Risk-adequate motor underwriting of automated vehicles: a qualitative evaluation using German focus groups

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Abstract

The advent of automated vehicles is already taking place and will significantly disrupt the motor insurance industry. The shift from the human driver to the system as the driver cannot be reflected in the current insurance risk assessment. This call for an amendment of the insurance underwriting was discussed with German experts from both the primary insurance and reinsurance sector with their professional background on motor insurance. Based on the findings, we propose an alternative method to underwrite automated vehicles of level 4 & 5 using an enhanced telematics-approach which considers new risk categories such as systems used and the transformed role of the driver as the general user of the automated vehicle.

Keywords: automated driving; motor insurance; expert discussion; risk assessment

1. Introduction

The technological progress of automated vehicles (AV) is advancing fast and will take place in different technical stages, commonly referred to as levels of automation. In the highest level of automation, systems will optimally execute the dynamic driving task providing the highest level of safety surpassing the human limitations (SAE International 2018). This increase in safety level will accordingly decrease the frequency of losses because of the progressive removal of the human-error, which is the leading cause of accidents (European Commission 2016). The advent of autonomous vehicles will sustainably transform the insurance landscape as the increase in safety level will ultimately result in lower anticipated claims and hence, motor insurance premium. Besides the anticipated shift in frequency and severity of losses, insurers are faced with another challenge: the gradual shift from the human driver to the system as the driver. Starting in automation level 3, it is expected that the on-board system will operate all driving mode-specific performances in pre-defined scenarios which will increase with the corresponding levels of automation (SAE International 2018). Because the system mainly monitors the driving environment and executes driving commands on its own, the human driver only has got a control character and intervenes if the systems prompt the driver to do so or if the driver perceives a need to act. Hence, the driving performance and therefore, the risk exposure is no longer depending mainly on the human driver, but also on the vehicle as such. Hence, it is expected to be a necessary shift from a mainly driver-centric to a mixed risk assessment which also considers the system's capabilities. This paper is dedicated to analyse the current underwriting approach of vehicles and future considerations for underwriting automated vehicles based on two expert discussions which were taken out with representatives from the German primary and reinsurance market.

The second section illustrates the technological progress of automated vehicles which provides the basis for the discussion. In the third section, the methodology, as well as the results, are displayed. Based on the findings of the focus groups, the last section discusses and concludes.

2. The evolution of technology and the call for amendment of risk assessment

The technological progress of "connected and automated vehicles" (CAV) is progressing in various steps referred to as automation levels. According to the Society of Automotive Engineers (SAE), a total of 6 stages are distinguished. Automation level 0 represents conventional vehicles that do not include any assisted or automated driving feature at all. The driver executes the dynamic driving task and monitors the driving environment as well. In the automation level 1, simplified assistance systems support the driver in specific driving tasks for either steering, acceleration or braking actions. The driver must continue to perform the other driving tasks and monitor the surroundings. In automation level 2, vehicles assist human drivers utilizing advanced driving and assistant systems (ADAS) which can execute both steering and acceleration actions at the same time in a defined use case. The driver still continually monitors the driving environment and must be able to resume control if needed immediately. The first such Level 2 automated systems were already introduced to the public and represent approximately 8% of the newly registered vehicles in Europe in the second quarter of 2019 (Canalys 2019). As for the second quarter of 2018, level 2 automated features were included in only 3% of the newly registered vehicles. Level 3 automated vehicle perform more complex driving tasks in pre-defined scenarios with pre-defined conditions. The onboard systems mainly monitor the driving environment while the human driver has a latent control character. Although the driver no longer needs to monitor the surroundings to a full extent, the driver must respond appropriately to a systems' request to intervene and resume control. In 2017, Audi was

the first Original Equipment Manufacturer (OEM) to introduce level 3 automation with the "Audi AI traffic jam pilot", which takes over the driving task for specific use-cases, i.e. traffic jams (Audi Media Center 2017). Corresponding statistics regarding the penetration of these vehicles are not yet available. In Level 4, all dynamic driving tasks in defined uses cases are taken out by the vehicles' systems. These systems predominantly monitor the driving environment while the human driver has hardly control character. Besides, the automated vehicle can achieve a full performance even if the human driver does not respond appropriately to a request to intervene. The first commercial use of this level was announced in December 2018 by Waymo but is currently only available in selected cities in the USA (Hawkins 2018). Automation level 5 refers to a fully automated alias autonomous vehicle, which can optimally perform the dynamic driving task in each scenario and thus offers the highest safety level. In the last stage of this automation process, the vehicle can assumably handle all driving tasks without a driver but currently exists only in theory.

