THE AUTOMOTIVE DIGITAL TRANSFORMATION AND THE ECONOMIC IMPACTS OF LIMITED DATA ACCESS

EUROPEAN BUREAU

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Preface

This research paper is a collaboration between the management consultancies QUANTALYSE and Schönenberger Advisory Services. It is a study written upon request from Fédération Internationale de l'Automobile - Europe, the Middle East and Africa (FIA Region I).

The purpose of this work is to provide an update of our previous assessment of the economic impact of vehicle data access models on the European automotive aftermarket over the short to mid-term. A consumer survey; analysis of aftermarket insights and of technological and legislative trends; more than 10 interviews with experts and senior executives; and quantitative modelling experience serve as the foundation for findings presented in this paper.

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Nomenclature

2FA	Two factor Authorization
AAO	Android Automotive OS
ADAS	Advanced driver-assistance systems
AI	Artificial Intelligence
API	Application programming interfaces
AR	Authorized Repairers
AWS	Amazon Web Services
BEV	Battery Electric Vehicles
BER	Block Exemption Regulation
CAGR	Compound Annual Growth Rate
CSMS	Cybersecurity Management System
DCU	Domain Control Unit
DGVW	Design gross vehicle weight
ECU	Electronic Control Unit
E/E	Electric/electronic
ESP	Electronic Stability Programme
EV	Electric Vehicle
FOSS	Free and Open-Source Software
FNOL	First Notification of Loss
GAS	Google Automotive Services
GDP	Gross domestic product
GW	Wireless Gateway
HMI	Human Machine Interface
IAM	Independent Aftermarket
ICE	Internal Combustion Engines
IT	Information Technology
MAM	Maximum authorised mass
MEB	Modularer E-Antriebsbaukasten/Modular electric drive matrix
ML	Machine Learning
OBD/OBD2	On-board diagnostics, first and second generation
OEM	Original Equipment Manufacturer
OES	Original Equipment Supplier
QS	Quantum computing
ROM	Read-Only memory
RMI	Repair & Maintenance Information
R&D	Research & Development
SCA	Strong Customer Authentication
SDV	Software-defined vehicle
SME	Small and Medium-sized Enterprises
SMR	Service, Maintenance & Repair
SPAC	Special Purpose Acquisition Company
SOC	Security Operations Centre
TCU	Telematics Control Unit
TSP	Telematics Service Provider
UBI	Usage Based Insurance
UI	User Interface
VSOC	Vehicle Security Operations Centre

Executive Summary

The European aftermarket constitutes a major segment within the automotive value chain, providing maintenance, support, and enhancements for vehicles in operation. With approximately 360 million passenger and light commercial vehicles owned by consumers and businesses, the European aftermarket generates annual revenues exceeding €280 billion.

The automotive landscape in Europe underwent significant transformations in line with global automotive trends. These shifts encompass vehicles' technological advancement, including their intricate systems, communication capabilities, and data-generation capacities. Furthermore, there has been an increase in connected car technology, a growing adoption of electric vehicles (EVs), intensified competition from China, the emergence of novel mobility services, and disruptions to supply and demand patterns caused by the COVID-19 pandemic.

The repercussions of the pandemic, coupled with global supply chain disruptions and associated inflationary pressures, significantly impacted the expansion of the broader automotive and mobility value chain. A tangible reduction in consumer spending power, a progressively ageing vehicle park, and connectivity levels that have not met initial expectations led to a temporary decline in the demand for repair and maintenance services. Concurrently, there has been a shift in consumer preferences, with hyperscalers increasingly dominating the connected and software-defined vehicle realm.

Furthermore, our previous study anticipated that the European vehicle fleet connectivity would match the non-connected portion by 2020, with a projection of reaching 70% by 2025. However, these expected levels of connectivity have not materialized as anticipated. Achieving parity between connected and unconnected vehicles in Europe is now foreseen to occur shortly after 2025. This delay in connectivity progress can be attributed to various factors, including the disruptive effects of COVID-19 and supply chain challenges. Additionally, the relatively slow growth of OBD2-based dongle hardware usage has played a role, as it was initially expected to increase by 24% annually in Europe from 2016 to 2023.

This study assessed the positions of key (independent) players within the value chain, considering the significant market, technological, competitive, and consumer shifts described earlier. It underscores how the delicate balance that has been maintained for years among OEMs, the independent aftermarket, and retailers is now gradually eroding.

Amid the transition from internal combustion engines (ICEs) to electric vehicles (EVs) and from a hardware-centric to a software-centric focus, vehicle manufacturers are increasingly moving away from the OBD2 interface. This interface has traditionally been the primary method for independent, direct, real-time, and cost-free access to in-vehicle data, allowing for services by third parties like multi-brand data aggregation and diagnostics tools. Instead, manufacturers have started to control OBD2 data access (and implicitly the services of third parties) through gateways and are shifting their attention towards data-driven business models, which are made accessible to independent operators through off-board data access points. Tech giants have also solidified their presence in the realm of connected vehicles, exemplified by Apple's CarPlay and Google Android Automotive, continually enhancing their ecosystems and thus expanding their market shares within the vehicle data economy.

