Implementation scenarios and user acceptance of shared autonomous (electric) vehicle fleets in German cities

Lisa Kißmer a, Klaus Bogenberger b

a BMW Group, Parkring 19, 85748 Garching, Germany
b University of the Federal Armed Forces, Department of Traffic Engineering, Werner-Heisenberg-Weg 39, 85579 Neubiberg, Germany

In the last couple of years research on highly and fully automated vehicles in particular on sensor technology, customer acceptance and traffic impact has significantly increased (Almeida Correia & Arem, 2016), (Aeberhard, et al., 2015), (Lang, et al., 2016), (Leech, Whelan, & Bhaji, 2015). The investigations in the field of field of autonomous vehicles were even more enhanced by the implementation of automated driving functions for example driverless self-parking systems and new market competitors such as Google and Uber. With the rise of these functions, new synergy effects come along (Chen, 2016). Besides natural synergies between driverless vehicle technologies and electric battery technologies that can occur, synergies between automated vehicles and shared mobility services e.g. carsharing concepts can come along, too. Vehicle reallocation, searching for parking spaces and walking distances to the nearest carsharing vehicle, are only a few issues that can be resolved. From a carsharing operator’s as well as carsharing customer’s point of view many advantages go hand in hand with robotic taxis. The abstract presents the results of a survey conducted in Germany about autonomous electric vehicle fleets in carsharing concepts. It examines implementation scenarios, market potentials and the technological transition phase from highly to fully automated car sharing systems (SAV) in the year 2040. The findings are based on expert interviews (n = 19), conducted from February to June 2016. The study outlines key performance indicators such as political regulations and cultural acceptance for a successful implementation of shared autonomous (electric) vehicle (SAE(V)) fleets in German cities. With this research the author generates possible application SAEV design models for German cities (< 550.000 citizens).

In order to develop future implementation scenarios for automated carsharing systems in German cities, it is important to imagine and evaluate possible applications of driverless cars. The purpose of this paper is to create a holistic approach for early use cases of shared autonomous (electric) vehicle (SAE(V)) systems. The findings show a realistic vision of automated carsharing systems in Germany and an understanding of policymakers’ as well as car sharing businesses’ desires. The interviews help to create city-designed A(E)V deployment scenarios to identify and meet the key needs of German carsharing customers, operators and cities. The study data was divided into five purposive samplings. The non-probability sampling method was chosen as the author assessed each interviewee a priori by specific criteria (Saunders, Lewis, & Thornhill, 2007). For consistency in the research data, one sample consists of a homogeneous group of experts with the same professional background or expertise. Ensuring the most reliable and representative responses to guarantee scientific validity – a maximum variation strategy among the samples is applied. The first sample ‘carsharing operators’ represents CEOs from German carsharing businesses (n = 4). For this study, station-based as well as free-floating carsharing companies were interviewed. An extra influencing factor was included: the national distribution of each company’s carsharing fleet as well as the whole sample fleet distribution. The second sample ‘German cities’ represents official city authorities such as the head of traffic planning departments, urban mobility planners and sustainability directors (n = 5). From northern Germany (e.g. Bremen) to southern Germany (e.g. Munich) city officials were interviewed, as factors such as cultural differences in mobility behaviour of citizens and political tendencies were analysed of being influencing factors for the implementation of SAEVs. Only authorities from cities with more than 550,000 citizens were interviewed1. Another criterion for the city sample was the existence of at least one carsharing provider in a city’s centre. The 3rd sample ‘urban mobility researcher’ (n = 8) is a

1 In Germany, the biggest free-floating carsharing businesses such as Car2Go and DriveNow are operating in cities with more than 500,000 citizens (www.DriveNow.de & www.Car2Go.com).

* Presenter (lisa.kissmer@bmw.de)
group of experts of transportation and urban mobility institutes such as the German Fraunhofer Society, Institute for mobility research (ifmo) and the German Institute for Urbanism (difu). The ‘German carsharing association’ (n = 1) was asked for an interview. A very important criterion for the ‘OEM’ sample (n = 1) was the existence of a highly automated vehicle prototype within the company. The data in this paper is collected through guided, semi-structured interviews (Lamnek, 2010), (Flick, 2007). Five different question sets, one set per sample, with at least 15 open questions, were developed. Question categories like user acceptance or the potential of AVs in carsharing are shared between the question sets and could vary, depending on the knowledge of the interviewee. This ensures the comparability between the samples (Saunders, Lewis, & Thornhill, 2007), (Given, 2008). Within one expert panel, the same question set was asked. Interviews with open questions and the participation of different mind-sets are the best way to study such an uncertain and complex topic, as open questions do not bear the risk of being scientifically biased (Lub, 2015). The respondents can decide on their own what they assume to be important and convenient for the question as well as how detailed they want to answer. It is at the author’s discretion to evaluate the quality of responses and getting a deeper understanding of the themes. In particular for autonomous (electric) vehicle deployment scenarios, this methods is likely to generate more creative and various implementation use cases for urban environments. The interviews were conducted face-to-face, via Skype or telephone and evaluated according to the methodology of (Mayring, 2015) and (Gioia, Corley, & Hamilton, 2012).