As level 2 and 3 automated vehicles are already are accessible to the public and projects with automation level 4 are taking place, the penetration of these new and transformed risks may already affect motor insurance business and hence, should be discussed with the experts. Considering the shift of the driving task, it is questionable whether the traditional underwriting-approach of motor insurance would be still risk-adequate for vehicles of higher automation levels. Since a quantitative evaluation of the risk is not possible due to the missing historical data, we conducted expert discussions to gather and evaluate primary qualitative data to answer the above-raised research question.

3. Focus Group

The concept of insurance appeals to the individual's desire for safety (Ewald 1999). By providing cover for an individually uncertain, but in the collective estimable funding requirements, insurance transforms uncertainties into calculable, monetary risks (Luhmann 1993; Farny 2011). Due to the risk bearing-character of the insurance industry, these entities are considered a key stakeholder concerning emerging risks (Haller 1998; Johanntoberens 2002; Ericson and Doyle 2004). Therefore, the response of the insurance industry, namely the primary insurance sector and the reinsurance sector, towards the introduction of emerging risks, must be analysed. Based on two focus groups, we obtained a detailed perspective and hence, understanding, on the primary insurer's and reinsurer's point of view regarding automated vehicles. The focus of these open discussions was to identify the disruptive technologies within the motor insurance market, the (re)insurer's role regarding these developments, the current underwriting of vehicles, and which characteristics of automated vehicles must be considered to ensure an adequate risk assessment.

3.1. Methodology

We chose a semi-structured approach using a general guideline protocol to ensure an increased degree of openness and reflexivity, allowing the interviewer to be quite flexible (Gläser and Laudel 2010; Mayring 2015). Furthermore, an expert discussion is chosen instead of individual interviews because of group dynamics foster – among other things – validity and accuracy (Fern 2001). In the absence of quantitative assessments, expert opinions are acknowledged as a valid source of information reflecting the experience and views of the industry to prepare research

with more standardized approaches (Schnell *et al.* 2010). Therefore, we considered the use of focus groups to be the most suitable approach for this research objective.

3.1.1. Participants

The two focus groups represent the risk-transfer chain as the first group consisted of only reinsurance experts. In contrast, the second one consisted of representatives of the primary motor insurance market in Germany. We randomly chose the invited experts with the conditions that they have a profound degree of knowledge regarding motor insurance business, namely actively working either in underwriting, actuarial, claims or legal departments. Due to these chosen occupancies, the participants have relevant experience in risk or claims assessment. Other characteristics were neglected for the selection of the participants but are displayed in Table 1 for information purposes.

Table 1: Characteristics of the focus group participants

	Focus group one	Focus group two
Number of participants	12	8
Occupational background		
Underwriting Department	8	5
Actuarial Department	2	3
Claims Department	1	0
Legal Department	1	0
Gender	4 female, 8 male	1 female, 7 male
Age range	Early 30s to 50s	Early 30s to 60s

3.1.2. Procedure

The focus groups took place in August and September 2019 and lasted 45 – 60 Minutes. The participants were invited via email and declared their informed consent following the stipulations set out by the General Data Protection Regulation (GDPR). Based on the

participant's declaration of consent, we sent additional information regarding the content and the progress of the focus group to the participants. Before the focus group started, the interviewer made additionally reference to recording and usage of data as well as to the anonymity of data and participants to be compliant with the GDPR. An anonymized transcript of records is available on request and was translated from German into English as the mother tongue of the participants was predominantly German. The noted-down and anonymized transcript of records was sent to the participants to ensure the accuracy and validity of the focus group and allowed the respective contributors to make changes if required.

The first focus group consisted of participants of the reinsurance industry representing underwriting, actuarial, claims and legal departments. Overall, fifteen respondents and therefore, twelve participants attended the focus group. The second focus group consisted of members of the primary insurance market in Germany with participants from the underwriting and actuarial departments. The employers of the participants have an accumulated market share of approximately 9,35 % of the German motor insurance market (Bundesanstalt für Finanzdienstleistungsaufsicht (BaFin) 2018). Furthermore, an actuarial consultancy firm was present during the second focus group. For this event, there were eleven registrations, of which eight respondents attended and contributed to the focus group. An overview of the asked questions is displayed below.

