

FUTURE OF MOBILITY

Autonomous driving and the impact on our life

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Since the end of the last century innovation labs have started to work on self-driving technology. As of the early 2000's the Automotive and Tech industry heavily invested in the development of Autonomous Driving (AD). Getting AI technology to be safe for both passengers and other traffic participants is far more complex and challenging than predicted. It was expected that the shift towards self-driving functions would have come

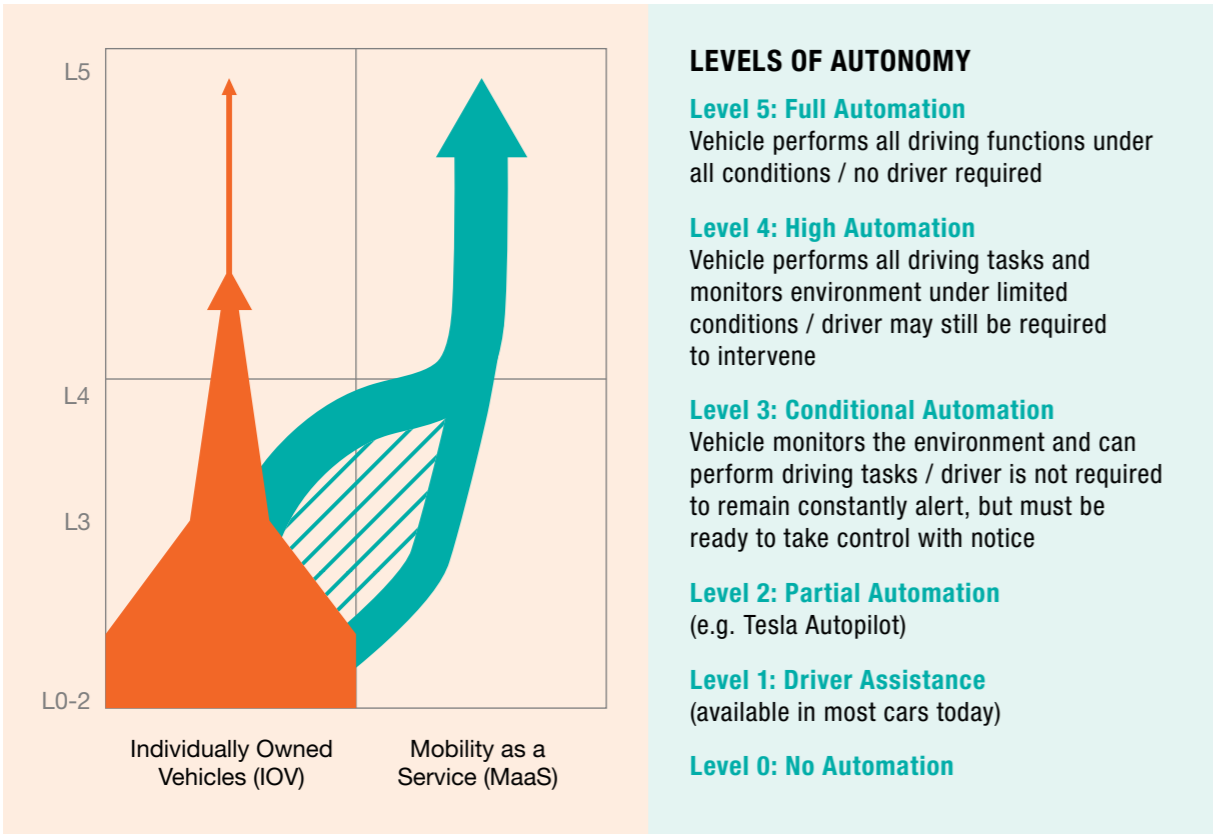
earlier, but today the offer of semi-autonomous vehicles is still limited and there are very few examples of highly Autonomous Vehicles (AV) on the road. However, the transformation from traditional to self-driving cars is expected to come and it won't be a technical gadget. Once fully Autonomous Driving is here, it will have a huge impact on our daily habits and routines. It will change our lives.