Contrary to the technology time horizon of AV implementation in management studies (Leech, Whelan, & Bhaji, 2015), (Bertoncello & Wee, 2015) and the general literature (Cacilo A., Schmidt, Wittlinger, Herrmann, Bauer, & Hartwig, 2015), the research findings show technological as well as timing variation. Three main technology eras can be deduced from the responses of urban mobility researchers and the OEM. In the early stage, from year 2016 to 2025, only partial and highly automated functions are implemented in private (premium) owned vehicles on motorways. The second era is the transition phase from highly to fully automated cars. These cars will be found on German motorways as well as first specified urban quarters. It is expected that from 2030 onwards, new urban mobility services emerge: the very first highly and fully automated functions will be implemented in carsharing concepts. In the last era, the development of driverless vehicles in urban environments will technologically be completed. From 2040, onwards self-driving cars are managed by fleet operators and adopt the role of on-demand robotic taxis. In the early stage of AVs, OEMs will offer the technology just to the private car market, to generate as long as possible profit and hold a leading position in the automobile market, before entering the mass market with for example carsharing cooperations for AV-based services (e.g. Daimler and Car2Go). This strategy prevents the German traditional carmakers from becoming a hardware supplier for companies such as Didi, Lyft and Uber. Furthermore, it ensures the strategic lead of OEMs as mobility service providers.

Despite the natural synergy effects of electric cars and self-driving technology (Chen, 2016), the author’s results show that from almost every sample, except the German carsharing association, at least one expert hold the opinion that the electrical drive technology do not play an important role for the implementation of AVs in carsharing systems. Electric engines were seen as a “nice-to-have” feature, which can reduce noise, pollution and CO₂-emissions but do not resolve the main future urban city and carsharing problems. Surprisingly, the collected data barely exhibits advantages and disadvantages known from general literature and the press (Lang, et al., 2016) (Maurer, Gerdes, Lenz, & Winner, 2015). Positives, such as the increase of traffic safety, customer ME-time e.g. working and relaxing during the ride nor negatives like AV accidents and hacker attacks were not mentioned often. Instead, the experts adopted the vision of an on-demand autonomous (electric) fleet to current and future German cities’, users’ as well as carsharing businesses’ problems and needs. On-demand autonomous carsharing will not be a mobility niche product in Germany. Cities, researchers and carsharing businesses see AVs in carsharing concepts not only as a further “add-on” mobility to the existing and future public transit system and to shared mobility services but as a support and in the long term as a replacement of unprofitable bus systems. German city politicians and traffic planners do not see autonomous carsharing fleets as an existential threat for public transit, but as a part of it e.g. at the end station of suburban trains. Almost every expert stated, that rail-bound transport can

* Presenter (lisa.kissmer@bmw.de)
never be entirely replaced in large German cities, as A(E)V systems cannot reach its transport capacity. The main potential for cities is the discharge in public transportation such as the replacement of unprofitable bus routes by robotic mini busses with 6-8 persons. Experts believe that in some German cities only (shared) autonomous vehicles and busses will be allowed. They can imagine that shared autonomous vehicles and mini busses are the future public transport system for small and medium-sized German cities. These cities do not have subways nor tram systems. Another implementation scenario is the implementation of robotic taxis and busses in rural areas, which creates more mobility flexibility, stops the migration into cities and has a great benefit for old people.

Due to a step-by-step technology implementation process that is introduced to customers within the transitions period from highly to fully autonomous cars, no user acceptance barriers are expected from the experts. The process goes hand in hand with the automation technology transition period and is developed by the author. It describes the implementation lead from partly to highly and fully automated driving functions within carsharing autos. The research findings show, that user acceptance can only be guaranteed by the implementation of this process within carsharing concepts. When AVs are offered to the common run of mankind, the interviewed experts stated that carsharing is the best platform to get customers used to the new technology as cars can be technological upgraded and due to its utilisation capacity affordable to all social classes. Beginning with the implementation of partial driving function such as remote control parking, users who do not like to use carsharing autos for the reasons of parking are introduced not only to the technology but also to the concept of carsharing. The next step is to upgrade the cars with highly automated functions such as self-parking and fully automated functions to pick-up carsharing users. When autonomous driving functions are implemented, reallocation, charging and general maintenance strategies are added. These strategies were discussed with German carsharing businesses and politicians. Within each process step user groups need to be considered depending on the automation degree of the carsharing auto. In Germany, all types of customers can use AVs in carsharing. According to some experts, children need to be at least six years old to be driven on their own. Regarding health condition of old people and the degree of disability of handicapped people, an accompanying person is required. The study found out that the success of AVs in carsharing systems is depending on Key Performance Indicators: cultural acceptance, state regulation and city related factors such as population, city structure, public transportation and the governing authority. For carsharing operators, the most important success factor is state regulation. They fear governmental monopoly, being nationalized or controlled by the cities e.g. by price and competition regulations. The study shows, that even in Germany different SAEV systems need to be adapted to cities as every city has unique features. SAEV use cases are dependent from various factors such as implementation challenges (e.g. customer acceptance, regulatory requirements), public transportation and future city needs. Depending on the country and its cities, different SAEV implementation scenarios and state regulations need to be applied. Consequently, there is no generally applicable SAEV design model for (mega) cities and therefore the study must be transferred to European cities as well.
References


* Presenter (lisa.kissmer@bmw.de)