

# TRUST IS KEY

## HOW TO DEAL WITH SOCIETAL INSECURITY REGARDING AUTOMATED AND AUTONOMOUS DRIVING

### Authors

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### Executive Summary

#### **Building trust as core mission**

The automotive industry is on the cusp of a fundamental change: the delegation of the driving task to artificial intelligence. But is the society ready for this development? And if not – which actions have to be taken to respond to uncertainties and thereby to pave the way for the acceptance of this technology?

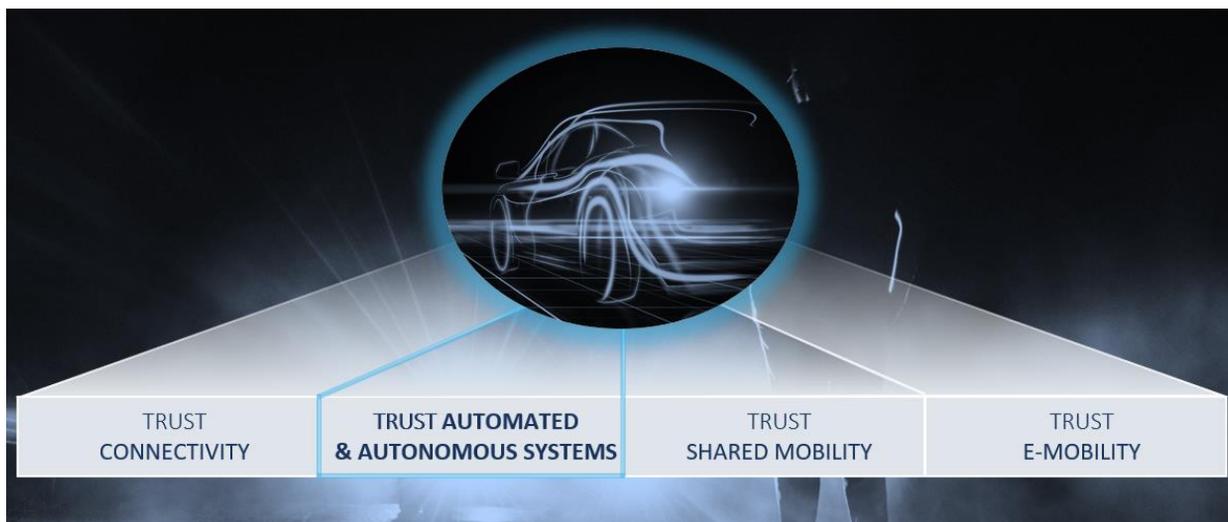
Supporting the customers in building trust in automated and autonomous driving is one of the current fundamental challenges of car manufacturers (OEMs). Therefore, a variety of different actions has to be taken in order to serve this task, which include the *adaptation of the brand concept*, the *adequate preparation of car dealers*, the *generation of user experience* as well as the *provision of transparency regarding test results*.

### Introduction

#### **The time to act is now**

Car manufacturers and IT companies are currently presenting their visions of autonomous vehicles hitting the road at some point around 2025. The dream and the vision of self-driving vehicles, however, is not a recent one. *'One day your car may speed along an electric super-highway, its speed and steering automatically controlled by electronic devices embedded in the road. Highways will be made safe – by electricity! No traffic jams ... no collisions ... no driver fatigue.'*<sup>1</sup> This advertisement by America's Independent Electric Light and Power Companies from 1957 already refers to electronic devices which shall one day take over longitudinal and lateral control. Additionally, it points out the advantages of autonomous driving, including avoidance of traffic jam, prevention of accidents and risk minimization.

Even though this technology has been present in people's minds, users only start coping with it when the utopia turns into reality and when they realize what it means to hand over the vehicle's steering control to the vehicle itself. At this point, questions are raised like 'Do I even want this?', 'What does this mean for me?', 'How does this work?' and 'What is my car already capable of today?'. This is where insecurity begins.



Trust in new technologies is the key factor for acceptance. Source: P3

Convincing today's society of the wide range of benefits of automated and autonomous vehicles is a necessary element of the providers' mission paper. Hence, if the self-driving technology shall be successful, societal acceptance – besides technological challenges, legal restrictions and economical potential – must be focused on and is a key success factor for the OEMs.