THE TWO ROADS TOWARDS AUTONOMOUS DRIVING

First, there will be individually owned autonomous vehicles (regardless, if purchased, leased, financed, or subscribed) and secondly,

there will be shared mobility, so called **Mobility as a Service (MaaS)** which will happen autonomously without human drivers.

Figure 1 Road towards AD



Source: Ipsos

Two-thirds of consumers believe that it will be too expensive for them to personally own an AV.¹ Experts assume that the prices for self-driving mode (Level 3-5) will be expensive and therefore it is likely that the first solutions will only be available on premium and luxury models in high-end segments.

For private cars in the lower and midsize segments of volume or budget brands, there might not be high Automation implemented any time soon. But self-driving will not only be for wealthy consumers, who pay extra for the ownership, any consumer will have the chance to experience self-driving e.g., when using robot taxis, autonomous public transport, or as ride hailing/car sharing offers. Plus, all consumers can experience semi-autonomous driving when riding or driving a recent vehicle with active ADAS (Advanced Driver Assistance Systems) with Emergency Braking, Adaptive Cruise Control or Lane Keeping Assistance.

THE LIGHT IS GREEN FOR SELF-DRIVING

Traffic can be extremely busy, chaotic, and overcrowded. In bad weather, car drivers must navigate their way around other motorists, pedestrians, bikers, and scooters. As a result, the AI development for autonomous driving is extremely complex, but driverless Autonomous Driving (Level 4-5) is technically possible today.

In the streets of San Francisco, *General Motors* has started to offer *Cruise* taxi shuttles without human drivers and *Google's Waymo* operates its robo taxis in downtown Phoenix, Arizona. In South-East Beijing, the so-called Beijing High-level Automated Driving Demonstration Area (BJHAD), driverless robo taxis both from *Pony* and *Baidu* are commercially in action on public roads. Also, in Guangzhou, *Pony*, *WeRide* and *AutoX* are operating as self-driving traditional taxis. *AutoX* launched a driverless robo taxi fleet with more than 1,000 AVs in five Chinese mega cities, as well as San Francisco.



In Europe, several fenced facilities (e.g., at factory sides) have autonomous vehicles in regular use. There have been several announcements that self-driving robo shuttles on specific routes (e.g., between airports and city centers) or in specific metropolitan districts could be launched in the coming years, predictions as early as 2025.

42%² of consumers expect fully autonomous vehicles that can handle all local roads and environmental conditions by **2025**. Experts are more reserved and believe it might take a bit longer before L4/L5 Autonomous Vehicles (AVs) will be broadly offered and can be used everywhere – both on highways, cities and in rural areas. Fully autonomous driving functions are expected to be available in many areas from **2030** onwards.

There are enterprises in some regions which will be the first to move towards autonomous driving. Companies in the USA (especially in California) and in China are pushing towards self-driving. Some smaller city states are expected to launch self-driving faster than others. European and Japanese car manufacturers are also investing a lot in autonomous, thus there will be specific self-driving pilot areas, but it's likely it will take a while before autonomous transport will be possible on a large scale. India, Brazil, and the rest of the world including all the developing markets will have to wait for fully autonomous driving. Nevertheless, in a couple of decades we very likely could live in a world where self-driving is available everywhere around the globe.

THE COMMERCIAL POWER OF AUTONOMOUS DRIVING

Companies which are transporting goods are interested in the use of AD. **Long-haul truck driving** might soon become a profession of the past. Automated truck driving will lead towards lower logistical costs, which should result in lower consumer prices. In the USA, Germany, and other countries there are already autonomous trucks on the road and implementation of self-driving commercial vehicles on highways are predicted for daily use by the middle of this century.

