

# THE WORLD IN TRANSITION

TRENDS AND CROSS DOMAIN IMPACT OF FUTURE MOBILITY

WHITE PAPER

BEST OF BOTH

### Contact

#### AUTHOR



Ayhan Mehmed is a Ph.D. graduate in automated driving and safety from Mälardalen University, Sweden. He has been in the Automotive industry since 2014. He has worked as Research Engineer, System Architect, and Technology Expert in automated driving and its cross-domain impact ranging from safety, security, and sensor fusion to standardization and regulations. As a Lead Business Consultant at msg Plaut, Ayhan Mehmed supports the further development of the automated driving portfolio.

#### HEAD OF MANUFACTURING



#### Gerhard Krennmair

gerhard.krennmair@msg-plaut.com +43 664 807 402 80

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### Foreword

As the Head of the Business Unit Manufacturing at msg Plaut, a leading technology consulting company, it is my pleasure to unveil our latest study, which delves into the ever-evolving transportation industry and the powerful quartet of technological trends, known as ACES (Autonomous Driving, Connectivity, Electrification, and Shared Mobility). These forces have the potential to fundamentally transform the way we move and will have a far-reaching impact on a diverse range of industries in the European Union and worldwide. At the same time, our company actively pushes for new technologies and ways to reduce our carbon footprint substantially, saving our world for our kids and their children.

At msg Plaut, we understand the importance of staying ahead of the curve and anticipating the challenges that these technological advancements will bring. That's why we've conducted a comprehensive study on the future of mobility, examining the various industries that will be affected by these changes. Our goal is to help our clients better comprehend the problems that are ahead and provide them with valuable insights and solutions that will enable them to thrive in this rapidly evolving landscape.

One of the key findings of our study is the need for traditional **automotive** companies to completely transform their business models and adopt an ecosystem approach. This means seamlessly blending products and services together and finding new revenue streams from non-traditional sources. Additionally, the industry must find ways to effectively manage the complexity of modern vehicles and explore sustainable solutions for recycling and disposing of electric vehicle batteries.

In a series of complementary white papers, we also delve into the challenges imposed by ACES on the **public sector**, as well as insurance and banking industries. In the **insurance industry**, for example, the lack of historical data on the risks of new technologies presents a significant obstacle for assessing risk and pricing insurance policies.

The **banking sector** also faces its own set of challenges, such as shifting from a product-oriented approach to a service-based model and embracing digitalization.

**Public institutions** will have to modernize their infrastructure and find alternative ways to generate revenue as autonomous vehicles decrease traditional income sources.

Finally, we stress the importance of adopting a customer-centric mindset and leveraging new technologies to stay ahead in this rapidly evolving landscape. By understanding the challenges and potential solutions outlined in this white paper, industries can navigate and thrive in the future of mobility without uncertainty.

By Gerhard Krennmair Head of Manufacturing

### EXECUTIVE SUMMARY

### EXECUTIVE SUMMARY

The transportation industry is on the brink of a revolution driven by a powerful "quartet" of technological trends known as ACES (Autonomous Driving, Connectivity, Electrification, and Shared Mobility). These four forces have the potential to completely reshape the way we experience transportation - from the vehicles we use to the infrastructure that supports them. Moreover, the effect of these technological advancements will extend to diverse industries worldwide.

The **automotive sector** is no exception. To keep pace with these developments, the industry will need to undergo a complete transformation of its traditional business models. Specifically, car manufacturers will need to adopt an ecosystem approach, where products and services seamlessly blend together. To gain access to new markets and cutting-edge technologies, partnerships such as joint ventures, licensing agreements, or strategic alliances will be essential. Additionally, the automobile industry would need to explore innovative ways to generate revenue from non-traditional sources. This would also include finding creative methods



Figure 1: Mobility trends and cross-domain impact

for monetizing the large quantity of data generated by smart and connected vehicles.

As cars become increasingly comprehensive, it is crucial to effectively manage this complexity to reduce production costs and simplify diagnostic, repair, and recall procedures. Additionally, excessive customization of vehicles would lead to over-complicated production processes that must be addressed. Furthermore, the shift towards clean energy solutions in the automotive industry will present a variety of challenges, including increasing the driving range of electric vehicles to alleviate consumer concerns and partnering with governments and private companies to enhance charging infrastructure. Finally, finding sustainable and cost-efficient methods for recycling and disposing electric vehicle batteries will also be essential.

The **insurance industry** will also need to significantly improve its business models to keep up with the rapid evolution of in-car technologies. In particular, the lack of historical data on the potential risks of new technologies (e.g., self-driving vehicles) presents a significant obstacle to assessing the risk and pricing of insurance policies. Furthermore, to remain competitive, the industry must innovate and introduce new products tailored to the on-demand mobility market, such as the Pay-How-You-Move models. The insurance industry will also need to tackle the problem of rising claim costs due to the expense of in-car tech-

nology and batteries and, at the same time, fight the downward pressure on premiums as car trends such as automated vehicles come with the promise of reducing the accident rate. The changing risk landscape will also need to be addressed, with new types of risks emerging, such as cyber attacks, theft, and hazards beyond those normally associated with general repair and maintenance. As autonomous cars take over the roads, the accountability for the safety of the vehicle and the aftermath of an accident will no longer rest solely on the human driver, but rather on the cutting-edge technology and the manufacturer who created it. This paradigm shift will require insurance companies to re-evaluate their coverage policies and transition from individual coverage to insuring car and software manufacturers. Determining liability for data privacy breaches would be another significant challenge the insurance industry must address. This task, particularly within the automobile industry, requires a comprehensive understanding of the legal and technical aspects involved. To effectively determine liability, insurance companies would need to conduct a thorough investigation of not only the car manufacturer, but also its software and hardware suppliers.

The **banking sector** will need to tackle several challenges in order to capitalize on the technological advancements driven by the mobility trends. First, it will need to shift its business model from a product-oriented approach to a

service-based model to become an all-around mobility provider. One way they could do that is by expanding their traditional car financing option to include insurance, maintenance, and repair services. Furthermore, banks would need to lose their relationship with car dealers and find alternative sales channels to interact directly with customers. As with other industries, the banking industry will need to find ways to monetize the modern car's data. Finally, banks will need to embrace digitalization. This will include updating legacy IT architectures to cloud-based solutions and providing digital services throughout the customer journey to strengthen customer relationships. By doing so, the banking industry will provide a seamless and convenient experience for customers, keeping them engaged and loval.

**Public institutions** will also face their challenges. One of the most significant needs would be to modernize its road infrastructure to cater to the future mobility requirements. This includes digitizing roads with comprehensive vehicle-to-infrastructure technology, building specialized facilities for the maintenance and service of shared electric car fleets, converting existing infrastructure like parking spaces into staging areas for multiple fleet operators, and constructing infrastructure ture to support the production, storage, and distribution of alternative fuels like hydrogen and biofuels.

Ensuring a reliable energy grid that can support the needs of future electric mobility solutions is another crucial challenge facing the public domain. With the increasing popularity of electric vehicles, the demand for charging infrastructure is set to sky-rocket. The public domain will need to find innovative ways to meet this demand and ensure a stable energy grid. This could include smart electric grid load management systems and energy storage systems, such as batteries or vehicleto-grid technology enabling plugged-in electric vehicles to balance local power networks.

The decreased income from fuel taxes and the lack of driver licensing and registration fees with autonomous vehicles poses yet another challenge for the public domain. Finding alternative ways to generate revenue will be crucial. This could include revenue from data exchange and dynamic road curbs pricing. For instance, by utilizing dynamic pricing and designating the curb for specific purposes during peak hours, the government could charge a higher fee for the premium service of autonomous vehicle pickup and drop-off as part of the public transportation system. In the afternoons, this same space could be used by food trucks and at night by delivery trucks.

The complexity of the market is further compounded by the **shifting consumer attitudes**. To stay ahead, industries would need to adopt a customer-centric mindset and make it their top priority. This means going above and beyond to deliver unparalleled transparency and convenience to customers, whether it be through streamlined online contracts and insurance policies or other innovative solutions. By doing so, industries can foster a deep sense of trust and loyalty with their customers.

In addition, industries must also look to high-tech companies as a source of inspiration and leverage their existing brand and customer base to compete with these disruptors. This includes embracing new technologies such as AI and automation and utilizing data to understand customer needs and preferences better.

It is clear that there is still a long way to go in terms of fully embracing and utilizing the advent of new mobility technologies brought by ACES.

**Part A** of this paper, provides an overview of the ACES trends and changing consumer attitudes and their cross-domain impact. Whereas, **Part B** outlines a comprehensive summary of these challenges and their impact on the remaining domains, namely public, insurance, and banking.

### MOBILITY TRENDS & CHANGING CONSUMER ATTITUDES

### 1. AUTOMATED DRIVING

The Automated Driving (AD) industry has come a long way since its inception. In the past, the technology was in its infancy and was only used in limited applications such as military and industrial settings. Today, the industry has advanced significantly, and AD technology is being integrated into a wide range of vehicles, including passenger cars, buses, and trucks. For perspective, in 2035, the global market for autonomous vehicles (AV) is projected to reach US\$ 395 billion, and it is estimated that 9 out of 10 passenger vehicles will possess some degree of automation<sup>1</sup>.

The benefits of automating certain aspects of driving are numerous and far-reaching the primary benefit being improved safety. In particular, it can significantly reduce the number of accidents caused by human error, which substantially contributes to traffic accidents. Other benefits include increased efficiency (e.g., time efficiency), reduced fuel consumption (via vehicle platooning), and improved mobility for people who may not be able to drive due to age or disability.

While AVs are expected to bring benefits, their widespread adoption is also projected to bring significant disruptions, requiring various industries to adapt, and overcome new challenges.

The **automotive sector** will need to ensure the utmost safety of their self-driving car technologies to ensure passenger and road participants' safety. In the **insurance industry**, for example, the reduced number of accidents caused by human error will likely lead to lower premiums. Furthermore, with the advent of self-driving cars, the need for car ownership and car loans may decrease, as consumers will be able to access a fleet of shared on-demand driver-less vehicles. This, in turn, will significantly impact traditional **banking** models and car loan schemes, as fewer people may be taking out loans to purchase cars.

Finally, as the widespread adoption of selfdriving vehicles is projected to result in a decrease in income from driver licensing and registration fees, the **public domain** will need to explore alternative means of revenue generation. The remaining chapters take an in-depth look at these challenges and delve further into an array of related subjects.

Part B of this paper will take an in-depth look at these challenges, their cross-domain impact, and potential solutions.

<sup>1</sup> McKinsey & Company. Autonomous driving's future: Convenient and connected. Technical report, 2023.



(A) Estimated global market size for passenger cars per level of automation (€ Billion)<sup>[1]</sup>



(B) Estimated passenger cars sold globally with autonomous driving technology installed in 2030 and 2035 (%)<sup>[1]</sup>

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### 2. CONNECTED CARS

Connected vehicles, which feature internet connectivity and advanced sensors, enable communication with other vehicles, road infrastructure, and devices. Historically, connected vehicles were mostly used for navigation and entertainment, such as real-time traffic updates or streaming music. However, today's connected car technology is applied for broader goals such as enhancing safety, reducing emissions, and optimizing traffic flow. According to market projections, the global connected car market is expected to reach US\$ 450 billion by 2030. Furthermore, it is predicted that 92 % of all new light-vehicle sales in 2030 will possess some level of connectivity<sup>2</sup>.

The implementation of connected vehicles brings a host of benefits; however, it also brings about disruptions that require various industries to adapt. One such disruption is the generation of a large volume of data about the car, its usage patterns, and customers. If effectively utilized, this data could be a valuable source of revenue for various industries. For instance, car manufacturers will need to explore new ways to monetize this data, such as by selling it to third parties for insurance, marketing, and urban planning or using it to improve their products and services. In the insurance sector. data from connected vehicles could be used to better evaluate and manage risk, adjust premiums, and offer personalized coverage. Banks will also need to find ways to leverage this data, which could include some of the above solutions or more creative ones. The public domain could use connected car data to optimize routes and improve efficiency. However, all of this must be done while meeting regulatory requirements and prioritizing data protection, privacy, and security. The second part of this paper delves into a comprehensive analysis of these challenges, their multifaceted impact, and possible solutions, in a descriptive and in-depth manner.

### INNOVATION advanced sensors

### REVENUE DATA VEHICLES CONNECTED CARS

<sup>2</sup> INTERNATIONAL ENERGY AGENCY. Global EV Outlook 2022 Securing supplies for an electric future. Technical report, 2022.





(A) Estimated global connected car market size (€ Billion)  $^{\mbox{\tiny [2]}}$ 

(B) Global penetration of connected cars, as % of new light-vehicle sales<sup>[2]</sup>

45 % of this value pool would come from new revenues (trough direct monetization, tailored advertising, and data sales) 40 % percent from cost reductions (for R&D and materials, customer acquisition, and customer satisfaction), and 15 % from enabling improved safety and security (real-time driving intervention and hazard warnings).

### 3. ELECTRIC VEHICLES

Electric vehicles (EVs) are a rapidly growing sector of the transportation industry. In the past, EVs faced limitations such as limited range and high costs, but advances in battery technology and manufacturing processes have significantly improved their performance and affordability. Today, a wide range of EV models are available on the market, from compact city cars to long-range SUVs. Major automakers are investing heavily in EV technology and offering an increasing number of models. Projections from the International Energy Agency estimate that EVs will represent more than 30 % of global vehicles sold in 2030<sup>3</sup>.

This trend is primarily driven by international and local climate agreements aimed at reducing emissions. One example was the Paris agreement in 2016. Similarly, the recent European Union's "Fit for 55" package mandates that car manufacturers reduce the emissions of new vehicles by 55 % by 2030, with the ultimate goal of achieving a 100 % reduction by 2035<sup>4</sup>. These initiatives demonstrate a commitment to reducing emissions and addressing climate change, making the adoption of electric vehicles a vital component of these efforts.

While the goal of reducing emissions through electric vehicles (EVs) is commendable. their integration also brings disruptions that require various industries to adapt and overcome new challenges. Car manufacturers, for instance, will need to innovate in battery technology and improve charging infrastructure to address range anxiety, as well as address the problem of battery recycling and disposal at the end of a vehicle's life. The insurance industry may need to adjust its pricing models to account for the higher claim costs associated with FVs'

expensive batteries and limited repair networks. The **banking industry** may also need to adapt as consumers increasingly finance EV purchases through loans or leases. The **public domain** will need to improve the electric grid system to meet the high demand for EV charging. The second part of this paper will provide a thorough and descriptive examination of these challenges, their cross-domain implications, and potential solutions.



<sup>3</sup> statista. Shared Mobility Worldwide. Accessed: Jan-2023.

<sup>4</sup> McKinsey and Company. The future of mobility is at our doorstep. Technical report, 2019.