The provision of in-vehicle data by OEMs to independent operators on the OEMs' terms is characterised by significant shortcomings. These include insufficient data quality, granularity, and availability; lack of real-time data; inconsistencies between different OEMs (in terms of data format and structure, consent management process, connected platform architectures, etc.); absence of an opportunity to interact with the driver in real-time; as well as inconsistent and cumbersome pricing schemes.

Independent third parties are grappling with the challenge of establishing sustainable business models that offer a reasonable cost-to-benefit ratio. This struggle arises from the limitations associated with accessing in-vehicle data through OEM-controlled servers. As a result, they face difficulties in effectively delivering services and deriving commercial advantages from in-vehicle applications. The drive for innovation among telematics and data platform start-ups has waned, primarily because many have shifted their focus away from OBD2-data-based business models. Instead, they are exploring alternative opportunities, such as gaining access to EVs charging infrastructure, recognising these opportunities as more viable and lucrative in the evolving automotive landscape.

This study analyses the current state of European regulation on data access in the automotive sector, highlighting the continued gaps and limitations of the existing regulatory framework, which has only been changed incrementally since our first report.

A consumer market survey conducted across 11 EU countries highlights their preferences and perceptions regarding vehicle servicing, maintenance, and in-vehicle data. The findings reveal that a significant portion of European citizens still prefer independent workshops for their vehicle maintenance, primarily driven by their sensitivity to pricing factors. Interestingly, the survey highlights that most consumers do not yet own connected cars, with half of them lacking awareness about connectivity features and telematics. When consumers are educated about vehicle connectivity and presented with an option, 6 out of 10 become deeply engaged: factors such as content, management, portability between providers, and provider choice emerge as pivotal considerations that can influence their vehicle choice.

Concluding the research, this study quantifies the competitive edge held by OEMs in the aftermarket sector. This advantage persists in the absence of regulatory measures aimed at rectifying the privileged position that vehicle manufacturers currently hold. Our assessment involves a quantitative analysis of the most prevalent use cases of aftermarket vehicle expenditures. In these instances, both consumers and independent businesses incur tangible financial losses at the bottom line:

- Loss in service, maintenance, and repair due to wear-and-tear, by means of charging independents and consumers for data, biased lead generation at prognostics, and warranty issues.
- Loss in repair parts/services for insured random events, by means of superior pricing ability, optimal risk selection through advanced usage-based analytics, and upselling OEM parts/services.
- Loss in value for operational leasing fleets, by means of unrealized savings, unrealized innovation, biased lead generation in new business, and redundant aftermarket telematics hard/software.
- Loss in intermediation fees in optional add-ons aftermarket, by means of the platform monopoly in the infotainment hard/software.
- Loss due to anti-competitive advantages based on one-sided monitoring of data traffic of independents on the OEM-owned platform and preferential treatment of OEM services.

A data modelling analysis reveals a shift, with a moderate 3% of the total aftermarket value moving to the OEM network in 2023. The anticipated strong growth of this shift was dampened by the pandemic and supply chain disruptions, limiting adoption of advanced OEM telematics particularly to the

premium vehicle segment. As we project ahead to 2030, the growth trend is expected to intensify again, resulting in a negative revenue impact of 9% for that year. This will equate to an annual loss of €26 billion, ultimately affecting both consumers and the broader aftermarket ecosystem. Independent service providers are struggling with the challenge of retaining their customer base, with some experiencing client stickiness or even lock-in with OEMs. This trend coincides with rising consumer prices, a reduction in innovation, and a limited array of choices as competition progressively diminishes.

Looking further ahead to 2050, a critical transformation is expected to conclude, with all vehicles anticipated to be fully advanced connected. That shift is estimated to culminate in potential annual losses of around €95 billion. Restrictions on data and driver access constitute significant barriers within the automotive aftermarket, resulting in restricted consumer options, reduced competition, and stifled innovation.

Independent Aftermarket Loss Impact [€Bn/y]	2023	2030	2040	2050
advanced connected	7%	15%	60%	100%
Service, maintenance, and repair due to wear-and-tear	3	8	23	36
Insurance anticompetitive pricing, repair parts/services	1	3	11	18
Operational leasing unrealized gains and conversion	4	10	12	12
In Vehicle Infotainment fees on luxury segment	0.5	1	3	5
Non-public insight and preferential treatment	2	4	14	24
TOTAL	**10**	**26**	**63**	**95**

Estimated -annual- economic impacts for independents and consumers in case the regulatory framework fails to enforce equal access to data generated by the driver and communication through the HMI.