Introductory question: How do you assess the significance of the motor business for your company and which trends are opposed to the industry?

- Is the motor business a critical "backbone"? If so, why?
- From a 10-year perspective, how do you assess the impact of automated driving on the motor business? What are other disruptive trends?
- Do the identified trends represent an emerging risk? What challenges do you see as a motor (re)insurer? What role does a (re)insurer play in overcoming these challenges?

Core question: Can telematics data be used to insure automated vehicles?

- What is the current underwriting approach for motor insurance? What data is used?
- Considering the level of automation, is the current underwriting approach adequate to underwrite these risks? If not, indicate why.
- Considering the progressive change from the human driver to the system as the driver, at what level of automation could the current underwriting-approach no longer be risk-adequate?
- What is your understanding of a telematics tariff/product?
- Can an enhanced telematics-approach be used for these new risks? Which risk categories must be changed/ deleted or extended? Do you see any limitations?
- Do you believe that motor insurers can pursue a different approach to underwrite highly automated vehicle in a risk-adequate manner?
- What else do you have in mind on this topic, which is important but was not dealt with in the overall discussion?

3.1.3. Evaluation

We evaluated the focus groups using qualitative content analysis using a search grid (Gläser and Laudel 2010; Mayring 2015). In the first instance, the recorded expert discussions were transcribed by the authors and anonymised so that we referred to the participants as “industry expert X”. We deleted the recording after an appropriate period. Afterwards, we analysed the transcript of records using a search grid based on preliminary theoretical considerations which allowed the identification, extraction and classification of crucial text sections (Rustemeyer 1992). Subsequently, the raw data for the individual categories were then assessed, sorted according to their characteristics and checked for redundancies and contradictions (Rustemeyer 1992; Neundorf 2011). The identified passages provided the information basis for the subsequent evaluation of the findings of this paper and an overview of the used categories are displayed in Table 2.

Table 2: Categories used to evaluate responses

Introductory questions	1. Motor business considered to be important a.) due to insurance penetration b.) due to predictability of business c.) due to marketing reasons 2. Motor business is facing disruptive trends a.) shared mobility b.) electro mobility c.) automated driving d.) use of mobile phones 3. Automated driving can be classified as an emerging risk a.) yes b.) no 4. The insurer's role is to a.) ensure victim protection b.) provide coverage 5. The reinsurer's role is to a.) provide capacity b.) provide knowledge
Core questions	1. Currently, vehicles are underwritten using a.) risk-independent data sets b.) vehicle-specifications via model code number c.) other vehicle-specifications 2. The current underwriting focuses mainly on a.) the vehicle as the risk driver b.) human driver as the risk driver 3. Considering the shift of the driving task, the current underwriting approach is suitable for a.) Level 0 - 1 automation b.) Level 2 automation c.) Level 3 automation d.) Level 4 automation e.) Level 5 automation 4. An alternative risk assessment could be the use of a.) telematic data b.) a unitary premium for automated vehicles 5. The use of telematic approach a.) requires "real-time" data access b.) an amendment of risk categories c.) a continous amendment due to software updates 6. Other aspects a.) introduction of a public pool to compensate victims

3.2.Results

3.2.1. Importance of motor insurance business

Both groups identified the motor insurance business as the most crucial non-life segment. The majority of the experts argued that this importance due to the premium volume of the business, which is mainly due to the insurance penetration as Motor-Third Party Liability (MTPL)-insurance is mandatory. Other characteristics of this line of business like the relatively stable loss pattern, namely the high frequency, low severity of losses and the relatively low Solvency II risk capital requirements make it quite lucrative for insurers to offer. Additionally, motor

insurance is seen as a door opener to get access to the customer and provide the basis for further insurance sales.