		☆☆介			
		Revenue	Compound Annual Growth Rate (2023-2027)	Electric Vehicle Unit Sales (Projected in 2027)	Average Electric Vehicle Price (In 2023)
(FS)	Worldwide	421 bn. (2023) 789 bn. (2027)	17,02 %	16,2 mil.	3,19k
535	Americas	62 bn. (2023) 141 bn. (2027)	22,61 %	2,3 mil.	63,50k
Serves .	Asia	191 bn. (2023) 332 bn. (2027)	14,85 %	8,2 mil.	45,51k
Jan Bar	Europe	163 bn. (2023) 306 bn. (2027)	17,05 %	5,6 mil.	60,53k
B	DACH	56 bn. (2023) 109 bn. (2027)	18,07 %	1,98 mil.	59,88k

In-scope is Battery electric vehicles (BEVs,) Plug-in hybrid electric vehicles (PHEVs), Road electic vehicles, Passenger cars | Source: [3]

### 4. SHARED VEHICLES

The utilization of shared vehicles has grown in popularity in recent years as a more cost-efficient and practical alternative to personal car ownership. This method allows individuals to access a vehicle only when necessary; instead of bearing the costs of full-time possession and maintenance.

Several forms of shared mobility solutions exist, including peer-to-peer sharing, carsharing, and ridesharing. Peer-to-peer sharing allows individuals to rent out their personal vehicles to other users through online platforms. Car-sharing involves a fleet of cars owned by a company or organization and available for multiple users to rent by the hour or day (e.g., Car2Go). Ridesharing connects riders with drivers who provide transportation services in their vehicles (e.g., Uber and Lyft). The benefits of shared mobility solutions are numerous, including cost savings, improved access to transportation for those without personal vehicles or driver's licenses, and reduced traffic congestion and pollution. Because of these and other benefits, the global market for shared mobility is expected to reach US\$ 531 billion in 2027<sup>5</sup>.

However, the widespread adoption of shared vehicles is expected to bring significant disruptions across various industries. As shared mobility solutions become more prevalent, fewer individuals may feel the need to own a car, leading to a decrease in car sales and lower revenues for **car manufacturers**. OEMs may shift their focus from designing cars for individual ownership to designing cars for high utilization in ridesharing fleets.

The **insurance industry** will need to adapt to a changing risk landscape as shared vehicles are used by a much higher number of people for a much higher number of miles. Shared vehicle companies may also offer financing or leasing options for their vehicles, which could impact traditional **banking** and financing companies. Additionally, the increasing popularity of shared vehicles will require **public** authorities to adjust road infrastructure by building designated areas for shared cars to wait while picking up or dropping off passengers. Part B of this paper depicts an extensive and descriptive analysis of these challenges, their far-reaching impact, and possible solutions.

<sup>5</sup> Capgemini. Monetizing Vehicle Data How to fulfil the promise. Technical report, 2020.

					<u></u>
		Revenue	Compound Annual Growth Rate (2023-2027)	Number of Users (Projected in 2027)	Percentage of total revenue generated online
B	Worldwide	421 bn. (2023) 489 bn. (2027)	3,87 %	2,33 mil.	61 %
35	Americas	122 bn. (2023) 132 bn. (2027)	1,88 %	337 mil.	72 %
Sec.	Asia	219 bn. (2023) 268 bn. (2027)	5,14 %	1.619 mil.	56 %
95 N-E5	Europe	68 bn. (2023) 74 bn. (2027)	3,01%	238 mil.	59 %
3	DACH	12 bn. (2023) 14 bn. (2027)	3,23 %	31,2 mil.	61 %

In-scope is Shared Rides including: Free-floating car-, e-scooter- or bike-sharing bookings, Station based car-, e-scooter- or bike-sharing bookings, Companies offering a combination of free-floating and station-based car-sharing services such as Share Now, SIXT ride, Enterprise CarShare, nextbike, ofo, Mobike, and LimeBike, Rental car | Source: [5]

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### 5. CONSUMER ATTITUDES IN MOTION

As we move into the digital age, consumer attitudes are shifting rapidly. Gone are the days when business as usual is sufficient to meet the needs and expectations of today's consumers. Instead, industries must adapt and pivot towards customer-centric business models to stay competitive and relevant.

One industry that will soon see significant changes is the **automotive industry**. In the past, car manufacturers primarily focused on producing and selling vehicles, with little consideration given to the customer experience beyond the initial sale. However, as consumers become more environmentally and socially conscious, they demand more from their vehicle purchases. To meet these demands, car manufacturers will need to improve the online car purchasing process, provide exceptional customer support, and capitalize on the concept of an app store, enabling drivers to add features after the car purchase.

For a long time, **insurance companies** were known for their complex and often confusing policies, leaving customers feeling uncertain and unsatisfied. Today, consumers are becoming savvier and are demanding more transparency and value from their insurance products. The transparency challenge is not only about making it easier for consumers to compare and purchase insurance products but also ensuring they have a clear understanding of the terms and conditions of their policies, the claims process, and any exclusions or limitations. To respond to these needs, insurance companies must be more transparent in their communication, clearly explaining the details of their policies to consumers. They also need to be more responsive and transparent in the claims process, providing timely and accurate information to policyholders and addressing any issues or concerns they may have. Ultimately, the transparency challenge is about building trust and confidence with consumers, which is crucial in today's competitive insurance market.

The **banking industry** will also need to undergo a transformation as it strives to adapt to the changing needs of consumers. Banks will need to re-evaluate their approach to customer value by adopting modern, customer-centric strategies. They will also need to meet customers' expectations for a convenient and seamless online purchasing experience and adapt to the shift from traditional car ownership to on-demand mobility. This would require banks to be more agile and responsive to customer needs, leveraging technology to create a seamless and personalized customer experience.

As consumer attitudes towards mobility evolve, city infrastructure must also adapt to keep pace. In the past, cities were primarily designed for car travel, with little consideration given to alternative modes of transportation. However, as consumers become more environmentally and health-conscious, they seek more sustainable and active transportation options such as biking and shared autonomous and electric vehicles. To meet these changing attitudes, cities must invest in infrastructure that prioritizes these modes of transportation, such as dedicated areas for shared and autonomous cars, ample and easily accessible charging stations, digitize roads with comprehensive vehicle-to-infrastructure technology, and similar. This will not only help cities to meet the changing needs of their residents but also promote sustainable and healthy mobility options.

B) DISRUPTION AHEAD: NAVIGATING THE IMPACT OF ADVANCES IN MOBILITY

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# AUTOMOTIVE

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### 6. AUTOMOTIVE

The automotive industry is facing a significant shift as Automated, Connected, Electric and Shared (ACES) vehicles, changing consumer attitudes, and disruptive new players entering the market, are creating new challenges for traditional players. To stay relevant and competitive, companies operating in the automotive and transportation space must adapt to the new paradigm shift.

This requires rethinking traditional business models and strategies, such as moving towards an ecosystem approach, leveraging advanced technologies like Artificial Intelligence to optimize costs and increase profitability, and exploring alternative car ownership models like subscription-based or pay-per-mile options to meet evolving consumer needs.

The increasing complexity of modern vehicles, due to sophisticated technology and excessive customization options, also requires specialized knowledge and experience to design, manufacture, and service these cars safely and reliably. Furthermore, ensuring a seamless and personalized digital customer experience, by investing in advanced online platforms and convenient purchasing processes, is a crucial challenge for the industry to meet the evolving consumer needs. Finally, finding environmentally friendly and cost-effective solutions for the disposal and recycling of electric vehicle batteries and other components is a critical task for the industry to mitigate its impact on the environment.

- the use of secure payment systems and financing options + Leverage advanced technologies, such as Artificial + Providing excellent customer support, including Intelligence to optimize costs and drive profitability chat-bots and other online tools + Need for alternatives to traditional car ownership + Virtual test drives of cars through the use of immersive models: e.g., subscription-based or pay-per-mile technologies such as virtual reality + Discover ways to efficiently harvest vehicle data to boost + Capitalize on the concept of an App Store for vehicles revenues that allows add-on features after car purchase **Business Model** Digitalization **Clean Mobility** Complexity
  - + Adopt innovative strategies to manage the technological complexity of modern cars, which in the past years has led to increase production costs, complicated diagnostic and repair, and a high number of recalls

+ A shift from a value chain approach and distribution of

physical vehicles to an ecosystem approach and services

+ Tackle the excessive customization of vehicles which has led to a complicated production process

+ Increase the driving range of electric vehicles to reduce driver's range anxiety

+ Streamline the online car purchasing process, including

- + Work with government and private companies to improve the currently limited charging infrastructure
- + Find sustainable and cost-effective ways to recycle and disposal of electric vehicle batteries

Figure 2: Outlook of the challenges in the Automotive industry.

#### 6.1 RETHINKING BUSINESS MODEL

#### 6.1.1 FROM VALUE CHAINS TO ECOSYSTEMS

The traditional value chain approach in the automotive industry has centred on producing and distributing physical vehicles. However, in recent years, there has been a shift towards an ecosystem approach, in which car manufacturers focus on creating and facilitating a network of interconnected services and products that revolve around the vehicle.

One example of a company successfully adopting an ecosystem approach is Tesla. In addition to producing electric vehicles, Tesla has developed a network of charging stations and a suite of services such as over-the-air software updates, remote diagnostics, and entertainment options for their cars. This has helped the company to create a loyal customer base and differentiate itself from traditional car manufacturers.

There are several benefits to the ecosystem model in the automotive industry. By focusing on creating a network of interconnected services and products, car manufacturers can increase customer loyalty and create new sources of revenue. This approach also allows car manufacturers to stay competitive in a rapidly changing market by being able to adapt quickly and introduce new services and technologies. Additionally, the ecosystem approach can help car manufacturers to create a more sustainable and environmentally friendly business model by focusing on services that reduce the environmental impact of driving, such as car-sharing or electric charging infrastructure.

Overall, the shift towards an ecosystem approach is necessary for car manufacturers to stay competitive in a rapidly changing market and meet the evolving needs of consumers. By building a network of interconnected services and products, car manufacturers can create new sources of revenue, increase customer loyalty, and drive innovation in the industry.

#### 6.1.2 WORKING IN TANDEM

One way that car makers can improve their business is by forming partnerships with other companies. These partnerships can take many forms, such as joint ventures, licensing agreements, or strategic alliances. By partnering with other firms, car makers can benefit from the following:

- + Access to new technologies: By partnering with companies that have expertise in areas such as autonomous driving, electric power-trains, or advanced manufacturing techniques, car makers can access new technologies that can help them optimize and differentiate their products and stay ahead of the competition.
- + Expansion into new markets: Partnerships can help car makers enter new markets that they might not have been able to enter on their own. For example, a car maker might partner with a local company to manufacture and sell its vehicles in a new country.
- + Cost savings: Partnerships can allow car makers to share costs and resources, which can help to reduce expenses and improve profitability. For example, a car maker might partner with a supplier to negotiate better prices for raw materials or components.
- + Increased efficiency: Partnerships can allow car makers to coordinate their operations better and streamline their supply chains, leading to increased efficiency and productivity.
- + Risk sharing: Partnerships can allow car makers to share risks associated with new product development or expansion into new markets. This can help to mitigate the potential for financial losses and increase the chances of success.



### 6.1.3 LEVERAGING AI FOR COST REDUCTION

While traditional cost optimization strategies have long been a staple for car manufacturers looking to increase profits, it takes more. Car manufacturers need to turn to more advanced technologies, such as Artificial Intelligence (AI), in today's competitive marketplace to optimize costs further and drive profitability. Example use cases of AI in the automotive industry are listed below:

- + In R&D , it can analyse large amounts of data to uncover trends and patterns, aiding car manufacturers in making more informed decisions about which technologies to invest in.
- + In development, AI can be used to automate the testing and validation of new technologies, reducing the time and resources required for these processes
- + In procurement, it can be used to analyse supplier data and identify cost savings opportunities, such as finding more cost-effective suppliers or negotiating better terms with existing suppliers.

- + In supply chain management, AI can be optimizing the flow of goods and materials through the supply chain, reducing waste and increasing efficiency.
- + In manufacturing, it can be used to optimize production processes, reducing costs, and increasing efficiency through predictive maintenance and automated material flow management.
- + In sales, AI can be used to enhance sales and marketing by analysing customer data and personalizing outreach.
- + In after-sales and services, AI can be used to optimize the scheduling and dispatch of service technicians, as well as predict and prevent potential vehicle issues through predictive maintenance.
- + Customer support can also benefit from AI by automating routine tasks and personalized responses to customer inquiries.

It is estimated that the global value potential of AI for car makers through 2025 is \$ 215 billion<sup>6</sup>.

#### 6.1.4 ALTERNATIVES TO TRADITIONAL OWNER-SHIP MODELS

Car makers are under pressure to develop innovative and competitive car ownership models alongside the traditional purchase and leasing. The later, for examples, has been a popular option for car buyers, allowing them to drive a new vehicle without paying the full price upfront. However, traditional leasing models may not fit the expectations and needs of today's customers, as they are looking for even more flexibility and convenience in their transportation options.

One alternative is subscription-based models, where the customer pays a monthly fee to access a fleet of vehicles. This allows them to switch between different models and brands. and avoids the long-term commitment of a lease. Subscription models can also include maintenance and insurance, making them a convenient and all-inclusive option. Another alternative is pay-per-mile models, where customers only pay for the miles, they drive. This can be a cost-effective option for those who don't drive frequently, as they only pay for the actual use of the vehicle rather than a fixed monthly fee. Pay-per-mile models can also include maintenance and insurance, making them a hassle-free option for low-mileage drivers. There are also "rent-to-own" models, where the customer pays a monthly fee and can purchase the vehicle at the end of the

<sup>6</sup> Forbes. Automakers With The Most And Fewest Recalls In 2022. https://www.forbes.com/sites/ jimgorzelany/2022/12/30/automakers-with-the-mostand-fewest-recalls-in-2022/. Accessed: Dec-2022.

term. This can be a good option for those who want the flexibility to return the car at the end of the term or purchase it outright.

There are several challenges that carmakers need to tackle to introduce alternative leasing models successfully. One of them is the need for customer education. Many consumers may need to become more familiar with these options, and it will be necessary for carmakers to explain the benefits and how they work. To offer subscription-based or pay-per-mile models, carmakers must also invest in the necessary infrastructure, including a more extensive fleet of vehicles and a system for managing and maintaining them. Pricing can also be a challenge, as carmakers must balance the cost of providing the service with the perceived value to the customer. Additionally, alternative leasing models may be subject to different market regulations, requiring carmakers to navigate these differences to offer the models in various locations. Finally, carmakers will need to compete with similar alternative models provided by other companies, so it will be vital for them to differentiate their offerings and demonstrate their value to potential customers.

#### 6.1.5 DATA MONETIZATION

As we move into the future of transportation, the next generation of vehicles will be equipped with abundant data-gathering capabilities. From vehicle health and fuel levels information to navigation and smartphone applications, these vehicles will provide a constant stream of information. The steady stream of data gives automakers a variety of business opportunities.

