecting information on the individual driving style to prevent the breaking of parts.	4.17	3.86	3.13	2.81	
	The components are checked autonomously by vehicle in specific intervals avoiding them from breaking.	X	3.29	X	1.29	
	The built-in surfaces are resistant to dust, dirt and water.	X	2.57	X	1.14	
	The vehicle has the ability to clean itself automatically.	3.83	X	X	1.14	
	Regular services have prolonged time intervals.	X	3.43	X	1.10	
	The vehicle influences the way of driving to minimise wear and tear of parts.	4.83	3.71	3.50	1.00	
	The vehicle is able to adapt itself the driver's personal needs and behaviours.	4.33	4.57	X	0.95	
Car-to-garage communication	Vehicle able to assist in language translations when service required abroad.	X	2.71	4.38	2.57	1.50
	Available-to-promise (ATP) with garage for required parts when vehicle needs service.	4.00	X	3.50	2.48	
	C2G Communication: vehicle informs the garage autonomously about service necessity and required spare and wear parts.	X	4.43	X	1.60	
	Car-to-Garage (C2G) communication: provision of general information on costs, duration of service and spare parts availability.	X	4.43	X	1.48	
	Recommendation on garage for quick repairs while abroad.	X	X	3.38	1.29	
	Calendar synchronisation between owner and garage to optimise scheduling.	4.50	X	X	1.29	
	The vehicle has an emergency-running program that allows to drive it to the nearest garage.	X	3.43	X	1.14	

	Provision of information about near garages and it capacities.	X	3.14	X	1.05	
Ability to upgrade/update vehicle	The system allows cross-platform connectivity and is independent from different operating systems on mobile devices (e.g. iOS or Android).	X	X	4.63	1.76	1.30
	Ability to update the car via mobile phone.	4.00	X	X	1.14	
	Ability to upgrade the car (i.e. hardware, car's colour).	3.50	X	X	1.00	
Time efficiency	The vehicle is able to service and repair itself.	4.83	X	3.00	2.52	1.24
	The garage provides Formula 1 (F1)-like pit stops by providing more mechanics per vehicle.	X	3.29	X	1.10	
	The vehicle suggests services on its own based on necessity instead of set intervals.	3.83	X	X	1.10	
	The vehicle will be generally replaced by an equivalent one.	X	2.57	X	0.86	
	Ability to put the chassis onto a new undercarriage.	X	1.86	X	0.62	
Car-to-owner communication on required service	C2C: information sharing	X	4.14	4.50	1.38	1.22
	C2O: Status on mobile devices	X	X	1.38	1.29	
	Tyre change reminder	X	1.86	X	1.00	
Saving costs	Warranty on parts (e.g. battery).	X	X	4.88	1.86	1.19
	Receipt of a discount granted on recurring maintenances.	3.17	X	X	0.90	
	Provision of a newsletter service (special offers) on authorised repair shops.	2.83	X	X	0.81	
Easy and eco-friendly acquisition of parts	Market for re-buying replacement parts/repared used parts.	X	X	3.25	1.24	1.13
	On-board disposability of spare parts (vehicle contains integrated depot of parts).	X	3.43	X	1.14	
	Possibility for parts leasing.	X	X	2.63	1.00	

Table 10: Items and corresponding needs for the situation 'vehicle requiring service'

Participants found it most important to have the need 'comfort' (2.26) fulfilled by a new vehicle concept. Rated as least important was the need 'easy and eco-friendly acquisition of parts' (1.13).

3.3.2 Overall Results

All needs derived from the items named by participants (see section 3.3.1) were further summarised into 'overall needs', merging the data of all situations into one concise set of information.