3.2.2. Disruptive trends within the motor insurance business

“Shared mobility" was named in both groups as the first trend opposing motor insurance business. Although this trend is mainly found among young drivers, it has not yet shaped the automotive industry as strongly as assumed in the past. Since this trend is currently gaining importance, it can be disruptive if there is a change from individual insurance policies into a comprehensive fleet insurance policy. Electromobility was also identified as another trend by both groups, as it affects various risks such as cars, buses and scooters. The group consisting of representatives from the primary insurance market pointed out that there is no valid data available regarding the expected frequency and severity of losses. However, the experts assume that repair costs could increase as only trained specialist personnel can adequately evaluate and repair these vehicles. Additionally, the experts believe that in the medium term, this trend will only be relevant in large cities due to climate protection. In the long run, however, the trend towards electromobility is not perceived as significant. The third identified trend was automated driving which will be discussed in the following sections. The primary insurance market participants gave a particular remark regarding the use of mobile phones as a crucial trend. The distraction represented using a smartphone already has an influence on the loss statistics and should be considered in the risk assessment. However, as the police prosecute the use of mobile phones in road traffic, the experts believe that relevant information cannot be gathered during the application process. Although this trend is considered significant, it is not reflected in the current motor underwriting.

3.2.3. Classification of automated driving as an emerging risk

The focus groups had different opinions regarding the classification of automated driving as an emerging risk. Although most experts would classify this trend as an emerging risk, four experts argue that this risk is an emerging risk only to a certain extent. Although many characteristics such as loss frequency are uncertain, other aspects such as legal background, risk perception, etc. are already present. Upon request, the experts would prefer to speak of an "evolving risk", since the known risk develops further due to technological progress.

3.2.4. The (re)insurer's role regarding this emerging risk

The answers given depended on the field of activity of the participants. The majority of the representatives of the primary insurance market found the victim protection as most crucial. Fast and fair compensation is based on sufficient insurance coverage and the prompt identification of the causative party. This process requires additional knowledge which the experts from the primary insurance sector expected to be provided by the reinsurer. This aspect was only confirmed to a minor context by the focus group consisting of reinsurance experts. Most participants of this group identified the reinsurer's role as a sole capacity provider. This role is especially crucial for emerging risks as these risks can hardly be adequately assessed due to missing historical information. Therefore, reinsurers can provide knowledge only to a limited extent and may rely on other public entities as well[1].

[1] As a unique indication, the reinsurance focus group discussed a public pool solution based on the model of the nuclear terrorism pool in Germany. A public entity would be set up by the authorities, would handle recourses affecting automated vehicles and would represent a central contact for injured parties, insurers and manufacturers. This approach would - among other things - ensure victim protection and fair allocation of liability costs. However, due to time constraints, the experts did not explore this aspect in depth.

3.2.5. Current underwriting approach in motor insurance

The consensus in both groups was that in the present motor underwriting in Germany, the specifications of the vehicle, as well as the usage behaviour of the drivers, are taken into account. These specifications are derived from the manufacturer code number and the model code number. However, the model code number only includes the standard model of the vehicle and not additional, fee-based special packages such as "safety packages", which includes, for example, lane-keeping assistants. The usage behaviour is evaluated by asking risk questions during the application process, which should, among other things, reflect the driver's driving ability, e.g. based on age, gender, etc. The questions used are based on risk categories derived from long-term historical loss statistics. Since large individual losses for motor insurance are distributed relatively independently in theportfolio, and human driving behaviour is relatively stable, these long-term historical loss statistics are reliable over time and thus suitable as a proxy for the true risk exposure of the human driver. In combination with the known no-claims bonus category, the subjective risk of the driver is thus evaluated with the aid of risk proxies

3.2.6. Applicability to automation level 0 – 5

Upon request, the experts voted if the current underwriting approach is risk-adequate for the different levels of automation. Up to and including level automation level 3, the experts considered the current underwriting approach to be adequate. For higher automation levels, namely levels 4 and 5, the systems used come to the fore, as they perform all complex driving tasks in specific areas referred to as "operational design domains". However, the participants pointed out that higher automation levels represent "mixed levels" since the safety functions

of different automation levels are active at the same time in these levels. Depending on the systems in use, the role of the driver thus changes from an active driver to a passive user with a latent control character. Because of this, a distinction must be made between the active and passive driving function of the driver, since the driver as a subjective risk continues to have a significant influence on the loss frequency, for example, by actively assuming the driving task in good weather. Furthermore, the used systems can pose a new risk driver which must be considered more in the future risk assessment. However, amending the current underwriting approach by adding further risk questions during the application process to focus more on the risk assessment of the automated vehicle, was considered as not risk-appropriate. As an explanation, the experts argued that there are no long-term historical loss statistics available for these automation levels from which meaningful risk proxies can be derived. As a result, both groups agreed that motor insurers are forced to find an alternative risk assessment approach for higher automation levels.