One way car makers can monetize the extensive data generated from modern vehicles is by selling it to third parties. This data can be valuable to companies in various industries, such as insurance, marketing, and urban planning. For example, an insurance company may be interested in purchasing data on driving patterns and car maintenance to understand risk and set premiums better. A marketing company may be interested in buying data on consumer habits and preferences to target advertising more effectively. Urban planners may be interested in purchasing data on traffic patterns and road conditions to improve infrastructure and transportation planning.

Another way that car makers can monetize the extensive amount of data generated from modern vehicles is by using it to improve their products and services. By analysing data on common issues, breakdowns, and maintenance needs, car makers can identify areas for improvement and make changes to their products to reduce costs and increase customer satisfaction.

Finally, by leveraging the extensive data generated from modern vehicles, car makers can create innovative services that customers are willing to pay for, generating additional revenue streams. One such example is a predictive maintenance program. By analysing data on vehicle usage, maintenance history, and potential issues, car makers can develop a service that pro-actively schedules maintenance appointments and alerts for potential issues before they become significant problems.

The global revenue for vehicle data monetization is expected to range **between \$ 80 billion and \$ 800 billion by 2030**<sup>7</sup>, showing the vast potential for both automotive OEMs and service providers to use data for service innovation. This highlights the importance of data in the future for car makers.

<sup>7</sup> OliverWyman. The Good, the bad, and the complicated: Dealing with car complexity. Technical report, 2021.

#### 6.2 MANAGING COMPLEXITY

#### 6.2.1 TECHNICAL COMPLEXITY

Today's cars are highly complex machines that require the integration of many different technologies in order to function correctly. This includes traditional mechanical systems such as engines and transmissions and a variety of electronic systems for infotainment, navigation, connectivity, and automated driving capabilities. The increasing complexity of modern cars presents several challenges for car makers.

To begin with, the production costs are at their height due to the ever-increasing complexity of software and systems of modern vehicles. Features, such as autonomous driving, advanced infotainment, and connectivity, require significant investment and expertise to develop and integrate. Unless car manufacturers adopt efficient software and hardware development practices from successful tech companies, the production time and cost of these features will remain high.

Diagnostics and repair of today's vehicles can also be complicated, as technicians need to have a deep understanding of the various systems and components in order to troubleshoot issues effectively. This can be time-consuming and costly, particularly if technicians need to spend a lot of time diagnosing issues that ultimately turn out to be unrelated to the problem.

Furthermore, the number of recalls that automakers have had in recent years have been increasing significantly. As vehicles become more complex and incorporate more advanced technology, there is a greater potential for something to go wrong. This can lead to recalls, which can be costly for automakers and damage their reputation with customers. In 2022, carmakers issued a record number of recalls (see Figure 3) in the aftermath of the pandemic, and the transition to Electric Vehicles started. The top 10 automakers that initiated the most recall campaigns accounted for total of 315 recall campaigns which affected more than 26 million cars8.

**Ensuring Safety** of modern cars is yet another topic, as it has become a complex and interdisciplinary challenge. The systems that make up a car are diverse and interconnected, meaning that a problem in one area can have consequences in others. In addition, the increasing level of automation in cars presents its own set of safety challenges as the responsibility for overall vehicle safety is shifting from the driver to the automated driving system itself. On top of that, the rapid pace of technological change means that new safety risks are constantly emerging.

Finally, the **usability** for drivers has also been impacted. With so many different systems and features, it can be difficult for drivers to understand and use all the available functions. This can lead to frustration, decreased satisfaction, and, in some cases, safety risks which can ultimately affect the manufacturer's profitability.

Car makers can adopt strategies such as modular design, standardization, and simplification to manage the complexity of modern cars. Modular design allows for more straightforward diagnosis and repair of problems, while standardization ensures compatibility and interoperability. Simplification improves usability. Testing and validation can identify and fix potential issues, improving reliability. Car makers can also learn from tech giants like Google and Apple to benefit from their expertise in complex software development and other advanced technologies. By adopting these strategies, car makers can improve the performance, reliability, and usability of their vehicles while also reducing costs and increasing safety.

<sup>8</sup> McKinsey and Company. From no mobility to future mobility: Where COVID-19 has accelerated change. Technical report, 2021



Figure 3: The 10 automakers that have initiated the most recall campaigns during 2022 and the total number of vehicles involved | Source: [8]

#### 6.2.2 EXCESSIVE CUSTOMIZATION

The automotive industry has always been driven by the desire to cater to car owners' unique tastes and requirements. But in the pursuit of this goal, the complexity of cars has reached a point of overwhelming clutter not just for manufacturers, suppliers, and dealers, but also for buyers.

And things are only set to get worse by 2025, the proliferation of electric vehicles is expected to increase the number of variants per car maker by a staggering 50-100 % globally<sup>9</sup>. This level of complexity impacts not just end customers but also OEMs and suppliers, who must stock or make readily available every possible option at a significant cost in terms of money and resources. In fact, a staggering 30-40 % of all OEM employees

currently deal with variant and complexity issues<sup>9</sup>. This leaves limited capital for company transformation, new technologies, and new business models.

But there is hope on the horizon by adopting strategies to address and optimize complexity, automotive players, according to estimates, could improve profits by a hefty  $\in$  500 -  $\in$  750 per car, streamline their supply chain, and provide a better customer experience<sup>9</sup>. The contrast between the markets in Germany and China offers a particularly illuminating example. While Chinese automakers offer limited choices. German consumers often specify and order their cars themselves, even if it means waiting months to get exactly what they want. By learning from the German market. OEMs in other markets can find the perfect balance between beneficial complexity and its value and the negative effects of excess complexity.

#### 6.3 DIGITIZE CUSTOMER EXPERIENCE

#### 6.3.1 SUPERIOR ONLINE EXPERI-ENCE AND PURCHASING

As consumers increasingly turn to the internet to research car purchases, car makers must provide a high-quality online experience. A recent study found that the average car buyer spends around 14 hours online and one hour offline before making a decision<sup>10</sup>. Furthermore, there is a growing trend for online purchasing as customers become accustomed to the convenience of purchasing products with just a few clicks through companies like Amazon. In particular, 50 % of electric vehicle consumers are comfortable with signing contracts online and 12 % of same type of customers in the US have already made their purchase transactions online<sup>10</sup>.

To meet customers' expectations, car makers should offer a seamless, personalized, and modern online store setup that is easy for consumers to use. There are several ways to achieve that:

<sup>9</sup> OliverWyman. The Good, the bad, and the complicated: Dealing with car complexity. Technical report, 2021

<sup>10</sup> McKinsey and Company. From no mobility to future mobility: Where COVID-19 has accelerated change. Technical report, 2021.

<sup>29</sup> 

- + Streamlined purchasing process: Making it easy for customers to purchase vehicles online, including through the use of secure payment systems and flexible financing options, can improve the overall experience.
- + Enhanced product information: Providing detailed, accurate, and up-to-date information about the vehicles on offer can help customers make informed decisions.
- + Strong customer support: Providing excellent customer support, including chat bots and other online tools, can help address any questions or concerns that customers may have.
- Virtual test drives: Allowing customers to take virtual test drives of vehicles through the use of immersive technologies such as virtual reality can help them get a better sense of the cars before making a purchase.



- + Personalization: Using customer data and preferences to personalize the online experience, such as by offering personalized recommendations or custom configuration options, can improve the customer's experience.
- + Improved website design: A modern, user-friendly website that is easy to navigate can make a big difference in the online experience for customers.
- Mobile optimization: Ensuring that the online experience is optimized for mobile devices, including through the use of responsive design and mobile apps, can improve the experience for customers on the go.

One example of a car maker that has already implemented such an App Store is Tesla, which offers its drivers the ability to purchase additional features and functionality through its "Tesla Arcade" platform. This includes options like "Smart Summon," which allows the vehicle to be summoned to a driver's location using the Tesla app, as well as a range of games and other entertainment options. Another example is BMW, which has developed the "BMW ConnectedDrive" platform that offers drivers the opportunity to purchase additional features and services, including advanced driver assistance systems (ADAS), infotainment options, and remote-control capabilities.

By offering drivers the ability to purchase additional features and capabilities for their vehicles through an App Store platform, traditional car makers can provide greater customization and flexibility while generating a new source of revenue.

This could be a desirable option for car makers looking to differentiate themselves in a crowded and highly competitive market.

#### 6.3.2 APP STORE

There is a significant opportunity for traditional car manufacturers to capitalize on the concept of an App Store for vehicles. By creating a platform allowing drivers to purchase additional features and capabilities for their cars, these companies can offer their customers a higher level of customization and flexibility. This could include a wide range of options, such as advanced safety features, automated driving capabilities, and enhanced infotainment systems.



#### 6.4 TOWARDS CLEAN MOBILITY

The transition towards clean mobility solutions for cars, such as electric and hybrid vehicles, is gaining momentum in the automotive industry. This shift is being driven by a number of factors, including increasing concerns about climate change, stricter emissions regulations, and a growing demand for sustainable transportation options.

Car manufacturers need to address several challenges when it comes to the production and adoption of electric vehicles (EVs). Some of these challenges include:

- + Range anxiety: One of the main concerns about EVs is their limited driving range compared to traditional gasoline-powered cars. To address this issue, car manufacturers can focus on improving battery technology and increasing the driving range of EVs.
- + Limited charging infrastructure: Another challenge is the limited availability of charging infrastructure, which makes it difficult for EV owners to find places to charge their vehicles. To solve this problem, governments and private companies can invest in building more charging stations and improving the accessibility and convenience of charging.

- + High upfront cost: The initial cost of purchasing an EV is often higher than that of a traditional gasoline-powered car. To make EVs more affordable, manufacturers can work on reducing the cost of production and finding ways to make EVs more cost-competitive with traditional cars.
- + Battery recycling and disposal: As EVs become more widespread, there will be an increase in the number of used batteries that need to be disposed of or recycled. Car manufacturers will need to find sustainable and cost-effective ways to manage the end-of-life of EV batteries.
- + Dependence on fossil fuels: Many EVs are still powered by electricity generated from fossil fuels, which can limit the environmental benefits of EVs. To address this issue, manufacturers can develop renewable energy sources, such as solar or wind power.
- + Limited production capacity: The production capacity for EVs is currently limited, which can make it difficult for manufacturers to meet the growing demand for these vehicles. To increase production capacity, manufacturers can invest in expanding their production facilities and streamlining their production processes.

- + Supply chain issues: The production of EVs requires a complex and global supply chain, which can be disrupted by various factors such as natural disasters, trade disputes, and transportation issues. To address this challenge, manufacturers can work on building a resilient and flexible supply chain that can adapt to changing circumstances.
- + Regulation and incentives: The adoption of EVs is often supported by government regulation and incentives, such as tax credits or subsidies. Car manufacturers will need to stay up to date with changes in regulation and take advantage of incentives to make EVs more attractive to consumers.
- + Competition from new entrants: The production and adoption of EVs is attracting new players to the automotive industry, such as tech companies and start-ups. This increase in competition can make it challenging for established car manufacturers to stay ahead in the market.

Ultimately, the transition to clean mobility solutions will require a collaborative effort from car manufacturers, governments, and consumers in order to create a more sustainable and environmentally friendly transportation sector. By working together, it is possible to accelerate the adoption of clean vehicles and reduce the negative environmental impact of transportation.



#### 6.5 KEEPING UP WITH THE TECH LEADERS

Tech giants, such as Google, Apple, and Tesla, are disrupting the traditional automotive industry by bringing new technologies and innovative business models to the market. These companies, which often have significant financial resources, are trying to shape the future of mobility by creating new ecosystems, partnerships, and ways to improve efficiency.

In response to this disruption, automakers should continue to focus on their traditional strengths, such as design and production excellence, while also considering how they can adapt and learn from tech companies to stay competitive. This may involve creating new business models, forging partnerships, and introducing new ways to gain efficiency.

To stay competitive, traditional car makers can invest in the following:

- + Leveraging their existing brand and customer base to compete with tech giants. This may involve offering new products or services to their current customers or expanding into new markets.
- + Leveraging their existing dealer network and service infrastructure to provide a seamless and convenient experience for customers, which can be a competitive advantage over tech giants and disruptors who may not have the same level of established infrastructure.
- + Creating in-car experiences and services, such as personalized entertainment options, connected services, automated driving features, or enhanced safety features. This can help them to build customer loyalty and stay ahead of the competition.
- + Introducing new mobility services, such as ride-sharing or car-sharing, to stay competitive with companies like Uber and Lyft.

- + Expand into new revenue streams and appeal to consumers looking for more flexibility and convenience. With the rise of ride-hailing and car-sharing services, traditional car manufacturers can stay competitive by offering alternative ownership models such as subscriptions or pay-per-use.
- + Partnering with tech companies to bring advanced technologies, such as artificial intelligence and machine learning, to the market. This can help them stay competitive while also leveraging the expertise of tech companies.
- + Investing in research and development to bring new technologies and innovations to the market. This can include developing advanced safety features, improving fuel efficiency, or introducing new materials and designs.

# INSURANCE

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### 7. INSURANCE

The insurance industry is facing a range of challenges due to the rise of ACES (Automated, Connected, Electric, Shared) mobility trends, changing consumer attitudes, and disruption in the market. This challenges traditional business models and demands insurers to prioritize customer-centric insurance models and stay up to date with the developments in the in-car technology. To stay competitive, insurers must also be agile in their premium estimation techniques and frequently update pricing models. The situation gets even more complex as higher claim costs of expensive in-car technology lead to more expensive premiums, while increased competition and changing consumer attitudes put downward pressure on premiums.

Moreover, the insurance industry is facing new risks, such as those related to the safety issues of complex technology and the increased risk of cyber attacks in the cars. The growing popularity of electric vehicles also brings new fire risks and the potential for new types of thefts. Finally, there are challenges surrounding liability in the event of accidents, as liability shifts from drivers to car makers producing highly automated vehicles, or new situations such as alcohol consumption in highly automated cars may raise questions about liability. It is crucial that the insurance industry addresses these challenges in order to thrive in the modern market.


- + Manage change in the face of continuous innovation and lack of historical data on performance and risks
- + Decrease in the number of private-owned vehicles insurance due to on-demand mobility
- + Reduced access to customers as carmakers provide bundled insurance packages at the point of sale
- + Necessity of tailoring for electric vehicles due to their different risk profiles

- + Need to identify and manage emerging risks: e.g., a high-voltage battery delivering a fatal electric shock
- + Managing the higher risks of a sheared fleet of vehicles, as it is used in heavily populated urban areas
- + Risk assessment reliability difficult due to limited access to historical data on new car technologies
- + An increase in elderly drivers lead to higher accident rates

Business Model	Risk Landscape
Premiums	Liability
Agile premium estimation techniques need due to the speed and frequency pricing models will be updated	<ul> <li>Shift from individual driver coverage to insuring car makers to address the liability case for automated cars</li> </ul>
Rising claim costs due to expensive in-car technology, electric vehicle batteries, inefficient supply chains	<ul> <li>Difficulty in drawing the liability line in case of accidents by a shared fleet of vehicles</li> </ul>
Downward pressure on premiums due to new safety systems in cars reducing the risk of accidents	<ul> <li>Difficulty in determining the liability in case of data privacy breaches</li> </ul>
Need for rapid data analysis for timely decision-making to asses newly emerging as cyber-threats	<ul> <li>Need to address emerging new use cases: e.g. an accident by remote-controlled vehicle</li> </ul>

### 7.1 BUSINESS MODELS: A CALL FOR INNOVATION

The traditional business model is no longer sufficient in the face of changing customer demands, technological advancements in vehicles, and new disruptors in the market. In order to stay relevant and meet the needs of customers, insurance companies must adapt their business models to focus on customer-centric approaches, leveraging technology and data analytics to offer personalized coverage options, and successfully manage the continuous change in the in-car vehicle technology. Only by embracing innovation can the insurance industry continue to thrive and meet the challenges of the modern market.