In addition, the **last-mile delivery** will benefit from AD. The AD delivery pod concept for example, allows consumers to pick-up their package in front of their house. Walmart or UBER Eats in collaboration with Nuro are offering AD food delivery where consumers can pick up their order from an AD vehicle at the sidewalk.

Of course, the **transportation of people** will be a main application for AD. Public transport, taxi offer, ride-hailing (like Didi, Uber or Lyft) and location-to-location shuttles at airports,

sporting events, concerts, city centers or other occasions will be the first using autonomous driving. When this happens, the job description of bus and taxi driver will significantly change, a transition period will occur where they will be on board for ensuring safety protocols. Large enterprises with many sales reps or technical support will also use AD vehicles to increase the productivity of their staff while driving.

There will be **commercial applications beyond transportation** where self-driving is imminent, if not already in operation. AD tractors or mowing machines are used in the agricultural industry for seeding and harvesting. Lawn care machines in parks or at golf courses will be autonomous. For waste collection, AD garbage trucks could be used. Street cleaning can be done fully autonomously, for instance due to COVID there were concepts for self-driving air disinfection vehicles. And the more established AD functions get, the more services are expected to include autonomous driving into their offers.

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THE CONSUMER BENEFITS OF AD

DEMOCRATIZE MOBILITY

The world's population is ageing, and the number of persons aged 80 years or over is projected to triple by 2050.³ A major worry for the elderly is loss of mobility.⁴ Autonomous Driving therefore will be a significant benefit to elderly people keeping or winning back their level of mobility and freedom.

Foremost, disabled people with a visual impairment or lacking eyesight who rely on the support of others for transportation, will become more independent. People without driving licenses or who have less experience will get a new freedom to travel where and when they want.

SAFER MOBILITY

In addition to the gained freedom, traveling will get **safer** especially for elderly people with physical challenges, less experienced drivers, and therefore for everybody else. According to the World Health Organization, there are about 1.3 million deaths due to traffic accidents in the world every year, and more than two people die in traffic accidents every minute on average. Although the growth rate of accidents is relatively slow compared with the rapid increase of mobility, the number of occurrences cannot be ignored, and reduction of accidents will benefit everybody.

Today the media is reporting mainly about accidents that are happening with the involvement of driverless cars. There is nearly no coverage about all the crashes which could

have been avoided by using Advanced Driver Assistance Systems (ADAS) or other semi-automated features. To get a significant boost in trial and acceptance of AD, manufacturers need to address consumer worries around safety. Most consumers aren't comfortable giving up the control of driving without knowing the vehicle is safe, but if they can be shown and convinced of its safety they may convert to AD on more journeys. The driver or consumer wants to activate AD when they feel safe based on the conditions and the type of drive it is. Another way of convincing consumers of AD safety will be when it becomes more ubiquitous in commercial applications. Publicly available self-driving transportation experiences will be advantageous to get general consumers exposed and comfortable with the technology.

LESS TRAFFIC JAMS, MORE HOSPITABLE CITIES

AVs are fully connected and therefore continuously communicate with the environment. Vehicles communicate with vehicles (V2V), with pedestrians (V2P), the infrastructure (V2I), the network (V2N) or with the whole environment (V2X) to achieve anticipatory driving and avoid abrupt maneuvers. Therefore, self-driving cars could improve the overall traffic flow by up to 35%⁵ and reduce traffic jams, especially in metropolitan areas. There would be less wasted time and passengers would suffer a lot less in congestion.

Personally owned cars are parked, or stationary, for 95% of the time. But Robo Taxis or other shared mobility vehicles would always be on the move. As soon as one passenger ends their AD ride, a new passenger is picked up and heading to the next destination. This means AVs will need to park much less and won't block so many parking lots. Parking spaces could be transformed into green areas. Less traffic and greener cities will significantly increase quality of living for urban residents.