However, we conclude that it is entirely feasible to reverse the anticipated scenario by establishing a robust, regulated, and competitive environment that can nurture innovation and ultimately yield benefits for both consumers and businesses. This transformation can be realised through the implementation of three pivotal principles into regulation: Accessibility, Portability, and Compatibility (APC). An *ex-ante* regulatory response can facilitate this transformation by:

- Enabling fair data read/write and driver access, ensuring a level playing field for all stakeholders, promoting fair competition, and preventing monopolistic control.

- Granting motorists the right to choose their preferred Telematics Service Provider (TSP), empowering consumers with the autonomy to select the TSP that hosts their vehicle data, thereby enhancing consumer control and choice.

- Engaging OEMs, tech players, consumers, and independents in collaborative standardization efforts, fostering transparency and inclusivity, enabling diverse stakeholders to collectively shape standardised practices that benefit the entire ecosystem.

1 Introduction

Our previous study[1], "*The automotive digital transformation and the economic impacts of existing data access models*", published in 2019, aimed to provide a comprehensive overview of the automotive industry with a focus on the aftermarket and prevailing technological trends at that time.

Many fundamental developments have been described in principle in the previous study, and numerous reports on current and future developments have since been published (e.g. [2], [3]) and submitted to the EU Commission in the course of the public consultation on the (stalled) call for evidence on "*Access to vehicle data, functions and resources*" in 2022[4]. As such, we will focus only on the most relevant changes and developments in the field since 2019.

In this study we rely upon mainstream business and academic literature, as well as publicly available and well-known frameworks of the automotive aftermarket.

1.1 Background

Since the turn of the century, the European automotive sector has undergone numerous EU Regulation and regulatory amendments. These measures have been instrumental in safeguarding consumers against monopolistic or oligopolistic developments, particularly in terms of open access for independent players compared to vehicle manufacturers.

The EU Commission fosters competition by establishing a level playing field for all players in the vehicle sales aftermarket. This sector complements the original equipment automotive manufacturing market by ensuring the continued operation of vehicles post-production. Effective competition not only enhances the consumer's position but also reduces costs for European citizens and enables innovation, both in terms of engineering and data analytics.

Resulting from substantial innovation in the past decade, telematics and related services have been deployed in the automotive sector. The introduction of telecommunications-based data transmission and digital processing of vehicle information has led to modern vehicles becoming increasingly 'connected'. This is achieved by incorporating send/receive capabilities, advanced sensors, and providing networking and internet access to passengers.

However, stakeholders active within the automotive aftermarket now confront considerable uncertainty and are encountering a growing lack of a level playing field regarding open and fair access to in-vehicle data. This regulatory vacuum has led vehicle manufacturers to lay claim to the exclusive right of providing telematics platforms. This approach, known as the 'Extended Vehicle' or 'Neutral Server' approach, has been introduced as a response to this situation.

[1] Quantalyse Belgium, Schönenberger Advisory Services, (2019) "The automotive digital transformation and the economic impacts of existing data access models", Technical Report.

[2] D. Brown, M. Flickenschild, C. Mazzi, A. Gasparotti, Z. Panagiotidou, J. Dingemanse And S. Bratzel, for the Policy Department for Economic, Scientific and Quality of Life Policies, Directorate-General for Internal Policies, The Future of the EU Automotive Sector, report, October 2021

[3] D. Gill, The Data Act Proposal and the Problem of Access to In-Vehicle Data and Resources, SSRN paper, May 2022

[4] European Commission, *Access to vehicle data, functions and resources*, published initiatives, 2022.

1.2 Purpose

This issue of fair and equal access to (in-)vehicle data has been subject to a longstanding debate spanning a variety of European legislative initiatives, such as the Block Exemption Regulation (BER), the Type Approval regulation, the eCall legislation and, in 2018, the European Commission's Communication on automated and connected cars.

Several consumer and aftermarket stakeholder organizations have repeatedly urged the Commission to propose a binding legislative solution on open-access, secure, and transparent networks for connected cars, as well as in-vehicle data, driver interface, and communication access.

As the Commission's lack of clarity has left independent service providers without equal data access rights, this study aims to investigate the potential consequences of limiting data access to embedded connected vehicles on both independent operators and consumers.

Specifically, the study seeks to address five key areas: (i) assessing the value of the aftermarket from a consumer standpoint; (ii) outlining recent prominent developments and forthcoming challenges; (iii) describing the legal issues surrounding data access; (iv) presenting the consumer perspective on the topic; and (v) providing estimations of the potential economic impact resulting from unregulated in-vehicle data access.