#### 7.1.1 MANAGING CONTINUOUS CHANGE

The insurance industry is struggling to keep up with the rapid evolution of in-car technologies, such as self-driving features and electric vehicles. These innovations are being introduced at a rapid pace and lack historical data on the performance and potential risks, making it challenging for insurers to accurately assess the risk and price insurance policies accordingly.

To tackle this matter, the insurance industry could consider the following:

- + Collaborate with tech companies and automakers to gain access to data and insights on the performance and risks of autonomous, connected, and electric vehicles. This could help insurers better understand and assess the risk of these technologies.
- + Partner with telematics providers to gather real-time data on the performance and usage of autonomous and electric vehicles. This data could help insurers better understand the risks associated with these technologies and price insurance policies accordingly.

- + Experiment with new insurance products specifically designed for autonomous and electric vehicles. These products could include coverage for new risks associated with these technologies, such as cybersecurity threats or failures of autonomous systems.
- + Engage with regulators and policymakers to provide input on regulatory proposals related to autonomous and electric vehicles to help shape the regulatory environment in a way that is beneficial to the industry and promotes the safe development and adoption of these technologies.
- + Monitor and assess emerging technologies to stay abreast of new developments and understand the risks and opportunities they could This present. involve conducting research. gathering data, and engaging with industry experts and stakeholders.

#### 7.1.2 TACKLING THE ON-DEMAND MOBILITY USE CASE

Demand-oriented mobility solutions, such as ridesharing and car-sharing platforms, have had a significant impact on the insurance industry. These platforms allow individuals to access transportation on an as-needed basis, rather than owning a personal vehicle. This shift in transportation habits has led to a decrease in the number of personally owned vehicles on the road and, subsequently, a decrease in the demand for traditional personal auto insurance. In response, insurance companies need to develop new insurance products tailored for the on-demand mobility use case. One such product is Pav-How-You-Move

(PHYM), a hyper-personalized mobility insurance that covers individuals when using all types of transportation, including buses, trains, bikes, cars, scooters, and more. Premiums for this insurance are tailored to the individual's specific mode of transportation, usage, and driving habits.

Furthermore, there are numerous features that insurers can include in a PHYM offering. Some examples are rewards for sustainable mobility behaviour, monitoring of CO2 emissions, rewards for safe drivers, coverage for physical injuries sustained while using mobility as a service option, coverage for loss or damage of property while using public transportation, and coverage for cancelled train trips. The fundamental principle behind PHYM mobility insurance is a shift from insuring a single vehicle to covering an individual across multiple modes of transport.

#### 7.1.3 TOWARDS BUNDLED PRODUCTS AT POINT OF SALE

There is a growing trend towards offering comprehensive and integrated product bundles for vehicles that include not only traditional automobile insurance coverage. These bundles, often provided by original equipment manufacturers (OEMs) through their in-house insurance services in cooperation with automobile insurers, may include financing, leasing, maintenance, and insurance coverage and are typically distributed directly through the point of sale of the vehicle. As a result of this shift, insurers may lack access to the customer interface.

To address this issue, insurers may consider forming strategic partnerships with OEMs to gain access to the customer interface and position themselves at the point of sale. This could involve working with OEMs to develop integrated bundles of products that combine risk-bearing functions with additional service components, such as financing, leasing, and maintenance. In addition, insurers may also want to consider investing in digital technologies and platforms that can help them better engage with customers and deliver a seamless, integrated experience. This could include developing mobile apps or online portals that allow customers to easily access their policies, report claims, and receive support.

#### 7.1.4 TAILORING FOR ELECTRIC VEHICLES

As the adoption of electric vehicles (EV) continues to grow, insurers are also looking at ways to tailor their business models to this market. This includes developing new insurance products specifically designed for electric vehicles, as well as using data and analytics to better understand the risks associated with these vehicles.

There are several reasons why a separate insurance model is necessary for EVs. One reason is that EVs have a different risk profile than traditional internal combustion engine vehicles. For example, EVs have fewer moving parts, which reduces the risk of mechanical breakdowns. On the other hand, EVs do have unique risks, such as the potential for battery fires, hazards from charging infrastructure, and similar. The EV industry is also evolving quickly, with new technologies and designs being introduced regularly. An insurance model specifically tailored to EVs can better adapt to these changes and provide coverage that is relevant to the latest developments in the industry.

One way insurance for insurance companies to deal with this matter is to partner with EV manufacturers and other stakeholders to gather data on the performance and reliability of EVs. This will help insurance companies better understand the risks associated with these vehicles and create more accurate risk models. Another solution is to invest in developing in-house expertise on EV technology and charging infrastructure. This will allow insurance companies to better understand the specific risks associated with these technologies and design coverage that is relevant and tailored to the needs of EV owners. Insurance companies can also work with regulators to understand the specific requirements and challenges associated with insuring EVs in different jurisdictions. This will help them develop an EV-specific insurance model that is compliant with all relevant regulations.

# 7.2 PREMIUMS

Vehicle insurance premiums have traditionally been based on factors such as the make and model of the vehicle, the age and driving history of the policyholder, and the location where the vehicle is primarily driven. However, with the emergence of new mobility trends such as ACES (Automated, Connected, Electric, Shared) vehicles, changing consumer attitudes, and disruptors in the market, the landscape for determining insurance premiums is rapidly evolving.

#### 7.2.1 AGILE PREMIUM ESTIMATION FOR UNPREDICTABLE RISKS

One aspect of the evolution is driven by the need for agile premium estimation techniques due to the speed and frequency with which pricing models will need to be updated.

Pricing models in the insurance industry are typically based on historical data, but as more and more innovative in-car technologies, with no historical data are introduced, there is a need for more agile and experimental approaches. This will require the development of new methodologies that enable updates to be made over a shorter cycle. While this may introduce some volatility into pricing, it is necessary for insurers to adapt to a more dynamic environment.

- + Data availability and quality: Insurers often rely on data to make informed decisions about risk assessment and premium pricing. However, when data is scarce or of poor quality, it can be difficult for insurers to accurately estimate premiums.
- + Complexity of risks: Some risks, particularly emerging risks that do not have a clear historical precedent, can be difficult to fully understand and assess. This can make it challenging for insurers to develop agile premium estimation techniques that accurately reflect the risks involved.
- + Time constraints: Insurers may be under pressure to quickly assess and price risks in order to stay competitive in the market. However, this can make it difficult to thoroughly assess the risks involved and develop accurate premium estimates.
- + Changing regulatory environment: Insurers must often navigate a complex and constantly evolving regulatory environment. Changes in regulations can impact the way insurers assess and price risks, making it difficult to develop agile premium estimation techniques.

To address these challenges, insurers can turn to a number of solutions, such as **use predictive analytics** to identify and assess emerging risks more quickly and accurately,**collaborate with external experts** to gain a deeper understanding of emerging risks and how they may impact premiums, **use alternative data sources** such as social media or IoT data to better understand emerging risks, **engage with regulatory bodies** to influence and be informed about the current and upcoming regulations, **develop agile processes** to allow for a more rapid response to changes in the risk landscape and regulations.

# 7.2.2 RISING CLAIM COSTS IN A COMPETITIVE MARKET

Another challenge is the higher claim costs which ultimately lead to more expensive premiums for car insurance. There are several reasons contributing to the higher claim costs:

- In-car technology: As cars become more technologically advanced, the cost of repairing or replacing damaged components can increase. A study<sup>11</sup>, estimated that the cost of repairing a front radar sensor used for emergency braking and adaptive cruise control system could cost between \$ 900 and \$ 1300. Front or rear ultrasonic sensors used with parking assist systems could cost \$ 500 to \$ 1,300 to repair. Rear radar sensors, used for blind spot monitoring and rear cross-traffic alert systems, could cost as much as \$ 2,000 (Estimates from 2018, costs are likely higher after COVID and inflation in the past years).
- + Expensive batteries: Overall, the parts for an EV are 2.7 % more expensive than replacement parts for a gas-powered car<sup>12</sup>. Furthermore, electric and hybrid vehicles often have large, expensive batteries that can be costly to replace if they are damaged

or fail. In fact, a report<sup>12</sup> points out that the cost to replace a damaged battery in an EV can range between \$5,000 to \$15,000. This can increase the overall cost of repairing or replacing a damaged vehicle.

- + Limited repair networks: Many electric and hybrid vehicles require specialized training and equipment to repair, which can be hard to find in some areas. This can lead to longer wait times for repairs and higher labour costs.
- + Inefficient and constrained supply chains: It can be difficult to get replacement parts for electric and hybrid vehicles, especially if they are specialized or in high demand. This can lead to delays in repairs and higher costs due to the need to expedite shipping or pay premium prices for parts.

To address these issues, some potential solutions could include partnering with manufacturers and repair shops to offer discounts or bundled policies for electric and hybrid vehicles. This can help to lower repair costs and make these vehicles more affordable for consumers. Partnering with electric and hybrid vehicle manufacturers to offer extended warranties or maintenance programs. This can help to lower repair costs and make these vehicles more affordable for consumers. Implementing telematics programs that track the driving habits and maintenance routines of electric and hybrid vehicle owners can help to identify high-risk drivers and encourage safer driving practices, which can ultimately lead to fewer claims.

#### 7.2.3 DOWNWARD PRESSURE ON PREMIUMS

On the other hand, there may also be downward pressure on premiums. There are several factors that may lead to that. One factor is the reduction in the number of privately insured vehicles. An additional car-sharing vehicle in a city leads to a decline in annual new car sales of three vehicles, corresponding to an average decrease in overall new car sales of around 1.5 %<sup>13</sup>. If the number of privately insured vehicles decreases, there may be less demand for car insurance, which could lead to lower premiums.

Another factor is the expected reduction in the accident rate and severity due to the adoption of automated driving and advanced safety assistance systems (ADAS). In fact, 52 % of consumers from a survey<sup>14</sup> said, getting lower insurance rates was an important benefit of an ADAS. Additionally, car owners may be less willing to pay high insurance premiums in the case of a highly automated car, as the automaker is expected to absorb the liability. This could lead to downward pressure on premiums as insurers may need to offer more competitive pricing in order to attract and retain customers.

<sup>11</sup> RDN Repair Driven News. AAA: ADAS can bump repair costs significantly. https://www.repairerdrivennews. com/2018/10/26/aaa-adas-can-bump- repair-costs-significantly/. Accessed: Dec-2022.

<sup>12</sup> Forbes. Electric Car Insurance: Why It Costs More. https:// www.forbes.com/advisor/car-insurance/electric-vehicle/. Accessed: Dec-2022.

<sup>13</sup> Peter Schmidt. The effect of car sharing on car sales. International Journal of Industrial Organization, 71:102622, 2020

<sup>14</sup> LexisNexis Risk Solutions. The impact of Advanced Driver Assistance Systems (ADAS) on insurance claims. Technical report, 2021.

To make up for the lost revenue from the privet owned vehicles, insurance companies can diversify their product offerings by providing new types of coverage, such as insurance for ride-sharing drivers or self-driving cars. This could involve covering new risks, such as cyber attacks or liability for accidents involving shared or automated vehicles. In addition, insurance companies can adjust premiums based on the level of automation, allowing them to more accurately assess and price the risk of insuring a particular vehicle. To better understand and assess the risks associated with shared and automated vehicles, insurance companies can also invest in technology to improve their risk assessment capabilities. By doing so, they can more accurately price their insurance products and ensure that they remain profitable despite declining premiums.

#### 7.2.4 RAPID DATA ANALYSIS FOR TIMELY DECISION MAKING

To effectively navigate these challenges, the ability to analyse and act on real-time data will be vital. With little historical data to inform risk models, insurers will need to gather and analyse a wide range of data, becoming "vacuum cleaners" for relevant statistics and developing rapid-fire analytics capabilities to decipher this information.

In the context of automated driving, for example, insurers will need to determine the value of safety systems such as lane departure warnings and automatic braking, and how this information affects their pricing calculations. This task is further complicated by the fact that these systems are pro-

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duced by different manufacturers, some of which may be more effective than others. Furthermore, as the number and sophistication of cyber threats continue to increase, insurance companies may need to analyse real-time data to assess the risk of a c and provide coverage for businesses and individuals.

Under the context of shared vehicles, insurance companies may need to analyse realtime data to accurately assess the risk associated with different types of shared vehicle usage.



For example, an insurance company may need to analyse data such as the number of miles driven, the number of drivers, and the types of roads travelled to determine the appropriate coverage and pricing for a car-sharing service. This could also include analysing data on the condition of the vehicle, such as maintenance records and collision history, to assess the overall risk of providing coverage.

There are several solutions that insurance companies can use to efficiently collect and analyse real-time data. These include data analytics platforms and tools, which can gather and process large amounts of data from various sources and use advanced algorithms and machine learning techniques to analyse it. Insurance companies can also partner with data analytics companies or use third-party data sources to access realtime data, or they may use cloud computing platforms to store and process data in real time. In addition, insurance companies may use **big data analytics tools** to identify trends and patterns relevant to their operations. By adopting these solutions, insurance companies can effectively collect and analyse real-time data to make informed decisions and remain competitive in a rapidly changing market.

# 7.3 CHANGING RISK LANDSCAPE

The automotive insurance risk landscape is in constant change. One contributing factor is the emergence of new risks such as increased safety risks as a result of the advanced in-car technology, the threat of cyber attacks, and the possibility of fires and explosions associated with high-voltage batteries. The rise of shared vehicles and fleet risks is also contributing to the changing risk landscape as such vehicles are used by a much higher number of people for a much higher number of miles. Moreover, changing population figures, particularly the increasing elderly population, may impact portfolio composition and potentially lead to higher accident rates. To make matters even more complicated, the limited access to historical claims data makes it difficult to accurately assess and manage risks. All of these factors are requiring insurers to find new ways to navigate the changing risk landscape in the automotive insurance industry.

#### 7.3.1 IDENTIFYING AND MANAGING EMERGING RISKS

Insurance companies need to consider how to account for new types of risks in their coverage and pricing models. This may involve developing new insurance products specifically designed to cover the risks associated with the risks listed below or adjusting the terms and conditions of existing policies to reflect the increased risks.