Overall Need	Need	Mean
Information	Car-to-owner communication on required service	1.22

Driving performance/pleasure		Provision of information on traffic situations	1.05
		Provision of information on parking space	1.05
		Adaption of technical propositions of vehicle	2.21
		Lift drivers mood	2.11
		Mechanical support during parking manoeuvre by vehicle	1.47
		Simple use/drive of vehicles	1.25
		Entertainment	0.79
Safety		Simple, fast and secure identification system	2.74
		Assistance systems enhancing safety	1.92
		Protection of goods	1.85
		Technical features enhancing safety	1.81
		Protection of driver	1.61
		Safety	1.39
		Protection of vehicle	1.32
Comfort	Adjustability	Mechanical adaptations facilitating parking manoeuvre	2.96
		Additional storage spaces	1.43
		Easy adjustability of vehicle	1.36
		Ability to upgrade/update vehicle	1.30
		Mechanical adjustment of vehicle in accordance to goods	1.08
		Alternative doors	1.05
	General comfort	Autonomous parking manoeuvre (including search)	1.88
		Ability to regulate temperatures in order to carry load adequately	1.80
		Simple and easy loading	1.73
		Features preventing wetness	1.67
		Features dealing with wetness	1.66
		High-class technical basic configurations	1.56
		Simple organisation of goods	1.45
		Comfort	1.40
		Broad range of vehicle types	1.14
		Supporting DIY approach	1.79
		Ability to avoid/postpone service	1.56
		Saving costs	1.19
Time-efficiency		Simplified payment systems	4.16
		Adaption of parking spaces	2.74
		Efficient usage of parking time	2.58
		Reservation of available parking spaces facilitating search	2.37
		Alternative transportation options if search for parking not successful	1.89

	Efficient planning of routes/destination times	1.84
	Efficient usage of time	1.56
	Car-to-garage communication	1.50
	Possibility to leave traffic situation instantly	1.44
	Traffic jam avoidance	1.42
	Time-efficiency	1.39
	Broad area of availability	1.26
	Designated parking spaces for particular types of vehicles	0.84
Eco-friendliness	Alternative fuels	1.24
	Easy and eco-friendly acquisition of parts	1.13

Table 11: Overall needs

Table 11 gives an overview of all these overall needs and their corresponding individual needs based on participants' items i.e. desired technical features of a future vehicle. The seven overall needs are 'information', 'driving performance/pleasure', 'safety', 'comfort' (divided into 'adjustability' and 'general comfort'), 'cost efficiency', 'time efficiency' and 'eco-friendliness'. They give an idea on rough criteria a future vehicle will have to fulfil in order for customers to be satisfied with the product.

It is remarkable that some of these results are in good accordance with D1.1 [1]. 'Safety', 'comfort', 'Driving performance/pleasure', 'cost efficiency' and 'eco-friendliness' correspond to the ones named in D1.1 [1]. However, 'information' and 'time efficiency' are new additional criteria resulting from the present deliverable to be considered.

3.3.3 Summary

The situational and overall results offer an insight into user needs during different traffic situations. By using the prioritisations of each need and of the corresponding items i.e. vehicle features participants desired and suggested, the vast amount of input can be structured and considered more efficiently during product development phases, e.g. the product specification phase. Certain needs such as 'comfort' and 'safety' became obvious to be relevant in almost every situation. However, it was surprising that they were prioritised differently. This may be dependent on the actual situation itself. In 'active' situations (such as 'driving in severe weather conditions') where the driver and the vehicle are actually moving, the aspect of safety is more prominent than in less active situations (such as 'parking') where the movement of vehicle and driver is at a very low speed.

Generally, the selection of the situations discussed in the focus groups influences the resulting needs/desired technical solutions named by the participants. As a consequence, certain needs do not have as many potential technical solutions suggested by the participants than others due to the selection of situations. The overall need 'driving performance/pleasure' for example does not consist of many corresponding needs/items since the selected situations do not represent experiences in which driving pleasure/experience would be applicable. As mentioned above, the selected situations involve relatively low speeds whereas 'driving performance/pleasure' rather applies to situations involving high speeds. Therefore, a careful selection of the situation in which the items were named and corresponding needs were derived from is crucial.