3.2.7. Use of an enhanced telematics approach

In both groups, the participants discussed alternative risk assessment approaches [2] of which the use of telematics data was considered to be the most reasonable one. Underwriting based on telematics data requires the collection and transfer of data stored in the vehicle's black box, which stores driver-specific as well as vehicle-specific data. This so-called 720-degree observation would enable insurers to triangulate data sets that can capture not only biometric data but also behavioural characteristics of the driver. Based on this data, the driving function

[2] The representatives of the primary insurance market pointed out the concept of an "unitary premium" for highly automated vehicles. According to this approach, "hard" tariff characteristics such as annual mileage are placed in the context of time and place of use. As a result, other tariff features such as no-claims bonus category would be redundant. However, the extent to which this approach would be risk-adequate was not discussed further.

of the driver, either the active or passive state, can be differentiated as well. Since the user of the vehicle can influence the functionality of the car even in higher automation levels, for example, due to omitted system updates, the user must also be considered in the risk assessment. The participants from the primary insurance sector also noted that the triangulated data sets are crucial for fraud detection as well as the reconstruction of the course of the accident. In respect of possible technical errors, the experts noted that the risk categories must be extended by the vehicle systems used, which among other things include the type of perception of the driving environment.

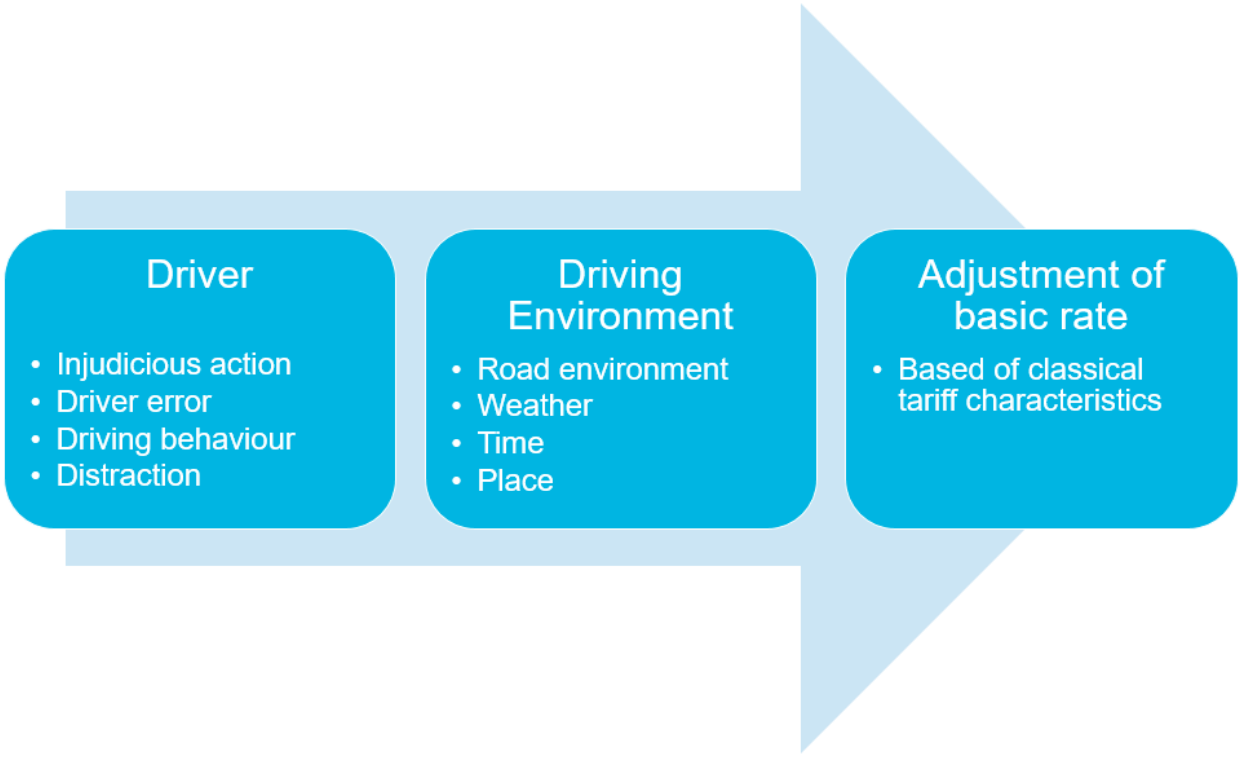
With regard to the feasibility of such an approach, the problem of data access was considered to be the most predominant one. To enable a 720-degree observation, real-time access to these data sets is required. Based on current developments as well as statements made by automobile manufacturers, the experts assumed that the automobile manufacturers are not prepared to provide this data free of charge. The reinsurance experts remarked that the programming and hence, the execution of driving commands depends on the manufacturers' version of the software. According to the expert's opinion, each update represents a new risk, since this can influence the driving behaviour of the vehicle as the underlying software code is amended. As a result, the telematics approach would have to adapt dynamically to take account of these new factors. However, this is practically impossible due to the diversity of manufacturers as well as system versions.