- Increased safety risk: In-car technology has the potential to greatly improve the comfort, efficiency, and safety of vehicles. However, the complexity of the technology involved also introduces new risks, such as software and hardware malfunctions, sensor failures, and communication errors. These risks can compromise the safety of the vehicle and its occupants.
- + Increased risk of cyber attacks: Furthermore, as cars become increasingly connected to the internet and to the outside environment (e.g., vehicle to infrastructure), they are also becoming more vulnerable to cyber attacks. These attacks can range from relatively minor incidents, such as unauthorized access to a vehicle's entertainment system, to more serious threats that compromise the safety and security of the vehicle and its occupants.

- + Increased fire threat: The use of high voltage batteries in electric and hybrid vehicles introduces new fire and explosion risks that could give rise to claims for property insurers. These risks may be particularly significant in cases where multiple vehicles are charged in underground car parks, as the concentration of high-voltage batteries in a confined space could increase the likelihood of incidents occurring. There are a variety of potential claim scenarios that could arise in relation to these risks, including fires and property damage caused by overheated battery leads, and fires resulting from electronic failures in the battery management system.
- New theft risk: Electric and hybrid vehicles (HVs) also introduce new theft risks that insurers will need to consider in their coverage and pricing models. One such risk is the theft of charging cables and other equipment, which could be targeted by thieves looking to sell the items on the black market.
- + New hazards at workplace: Finally, EVs and HVs also introduce a number of additional hazards into the workplace that goes beyond those normally associated with general repair and maintenance. One example of a hazard introduced by EVs and HVs is the presence of high-voltage components that are capable of delivering a fatal electric shock, even when the vehicle is switched off. These components may be exposed or easily accessible during maintenance or repair operations, and workers may be at risk of accidental contact with them. Another hazard introduced by EVs and HVs is the potential for vehicles to move unexpectedly due to the presence of magnetic forces within their motors. This could pose a risk to workers who are in close proximity to the vehicles, particularly if they are not properly secured or if they are positioned in areas where they may come into contact with pedestrians or other objects.

#### 7.3.2 MANAGING RISK IN A SHEERED FLEET OF VEHICLES

Shared vehicles differ significantly from privately owned and used vehicles in terms of risk, as they are largely determined by the size of the sharing community and the scale of the fleet. Moreover, car-sharing insurance coverage is typically needed in heavily populated urban areas with high traffic, which can increase the risk exposure for insurance companies. Another contributor to the increased exposure for insurers is the likelihood of increased claims frequency resulting from behavioural changes of drivers, such as shortterm, on-demand access and the possibility of unauthorized users or fraudulent activity. Overall, the unique risk profile of shared vehicles requires insurers to adapt and find creative ways to manage this emerging risk<sup>15</sup>.

Insurance companies can use partnerships with fleet management companies and data analytics to better understand and manage the risks associated with vehicle fleets. This may involve sharing data and insights about claims trends, collaborating on safety and risk management initiatives, and analysing data about vehicle usage patterns and maintenance histories.

<sup>15</sup> Nadine Gatzert and Katrin Osterrieder. The future of mobility and its impact on the automobile insurance industry. Risk Management and Insurance Review, 23(1):31–51, 2020

#### 7.3.3 ENSURING RISK ASSESSMENT RELIABILITY

The limited access to historical claims data can make it difficult for insurance companies to accurately assess and manage risks. This is especially true in emerging areas of risk, where little or no data may be available to inform decision-making.

Without access to accurate and comprehensive claims data, insurers may struggle to accurately assess the likelihood and severity of potential losses. This could lead to inadequate risk management strategies and suboptimal pricing of insurance products, which could result in financial losses for the insurer.

To address this challenge, insurance companies may need to adopt new approaches to data collection and analysis. This could include working with industry partners and stakeholders to share data and insights or investing in new technologies and analytics capabilities to better understand and predict risks. By taking these steps, insurers can improve their ability to accurately assess and manage emerging risks, which can help to ensure their financial stability and long-term success.

#### 7.3.4 CHANGING POPULATION FIGURES

As the population ages, the composition of an insurer's portfolio may be impacted by the increasing number of elderly drivers on the road. Seniors motorists may be more likely to be involved in accidents due to factors, such as declining physical and cognitive abilities, which could lead to higher accident rates and increased claims frequency.

Apart from the anticipated adjustment of pricing and underwriting practices, insurance companies may also need to consider other strategies to mitigate the risks associated with elderly drivers. This could include partnering with organizations that promote safe driving for seniors, i.e., insurance companies can offer discounts to policyholders who complete safe driving courses designed specifically for elderly drivers. These courses can help seniors to refresh their skills and learn about the latest safety technologies and techniques, which can help to reduce the risk of accidents and claims. By taking similar actions, insurers can help to reduce the likelihood of accidents and claims involving elderly drivers, which can help to ensure the financial stability and sustainability of their business.



# 7.4 LIABILITY

As the automotive industry moves towards increased automation and electrification, new liability challenges are emerging for the insurance industry. One such challenge is the potential for accidents or injuries caused by autonomous vehicles leaving the question, "Who is responsible in case of an accident?", "the driver or the car maker?" Other challenges include new use cases, such as the potential for alcohol consumption in fully automated cars, vehicles operating under third-party service or fleet operator, and similar. Additionally, there is the risk of data privacy breaches and the challenge of determining the liable party. To address these matters, the automotive insurance industry must work with policymakers and industry stakeholders to develop new frameworks for assessing and mitigating liability risks. INSURANCE POLICY

#### 7.4.1 THE LIABILITY CASE FOR AUTONOMOUS VEHICLES

Insurance companies have been continuously improving the claims process for all types of accidents with the objective to minimize the costs for both themselves and the consumers. However, the emergence of autonomous vehicles has thrown a wrench in this system.

With the shift towards self-driving cars, the insurance industry is considering the possibility of transitioning from individual coverage to insuring car and software manufacturers. Even though some manufacturers have agreed to take responsibility for any malfunctions of their autonomous systems, this does not necessarily eliminate the risk of legal action. The novelty of these situations may lead to a surge in litigation, especially when determining blame becomes more complicated due to the presence of technology<sup>16</sup>.

<sup>16</sup> Forbes. Even Before Self-Driving Cars Hit The Road, Auto Insurance Faces Big Challenges. https://www.forbes.com/ sites/oliverwyman/2017/05/02/even-beforedriverlesscars-hit-the-road-auto-insurance-faces-big-challenges/. Accessed: Dec2022

In particular, it is still unclear how liability will be determined in the event of an accident involving a self-driving car. Will it be the fault of the software manufacturer, the car manufacturer, or the individual operating the vehicle at the time of the accident? These questions will need to be addressed as the use of autonomous vehicles becomes more widespread.

To address the liability challenges posed by autonomous vehicles, insurance companies have several options. They could switch focus from insuring individuals to insuring the risks associated with car and software manufacturers. This would cover damages or liability issues caused by malfunctions in autonomous systems. Insurance companies could also create specialized insurance products specifically for autonomous vehicles, which would consider the unique risks and challenges posed by this technology. Additionally, they could partner with tech companies involved in the development of autonomous systems and use data analytics to better understand and predict the risks associated with these vehicles.

#### 7.4.2 THE LIABILITY CASE FOR A FLEET OF VEHICLES

Similar is the problem with accidents or injuries caused by a vehicle operating under the control of a third-party service or fleet operator. For example, suppose a fleet operator contracts with a car manufacturer to provide a fleet of autonomous vehicles for use in a ride-sharing service. If one of these vehicles is involved in an accident, it may be unclear whether the fault lies with the car manufacturer, the fleet operator, or the driver (if there is one). Depending on the circumstances, any of these parties could potentially be held liable for any damages or injuries resulting from the accident.

In such cases, the liability of the car manufacturer and the fleet operator may depend on the terms of their contract and the specific obligations and responsibilities each party has assumed. For example, if the car manufacturer has agreed to maintain and repair the vehicles, they may be held responsible for any failures or defects that contribute to an accident. If the fleet operator has agreed to provide training and supervision for drivers, they may be held responsible for any mistakes or reckless behaviour that leads to an accident.

#### 7.4.3 PRIVACY BREACHES

Determining liability for data privacy breaches in the automotive industry can be a complex and time-consuming process for insurance companies, requiring careful analysis and a thorough understanding of the relevant legal and technical issues.

One of the main reasons for this is the difficulty in determining which party or parties to hold liable for a data privacy breach. There may be multiple parties involved in the design, manufacture, and maintenance of a vehicle's systems, any of which could potentially be held liable for a breach.

Determining the root cause of a data privacy violation and identifying the party responsible can be complex and may require extensive investigation and analysis. This may involve reviewing technical documentation, conducting forensic analyses of the systems involved, and gathering and analysing other relevant data.

Insurance companies may also need to consider a variety of factors when determining liability, such as the terms and conditions of contracts or warranties, the specific obligations and responsibilities of each party involved, and the applicable laws and regulations.

#### 7.4.4 NEW USE CASES

The emergence of new use cases as a result of new vehicle features is presenting new liability challenges as well. One such challenge is the possibility of alcohol consumption being allowed in fully automated vehicles. Suppose an accident occurs and the passenger has consumed alcohol. In that case, it may be difficult to determine who is at fault and how liability should be apportioned, potentially leading to complex legal disputes and insurance claims.

Another challenge is the possibility of remote operation of autonomous vehicles. If an operator is controlling a vehicle remotely and causes an accident, determining fault and allocating liability may be difficult. These new use cases highlight the need for the insurance industry to carefully assess and manage the risks associated with fully autonomous vehicles, and to develop new approaches for assessing and allocating liability. One approach to deal with this is to (**develop specialized insurance products** that are tailored to the unique risks and liabilities associated with these use cases. For example, insurers may offer coverage specifically designed to protect against the risks of alcohol consumption in fully automated vehicles or to cover the liability of remote operators of autonomous vehicles.

Another approach is to **work closely with regulators and policymakers** to develop legal and regulatory frameworks that address the specific liabilities and risks associated with these new use cases. This could involve advocating for reforms to existing laws or working to develop new regulations or standards that reflect the unique challenges and opportunities of fully autonomous vehicles.

# 7.5 DEMAND FOR TRANSPARENCY

Changing consumer attitudes are also impacting the insurance industry. Customers are becoming savvier and demand more transparency and value from their insurance products. This has led to the emergence of new distribution channels, such as online and mobile platforms, which allow consumers to easily compare and purchase insurance products. It has also led to the increased use of data analytics and machine learning to better understand and serve customer needs.

The transparency challenge is not just about making it easier for consumers to compare and purchase insurance products. It is also about ensuring that consumers have a clear understanding of the terms and conditions of their policies, as well as the claims process and any exclusions or limitations. Consumers want to feel confident that they are getting the coverage they need and that their insurance company will be there for them when they need it most.

This requires insurance companies to be more transparent in their communications and to clearly explain the details of their policies to consumers. It also requires them to be more responsive and transparent in the claims process, providing timely and accurate information to policyholders and addressing any issues or concerns they may have. Overall, the transparency challenge is about building trust and confidence with consumers, which is critical in today's competitive insurance market.

### 7.6 NEW ENTRANTS IN THE MARKET

Speaking of competition, there are new entrants and disruptors in the insurance market. These companies have the ability to leverage technology and data to offer more personalized and efficient products. They are often able to use advanced analytics and machine learning algorithms to analyse vast amounts of data and offer more tailored insurance products to consumers. This can be a significant advantage over traditional insurance companies that may not have the same access to data or technology.

Another challenge posed by new entrants and disruptors is their ability to enter and scale in the market quickly. These companies often have access to large amounts of capital and are able to use this to aggressively enter new markets and gain market share. This can make it difficult for traditional insurance companies to compete and respond to these new entrants.

White paper Mobility: Trends & cross-domain impact

Finally, new entrants and disruptors are often able to offer insurance products and services in new and innovative ways. This includes the use of digital platforms and mobile apps, which can make it easier for consumers to compare and purchase insurance products. These new distribution channels can also allow these companies to reach new consumers and expand their market reach. Overall, the challenges posed by new entrants and disruptors in the insurance market require traditional insurance companies to adapt and innovate in order to remain competitive

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# Banking

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# 8. Banking

The banking industry is facing significant challenges in today's rapidly changing market. Major contributors to that are the emergence of Automated, Connected, Electrified, and Shared (ACES) vehicles, changing consumer attitudes, and disruptors in the market. These trends are transforming consumer behaviour and requiring banks to shift from a traditional product-oriented business model to a service-oriented model and from indirect sales (via car dealerships) to direct sales. Banks also need to find creative ways to secure and monetize data generated from smart vehicles and meet changing consumer demands for a seamless purchasing process and on-demand mobility solutions. The need for digitalization is also a challenge, with banks struggling to modernize legacy systems and provide end-to-end digital services. Finally, new competitors are disrupting traditional business models and challenging banks to innovate. By embracing new technologies and adopting a customer-centric approach, banks can navigate these challenges and thrive.

### 8.1 BUSINESS MODEL

Automotive banks have enjoyed a long period of stability, but in order to continue to succeed, they must adapt and improve their business model. This means shifting towards a customer-centric approach, considering alternative ways of interacting with customers, and offering service-based platforms in addition to traditional products. Furthermore, the banks must find ways to monetize the data generated by modern vehicles, which can help them better understand and serve their customers while also increasing profits. By addressing these challenges and evolving their business model, automotive banks can remain competitive and successful in the long term.

#### 8.1.1 BEYOND PRODUCTS: THE VALUE OF SERVICE-BASED PLATFORMS

In recent years, platform providers such as Amazon, Google, Airbnb, and similar gained popularity by providing customers with an easy and efficient way to access a variety of services. These platforms offer a single location for customers to find everything they need and often act as digital brokers by aggregating services from partners and making them available to a broad audience. The open API-based architecture of these platforms also makes it easy for partners to integrate their services. Both customers and partners benefit from the convenience and accessibility of these platforms. Within this context, banks have the opportunity to become all-around service providers for their customers in the rapidly evolving world of mobility. One way they can do this is by expanding their traditional car financing option to include insurance, maintenance, and repair services. This allows banks to provide a one-stop shop for customers' mobility needs. Another option is for banks to own and operate a multi-brand vehicle fleet, offering subscriptions or usage-based services to customers. Alternatively, banks can partner with ride-hailing or car-sharing companies, allowing customers to access these services through the bank's platform. Banks can also provide mobile apps for managing car financing and offer resources and support for car buyers, including information on the carbuying process, price comparisons, and guidance on financing options.

To successfully transition to a service-based platform business, banks must invest in digital technologies and infrastructure, prioritize delivering a superior customer experience, and prioritize the security and privacy of customer data. This transformation may require a cultural shift within the organization, adoption of new technologies and processes, and the training of employees to align with the new business model. In addition, banks must also compete with fin-techs, big tech firms, and other platform providers, and continuously innovate and differentiate themselves to remain competi-



# 8.1.2 FROM INDIRECT TO DIRECT SALES

The automotive banking industry has traditionally relied on car dealerships as the primary point of interaction with customers. However, as the industry evolves and customer preferences change, banks need to consider alternative approaches to customer interaction and broaden their product offerings.