In order to gain a broad picture of general needs existing in today's traffic situations, the overall needs (section 3.3.2) should be considered. They display that the needs 'information', 'driving performance/pleasure', 'safety', 'comfort' (divided into 'adjustability' and 'general comfort'), 'cost efficiency', 'time efficiency' and 'eco-friendliness' form the basis of all precise, individual items named by participants and, therefore, summarise today's user needs. Furthermore, the overall needs match to some extent the requirement criteria used in the user study of D1.1 [1]. The categories 'information' and 'time-efficiency', however, have been gained as new criteria to be potentially considered in future studies

4 DISSEMINATION, EXPLOITATION AND STANDARDISATION

This deliverable will be published on EU-LIVE's website.

Since this deliverable shows the applicability of a highly innovative method, its content will be published in scientific papers and at relevant conferences. Parts of this work will additionally contribute to an ongoing PhD-thesis at the RWTH Aachen. Furthermore, the content of the present deliverable will serve as crucial input for further development and respectively marketing purposes of the newly developed vehicle concepts and may, therefore, also be published by further project partners of EU-LIVE.

5 CONCLUSIONS

The aim of the present deliverable was to gain insight into today's user needs regarding current urbanisation and corresponding traffic situations. In order to focus the development of the vehicle concepts L3e and L5e on meeting customer requirements and, therefore, gaining higher acceptance levels later, non-functional requirements i.e. user requirements towards the concepts, were collected.

As a first step, relevant traffic situations to be discussed with potential customers in order to gather their user needs in the respective situation, were selected. Using an online survey the EU-LIVE consortium rated different traffic situations on relevance for the new vehicle concepts. The derived six situations are:

- > City drive in adverse weather conditions
- > City drive in severe traffic conditions
- > Parking the vehicle
- > Transportation of small goods
- > Collecting and entering a carsharing vehicle
- > Vehicle requiring service

The selected traffic situations were then used for the subsequent focus groups. These were conducted at three different European locations (Italy, Austria and Germany) involving six to eight participants per group. A total of 59 target customers were questioned on their current needs within the six situations selected. The selection of relevant target customers was based on the output of D1.1 [1] in which user profiles of target customers for the new vehicle concepts were identified. Furthermore, suggested user requirements were defined which were to be verified by the resulting user needs of the present deliverable. The user needs as well as the corresponding target experiences i.e. desired technical implementations that serve as crucial input for planning the further technical specifications of the vehicle concepts which will be conducted in D2.1 [2].

We wish to point out that in addition to the list of current user needs and a verification of most of the suggested user needs in D1.1 [1], this deliverable also contains their prioritisation. Following the discussion of a traffic situation within the focus groups, the participating customers were asked to rate the suggestions they made using a 5-point Likert scale ranging from 'not important at all' to 'very important' with respect to the realisation of the desired technical implementation in a future vehicle. This prioritisation facilitates the later translation of non-functional requirements, i.e. user needs, into functional requirements, i.e. technical specifications of the vehicle concepts. Based on these prioritisations, the foci of the planned technical specifications can be adapted and, therefore, facilitate developing vehicles fulfilling customer requirements.

However, it is crucial to consider the methodology used for the calculations of the mean values. The mean values of each item named by the participants in each location were summarised using a weighted mean value. By this, the fact whether an item was named in a particular location or not was considered and affected the values. If an item was only suggested in one location rather than in two or even all three of them, however, still gained a high mean value for that individual location, the weighted mean value was relatively low compared to items named in more locations with similar individual mean values. The idea behind using the weighted means instead of general ones is to give the fact of the item being named in one, two or all three locations a certain value in itself allowing for it to impact the prioritisation. As a consequence, the amount of locations the item was named in serves as an additional benchmark.