Furthermore, along with consumer feedback, the study's findings strongly underscore that in the absence of proactive intervention by the European Commission, the independents' access to in-vehicle data is at risk of being discontinued. To summarise, the key supporting points for this argument include:

- Findings derived from formal interviews with AFCAR members, all unanimously requesting legislation.
- Conclusions drawn from the Commission's internal studies and feedback collected through the Call for Evidence regarding access to vehicle data, functions, and resources.
- Insights gathered from informal interviews with market players who emphasise the need for fair and relevant standards across all vehicle brands and types.
- Input gathered from informal interviews with start-ups that depend on fair data access.
- Lessons learned from other industries, highlighting the benefits of open systems.
- Lessons taken from the US, where even tech giants have begun advocating for increased regulation.
- Conclusions from reputable research institutions that advocate for legislative action and standardization.
- Growing momentum in favour of open data, the right to repair, and data self-sovereignty.
- Increasing consumer awareness about the data economy.

The study's primary objective is to offer a comprehensive outlook of the existing level of asymmetry and challenges in the aftermarket, which arises from OEMs asserting exceptionalism, all while the automotive industry transitions into the era of the Internet of Things (IoT).

2 The European aftermarket

This section describes the most relevant changes in the European automotive aftermarket since 2019. For an introductory and detailed description of its structure, the automotive value chain, vehicle types and segments, key players, and a quantitative characterization of the European car park, please refer to the appendix of this report.

2.1 Changes in the value chain

Since the publication of our last report, the automotive value chain in Europe has undergone significant changes (Figure 1), reflecting global automotive trends of an increasing adoption of electric vehicles (EVs), the rise of new mobility services, advancements in technology as well as disturbed supply and demand patterns caused by COVID-19.

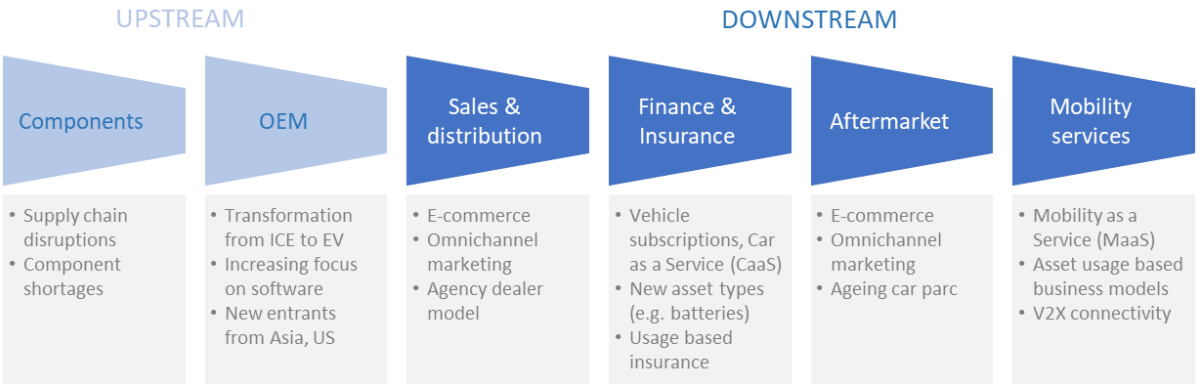

Figure 1: Recent changes in automotive value chain.

Some of the notable changes include:

- Supply Chain Disruptions: Like the rest of the world, Europe has been impacted by supply chain disruptions caused by closures of operations due to the COVID-19 pandemic. This has led to changes in production and sourcing strategies, with a focus on building more resilient and flexible supply chains.

- New Mobility Services: Europe has been a hub for the development of new mobility services, particularly in urban areas. These services, such as shared mobility and micro-mobility, have created new business models and revenue streams for incumbent companies and startups.

- Electric Vehicles: Europe has been at the forefront of the transition to electric mobility, with several countries and cities setting ambitious targets for the phase-out of gasoline and diesel-powered vehicles and many OEMs following suit with ambitious BEV transition plans. This has led to significant investments in EV production and the necessary infrastructure and has created new opportunities for suppliers and service providers.

- Increased competition from Asia: While European OEMs have taken up the transition to EV at varying degrees, some US-American, most Asian, i.e., Chinese and South Korean OEMs have fully embraced the transition and have started to challenge their European counterparts for market share in their domestic markets with the expectation that Europe might turn from a car exporting market to a net importer of cars within the next five years.[5]

- Technology Advancements:
  - Advanced Driver Assistance Systems (ADAS): European OEMs and their suppliers have been a leader in the development of ADAS offering increased levels of automation and safety.
  - Improved Connectivity Features: Features such as infotainment systems, smartphone integration, and voice commands are becoming more advanced, offering seamless integration with mobile devices, and providing real-time information and services to drivers.
  - Vehicle-to-everything (V2X) Communication: V2X communication is an important part of vehicle connectivity, allowing vehicles to communicate with other vehicles, infrastructure, and the cloud. In Europe, we have seen significant investments in V2X communication infrastructure, such as roadside units and 5G networks, which enable new safety and mobility services.
  - Over-the-Air (OTA) Updates: OTA updates have become increasingly common in the automotive industry, allowing automakers to remotely update software and firmware in vehicles. This technology enables automakers to improve vehicle performance, fix software bugs, and add new features without requiring the vehicle to be taken to a dealership.
  - Data Management and Security: With the increased connectivity in vehicles comes the need for improved data management and security. Automakers have been working to implement cybersecurity measures, secure data systems, such as blockchain technology, and to ensure that data collected from vehicles is handled responsibly and in compliance with data privacy regulations.