One way automotive banks can adapt to changing customer preferences is by establishing direct sales channels allowing customers to interact directly with the bank. This would require banks to loosen the relationship with car dealers and offer online platforms or mobile apps that enable customers to apply for loans, manage their accounts, and access educational resources directly with the bank. By providing these direct channels, banks can offer customers a more convenient and personalized experience, which can be particularly appealing in today's fastpaced and technology-driven world.

In addition to creating direct sales channels, automotive banks can also consider expanding their product offerings to meet customers' evolving needs better. This could involve offering a more comprehensive range of financing options, such as lease-to-own or subscription models, which can give customers more control and choice.

<ul> <li>business model to become all-around mobility provider</li> <li>Lose the relationship with car dealers and find alternative sales channels to interact directly with the customers</li> <li>Innovate methods needed to effectively monetize modern car data</li> </ul>	<ul> <li>Update legacy data architecture to a cloud-based solution to leverage today's data-driven landscape</li> <li>Transform legacy IT architecture to cloud-based micros-ervices to get in today's digital ecosystems</li> <li>Provide digital services along the entire customer journey to strengthen customer relationship</li> </ul>
Business Model	Digitalization
Customer demands	Competition
<ul> <li>Re-evaluate the approach to customer value by adopting</li></ul>	<ul> <li>Offer competitive financing options, such as low-interest</li></ul>
modern customer-centric approaches	rates or flexible payment plants, to retain customers
<ul> <li>Meet the customer's expectations for a convenient and</li></ul>	<ul> <li>Extend business to alternative mobility options, such as</li></ul>
seamless online purchasing experience	car subscription-based, to keep up with the competition
<ul> <li>Adapt to customer's shrift from pure car ownership to</li></ul>	<ul> <li>Partner with distributors in the market to find new ways</li></ul>
on-demand mobility sue cases	to expand the newly emerging markets

Figure 5: Outlook of the challenges in the Banking industry.

+ Shift from product-oriented towards service-based

Banks can also consider partnering with other organizations to offer additional products and services, such as insurance or maintenance plans, which can provide customers with a more comprehensive and convenient experience. By adapting to changing customer preferences and expanding their product offerings, automotive banks can remain competitive in a crowded market and build stronger customer relationships. This can ultimately lead to increased profits and shareholder value.

#### 8.1.3 MONETIZING CAR DATA

As vehicles become more advanced and connected, a large amount of data will be generated about the car itself, its usage patterns, and the customers themselves. If banks manage to secure a portion of this data, it could provide a significant source of revenue for automotive banks in the future. Clearly, automotive banks must find ways to utilize this data while also meeting regulatory requirements and prioritizing data protection, privacy, and security.

There are several ways that banks can make revenue from the data generated by vehicles. Some examples include:

- + Offering data-driven services: Banks can use the data they collect to offer new services to customers. For example, they could use data on a customer's driving habits to offer personalized insurance policies.
- + Advertising: Banks can use the data they collect to target advertising to specific groups of customers. For example, they could use data on a customer's travel patterns to show them ads for hotels or rental cars in their most likely visit areas.
- + Predictive maintenance: Banks can use data on a vehicle's usage and performance to predict when maintenance will be needed and offer services to customers to address those needs.
- + Fraud detection: Banks can use data to identify fraudulent activity, such as deceptive insurance claims or the use of stolen vehicles.

The banking industry will face several challenges to successfully turn vehicle data into profit. One key challenge is **compliance with a wide range of regulations** that govern the use of vehicle data. From data privacy laws to industry-specific regulations, banks must ensure that they are operating within the bounds of the law in order to avoid legal and reputational risks. Another critical issue is **data security**. Vehicle data can contain sensitive and personal information that must be protected from unauthorized access or misuse. This requires robust security measures and a commitment to regularly update them to stay ahead of evolving threats.

In addition to these challenges, banks must also focus on the quality of the data they are using. To be effective, the data must be accurate and up to date. This can be a challenge if the data is coming from a variety of sources or if it is not consistently structured. Banks must also prioritize data privacy and be transparent about how they use vehicle data. This also includes obtaining the appropriate permissions from customers before collecting and using their data. Finally, to succeed in this space, banks will also need to compete with other organizations that are looking to leverage vehicle data as a source of revenue. This may involve differentiating their products and services, building strong partnerships, and investing in technology and expertise.

By taking a proactive approach to these challenges, the banking industry has the opportunity to turn vehicle data into a significant source of income and drive growth in the coming years.

# 8.2 DIGITALIZATION

#### 8.2.1 MODERNIZING DATA ARCHITECTURE: FROM LEGACY TO CLOUD-READY

In today's data-driven landscape, the ability to effectively capture, process, and analyse data is critical to making informed, strategic decisions and driving business outcomes. Companies that are able to leverage data effectively are well-positioned to succeed in an increasingly competitive market. This is particularly true in the automotive sector, where the sheer volume of data generated by people, organizations, and vehicles can be overwhelming.

Successful companies such as Amazon and Google have recognized the value of data and have made it a central part of their corporate DNA. However, many automotive banks struggle to fully leverage the opportunities offered by data and predictive analytics due to the limitations of their legacy data sourcing and integration systems.

To realize the full potential of data and become truly data-driven, it is essential for companies to transition to a modernized, flexible, and scalable data architecture in the cloud. By adopting a "data on cloud" strategy and linking it to clear business outcomes, companies can capture data in real-time, reduce processing times, and drive faster, more accurate business outcomes.

To transition from legacy systems to a "data on cloud" strategy, banks should first assess their current data infrastructure to identify areas that need to be modernized. They should then determine which data sets can be migrated to the cloud, considering factors such as data sensitivity and regulatory requirements. A migration plan should be developed, including a time line and budget, and measures should be taken to ensure the continuity of business operations during the migration process. As data is migrated to the cloud, banks should implement measures to secure the data and ensure compliance with relevant regulations. Staff should be trained on using the new cloud-based data infrastructure and any new tools or technologies being implemented. Once the migration is complete, banks should monitor the performance of their new data infrastructure and make any necessary adjustments to optimize its use. Furthermore, actions that banks can take as part of this process include partnering with a cloud provider, adopting cloud-based analytics tools and leveraging cloud-based AI and MI services.



#### 8.2.2 TOWARDS CLOUD BASED MICROSERVICES

As the mobility industry transforms, it has become clear that a single company can no longer meet customers' rapidly changing expectations and needs. Instead, these expectations will be met through digital ecosystems comprising partnerships between multiple companies.

For automotive banks to participate in these ecosystems, they must have interconnected IT systems and applications that can communicate with one another. This means that in addition to modernizing their data architecture, banks will also need to review and gradually separate the general legacy IT architectures in favour of lightweight, cloud based microservice architectures.

In the context of automotive banks, microservices can handle various functions such as customer account management and authentication, loan application processing and approval, car rental or car sharing services scheduling and booking, vehicle maintenance and repair tracking and management, and insurance premium calculation and payment.

#### 8.2.3 END-TO-END DIGITAL SERVICES ALONG THE ENTIRE CUSTOMER JOURNEY

Automotive banks have long utilized the concept of "lock-in" to cement their relationships with customers and maintain a dominant position in the market. This strategy involves establishing long-term connections with clients through the use of dealerships as a primary point of contact for customer service. When an individual begins searching for a new vehicle, they will often start online and may eventually visit a dealership. At the car trader, they will be presented with a personalized financing or leasing offer from one of the dealership's partnered banks. If the customer decides to move forward with the purchase and financing, they may also be offered additional after-sales services. However, it is common for the customer not to receive further communication from the bank until their contract nears expiration.

The lack of ongoing customer contact after a car purchase hinders the establishment of a strong customer relationship. Furthermore, with new competitors entering the market and changing customer expectations, the need to keep customers is becoming more intense. When car sales are completed online, it is easy for customers to switch to another financial service with just a few clicks, which further reduces customer retention. To maintain customer loyalty, automotive banks must enhance their customer management strategies to establish a "digital lock-in" effect. This involves offering seamless and desirable services to customers at every stage of their journey. For example, offering additional services or perks to customers who finance or lease their vehicles through the bank. These could include things like roadside assistance, maintenance reminders, or discounts on future purchases.

Additionally, making it easy for customers to access and manage their accounts online, with features such as online bill pay, the ability to view statements and documents, or the ability to make updates to their account information, can also contribute to the "digital lock-in" effect. Providing top-notch customer service through online channels, such as live chat or email. can further enhance the customer experience and help to build trust and loyalty. Finally, offering personalized recommendations or deals to customers based on their past purchases or interactions with the bank can make them feel valued and encourage them to continue doing business with the bank.

# 8.3 NEW CUSTOMER DEMANDS

The banking industry is facing significant challenges in meeting the evolving demands of consumers. In particular, there is a growing demand for a more consumer-centric banking experience, a shift towards more efficient purchasing processes, and a move away from traditional ownership models towards on-demand usage. To successfully navigate these changes, banks must undertake significant efforts to adapt to these emerging trends. Failure to do so could result in a loss of market share to more agile competitors who can better meet the modern consumer's needs.



#### 8.3.1 CUSTOMER-CENTRICITY

In today's competitive business landscape, it is essential for banks to re-evaluate their approach to customer value. While traditional methods have cantered on internal metrics and maximizing the value customers bring to the organization, this narrow perspective may no longer be sufficient in an increasingly customer-centric world.

Big tech firms have demonstrated the effectiveness of a customer-centric approach to value. By prioritizing the value, they offer to customers, these companies have achieved success and become leaders in their respective industries. This shift in mindset represents a fundamental change that allows companies to convert customer loyalty and engagement into profits and increased shareholder value.

In the context of automotive car sales, the banking industry can adopt a more customer-centric business model by focusing on the following areas:

- + Offer personalized financing options: Banks can offer personalized financing options to customers based on their unique financial situation, rather than a one-size-fits-all approach. This can include customizing the loan terms, interest rates, and down payment requirements based on the customer's credit score, income, and other factors.
- Improve the loan application process: The loan application process can be intimidating and time-consuming for customers. Banks can streamline this process by providing an online application option, reducing the required documentation, and expediting the approval process. Read more on that in section "Flawless Purchasing process"
- + Provide additional services: Banks can differentiate themselves from competitors by offering additional services to customers, such as extended warranties, roadside assistance, and insurance. These services can provide value to the customer and strengthen the bank's relationship with them.

- + Invest in customer education: Many customers may not fully understand the financing options available to them or the terms of their loan. Banks can invest in customer education by providing resources and information on their website or through in-person workshops. This can help customers make more informed decisions and feel more confident in their purchase.
- + Foster a customer-focused culture: A customer-centric approach necessitates a unified dedication from the company to prioritize the wants and needs of clients. Banks can foster a customer-focused culture by training employees on customer service best practices, soliciting feedback from customers, and regularly measuring customer satisfaction.

In order to stay competitive and meet the evolving needs of customers, it is necessary for banks to redefine their approach to customer value.

#### 8.3.2 FLAWLESS PURCHASING PROCESS

As more and more industries move towards a digital landscape, consumers have come to expect a certain level of ease and convenience in their online shopping experiences. This includes features such as seamless omni-channel e-commerce, flexible contracts, transparency, and consistent endto-end experiences. Tech giants like Amazon, Alibaba, and others have set the standard for customer satisfaction in purchasing processes and use of services, with Amazon in particular, known for its quick delivery times and efficient logistics.

However, the automotive banks still need to catch up to these online shopping leaders in terms of providing a smooth and convenient customer experience. One major obstacle to this is the indirect business model employed by many automotive banks, which requires transactions to be processed through car dealers rather than allowing for a fully digital process. This significantly hinders the ability to provide the same convenience and ease as in other industries.

There are a few steps that automotive banks can take to provide a smooth, flexible, transparent, and consistent end-to-end car purchasing experience:

- Adopt a direct business model: By eliminating the need to go through car dealers, automotive banks can streamline the purchasing process and provide a more seamless and convenient experience for consumers.
- + Improve online presence: Providing a user-friendly website and mobile app that allows consumers to browse and purchase cars, as well as manage their financing, can make the end-to-end process more consistent and convenient.
- + Offer flexible financing options: Allowing consumers to customize their financing plans, including the duration of their loan and the terms of their contract, can increase transparency and make the process more flexible for the customer.
- + Enhance customer service: Providing knowledgeable and helpful customer service representatives who can assist with questions and concerns throughout the process can improve the overall experience for the customer.
- + Increase transparency: Clearly disclosing all fees and terms associated with the financing can increase trust and transparency in the process.
- + Offer a trade-in program: Allowing consumers to trade in their old vehicles can save them time and hassle in finding a buyer for their old car.

#### 8.3.3 FROM OWNERSHIP TO ON-DEMAND USAGE

As the demand for flexible and convenient transportation options grows, the traditional car ownership model is shifting. Increasingly, customers are seeking short-term vehicle rentals to meet their transportation needs without the burden of residual value risk or long-term commitment.

Leasing has seen a constant growth in popularity in recent years. The CAR (Centre Automotive Research) institute predicts that leasing contracts in Germany will reach 1 million annually, with a market share of 40 % by 2030<sup>17</sup>. This trend is likely to displace traditional financing and cash purchases. Carsharing services have also seen exponential growth, with over 2.3 million registered users in Germany. Despite a temporary dip in 2020 due to COVID-19, 40 % of Germans now prefer car-sharing options over car ownership, a 10 % increase from 2018<sup>17</sup>.

To adapt to the shift towards on-demand vehicle usage, banks have a few options available to them. One way is to offer financing options for car-sharing and ride hailing companies. By partnering with these businesses, banks can provide financing for the purchase of vehicles as well as for operational expenses such as insurance and maintenance. Another option is for banks to launch their own carsharing or ride hailing services, either as a standalone business or as an extension of their existing offerings. As more and more people become independent contractors or gig workers, banks can also consider offering specialized financing options specifically tailored to this market, such as loans for the purchase of vehicles to be used for ride-hailing or delivery services. In addition, banks can explore partnerships with car manufacturers and other industry players to develop innovative financing options for on-demand vehicle usage: e.g., lease-to-own options, subscription-based financing, or pay-per-use models. Finally, banks can invest in technology and infrastructure that supports the growth of on-demand vehicle usages, such as mobile apps and payment systems, and charging infrastructure for electric vehicles.

<sup>17</sup> Accenture. The Future of Automotive Finance. Technical report, 2021

# 8.4 COMPETITION

New competitors have emerged in the car sales market in recent years, challenging traditional automotive banks. These competitors, including online car sales platforms and subscription-based car services, often offer customers a more convenient and innovative purchasing experience.