During the analysis of the data gathered within the focus groups, the items suggested by the participants were clustered into different groups. These groups represent the need the items named by the participants would fulfil. This clustering was conducted individually per situation but also in summary over all situations together. In this merge, the needs derived from the items were further summarised into 'overall' needs, allowing for a more precise view onto the overall rough needs, having to be fulfilled by new vehicle concepts. The resulting overall needs customers according to our study have in today's traffic are:

- > **Information**
 - > Customers desire to be informed about their vehicle as well as the surrounding traffic situation at all times.

> **Driving experience/pleasure**

- > Customers desire for a convenient driving experience in all traffic situations.

> **Safety**

- > Customers desire themselves and their vehicle to be safe, not only when driving it but also when picking up a carsharing vehicle or leaving the vehicle parked.

> **Comfort**

- > Customers want to be comfortable in any given situation.

> **Cost-efficiency**

- > Customers want the vehicle itself as well as respective expenses (e.g. parking) to be as cost-efficient as possible.

> **Time-efficiency**

- > Customers want to use their time as efficient as possible. This refers not only to the time spent in the vehicle while driving it but also the vehicle's time itself when being parked.

> **Eco-friendliness**

- > Customers want their vehicle and its parts to be as eco-friendly as possible.

These seven overall needs represent customer requirements crucial to be complied by the future vehicles in order to guarantee for the products' successes. Today's vehicles apparently leave space for innovations improving gaps in customer satisfaction they leave. Using this information on the existing gaps will inevitably lead to developing products with a high user acceptance and high levels of desires for this product.

6 REFERENCES

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7 APPENDIX

Demographic questionnaire used in focus groups:

Questionnaire		
General informations		
age	(number)	
gender	(m/f)	
number of persons in household	(1,2,3,...)	

	yes	no
a car available in household		
rides a motorcycle regularly (>125 cm3)		
use of public transport regularly (>4 times a week)		
Number of passengers >2		
use of car / bike / scooter sharing		

Question 1: What is your estimation: how often do you run the following distances:

total distance / frequency of use (go+return)	(fill out "X")				note
	5 times per week	3 times per week	1 time per week	monthly	
<10 km					
<25 km					
<50 km					
<100 km					
>300 km					
total annual distance with vehicles (if known):					

Question 2: Which type of ways do you have? Is the starting point / end point known?

route type/frequency of use	(fill out "X")				examples
	5 times per week	3 times per week	1 time per week	monthly	
starting point -fixed destination -starting point					home — office — home
starting point -variable destination -starting point					home -business trip to customer -home
one way continuous					A to B to C..., i.e. sales representative
one way discontinuous					car sharing

Question 3: Would you be willing to pay more for the following vehicle features:

Feature/Percentage	0%	<10%	<20%	<30%	> 30%	note
Comfort variant: fully covered cabin, AC						
fully connected, navigation + media entertainment						
Extra luggage space						
Safety functions (ABS, ESP, automatic tilt control)						
rear child-seat						
Zero emission pure electric or hybrid						

Thank you very much for your contribution.

Detailed demographics of focus group participants:

1= Session 1 → Parking the vehicle & collecting and entering a carsharing vehicle

2= Session 2 → Transportation of small goods & city drive in adverse weather conditions

3= Session 3 → City drive in severe traffic conditions & vehicle requiring service