#### Facts & Figures

### The fear is real

In order to put this challenge into perspective, hard facts from different international studies support gaining a better understanding of users' insecurity. Thereby, a differentiation between Advanced Driver Assistance Systems (ADAS) and autonomous driving has to be made. While the opinion towards the latter is mainly based on people's gut feelings, most drivers have already experienced ADAS – either actively or passively.

According to an international mobility study conducted in four countries 62 per cent of German study participants are scared of ADAS functions. In the USA even 77 per cent have negative feelings. In addition, 57 per cent of Germans and 77 per cent of Americans do not believe in the reliability of ADAS.<sup>2</sup> This is also related to the fact that the majority of drivers do not know the limitations of their ADAS: only 21 per cent of the American Automotive Association (AAA) study participants were able to select the right answer when asked about the functionality of the Blind Spot Monitoring System.<sup>3</sup>

A recent study conducted with test persons from nine countries (e.g. Germany, China, USA, Italy, South Korea) highlights that – even though interest (82 per cent) and curiosity (62 per cent) were considerably high – serious concerns

remain regarding autonomous driving in view of the loss of control (70 per cent), technically unavoidable residual risks (66 per cent) and the missing statutory framework (65 per cent).<sup>4</sup> This finding is consistent with the conclusion of another publication in which US citizens were interviewed: 73 per cent of them are too afraid to ride in a self-driving vehicle.<sup>5</sup>

#### Worst Case

### ADAS as emotional burden

The facts and figures illustrated above indicate several scenarios which occur once ADAS are perceived as an emotional burden for the driver. These issues are further fueled by missing knowledge about the vehicle's automated functionalities, culminating in the scenario where intended support functions are considered as negative influence.

For instance, in the context of *wrong interpretation*, the driver overrides ADAS procedures as he/ she is not able to interpret the vehicle's indications properly. This situation is likely to occur if, for example, the Active Lane Keeping Assist counteracts after the driver initiated a lane change manoeuvre without signalling. In case ADAS intervene unexpectedly, drivers might also be put in a situation where *sudden fright* leads to an inability to act properly.

An additional issue is the large number of visual, acoustic and haptic signals which accompany the assistance systems. Uninformed drivers may feel overtaxed by these which will lead to *uncertainty*. As a result, the *risk of causing accidents* increases. Especially when taking back the driving task from the ADAS, an attention deficit has to be overcome in order to avoid traffic accidents. This does not relate to SAE level 4 and 5<sup>6</sup>, which

describe the levels of driving automation in which the driver – in comparison to the below levels – is not required anymore to take over the driving task.

In the worst-case scenario, the driver develops a *fear of driving* based on general missing system knowledge which, in turn, leads to an avoidance of the car in general.

Summed up, facts and figures give an initial overview of potential customers' fears towards ADAS which constitute the underlying technology of autonomous vehicles. Moreover, once uninformed drivers with inadequate knowledge of the driving functions are faced with them, severely negative effects may occur whereby users might find themselves in an unintended but dangerous situation.

This examination shows that the human factor must be considered when creating future mobility concepts or refining company strategies. It underlines the necessity for rapid action and precise measures in order to meet the drivers' needs and dispel their fears.