Online car sales platforms allow customers to browse and purchase cars entirely online. These platforms often have a wider selection of vehicles available and can offer a more convenient and streamlined purchasing experience. Subscription-based car services, like Care by Volvo or SIXT+ Auto Abo, provide monthly subscriptions that allow customers to drive various car models. These services attract customers who want the flexibility to switch between car models or want to avoid the hassle of owning a car.

### 8.5 COMPETITIVE FINANCING OPTIONS

One way to address the challenges posed by these new competitors is to offer competitive financing options. There are several ways to achieve that:

- + Low-interest loans: Automotive banks can offer low-interest loans to make traditional car sales more attractive to consumers.
- + Flexible repayment terms: Automotive banks can offer flexible repayment terms, such as the ability to adjust the length of the loan or make extra payments, to make financing more accessible to consumers.
- + Zero down payment options: Automotive banks can offer zero down payment options, which can be especially appealing to consumers who do not have a large amount of money saved for a down payment.
- + Pre-approved financing: Automotive banks can offer pre-approved financing, which allows consumers to shop for a car with the confidence that they have financing in place.

- + No-interest financing: Automotive banks can offer no-interest financing for a limited time to make traditional car sales more attractive to consumers.
- + Leasing options: Automotive banks can offer leasing options, which allow consumers to use a car for a set period of time without owning it. This can be a more affordable option for some consumers.

#### 8.5.1 COMPETITIVE FINANCING OPTIONS

To address the challenge posed by these new competitors, traditional automotive banks can offer competitive financing options, such as low-interest rates or flexible payment plans, to make it easier for customers to purchase a car. They can also improve their online purchasing experience to make it more convenient and streamlined for customers. This could include offering online credit applications, digital contract signing, and tracking a loan application's progress. The bank could also consider partnering with new competitors, such as online car sales platforms and financing options for their customers. Alternatively, the bank could offer alternative financing options, such as leases or subscription-based financing, to meet the needs of customers interested in these types of services.

#### 8.5.2 ALTERNATIVE MOBILITY BUSINESSES

Car subscription services are a relatively new offering in the automotive industry that allows customers to pay a monthly fee to have access to a car, rather than owning one outright. These services are often seen as a way for traditional car manufacturers and dealerships to compete with disruptors such as ride-sharing companies.

There are several ways in which banks can get involved in the car subscription market:

- + Partnering with car subscription providers: One way for banks to enter the car subscription market is by partnering with existing providers. For example, a bank could offer financing options for customers who want to subscribe to a car or provide payment processing services for the provider.
- + Offering car subscription services directly: Some banks are starting to offer car subscription services directly to customers. For example, Volvo has a partnership with Santander Consumer USA to offer its "Care by Volvo" subscription service, which includes insurance, maintenance, and roadside assistance in addition to the car itself.
- + Investing in car subscription companies: Another way for banks to get involved in the car subscription market is by investing in companies that provide these services. For example, in 2019, Bank of America invested in Fair, a car subscription company.

Overall, car subscriptions represent a new and growing market, and there are several ways in which banks can participate in this space. By partnering with existing providers, offering car subscriptions directly, or investing in companies that provide these services, banks can help to meet the increasing demand for flexible and convenient transportation options.





# 9. Public

The emergence of Automated, Connected, Electric, and Shared (ACES) vehicles profoundly impacts the public domain. One of the most significant challenges is the need to modernize road infrastructure to cater to future mobility requirements. This includes the digitization of roads with comprehensive vehicle-to-infrastructure technology, specialized facilities for the maintenance and service of shared electric car fleets, conversion of existing infrastructure like parking spaces into staging areas for multiple fleet operators, and the construction of infrastructure to support the production, storage, and distribution of alternative fuels like hydrogen and biofuels.

Another challenge is ensuring a reliable energy grid that can support the diverse and dispersed needs of future mobility systems, including meeting the increasing demand for electric vehicle charging. Furthermore, finding alternative ways to generate revenue is another challenge arising from the decreased income from fuel taxes and the lack of driver licensing and registration fees with autonomous vehicles.

To add to that, legal and regulatory challenges such as data privacy, liability in accidents involving autonomous vehicles, and the need to update regulations as per technological advancements are also significant obstacles in this transition to future mobility. Solving all these challenges requires a coordinated effort from industry leaders and government officials to enable a seamless transition to the new era of mobility.

### 9.1 OPERATING MODEL

As governments across the country grapple with tight budgets and a lack of funding for transportation, the rise of automated, electric vehicles threatens to add even more strain to their finances. The reason behind this is twofold: firstly, electric cars do not use traditional fuel and thus do not contribute to fuel taxes, which is a significant source of revenue for many governments. Secondly, once widely adopted, autonomous vehicles have the potential to decrease demand for traditional personal car ownership and associated costs such as driver licensing and registration.

Public officials must consider new ways to generate revenue to address this looming financial challenge. The aim is to create a balance where the newly generated revenue doesn't discourage using more sustainable, comfortable, and shared transportation choices.

<ul> <li>Engage in public-private partnerships for generating new revenue for transportation projects: e.g., joint development of automated vehicles-only road lanes and collect user fees</li> <li>Develop models of monetizing data generated by V2I or ITS: e.g., charge companies to access traffic patterns</li> <li>Introduce dynamic road curbs pricing as a way to generate additional revenue from public spaces</li> </ul>	<ul> <li>Meet the needs of future mobility by digitizing roads with comprehensive vehicle-to-infrastructure technology</li> <li>Build specialized facilities to maintain, service, and charge shared electric car fleets</li> <li>Convert existing infrastructure (e.g., parking spaces) into stating areas for multiple fleet operators</li> <li>Build infrastructure supporting the production, storage and distribution of alternative fuels (e.g., hydrogen and biofuels)</li> </ul>
Business Model	Road Infrastructure
Regulations	Clean Mobility
<ul> <li>+ Establish new regulations from automated cars: for testing, certifying, and liability issues in case of accidents</li> <li>+ Ensure safety, fair competition, and accessibility of shared vehicles</li> </ul>	<ul> <li>Collaborate with businesses to re-purpose existing petrol stations to meet the demand for electric vehicle charging</li> <li>Develop smart charging systems to control the charging of EVs based on real-time data about power demand</li> </ul>

#### 9.1.1 PUBLIC-PRIVATE PARTNERSHIPS

Public-private partnerships (PPPs) have emerged as a viable solution for generating new revenue for transportation projects related to autonomous vehicles (AVs) and shared autonomous mobility (SAM). These types of partnerships bring together public sector entities and private companies to jointly finance, construct and operate infrastructure projects. They can provide access to a diverse mix of capital investments that may be needed to support the growth of AVs and SAM. However, when considering entering into a PPP, it is crucial to examine and weigh ownership issues, contract terms, and the future revenue streams expected from the project.

One example is to bundle small capital improvements across a large area, thus making use of economies of scale, attracting the most efficient and advanced private sector companies, for instance, by re-fitting multiple underutilized parking spaces to SAM staging areas.

Additionally, PPPs can be used to construct infrastructure for collecting user fees on shared AV-only lanes. For example, governments could partner with private companies to build and operate dedicated lanes for autonomous vehicles and charge a usage fee for access to these lanes. This could generate revenue for the government while also providing an incentive for people to use autonomous cars and reducing congestion on regular roads. These dedicated lanes could be built on existing infrastructure, such as the shoulder of a highway, or as an addition to new highway construction. The private partner could operate the lanes, collect the user fees, and use a portion of the revenue to maintain and upgrade the infrastructure, with the remaining going to the government. The governments could also use this revenue for transportation projects in the area or for other public services. Additionally, these dedicated lanes could come with added benefits such as increased safety and reduced travel times for users of these lanes, and it would also benefit from reduced pollution.

# 9.1.2 REVENUE FROM DATA EXCHANGE

The digitization of the road infrastructure (e.g., wireless Vehicle-to-Infrastructure communication) is set to generate a vast amount of data. Public officials can successfully harvest that and generate additional revenue. There are several ways to do that:

- + Data licensing: Public officials could charge companies for access to data related to transportation infrastructure, traffic patterns, and usage of shared autonomous vehicles. This data could improve transportation planning and provide valuable insights to private companies.
- + Advertising: Governments could sell access to data related to transportation usage to advertising companies, which could use it to target ads to specific groups of people based on their travel patterns.
- + Transportation planning: Public officials could partner with private companies to use data on transportation usage to improve planning and development decisions, such as determining the best locations for new transportation infrastructure or identifying areas with high demand for shared autonomous vehicles.

- + App usage: Governments could charge for access to their transportation apps that provide information about routes, schedules, and other relevant details or allow third-party apps to use their data for a fee.
- + Data analysis: Public officials could partner with private companies or research institutions to analyse data related to transportation usage and provide insights and recommendations for improving transportation systems, which could benefit private companies and the government.
- + Charging for data-driven decision-making: Governments could also charge private companies to access the platform or services they have built to make decisions around shared autonomous vehicles and their infrastructures that use real-time data, predictions, or other data-driven insights.

It's important to note that any revenue-generating activity related to data exchange should comply with local laws and regulations regarding data privacy and protection.

#### 9.1.3 DYNAMIC ROAD CURBS PRICING

The curb space in most cities is primarily utilized as parking spots. Still, public officials have an opportunity to optimize its usage in a more dynamic way that not only responds to market demand but also provides a way to generate higher revenue.

One way to achieve this is by installing smart meters at the curb side that display the current prices for that spot, accept payments and notify the servers when the spot is occupied. This way, not only can it help free up the curb space for other purposes as well, but it would also provide a steady stream of revenue for the government through collecting these usage fees.

For instance, during peak hours, the curb side could be allocated for the pickup and drop-off of autonomous vehicles as a part of the public transportation system, and government could charge a higher fee for this premium service during peak hours. In the afternoon, this same space could be used by food trucks and, at night, by delivery trucks. Using dynamic pricing and designating the curb for specific purposes could also encourage shared autonomous mobility (SAM), as travellers could share the costs related to drop-off, resulting in more revenue for the government.

This dynamic usage of curb space could also help reduce congestion and the problem of vehicles circling, which will continue to be an issue even in the world of autonomous vehicles. Additionally, by pricing curb space in line with demand, it would also provide delivery trucks and ridesharing services with more options for conducting drop-offs and pickups, as there would be more available spots and generate revenue for the government.

Overall, this system can help to make better use of the curb space, ease traffic and generate additional revenue for the government, all while making transportation more efficient and convenient for citizens.

# 9.2 ROAD INFRASTRUCTURE

As we move towards a future with more automated, connected, electrified, and shared vehicles on the road, the road infrastructure must be adapted to meet the needs of these new technologies. While the private sector will undoubtedly play a role in developing these technologies, it is ultimately the responsibility of public institutions to modernize our infrastructure and set guidelines for how it should be done.

Example enhancements would include vehicle-to-infrastructure communication, which allows for real-time communication between vehicles and traffic signals, road signs, and other infrastructure elements. Additionally, lane markings should be enhanced to be easily readable by automated cars, and maintenance and service facilities should be built to accommodate the needs of electric and shared car fleets. Alternative fuel infrastructure, such as charging stations for electric vehicles, should also be a focus to support the growing number of green cars on the road. By implementing these measures, one can improve safety and efficiency on the roads, reduce traffic congestion, and ensure that our infrastructure is prepared for the future of transportation.



#### 9.2.1 VEHICLE TO INFRASTRUC-TURE COMMUNICATION

Vehicle to Infrastructure communication, also known as V2I, refers to the communication between vehicles and the infrastructure they operate on, such as roads, traffic signals, and parking systems. V2I technology has the potential to significantly improve the efficiency and safety of transportation systems, particularly in the context of automated and connected vehicles.

Oneusecase for V2lis the use of machine-readable traffic signs, which can provide automated vehicles with real-time information about speed limits and construction zones. Another use case is traffic signal priority, which allows automated cars to request and receive priority at traffic signals, reducing travel time and improving efficiency. Dynamic routing is another use case where V2I provides real-time updates on traffic conditions and other events that may affect a vehicle's route, allowing the car to choose the most efficient way. V2I can also be used for parking assistance and to support electric vehicles by providing real-time information on charging stations and parking space availability. In addition, V2I can give real-time updates on weather and other environmental factors that may affect a vehicle's performance or safety.

Some of the challenges public authorities will face when adopting the V2I technology are:

- + Integration with existing infrastructure: Integrating V2I technology with existing road infrastructure can be a complex and costly process. One solution to this challenge is to adopt a phased approach, starting with a small-scale pilot program and gradually expanding to cover more of the city's infrastructure.
- + Data privacy and security: Ensuring that the data collected by V2I systems is secure and protected from cyber threats is essential. To protect data privacy, cities could address this challenge by implementing robust security measures, such as encryption and secure data storage.
- + Compatibility with different vehicle types: V2I technology may only be compatible with some kinds of vehicles, which could limit its adoption. To address this challenge, cities could work with manufacturers to ensure that the technology is compatible with various vehicle types.
- + Public acceptance: Another challenge may be convincing the public to accept and use V2I technology. To overcome this, cities could educate the public about the benefits of V2I, such as increased safety and efficiency, and address any concerns that the public may have about the technology.

#### 9.2.2 LANE MARKINGS

Lane markings are crucial for the correct operation of automated cars, as they provide the vehicle with clear visual cues about the road's layout, structure and help cars to safety navigate. There are several challenges in maintaining high-quality road lane markings. One challenge is the wear and tear those markings may experience over time. For example, heavy traffic, harsh weather conditions, and road maintenance activities can all contribute to the degradation of road lane markings. This can lead to fading, peeling, and cracking, significantly reducing their visibility and effectiveness. City infrastructure departments would need to invest in developing and using more durable and long-lasting materials for lane markings. These materials may be more resistant to wear and tear and require less frequent maintenance and replacement.

Another challenge is the **build-up of grime and dirt** on road lane markings. When grime and dirt build up on road lane markings, it can make them difficult to see, leading to accidents and other safety issues. This can occur due to various factors, including car exhaust, construction activity, and weather conditions. A solution would be to implement regular maintenance and cleaning programs to remove grime and dirt from road lane markings. This may involve the use of specialized cleaning equipment and techniques and the development of new technologies to remove dirt and grime. Lastly, in some countries, the percentage of roads with lane markings could be much higher, which presents a challenge for the adoption and use of automated vehicles.

#### 9.2.3 MAINTENANCE AND SERVICE FACILITIES

To support the growing trend of shared electric car fleets, specialized facilities will be necessary to maintain, service, and charge them. These facilities can be run by private organizations or by the government. If private companies are in charge, the officials must regulate the facilities.

However, if the government decides to run its own fleet, it will need to establish support centres just like it does for current bus systems. These centres can be located in re-purposed facilities that are no longer in use, such as underutilized parking garages. To maintain these centres, costs for rent (unless the government owns the facility), labour, and charging infrastructure for electric vehicles will be necessary.

Transportation officials need to consider the impact on the community when choosing the location for these support centres. The placement should not disturb the urban setting or negatively affect traffic, health, or civic life.