Demographics**Bergamo Vienna Aachen**

		1	2	3	1	2	3	1	2	3
General information										
Age		34	39	36	48	50	37	25	30	36
Gender	Male	4	5	5	6	3	3	3	3	6
	Female	2	1	1	1	4	4	3	3	2
Number of persons in household	1	0	0	1	2	5	2	3	4	2
	2	1	0	1	3	0	5	2	2	1
	3	4	2	3	2	2	0	1	0	3
	4	1	4	1	0	0	0	0	0	2
A car available in household	yes	6	6	6	6	6	5	5	4	5
	no	0	0	0	1	0	2	1	2	3
Rides a motorcycle regularly (>125 cm ³)	yes	2	4	0	2	2	1	2	1	0
	no	4	2	6	5	4	6	4	5	8
Use of public transport regularly (>4 times a week)	yes	0	0	0	6	3	5	5	3	4
	no	6	6	6	1	3	2	1	3	4
Number of passengers >2	yes	3	1	2	4	3	1	5	0	2
	no	3	5	4	3	1	6	1	6	6
Use of car/bike/scooter sharing	yes	1	1	1	2	2	4	2	1	3
	no	5	5	5	5	3	3	4	5	5

What is your estimation: how often do you run the following distances?

<10 km	5 times per week	1	2	1	2	1	1	5	3	4
	3 times per week	2	1	1	2	1	1	1	1	3
	1 time per week	0	0	1	1	0	1	0	1	1
	Monthly	0	0	0	0	0	0	0	1	0
<25 km	5 times per week	0	1	2	0	2	0	2	1	1
	3 times per week	0	0	0	4	0	1	0	0	1

Demographics

Demographics		Bergamo			Vienna			Aachen		
	1 time per week	2	0	2	1	1	1	1	2	2
	Monthly	1	0	0	0	0	0	0	3	0
	5 times per week	1	0	3	0	2	1	0	1	0
	3 times per week	0	1	0	1	0	2	0	0	1
<50 km	1 time per week	1	1	0	2	1	0	1	0	1
	Monthly	1	0	1	0	0	1	1	4	2
	5 times per week	3	4	2	0	3	1	0	1	0
	3 times per week	0	0	0	0	0	1	0	0	0
<100 km	1 time per week	0	0	1	2	1	0	1	0	1
	Monthly	0	0	3	2	1	3	2	4	3
	5 times per week	0	0	0	0	0	0	0	0	0
	3 times per week	0	0	0	0	0	0	0	0	0
>300 km	1 time per week	0	0	0	0	0	0	1	0	0
	Monthly	3	1	5	4	2	2	1	1	2

Which type of ways do you have? Is the starting point/end point known?

Starting point – fixed destination – starting point	5 times per week	6	6	6	2	4	3	3	4	4
	3 times per week	0	0	0	4	1	2	3	1	3
	1 time per week	0	0	0	0	0	0	0	0	1
	Monthly	0	0	0	0	0	1	0	0	0
Starting point – variable destination – starting point	5 times per week	0	0	0	3	2	1	1	0	1
	3 times per week	1	0	2	3	1	1	1	3	2
	1 time per week	2	2	2	1	1	0	2	2	2
	Monthly	1	0	2	0	1	2	0	1	0
One way continuous	5 times per week	0	0	0	0	1	0	0	0	0
	3 times per week	0	0	0	1	1	0	0	0	0
	1 time per week	0	1	0	2	1	0	0	1	0
	Monthly	3	0	1	0	0	4	1	2	1
One way discontinuous	5 times per week	0	0	0	0	0	1	0	0	0

Demographics

Bergamo Vienna Aachen

3 times per week	0	0	0	0	0	0	0	0	0	0
1 time per week	0	0	0	2	1	0	0	1	0	0
Monthly	2	1	1	2	2	3	1	1	1	0

Would you be willing to pay more for the following vehicle features?