- Regulatory Changes: The European Union has introduced several regulatory changes that have impacted the automotive industry such as the EU general data protection regulation (GDPR) in 2018, the Green Deal presented in 2021 with the "Fit for 55" package of several legislations with the objective to reduce net emissions by at least 55% (compared to 1990) by 2030 and to achieve climate neutrality by 2050, as well as proposed stricter Euro 7 emissions standards (cfr. chapter 4).

2.2 A complex structure

The structure of main channels largely remained as described by McKinsey in 2017[6] and BCG/CLEPA in 2021[7] who added a few changes - intermediary parties have now appeared also between wholesalers and workshops, see Figure 2. In addition to new intermediaries, who often use digital

[5] Pwc strategy&, Electric Vehicle Sales Review Q4 2022, February 2023

[6] The changing aftermarket game – and how automotive suppliers can benefit from arising opportunities, McKinsey, June 2017

[7] BCG, CLEPA, Wolk, At the Crossroads: The European Aftermarket in 2030, report, March 2021.

platforms, we consider the subscription or as-a-service proposition as a new and growing intermediary standing between repairers and customers with emerging mobility portals, car sharing or vehicle subscription providers.

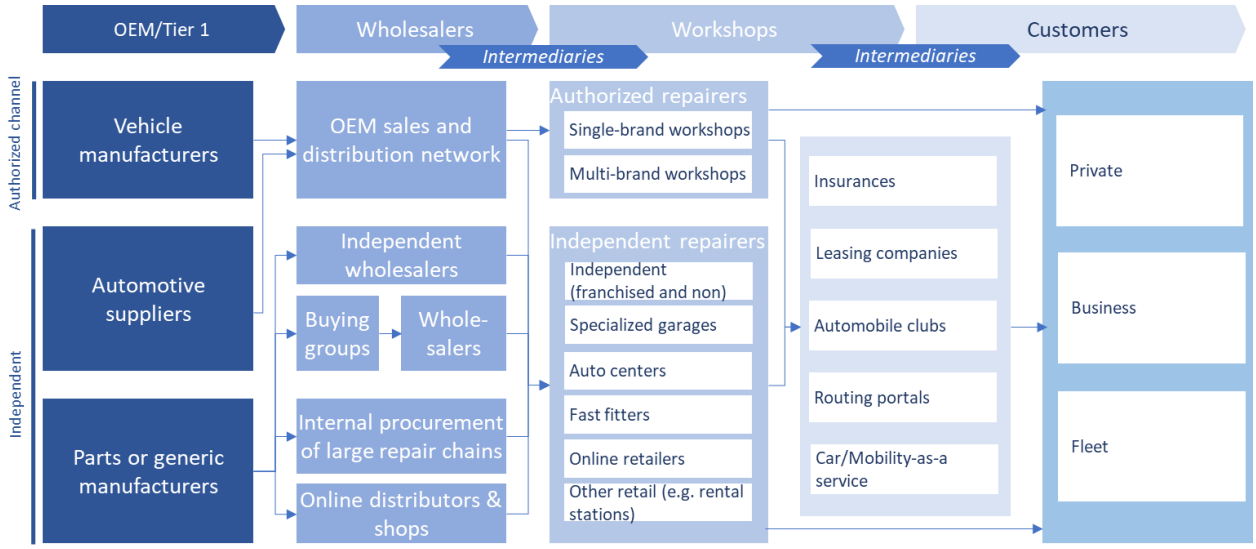

Figure 2: Structure of the European automotive aftermarket and key stakeholder groups, adapted from BCG[8]

2.3 OEM and IAM in equilibrium

The market is divided between what is known as the incumbent captives (also termed authorized repairers, AR) and independent players. In our last study, we assumed an equilibrium existed between the share of the aftermarket captured by IAM and OEM captive garages/authorized repairers at 50:50 as a pan-European average (parts and labour revenues combined). The share between both groups has been relatively stable over the past decade with COVID-19 causing a slight shift towards the independent segment.