Success Criteria

### Four critical factors

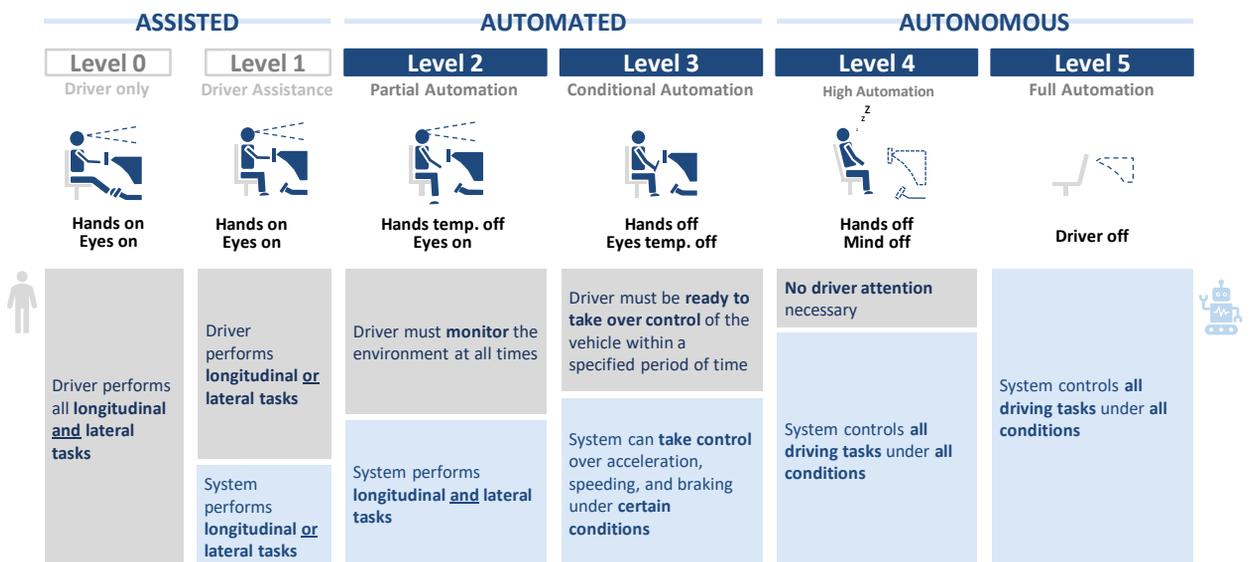
Customer acceptance refers to the formation of attitudes and intention to utilize prior to the eventual behavior (i.e. the decision of using the innovation or not) of the consumer.<sup>7 8 9</sup> The reasoning behind is the idea that an adoption of a technological innovation only happens in case consumers have created a positive attitude towards it and, after overcoming possible initial

resistance, have finally accepted it.<sup>6 10</sup> Hence, acceptance (and trust) may be considered a part of the adoption process and precedes the final adoption of an innovation.

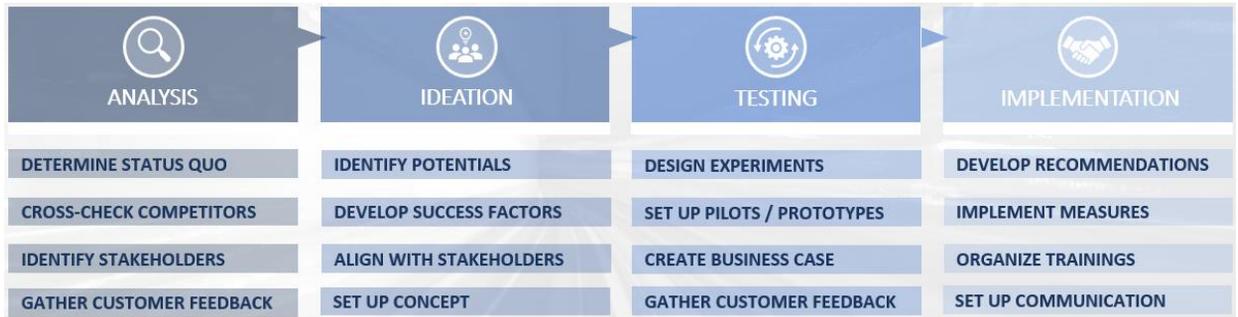
In order to examine and explain a consumer's intention to make use of technological innovations, science has developed a wide range of theoretical models. In this context, the *Technology Acceptance Model* by Davis<sup>11</sup> of 1989 represents the most popular one which in turn had significant influence on the *Universal Theory of Usage and Acceptance of Technology*.<sup>12</sup> The most recent model, the *Autonomous Vehicle Acceptance Model*<sup>13</sup> of 2019, which bases on the approach of Ventakesh et al.<sup>11</sup> as well as the *Car Technology Acceptance Model* by Osswald et al.<sup>14</sup>, is the first model of its kind to investigate behavior and appearance of human beings in the specific context of (highly) automated vehicles.

Based on these approaches as well as internal and external research findings and topic-related projects we have elaborated four critical success factors to generate trust and acceptance in autonomy:

- *Reliability*: safe and dependable ADAS and immediate provision of necessary support if needed,
- *Transparency*: permanent information about functionality and next steps performed by ADAS,
- *Familiarity*: orientation of support along already known services and permanent repetition,
- *Experience*: user experience events and personalized/ detailed support while driving.