Comfort variant: fully covered cabin, AC	0%	0	0	0	4	2	3	0	1	1
	<10%	0	2	2	2	1	3	1	3	4
	<20%	1	2	1	1	3	1	4	2	2
	<30%	2	0	1	0	0	0	0	0	1
	>30%	3	0	2	0	0	0	1	0	0
Fully connected, navigation + media entertainment	0%	0	0	0	1	2	0	0	1	1
	<10%	1	3	2	5	2	3	3	0	7
	<20%	2	1	1	0	3	3	1	4	0
	<30%	2	0	1	1	0	1	1	0	0
	>30%	1	2	2	0	0	0	1	1	0
Extra luggage space	0%	0	0	1	4	2	1	0	2	3
	<10%	2	3	3	1	1	2	2	2	4
	<20%	2	1	1	1	2	2	3	1	0
	<30%	1	1	1	1	0	2	0	1	0
	>30%	1	1	0	0	0	0	0	0	1
Safety functions (ABS, EXP, automatic tilt control)	0%	0	0	0	1	1	3	0	0	2
	<10%	0	1	1	3	1	0	0	1	2
	<20%	0	2	1	3	2	2	2	2	2
	<30%	2	0	2	0	1	2	3	2	1
	>30%	4	2	2	0	1	0	1	1	1
Rear child-seat	0%	0	0	2	7	3	5	2	3	4
	<10%	1	1	3	0	3	1	2	1	4
	<20%	2	4	0	0	0	0	2	2	0
	<30%	3	0	0	0	0	0	0	0	0
	>30%	0	0	1	0	0	0	0	0	0
Zero emission pure electric or hybrid	0%	0	0	0	2	1	0	0	1	2

Demographics

Bergamo Vienna Aachen

<10%	1	3	3	4	1	2	2	3	1
<20%	1	1	1	0	2	3	1	0	5
<30%	2	2	1	1	1	1	2	2	0
>30%	1	0	1	0	0	1	1	0	0

Total annual distance

Bergamo	1	23,417 km
	2	24,167 km
	3	23,333 km
Vienna	1	14,500 km
	2	20,067 km
	3	17,667 km
Aachen	1	14,800 km
	2	9,000 km
	3	14,600 km

Quotes of participants when naming items:**1) City drive in adverse weather conditions**

City	Item	Quote
Bergamo	System warning driver about changing weather conditions.	“Tunnel passage: When you enter the tunnel it is good weather and when you leave the tunnel the weather has turned to bad. In this case preliminary information about the changing weather would be helpful.”
	Detection and display of other surrounding road users.	“Often, pedestrians cross the street wearing dark coloured clothes, which makes it difficult to recognise them.”
	The vehicle has only one entrance from where every seat can be accessed for flexible arrangement of passengers.	“It is raining and you reach the car with two children and an umbrella in one hand. Now, it would be great if all people could get in the car through the same door and after that everyone can take place on his or her seat. Maybe this is possible with moveable seats.”
Aachen	Side windows are equipped with windscreen wipers for better visibility.	“It often happens that rain drops displace on the side mirrors and side windows or the mirrors and side windows steam up and you cannot really see much. It would be great, if there were windscreen wipers or air blowers for the side mirrors and side windows.”
	The vehicle comes with a protective cover to avoid getting wet.	“When I sit on e.g. a motor bike I would wish for a total coverage so I don’t get wet.”

2) City drive in severe traffic conditions

City	Item	Quote
Bergamo	Communication options (e.g. with friends, other people in traffic jam).	"You could use the time for common communication like asking your child how the day in school has been."
Vienna	<i>Concerning traffic situation in general</i>	"The biggest problem while being in a traffic jam is stop-and-go traffic."
	<i>Concerning traffic situation in general</i>	"The biggest advantage of using the train is the possibility to sleep while riding."
	Swivel chairs for communication enhancements with other passengers.	"Swivel chairs would be good for a family holiday (better communication, possibility to play games)".