HOW AD CAN REVOLUTIONIZE OUR TIME MANAGEMENT

When traveling in self-driving cars there is no need to watch the traffic anymore, the passenger can do whatever they want – they could increase their productivity, by mobile working in the vehicle, participating in video conferences or doing online shopping. Extra time while traveling autonomously could be used for relaxation and wellbeing or sleeping. Consumers can choose between being entertained (by streaming services) or they can use the extra time for communication with others via video conference or playing with children during the trip.

A significant AD advantage would be for commuters, who spend hours in the car each day with limited productivity. Consider this thought piece:

A commuter today brings his/her children to school (30 min) and travels to the office (45 min), including parking the car nearby (10 min). After work he/she heads to the grocery store to buy food (30 min) and then drives home (35min). They spend 2.5 hours in the car on a normal working day. All those in-car hours could be spent carrying out other tasks. Children, without driving licenses, could take an AD shuttle to school, and the time spent commuting to the office could become mobile working, all while the food is delivered autonomously to your doorstep.

Self-Driving vehicles will not only make our time traveling more comfortable and/or productive, it also will impact time-management and change all our in-home habits. Autonomous vehicles could soon lead to a large disruption to our daily routines.

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Contribution: Nuro



AD WILL LEAD TO NEW CONCEPTS AND CHANGE OUR HABITS

There will be further aspects and habits of people's daily lives that will change. Drinking and driving is strictly prohibited, but in the future drinking while in a car can become common. AD shuttles can turn into mobile bar lounges and express restaurants where you can spend time with friends while travelling. Perhaps entertainment groups could offer mobile cinemas or AD gaming pods – we already see early concepts of this with Audi Holoride. As drivers become users and passengers without the need to stay alert, sleeping while traveling will be the new normal. With such a change in

habits, this could change the hotel business and lead towards AD overnight accommodations with sleep & ride services. Maybe Marriott will decide to offer mobile beds for travelers?

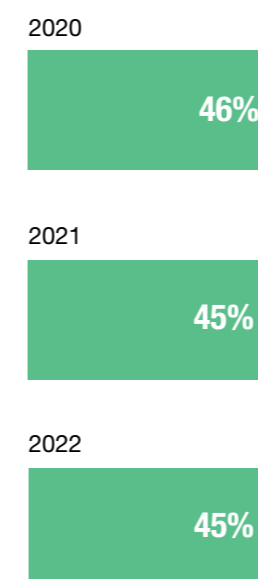
AVs could be in constant motion while the AV owner is working at home or in the office. Owners of autonomous vehicles can earn passive income by providing autonomous rides to others or by delivering goods without their involvement. Many new mobility concepts could become reality.

EDUCATION AND EXPOSURE ARE KEY

Within the last two years, there were a lot of Battery Electric Vehicles (BEV) launched with significant media coverage and advertisements – while there was less communication about AVs. We see that the interest and consideration of BEVs is significantly higher and has been continuously rising over the last two years, while the attitudes towards vehicles with full autonomous mode remained unchanged. Compared with 2020 and 2021, there was no significant movement in the overall interest in self-driving cars.

It will be interesting to see if the Automotive and Tech industry will be able to positively boost the opinions towards AVs in the coming years, as more and more models will be in the market which offer at least semi-autonomous driving (Level 2-3).

Positive sentiment towards vehicles with Full Autonomous Mode⁷

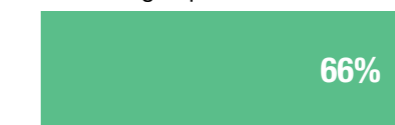


EXPERIENCE IS KING

In the coming years more consumers will have the chance to experience semi-autonomous features. For the industry, it is promising to see that consumers who have experienced semi-autonomous vehicles have a higher consideration for buying fully autonomous vehicles, compared to those who have no experience.