SAE Levels of Automated Driving. Source: SAE, P3



Trust Autonomy: P3 approach. Source: P3

These success criteria allow to open up a solution space with concrete measures to handle the challenge of establishing trust. In the next chapters we will give a brief insight into the general process of identifying relevant measures and initiatives as well as selected examples of potential actions to be taken by companies in the field of autonomous mobility.

Business Factors

### Chances vs economic threats

In contrast to the strong customer acceptance problems based on lack of knowledge and concerns regarding safety, the number of vehicles equipped with ADAS systems is high and increasing. For instance, the global market volume of newly assembled light vehicles fitted with adaptive cruise control (ACC) is expected to increase by about 84 per cent between 2020 and 2028.<sup>15</sup> This will also be attributed to legal provisions like the *General Safety Regulation* which will come into force in 2022 and requires the implementation of certain ADAS within the European Union.<sup>16</sup> However, the actual future use of these systems remains uncertain. Apart from that, forecasts of the overall ADAS global market volume differ considerably but still show a constant growth rate, even though many users do not yet have these technologies in their vehicles. These estimates vary between 36 billion U.S. dollars by 2025<sup>17</sup> and 130 billion U.S. dollars by 2026<sup>18</sup>. Notwithstanding concrete figures, these forecasts show the huge market potential of ADAS. However, trust and acceptance of end users play a major role in exploiting this potential and are crucial for automated and autonomous driving functions in the future. When the status of maximum trust is reached, chances for a variety of business opportunities open up for OEMs and Tier1 companies. More detailed, potential business opportunities for SAE level 2 ADAS are further increasing take rates and the distribution of additional equipment (e.g. well-being interior such as massage seats and implementation of ADAS as standard). Once trust towards these systems is established, it enables

transition to the next level of conditional automation. On SAE levels 3 to 5 business opportunities arise from autonomous parking solutions, upgrades and expansions, training on dedicated routes, productive mobile office, entertainment (e.g. games), robo taxis (also in the context of mobility-as-a-service), peer-to-peer (P2P) sharing with delivery services and 24/7 mobility (automated charging, maintenance, or courier services).

However, both market potential and business opportunities are accompanied by threats in terms of economic damages. If the automated or autonomous technology is not accepted, customers are not expected to be willing to pay extra for systems they do not know nor use and which, in addition, are not required by law. Moreover, customers who do not trust level 2 systems are not likely to accept level 3 to 5 systems either and, as a result, will probably not get into an autonomous driving vehicle. OEMs and tier 1 suppliers, who fail to create trust initiatives and therefore fail to generate customers' trust will run the risk of lagging behind and being overtaken by competitors in this regard.

Therefore, identifying individual measures and initiatives to create and maximize acceptance towards autonomy (by preparing the driver for his new role within the car) as well as creating competitive advantages (by starting to support the customer as early as possible) is crucial.

Theoretical Framework

### P3 approach: end to end view

While existing publications mainly point out lacking trust of society towards automated and autonomous driving and provide generic recommendation for action, our approach individually identifies and implements relevant measures and initiatives.

*Analysis*

Before defining the targets and direction a clear

understanding of the OEMs' current position is crucial. Based on the four critical success factors we mentioned earlier the *Analysis* phase includes the status-quo determination and therefore delineates the scope and extent of possible measures. An important consideration is to cross-check competitors with the aim to identify relevant players, spot new trends and successful tactics, assess their strategies, and finally determine strengths and weaknesses relative to the own business. Apart from competitors, internal and external stakeholders, namely those who are actively involved in the project, or whose interests may be affected as a result of project execution or project completion, must be identified. It is imperative to gain a holistic view of the human and institutional landscape and the aspects they are most interested in to eventually receive full support. This also includes customers respectively their feedback about existing initiatives, brand perception as well as individual positions, interests, fears and needs.

#### *Ideation*

During the *Ideation* phase the prior conducted holistic analysis allows to identify potentials to develop and expand current services, products, and initiatives. Concomitantly, the development of (critical) success factors provides a common understanding of key variables which have a tremendous impact on how successfully the OEMs' goals will be and additionally give insights on which tasks are truly important.