3) Parking the vehicle

City	Item	Quote
Bergamo	Real-time information on free parking lots, retrievable within the vehicle and on mobile devices.	"Looking for a parking space costs money and time. A satnav that does not only give information about the route to the destination but also information about free parking space would be clever. A system that can be used externally via an app on a Smartphone would be ideal."
	The vehicle can reduce its size while not needed.	"The car can change its size while parking. Meaning, the car can be disassembled to separate pieces."
	The car can be parked in the surrounding area while the electric bike on board guarantees a fast and sweat-free ride to reach the destination.	"Integration of an E-bike into the vehicle. So that the car can be parked and the rest of the way can be covered by bike. However, this system seems difficult for families."
	Simplified parking payment system (e.g. with mobile phone or periodically subscription) that deducts charges automatically from bank account/credit card.	"Often it happens that you don't have enough coins to buy a parking ticket. In this case you have to buy something extra in order to gain some change which is time-consuming."
	<i>Concerning traffic situation in general</i>	"Having a driver's license is not mandatory anymore, since there is traffic jam everywhere and using public transportation is more comfortable."
Aachen	Car-to-Car (C2C) communication: Vehicles inform each other about the duration of the allocation of parking lots.	"You are looking for a parking space in your neighbourhood, driving in circles for like 20 minutes and hoping that a parking lot becomes vacant. Suddenly, a car leaves a parking space directly behind you but the car after you takes it first. If you had been 20 seconds faster you would have gotten the parking space."
	Provision of information regarding the safety of the parking area.	"When I do not know the place, I would like to know whether the area is safe for parking. For example, when I drive to Hamburg on May 1 st , I do not want to park my car necessarily in the area of focus."
	Special area for vehicles that are able to park themselves autonomously.	"If there was a special parking zone for cars that could park autonomously, the parking lots could be much smaller as nobody has to enter or leave the car."

4) Transportation of small goods

City	Item	Quote
Bergamo	The storage space is adjustable. For motorcycles: Engine can be moved elsewhere.	"Shopping with a motor bike is difficult because there isn't enough storage space."
	Possibility to cool things on board in a refrigerator.	"After shopping you drive home for half an hour, while the food still needs cooling, so an integrated fridge would be great."
	<i>Concerning traffic situation in general</i>	"There is never enough space!"
	Camera system that restores rear view vision if fully loaded.	"It is a problem to load the car completely as you don't see anything in the rear mirror anymore."
	Rear seats move forward while loading the boot of the vehicle.	"Sometimes I have the impression that you cannot close the trunk although just a few centimetres are missing."
	The vehicle has an integrated rack system for improved loading.	"When I pick up my children from nursery, I don't want to carry my bag into the building. Therefore, an opportunity to store the bag well in the car would be great."
	Possibility to hide valuables efficiently inside the vehicle.	"When I come home from work I carry my laptop with me. When I decide to go shopping after work, I would like to store my laptop safely in the car."
	Availability of an electrically assisted trolley on board that supports bringing back the shopping goods to the car.	"I've seen an electro-trolley with four wheels in Florida. (mainly used by overweight people)."
	The storage space is adjustable. For motorcycles: Engine can be moved elsewhere.	"Shopping with a motor bike is difficult due to little storage space. It would be great if you could carry e.g. water bottles at the front part of the bike. This is impossible at the moment."

City	Item	Quote
Vienna	Handbag can be attached to a holder on the passenger seat.	"I like to have the window open while driving, but I am scared to leave my purse on the front passenger seat, because it could fall out of the window."
	<i>Concerning traffic situation in general</i>	"I often bang my head on the open boot lid."
	<i>Concerning traffic situation in general</i>	"When closing the boot lid, you could get your head caught."
Aachen	Availability of shopping bags in the vehicle.	"I'm often in the situation that I go shopping and realise too late that I have forgotten to put a shopping bag in the car. It would be great if shopping bags were always available in the car."
	Provision of a possibility to attach the shopping cart to the vehicle.	"I'm often in the situation that I'm afraid of putting the shopping cart next to the car, because it might either roll away or hit the car. It would be great if the car had a device to attach the shopping cart to it."
	Automatic opening and closing of doors.	"Sometime you've got your hands full with shopping bags or bits and a piece of IKEA and no hand is free to open the boot. It would be great if the boot would open its lid on command."