The ongoing technological developments like electrification, advanced driver-assistance systems (ADAS) and the increasing dominance of software in addition to ever improving and connected hardware will lead to additional market shifts between AR and IAM. The views amongst established strategy consulting firms on which market group will gain shares in the coming decade differs. BCG expects the OEM segment to regain market share even under the scenario of not being granted exclusive access to vehicle data.[9] For Roland Berger, the shift could move either towards IAM or OEM, depending on the assumed scenario.[10] And McKinsey expects a shift towards IAM driven by new sales models and fleet servicing.[11]

[8] Ibid.

[9] BCG, CLEPA, Wolk, At the Crossroads: The European Aftermarket in 2030, report, March 2021.

[10] Electrification Of Light Vehicles - Boon or bane for the European aftermarket, CLEPA & Roland Berger for FIGIEFA, study, December 2022

[11] Ready for inspection – the automotive aftermarket in 2030, McKinsey, report, June 2018.

At the retail level, the forecasted annual growth rates have been reduced since our last study from 4.6% to 2.9% per annum with an expected volume increase from €110 billion in 2020 to €150 billion in 2030.[12]

Since 2010, the consolidation of both OEM captive and independent repairer outlets has continued driven by the need for efficiencies and increasing overhead costs due to high OEM standards and more complex vehicle diagnostics technologies. The number of outlets of the OEM captive mechanical repair outlets has consolidated faster than those of the independent repairers (see Figure 3).

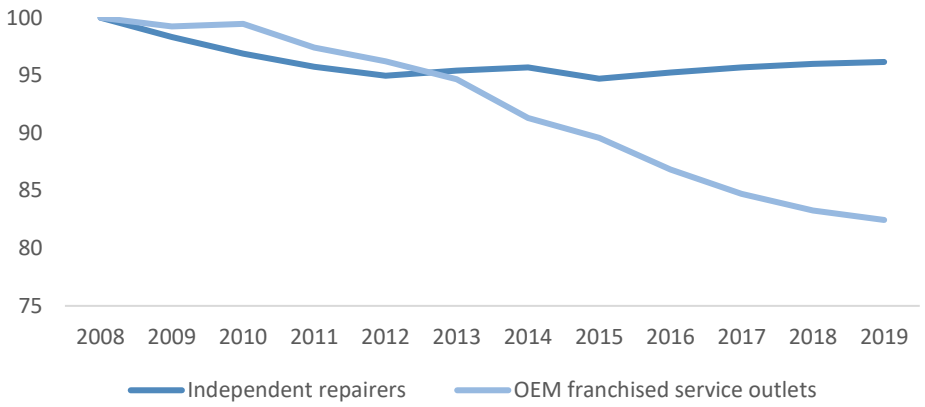

Figure 3: Mechanical repair outlets, indexed from 2008[13]

In recent years, OEMs have continued to focus on the aftermarket and developed commercial tools such as loyalty programs, extended warranties, service bundles to create consumer stickiness and extend their presence beyond the vehicle age segment of 0-3 years. On the other hand, independent garages have benefitted from increased price sensitivities of consumers and a good geographic coverage. At the time of the last study, the OEM/IAM balance in the aftermarket was fully intact, which is a feature of a well-functioning competitive environment. This balance is increasingly at risk caused by significant shifts in revenue and profit pools, not only between OEMs and IAM players but also towards new digital/tech entrants.

2.4 Financial services in the aftermarket

The financial services market is an entire industry of its own, but it overlaps with the automotive aftermarket for a segment of services like motor insurance, operational/full-service leasing or hire purchase and car subscriptions.

The automotive financial services players are divided into three types[14]: OEM captives 30%, Banks/insurers 40%, and Fleet Management Companies (FMC) together with specialized providers

[12] McKinsey, Die Online-Revolution im Kfz-Aftermarket, analysis, July 2021

[13] ICDP, ECDH 2019, OEM-franchised service outlets across 38 European markets, Independent repairers in France, Germany, Italy, UK, Spain

[14] Embracing the Car-as-a-Service model – The European leasing and fleet management market, Market Report, 2018.

(e.g. mobility players, telematics manufacturers and telcos) 30%. Banks and FMCs/multi-brand players together are considered as IAM segment. Figure 4 provides a general illustration of the market player types.