#### 9.2.4 STAGING AREAS

To prevent road congestion, autonomous vehicle (AV) fleets and shared-ride services need designated areas to wait while picking up or dropping off passengers. One potential solution is to convert existing parking spaces into staging areas that multiple fleet operators can use. This helps to alleviate the need for AVs to constantly be on the move, searching for a place to stop and instead allows them to remain stationary in a designated area until they are ready to begin their next trip.

There are several challenges that public authorities may need help with when implementing this solution. One challenge could be resistance from local businesses and residents who may want to keep their parking spaces for AV staging areas. Another challenge could be determining the best locations for these staging areas, as they should be conveniently located for passengers and operators while also not causing additional congestion.

In addition, there may be logistical challenges in managing and regulating these staging areas' use, including determining which operators have access and enforcing rules and regulations related to their use.



Public authorities might consider some of the following to address the mentioned challenges:

- + Use data and analysis to identify the most suitable locations for AV shared vehicle staging areas based on factors such as proximity to high-traffic areas, demand for shared-ride services, and potential impact on local businesses and residents.
- Develop clear rules and regulations for using AV and shared vehicle staging areas, including guidelines for fleet operators, such as how long they can use the space and how they should interact with other operators and passengers.
- + Use Intelligent Transportation Systems (ITS) to monitor traffic patterns and demand for shared-ride services in real-time and dynamically adjust the allocation of AV staging areas based on this data. This could help to ensure that AVs can efficiently pick up and drop off passengers while minimizing the risk of congestion in the surrounding area. In addition, an ITS could be used to manage the use of AV staging areas through digital parking permits or designated drop-off and pick-up zones. For example, fleet operators could be required to obtain a digital parking permit through a smartphone app, allowing them to use a designated staging area for a specific time. This could help to ensure that the staging areas are being used efficiently and fairly by all operators and reduce the need for physical infrastructure such as barriers and signage.

+ Engage in outreach and consultation with local businesses and residents to explain the benefits of AV and shared vehicle staging areas and address any concerns they may have. This could include providing information on how the staging areas will be managed and regulated and offering incentives or compensation for the use of parking spaces.

#### 9.2.5 MOBILITY HUBS

To ensure the success of shared and autonomous mobility, it is imperative that individuals can easily switch between various forms of transportation. Imagine a commuter who utilizes a self-driving taxi to get to the nearest train station and then hops on an electric scooter for the final stretch to the office. If this process is too complicated, passengers may opt for the convenience of private AVs for door-to-door travel, leading to increased congestion and decreased reliability.

One solution to this problem may be the implementation of mobility hubs, where travellers can access shared modes of transportation, including AVs. These hubs could take the form of micro-mobility pickup spots near subway stations or larger transit centres offering dining and shopping options at strategic locations. By investing in these hubs, authorities can facilitate seamless multi-modal travel and encourage the adoption of shared and autonomous transportation options. To further enhance the utility of mobility hubs, authorities could consider implementing several additional measures. For example:

- + Implementing intelligent ticketing systems that allow travellers to use a single ticket or payment method across different modes of transportation, regardless of operator.
- + Partnering with ride-hailing or micro-mobility companies to offer discounts or bundled services for travellers using multiple modes.
- + Offering incentives such as reduced fares or loyalty rewards to encourage the use of public transportation.
- + Investing in infrastructure like pedestrian- and bicycle-friendly paths, as well as dedicated bike-sharing stations, to make it easier for travellers to access multiple modes of transportation.
### 9.2.6 ALTERNATIVE FUEL INFRASTRUCTURE

As the demand for alternative fuels such as hydrogen and biofuels grows, the need for a comprehensive infrastructure to support their production, storage, and distribution becomes increasingly essential. However, achieving this has its challenges.

One of the main challenges in building an infrastructure for alternative fuels are the costs. The development of new technologies and facilities can be expensive, and there may be a need for significant investments in research and development to make these fuels more cost-effective and widely available.

Another challenge is the lack of standardization. Various technologies and approaches are currently being developed for the production and use of alternative fuels, and it can be challenging to determine which ones are the most promising or suitable for wide scale adoption. This can make it difficult to develop a consistent and cohesive infrastructure that can support the use of these fuels.

Finally, there may be challenges regarding public acceptance and adoption of alternative fuels. Some people may be sceptical of the benefits of these fuels or may be hesitant to switch from more familiar fossil fuels. It may be necessary to educate the public about the benefits of alternative fuels and address any concerns they may have to encourage wider adoption.

Despite these challenges, developing an infrastructure for alternative fuels is crucial to support the transition to a more sustainable and environmentally friendly energy system.

### 9.2.7 ROAD REINFORCEMENT

Autonomous vehicles (AV) rely on lane-keeping systems to operate accurately, often driving in the middle of the lane. While this is undoubtedly a positive safety feature, the constant presence of AVs in the middle of the lane can put a lot of strain on our roads. Over time, the continuous and precise positioning of AV wheels on the road can lead to wear and tear, such as the formation of ruts and cracks. This is especially true for AV-dedicated lanes. As public authorities responsible for the maintenance and construction of roadways, they face the challenge of finding cost-effective solutions to the issue of wear and tear caused by autonomous vehicles. One potential solution is using higher stiffness and more deformation-resistant materials in the construction of roads, particularly in areas where AVs are likely to be driving. However, this solution has its challenges.

One of the main challenges would be the cost of these specialized materials. They may be more expensive than traditional construction materials, which can add to the project's overall cost. Furthermore, there may be logistical challenges in sourcing and transporting these materials to the construction site, which can further increase costs. Another challenge is the complexity of the construction process when using these materials. They may require more specialized equipment and techniques, which can add to the time and effort needed to complete the project. This can ultimately increase the overall cost of the project.

### 9.2.8 PLATOONING

In recent years, the concept of platooning has gained significant attention from researchers and industry professionals due to its potential to reduce emissions and fuel consumption. However, there are also concerns that platooning may violate current structural design guidelines for bridges. For instance, a study<sup>18</sup> examined the impact of platooning on current design procedures, focusing on factors such as bridge span, span length, configuration, and the number of trucks in the platoon. The results of this study showed that more than the current standard specifications for highway and bridge design is needed to safely accommodate truck platoons in most cases.

This presents a challenge for those seeking to implement platooning on our roads. To take advantage of the potential benefits of platooning, it may be necessary to revise current design guidelines or find alternative solutions to ensure the safety and integrity of our bridges. This could involve using different materials or construction techniques or developing new technologies to accommodate the unique demands of platooning better.

There may also be other challenges to consider when implementing platooning, such as the need for advanced communication and coordination systems to enable the trucks in a platoon to operate safely and efficiently.

Despite these challenges, the potential benefits of platooning make it a promising area of research and development. By finding solutions to these challenges and carefully considering the safety and structural implications of platooning, we can work towards a future in which this technology can be safely and effectively implemented on our roads.

### 9.2.9 EMERGENCY REFUGEE AREAS

As autonomous vehicles become more prevalent, there may be a need for emergency refugee areas specifically designed for these vehicles in case of accidents or technical malfunctions. These areas could be located on the side of the road, in parking lots, or designated zones within cities. These areas provide a safe place for the vehicles to stop and wait for assistance and protect any passengers or pedestrians in the vicinity. Implementing emergency refugee areas for autonomous vehicles would not only ensure the safety of those involved in any incidents but also help mitigate any potential damage or disruption to traffic flow. In addition, having designated areas for autonomous vehicles in emergencies could also aid in the timely resolution of

any issues, ensuring a smooth and efficient return to regular operation.

There are several technical challenges that public authorities would have to consider when implementing emergency refugee areas for autonomous vehicles. These may include:

- + Identifying suitable locations for these areas: Public authorities would need to identify sites that are easily accessible to autonomous vehicles in case of emergencies while also considering the safety and convenience of pedestrians and other road users.
- + Implementing communication and navigation systems: Autonomous vehicles would need to be able to locate and navigate to the emergency refugee areas, which would require the development of robust communication and navigation systems.
- + Implementing safety protocols: Public authorities would need to develop and implement safety protocols to ensure the safety of passengers and pedestrians in the emergency refugee areas, as well as the safety of any personnel working in these areas.
- + Managing traffic flow: Public authorities would need to consider the impact of emergency refugee areas on traffic flow and develop strategies to minimize disruptions. This could include implementing detours or traffic control measures.

<sup>18</sup> Matthew T Yarnold and Jeffrey S Weidner. Truck platoon impacts on steel girder bridges. Journal of Bridge Engineering, 24(7):06019003, 2019

## 9.3 LEGAL AND REGULATORY IMPACT

The integration of automated, connected, electrified, and shared vehicles (ACES) into society presents a wide range of benefits, including increased safety, improved mobility, and reduced emissions. However, as these technologies continue to advance, public institutions will face various legal and regulatory challenges.

One significant challenge is ensuring the safety of ACES on the roads, as autonomous driving technology is still in its early stages. Governments will need to establish new regulations and guidelines for testing, certification, and liability issues in case of accidents. This includes procedures for accident investigations, liability assignments in case of accidents involving autonomous vehicles, and regulations for responsible data handling of the data generated by these vehicles.

Another challenge comes with the integration of shared mobility services, such as ridesharing and car-sharing. These include ensuring safety and fair competition through regulations for background checks, safety standards, and insurance requirements. They also need to regulate pricing and advertising to be transparent and non-discriminatory and ensure that the services are accessible to all social groups, including options for the elderly and disabled people and special schemes for low-income groups. Furthermore, they have to ensure integration with traditional forms of transportation, such as bike lanes, parking spaces, and traffic flows, and ensure compliance with local laws and regulations: i.e., including business licensing, taxes, and laws related to transportation. Finally, governments will have to address data privacy and security issues, as ACES vehicles generate a large amount of data that can be used for various purposes. Governments must ensure that data is collected, processed, and used in compliance with privacy laws and regulations, including GDPR, and that consumers know how their data is being used and have given their consent. This includes ensuring that data is collected for legitimate purposes, not being retained for longer than necessary, and is protected against unauthorized access, use, disclosure, or destruction.



# 9.4 ELECTRIFICATION

As we move towards a more electrified society, it's crucial that we have a reliable energy grid that can support the various and dispersed energy needs of our transportation systems. Unfortunately, today's grid is not yet up to the task of powering a world of electric vehicles.



Charging infrastructure is just a tiny piece of the puzzle we also need to consider the overall power supply and availability of renewable energy sources. Even with renewables, we may still fall short of meeting the energy demands of a fully electric transportation system. All of these challenges underscore the importance of thoroughly understanding the role of energy in shaping the future of mobility.

### 9.4.1 CHARGING INFRA-STRUCTURE: QUANTITY AND QUALITY

One of the biggest challenges facing electric vehicle adoption is the availability of charging infrastructure. It's about more than just having enough charging stations but also about ensuring that those stations can charge vehicles quickly. A full charge at a standard charging station can take a whopping eight hours. This lengthy charging time can cause "range anxiety" for drivers and lead to congestion at charging stations. To overcome these issues, public institutions need to get creative and develop new solutions that can speed up the charging process and alleviate concerns about charging availability. This will involve finding the right balance of charging stations with sufficient power in strategic locations.

One potential solution to the challenges is to re-purpose existing petrol stations. These stations are already conveniently distributed throughout the road network, making them easily accessible to electric vehicle drivers. Public authorities can support and motivate this re-purposing by providing financial incentives to petrol station owners who convert their facilities to charging stations. For example, governments could offer tax breaks or grants to help cover the conversion costs. Public authorities could also work with petrol station owners to develop a plan for the conversion and provide guidance on how to properly install and maintain charging equipment. In addition, governments could launch public awareness campaigns to educate the public about the benefits of electric vehicles and the availability of charging stations at re-purposed petrol stations.

### 9.4.2 ELECTRIC GRID LOAD MANAGEMENT

As we work towards a more sustainable future, it's essential that we use the power infrastructure we have built up over the years with care. This becomes particularly important as the number of electric vehicles on the road increases and demand for power spikes in certain areas. To manage these demands, one needs to be smart about load management.

Example solutions for managing the increased demand for power are the following:

+ Smart charging systems can be used to control the charging of electric vehicles based on real-time data about power demand and supply. This can help smooth out demand spikes and optimize the use of power resources.

- + Energy storage systems, such as batteries, can store excess power during low demand and release it during peak times. This can help smooth out demand and improve the stability of the power grid.
- + Demand response programs can incentivize customers to reduce their power usage during times of high demand by offering financial rewards or other incentives.
- + Vehicle-to-grid (V2G) technology could allow electric vehicle owners to plug in their cars and use them to help balance local power networks. They are rewarded for providing this service, and advanced control systems ensure their vehicle batteries are not overly depleted.
- + Microgrids, which are small-scale power networks that can operate independently of the primary grid, can be used to help manage local demand and increase the resilience of the overall power system.

# CONCLUSION

Achieving business success and maintaining a competitive edge in the rapidly evolving mobility sector would certainly not be easy. To help with this quest, this study concludes with the top competencies identified to be of essential importance for companies and public institutions.

To begin with, the ability of companies to adopt and use the ecosystem mindset in their dayto-day business decisions is of high importance. If successfully adopted, this would result in building a network of interconnected services and products that create new sources of revenue, increase customer loyalty, and drive innovation.

Business model agility is also crucial, enabling companies to swiftly adapt and optimize their models in response to market shifts. Furthermore, digitalization would be a key element for companies and institutions to keep pace with the technological advancements transforming the mobility industry. Whether it is upgrading existing IT infrastructure or investing in new road infrastructure, corporate and public entities shall be able to embrace digitalization to deliver cutting-edge solutions to their customers.

Complexity management across technical, process, and organizational domains is a critical capability as well. By effectively managing complexity, companies would be able to improve their efficiency and deliver better, more reliable products and services to customers.

The ability to efficiently leverage the vast amount of data generated by modern vehicles and smart road infrastructure can also bring an entity ahead of the others.

Among other things, by harnessing the power of data, companies and public institutions can make informed decisions, improve operations, and deliver a personalized experience to customers.

Companies must also have a strong emphasis on customer centricity, putting the needs and preferences of their customers at the forefront of their operations. Such an approach would require a company culture that prioritizes the customer experience, as well as a mindset that is focused on delivering the highest possible quality for customers.

Lastly, companies must prioritize environmental sustainability, taking into account the impact of their products and services on the environment and working towards meeting global emission reduction goals. This requires a commitment to "green" products and services.



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## CONTACT PERSON PER INDUSTRY

### Automotive

Stefan Wachter +43 664 6276856 Stefan.Wachter@msg-plaut.com

### Banking

Alexandra Kury +43 664 807 407 14 Alexandra.Kury@msg-plaut.com

#### Insurance

Markus Krassnig +43 664 80740188 Markus.Krassnig@msg-plaut.com

### Public

Andreas Aschauer +43 664 80740138 Andreas.Aschauer@msg-plaut.com

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© msg Plaut Austria GmbH Modecenterstraße 17/Unit 4/6.0G, 1110 Vienna msg-plaut.com | office.at@msg-plaut.com

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