Consideration

AD Driving Experience



AD Riding Experience



Non-AD Experience



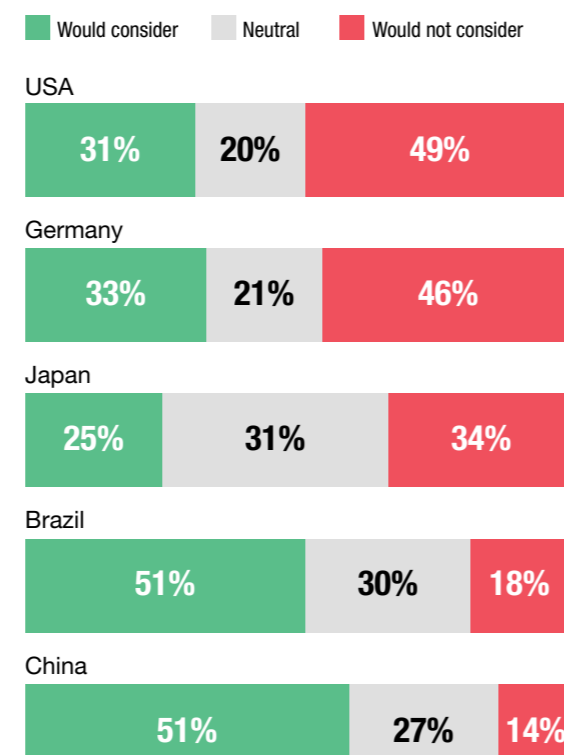
The amount of experience further correlates with country specific consideration levels – both in the USA (25%) and Germany (34%), the experience⁸ of driving or riding a car with semi-autonomous features is significantly lower than in China (43%).

GAUGING THE INTEREST OF AUTONOMOUS DRIVING

Many tech enterprises and OEMs in the USA are pushing towards self-driving. However, this doesn't mean that American consumers are excited about AVs. Today, new car owners in the USA, Japan and Germany are not seriously considering fully autonomous vehicles. But in contrast, the Chinese are far more interested in self-driving vehicles.

Overall, Western consumers generally tend to be more reserved, while the Chinese are more accepting. Therefore, it is not surprising that Chinese consumers are far more open towards new technologies and more interested in self-driving vehicles. The higher consideration in China and Brazil might also arise from a desire to escape the challenges of particularly high traffic density.

Consideration⁶



WHICH CONSUMERS ARE MOST EXCITED ABOUT AD?

Societies can benefit from autonomous driving, yet the level of consideration is different by age group.

Consideration

Gen Y/Z (18-41)



Gen X (42-57)



Boomers (58-74)



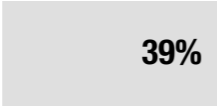
It is also not a surprise that those who are considering AD see themselves as early adopters.

I am an early adopter of cutting-edge technology

Likely AD Considerer



Neutral





Unlikley AD Considerer



And those who have the biggest personal advantages through AD, like commuters, show a higher consideration. Only 19% of the non-commuters state that they would consider buying a Fully Autonomous vehicle, while the interest from commuters is far higher (44%).

Comparing AV-Considerers and Non-Considerers leads to two opposed consumer types. Those who are interested in autonomous driving are younger commuters, living with children in metropolitan areas, while those people who are not interested are more likely to be from the Boomer generation, living in suburbs or rural areas as empty nesters without children in their household and less need to commute into the office.

Figure 2 AV consideration profile

| | |
|--|--|
|  |  |
| Likely to consider AVs38% | Not likely to consider AVs35% |
| More likely 18-41 (Gen Y/Z)56% | More likely 58-74 (Boomer)43% |
| Skews slightly male54% | Skews slightly female55% |
| Likely to have children at home69% | Unlikely to have children at home63% |
| More likely to commute to work83% | One third do not commute29% |
| Live in a major metropolitan city57% | Live in rural area/suburbs53% |
| Experienced in Semi-autonomous driving/riding50% | Unexperienced in Semi-autonomous driving/riding87% |

Source: Ipsos

Owners of autonomous vehicles can earn passive income by providing autonomous rides to others or by delivering goods without their involvement.