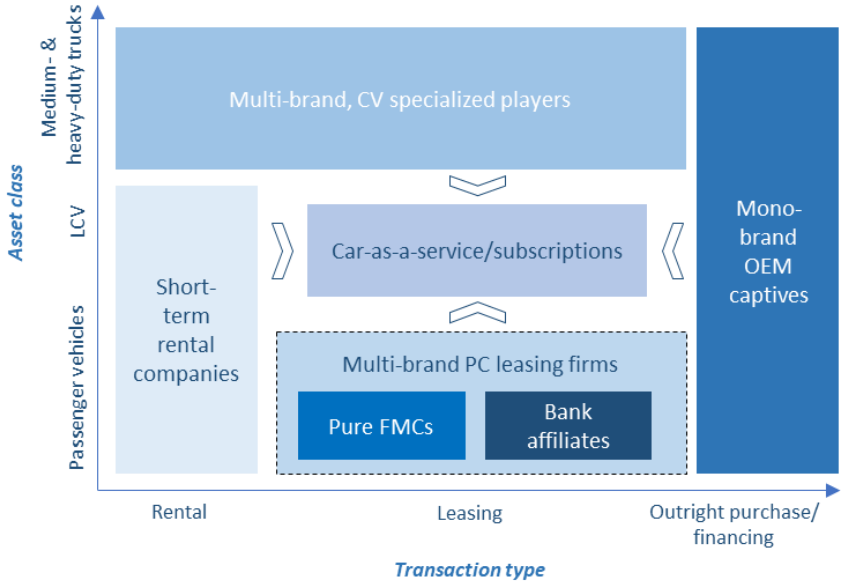

Figure 4: Market shares and types of leasing players. Adapted from Roland Berger

Most OEMs have setup captive insurance and financial services companies to cater to their needs[15] (e.g., VW Financial Services, BMW Financial Services, Stellantis Financial Services, Mercedes-Benz Versicherung AG). These OEM captive activities are generating around one third of the profits of OEMs[16], which they source exclusively downstream, and are thus very important. On the other hand, the success of captives is tied intimately to the success of the OEMs core products, i.e., the vehicles. For example, when it comes to the insurance service line, there is a major likelihood that the insurance is sold to the driver at the same time the new car is purchased, often denoted as cross-selling[17], as it can be perceived as service of convenience. Research as shown that this bundling of insurance (and other services) with the purchase is of tremendous value, especially for the millennium generation that wants a seamless experience.

In a recent EY-Parthenon consumer survey[18], 40% of respondents said they would *prefer* buying auto insurance at the point of sale versus from traditional agents. Given that circa 60% favours usage-based insurance (UBI), there is a margin of 24% (=40%*60%) of buyers' potential. This range is confirmed by the fact that in the US, Tesla[19], is reporting an average insurance purchase rate at point of contract of 17%.

Annual new insurance business in the European region is about 20 million vehicles annually, which represents about 5% of the total insured car park. The maximum exposure to bundling therefore

[15] Innovating for future growth, automotive assurance products' strategy, PWC, report, 2013.

[16] Deloitte, Future of Captives- What will be the core businesses for Automotive Captives in 2030, article, 2018.

[17] Cross-selling does not stop at motor insurance, but can also extend to warranty extension, maintenance programs, credit, mobility services, parking services, or simply other insurance types, e-bike, house or health, whether at point of sale, or during the lifetime of the vehicle. For this study focuses on the automotive aftermarket, such contributions are ignored.

[18] EY-Parthenon survey, How auto insurers can grow as a decade of disruption approaches, article, February 2023.

[19] Tesla online insurance, increasing coverage in US states, article, 2023

corresponds to €9 billion of gross written of €175 billion premium at point of sale in Europe, of which €2 billion can be potentially converted. Given that a 10% response rate[20] is a minimum, one may expect at least €1 billion in premium that is effortlessly obtained thanks to the sheer ownership of the point of sale. This is indeed a baseline result, as motor insurance by OEM captives ranges[21] between 10% and 20% of gross written premium.

However, there are big differences per country in the penetration of OEM captive insurance. Some OEM captives do not aim for vertical integration and rely on third parties and white label partnerships: e.g., Santander is a bank that cooperates closely with some car manufacturers like KIA, Mazda, Volvo, and Infinity. A possible reason are the increasing regulatory requirements of the insurance sector[22].

On the other hand, by most of the consultants, the latest technological developments such as digitalization, connectivity of vehicles, and autonomous driving, embedded insurance is seen as an area with major disruptive potential[23]. Tesla, Rivian, and Toyota launched an in-app usage-based insurance product in 2021, and many are expected to follow suit.

2.5 Car park connectivity

A connected car can be understood as a vehicle enhanced with wireless telematics technology, such that it can communicate bidirectionally with other systems outside of the car. For example, the vehicle can use dedicated short- or long-range communication technology via the telecom GSM networks to achieve internet connectivity. The information transferred includes data of (i) vehicle components (e.g., battery status, motor temperature, diagnostic data, error codes), (ii) driver (e.g., audio/video dialogues, driving style, speed) and (iii) environment (e.g., coordinates, traffic, dashcam), which can be stored in network storage points (e.g., servers in the cloud). Vehicles that do not come with embedded connectivity can be connected by retrofit solutions such as second-generation on-board diagnostics (OBD2) dongles or smart phones.