#### *Testing*

Once potentials are identified, success factors derived and all activities aligned with the stakeholders, an individual concept can be set up, further developed and validated in the *Testing* phase. Major activities within this stage are the design of experiments or the setup of pilots and prototypes. This approach aims at testing and validating prioritized ideas or uncovering new areas of focus for the next iteration. By involving potential customers, valuable feedback is gathered. Moreover, the OEMs are enabled to gain a deeper understanding of the users. This, in turn, may

**"Trust"** is often used as a synonym for **acceptance**. In this paper the concepts of trust and acceptance are not presented selectively. **Trust is considered the key factor for acceptance** which means that once trust in a technology is established, acceptance is concomitant with it.

have impact on prior stages, such as the *Analysis* phase (e.g. different status quo) or the *Ideation* stage (new ideas) and might finally lead to an iteration of the prototype or experiment.

#### Implementation

During the last stage, the *Implementation* phase, the specific measures are moved from development to 'production' status including all relevant project management activities. Apart from that, supporting actions include training for affected users (e.g. sales staff) and carrying out internal and external communication initiatives.

#### Solution Space

### Holistic cross-level trust concept

Based on the theoretical approach described above and building on the success criteria Reliability, Transparency, Familiarity, and Experience we built up a solution space in which we do not only focus on product level and single measures but on a holistic concept on several levels. For instance, it is crucial to refine the *Brand Concept*, to reach out to the *Car Dealers*, to create *Customer Experience*, and to actively provide *Results & Data*. On these levels we identify and implement relevant measures. In the following, an exemplary overview is presented briefly.

The goal of a redefined *Brand Concept* in this context is to embody the customers' ideal partner to enter the autonomous era. Exemplary measures are setting up in-house trust events including test drives with tech teams and real-life feature explanations as well as customer-group specific advertisements and simplified point-of-sale material.

Moreover, it is crucial to closely involve and enable *Car Dealers* to successfully enter the autonomous future. As a first step, sales staff needs to gain adequate knowledge of the vehicles' automated and autonomous functions through standardized functional and technical training. Furthermore, users must be sensitized to integrating ADAS into their daily rides. Once sales staff disposes of required knowledge, potential initiatives for car dealers could be e.g. a driverless handover process during car pick-up at the car dealer (including the presentation of relevant features and driving simulation) or a training supported by virtual reality.

Another part of a holistic trust concept is shaping *Experience* with the background of establishing ADAS branding as core feature. This includes a

EXEMPLARY MEASURE: ADAS DRIVING EXPERIENCE

- ★ Experience ADAS features during a **test-drive in real life situations** with specially trained staff
- ★ **Racetrack events** to show ADAS features supporting the car in **extreme situations**
- ★ Experience **drives in relax mode** for scenic rides



Trust Concept Element: ADAS Driving Experience. Source: P3

technical but 'personal companion' which means a personal relationship through direct approach by the systems. More precisely, potential measures include real time information and driving recommendations (e.g. audible support, in-car videos) to make technology self-explanatory.

The last level described within this paper and which we consider indispensable is the provision of *Results & Data*, which constitutes the presentation of hard facts to prove progress and success. This level aims at maximum transparency through disclosing system requirements (e.g. which features require data storage and in what sense are these data processed), autonomous vehicle test results and also focuses on regular reporting on testing procedures and progress.

Overall, our approach offers a framework and includes relevant levels and thereby helps companies develop an individual concept including best fitting measures with the aim to establish confidence and trust in automated and autonomous systems.

Conclusion

**Trust is key**

In public discourse on autonomous driving, technological challenges, legal restrictions, and economic benefits are predominant subjects. However, trust in and acceptance of automated and autonomous technology is a key factor on the road to success of self-driving vehicles.

Even today's ADAS have strong acceptance

problems from customers' side due to lack of knowledge as well as distrust. Apart from that, the number of vehicles with ADAS, which are the technological base of automated and autonomous driving, is rising constantly and expected to keep doing so in the following years. Moreover, automated driving functions open new opportunities for future business on SAE levels 1+2 and on levels 3-5 at a later stage. Therefore, confidence in safety, usefulness, and reliability of autonomous systems has to be created to reduce the danger of future economic damages. What is decisive is that OEMs, suppliers and other automotive industry companies recognize trust issues early on and take measures to make the customer become familiar with the functionalities and benefits of autonomous systems.

The presented P3 approach helps automotive industry companies identify relevant measures and initiatives and enables them to create a holistic trust concept on all relevant levels as TRUST IS KEY.



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