5) Collecting and entering a carsharing vehicle

City	Item	Quote
Bergamo	<i>Concerning traffic situation in general</i>	"The user will get a bonus of 15 minutes if he or she refuels the car. The payment is carried out via bank card that is available in the car. Generally, the costs for fuelling are included in the rental price; you pay for time and distance covered."
	<i>Concerning traffic situation in general</i>	"The searching for available cars via app works pretty well. Additionally, there are benefits like free parking or special parking spaces for carsharing cars."
Vienna	Individual preferences (e.g. favourite radio station, seat settings) will be saved and loaded on next hire.	"Driver settings (seat, steering wheel and mirrors) need to be adjusted every time using the car which is very annoying."
	On board provision of cleaning- and hygiene (e.g. disinfection spray) equipment.	"Cleanliness is a problem. There is usually no material for cleaning on board."
	Text-to-speech engine allows to explain technical features acoustically while driving.	"Sometimes I sit in a car and maybe I don't know the car's features. Then, much later, I realise that the car has cruise control. It would be great, if the car informed me about all available features."
	Provision of cars for people that smoke while driving/Provision of cars for people that carry along their pets.	"While I am sitting in the car, I don't want the car interior smelling of wet dog or cold smoke."
	The vehicle's interior is heated up before entering it.	"In winter, you often leave the house and the car is cold and totally frosty. It would be great, if the car is heated up in advance before arrival at it."

6) Vehicle requiring service

City	Item	Quote
Bergamo	The vehicle is able to diagnose technical difficulties autonomously and enables independent comparison to garage diagnosis.	“A detailed diagnosis system would be good as you cannot rely completely on the mechanics.”
	Problems related to the vehicle are explained in an understandable manner to the driver.	“Often, you don’t get comprehensive explanations concerning the problem. So I wish for explanation as simple as possible”.
Vienna	<i>Concerning traffic situation in general</i>	“Cars are built way too complicated to repair something on your own.”
Aachen	Poka-yoke (zero-error principle) mechanisms to prevent mixing up individual parts and making errors (e.g. light bulb fits only in one direction).	“Surely, sometimes things are easily repaired on your own but it is difficult to detect how exactly the pieces have to be (dis-)assembled.”
	Vehicle able to assist in language translations when service required abroad.	“When I’m abroad and don’t know the country’s language, it can be difficult to explain to the mechanic what exactly is broken. If they start to check the whole car, unnecessary expenses will arise. Because of that it would be great, if the car could explain the problem autonomously in many different languages. Alternatively, the car could give a feedback to a system, so the mechanic of the foreign country gets a contact partner in Germany assigned who is able to explain the problem in detail.”
	Possibility for parts leasing.	“I would like to have the opportunity of component leasing e.g. for the battery. I wouldn’t e.g. buy an electric car, if I ran the risk that the battery loses its capacity quickly, I would prefer to pay a monthly fee and if the battery’s life cycle is over, I would receive a new one.”

'Protection of Data Privacy' for participants of focus groups:



Protection of Data Privacy

I hereby give my consent to the recording of today's workshop regarding user needs in urban traffic situations in the form of

- ☒ image data
- ☒ audio data

The recording of the above mentioned data fulfills the following purpose:

- Logging of group discussion within workshop

I give my consent to the storage and analysis of all data collected and have been informed that all the above-mentioned data is stored and evaluated anonymously.

I give my consent to the publication of the collected, anonymised data, e.g. in scientific journals or conference proceedings. I have been informed that the participation in this workshop is voluntary and can be terminated by me at any time without giving reasons.

(Name)

(Date, Signature)

Prioritisation sheet for participants of focus groups:



Rating of Needs



Please rate all needs from 1 to 5 (not important at all – very important) according to how important it is to you, that a new vehicle concept fulfills the need.

Need 1	
Need 2	
Need 3	
Need 4	
Need 5	
Need 6	
Need 7	
Need 8	
Need 9	
Need 10	
Need 11	
Need 12	
Need 13	
Need 14	
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