4. Discussion and conclusion

As stated by the industry experts, the use of telematics data is of particular interest for the motor insurance industry, as it enables the insurer - among other things - to collect system

protocols of the vehicle as well as the creation of risk profiles of the drivers. Based on this data, a so-called "pay-how-you-drive" approach is implemented, which evaluates the driving skills of the users for each trip (Castignani *et al.* 2015). This evaluation of driving skills indicates to what extent the “basic rate”, i.e. the motor premium, of the policyholder theoretically should be corrected positively or negatively to reflect the risk adequately. The basic rate consists of historical data relating to risk categories and factors such as region, loss history, the vehicle used, etc. and thus represents the "traditional" motor pricing. The assessment using telematics data is done via a "risk score", which, depending on the granularity of the available data, represents an "exposure to risk", i.e. the driving behaviour concerning spatial and temporal components, using risk categories (see Figure 1).

Figure 1: Risk categories for telematics products, own evaluation



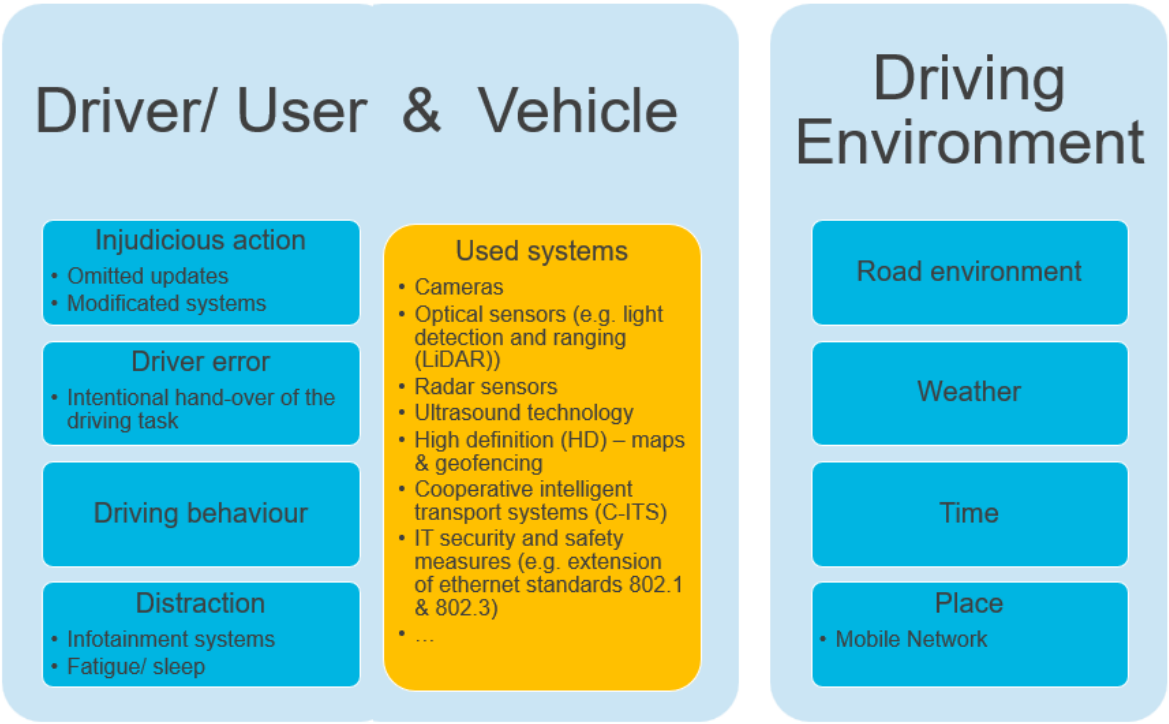
Since automation levels 4 & 5 represent new risk characteristics, these characteristics are only captured to a limited extent with the existing risk categories of telematics products. As stated during the expert discussions, the risk score must reflect the extended and more complex risk landscape emanating from the vehicle's characteristics. The significant risk driver like the evaluation of the systems used, the re-defined role of the human driver as the driver, but also the human-machine transitions should be considered in a sound risk assessment. Furthermore, risk categories like the possible deliberate negative behaviour of the driver/user should be extended, if, for example, the driver modifies the software in the vehicle or does not install essential updates. Also, the user of the car in Level 4 can intentionally take back the driving task if he has the urge to drive or recognizes the circumstances after which "the intended use of the highly or fully automated driving functions no longer exists" (Bundestag 2017). An overall assessment of the driver/user and vehicle should, therefore, be carried out, as both parties influence the accident risk.