THE ROAD TO AD: MANEUVERING THROUGH THE BARRIERS

The Automotive and Tech industry is investing a lot of resources and money into the development of connected and autonomous vehicles. If the industry wants to make Autonomous Vehicles a real success through transforming mobility, the interest in AVs across all age groups and customer segments must grow.

It is not just about increasing awareness, as most consumers are already aware about AD technologies. Over 80% of consumers in all markets are aware of AD technology – only in Japan (39%) do they state they have never heard about fully autonomous driving. It's more about educating the consumers to better understand the advantages – both personal and for the society overall.

Trust in the technology is also paramount. There is a lot of communication needed to overcome the fears about this innovation and digitalizing mobility.

There are many aspects Auto-Tech must take into consideration when discussing autonomous driving. Especially safety concerns, which are seen as an issue across all age groups when thinking about driving fully autonomous.

Concerned about my own safety in AD

Gen Y/Z (18-41)

64%

Gen X (42-57)

65%

Boomers (58-74)

72%

Concerned about the safety of others (motorists, pedestrians, cyclists)

Gen Y/Z (18-41)

64%

Gen X (42-57)

64%

Boomers (58-74)

74%

There is a fear of car crashes due to bugs in AI or hacking while traveling. There will be data security and privacy concerns too and the need to answer the question: “who is owning my personal information?”, like mobility patterns of passengers or video footage of others. There will also be a fear of loss of autonomy of when and where to drive. Not necessarily the scenario of potential mobility lockdowns, but the risks of black box mobility – not being able to choose the preferred route.

Consumers might be skeptical as to whether there are more advantages over disadvantages. Several new safety features became mandatory over the years, for instance having to wear

a seatbelt at all times. What if autonomous driving features will be compulsory in the years to come? Younger families who own a car and use their trunk as a mobile storage space for a baby stroller might not have enough money to buy a car with self-driving functions and will be forced towards AD shared mobility.

A lot of AD benefits are claimed (higher safety, less traffic, nicer and more hospitable cities, more spare time, and democratized autonomy) but before those benefits can be achieved trust must be gained. Both in the innovative technology itself as well in the ethics and standards of AD usage.

Trust in the technology is also paramount. There is a lot of communication needed to overcome the fears about this innovation and digitalizing mobility.”



Contribution: AutoX

THE FUTURE OF AD: THE JOURNEY AHEAD

Experts assume AD technology will be ready, launched and continuously improved over the coming years. For the next two decades, low market shares of highly / fully autonomous vehicles (Level 4/5) are expected, but we will see Robo Taxis and self-driving transportation of people and goods and other new concepts first.

There will be more semi and highly automated vehicles arriving in the premium and luxury segments and becoming more prominent on the roads. Plus, all consumers can be exposed to semi-autonomous experiences made possible by using active Advanced Driver Assistance Systems (ADAS) features in the latest vehicles

on the road today. Trial and experience of these vehicles and features will help consumers get over the fear hurdle and trust vehicles to handle more drives over time.

In addition to solving all the technical AI questions within the complex environment, it is equally important to ensure that the industry is taking the consumers on the journey towards autonomous. Without any increased consumer consideration in AVs, the Return on Investment might take longer than expected. Communicating, show-casing trials, and proving the benefits of Autonomous Driving will be key.

A lot of AD benefits are claimed (higher safety, less traffic, nicer and more hospitable cities, more spare time, and democratized autonomy) but before those benefits can be achieved trust must be gained.”

Contribution: Nuro

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This Ipsos View is based on Consumer Insights – which were collected in the Ipsos Mobility Navigator Study in USA, China, Germany, Japan, and Brazil. 1,000 new car owner were interviewed in each country (USA n=2,000) in June and July 2022. In addition, 25 expert interviews were conducted with internal and external experts (at Car Manufacturers, Automotive Suppliers & Tech companies, as well Universities (professors & scientific staff)) in USA, China and in Europe.

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