The experts agreed that the systems used in the automated vehicle, in particular the type of environment detection, represent the main risk for a possible accident due to a failure of the driving systems. For example, the use of high definition maps allows automated vehicles to capture the driving environment better and reduces the amount of raw data the systems need to capture and process. According to this approach, vehicles can only operate in areas that have been mapped very precisely, which is referred to as "geo-fencing". If, however, other changes occur in the actual driving environment as in the digital version, e.g. temporary blocking due to a construction site, this could lead to system failure. This issue underlines the importance of "contextualisation of the risk", meaning the time and space of operating. Concerning area, the location of the car such as city, country or highway is of relevance, since in these

environments the availability and bandwidth of the mobile Internet vary greatly. The optimal functionality of highly and fully automated vehicles requires the "5G" Internet (ABIresearch 2016), which is currently not yet available in Germany. According to the initiative "5 Steps to 5G" this network should be available by the year 2025 only in the 20 largest cities of Germany (Federal Ministry of Transport and Digital Infrastructure 2017). By implication, the optimal use of a safety system cannot be guaranteed at the current state, for example, in rural areas as these areas are characterised by slow and unstable mobile networks.

Furthermore, the industry experts assume that the weather conditions can influence the systems as well. Optical sensors and cameras are more sensitive to interference in bad weather or poor lighting conditions. If no other redundant systems such as radar sensors are in place, it is questionable whether safety-relevant systems such as emergency brake assistants can function optimally (Tuveri 2017). Based on the expert discussion and research, Figure 2 provides an overview of the modified risk categories for highly and fully automated vehicles.

Figure 2: Modified risk categories for highly and fully automated vehicles; own evaluation



As outlined above, new risk categories, such as active systems, and changes to existing categories, such as mobile network, must be introduced to correctly capture the new risks emanating from highly and fully automated vehicles and to ensure an appropriate telematics product. However, the feasibility of this approach heavily depends on data access in real-time, which is according to the insurance experts not given at the current state. Furthermore, the time until such a product can be put on the market is dependent on other factors for which the motor insurer has often not established a corresponding network. For example, the involvement of third parties such as mapping providers is essential for the contextualization of the "risk score", which is relevant for all automation levels. Therefore, an early assessment and implementation by the insurance industry are necessary.

The consensus of both focus groups was that traditional motor underwriting uses risk categories that are accepted as risk proxies to assess the driving skill of the human driver and to a limited extent, the vehicle's specification. As the driving tasks are increasingly taken over by the vehicle systems, this approach is not suitable for higher automation levels. However, higher levels are representing "mixed levels", since safety functions of different automation levels are active at the same time in these levels. The human driver, as the subjective risk, continues to have a significant influence on the probability of loss occurrence. However, since there are no long-term historical loss statistics from which risk proxies can be derived for this new risk, another transitional solution must be found. One approach would be to use an enhanced telematics approach that considers the unique risks of automated driving, such as the systems used.

In summary, motor insurers should differ according to the different automation levels to position themselves strategically correctly and, above all, adequately in terms of risk. Among other things, this means the early implementation of an appropriate, risk adequate underwriting approach. By using an enhanced telematics approach, these new risks can be assessed more adequately but require unhindered and direct data access. Therefore, there is a call for greater engagement between automobile manufacturers and the insurance industry to ensure the necessary data access and hence, ensure an adequate risk assessment of automated vehicles.

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Conflict of Interests:

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