At the time of our previous study, the connectivity level of the European car park was still expected to be at par with the non-connected share of the fleet by 2020 and to represent 70% of the car park by 2025. These connectivity levels have so far not materialized and parity between connected and unconnected vehicles in Europe is now expected to be achieved just after 2025. Possible reasons are the COVID-19 and supply chain consequences but also a relatively slow increase of OBD2-based dongle hardware usage, which in 2016 was still predicted to grow at 24% p.a. in Europe for 2016-2023.[24]

[20] Direct Marketing Association, Response Rate Report: Performance and Cost Metrics Across Direct Media, report, 2018. House mail response rate of 9%, social media 1%, and online ads about 0.3%. It is reasonable to assume the response rate at vehicle purchase to is at least larger than house mail. Mckinsey expects embedded insurance to reach a response rate of 30% by 2030 at point of sale, but we remain conservative at 10%. This is a distribution channel advantage, that we not consider further in the evaluation of the data limitations impact.

[21] Automotive Finance Study 2016, The European Market And Its Future Challenges, Nextcontinent

[22] Deloitte, Future of Captives- What will be the core businesses for Automotive Captives in 2030, article, 2018

[23] "The Future of Auto Insurance: Connected, Embedded & Subscribed" from Insurance Evolution Partners, study, April 2022

[24] Frost, OBD II-based Dongle Sales to Double in the Next 5 Years in North America and Europe, article, 2018

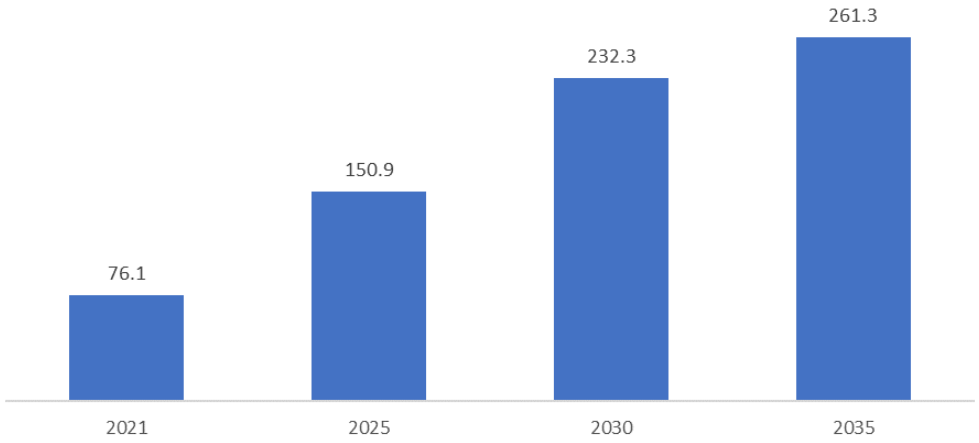

Figure 5: Connected cars in million in Europe, 2021-35[25]

The connectivity levels of fleets operated by commercial operators, leasing or rental car providers are usually higher than those of private vehicles and are expected to continue to grow faster than the private segment. This is because these fleet operators tend to employ newer vehicles and equip their fleet more consistently with telematics devices. The telematics penetration rate across the car rental fleets in Europe and North America is expected to grow from 38 percent in 2021 to 86 percent in 2026.[26]

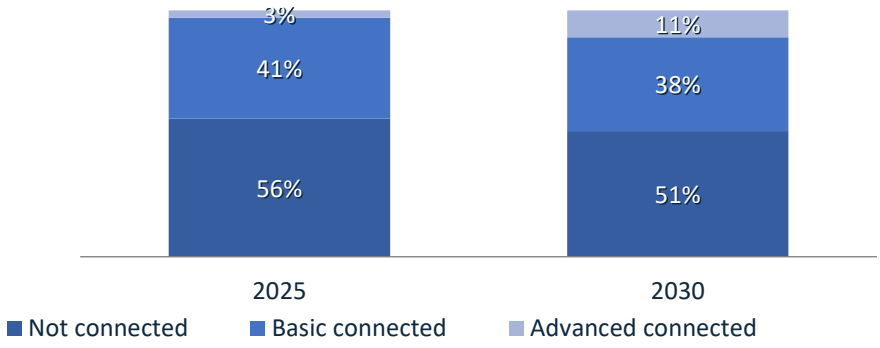

Figure 6a: Connected car market penetration in Europe in 2025 and 2030[27]

There are unconnected, basic, or medium connected and advanced connected types of telematics. In this study we focus upon the advanced connectivity, meaning the OEM embedded cellular connected vehicles with a fully integrated data and computing processing unit, that allow for advanced data

[25] PwC; Statista; Strategy, Connected cars in Europe, 2020, ID 1155517

[26] Berg Insight, The rental and leasing car telematics market is expected to grow at a CAGR of 17.6 percent in the next 5 years, article, 2023

[27] BCG, CLEPA, Wolk, At the Crossroads: The European Aftermarket in 2030, report, March 2021.

collection and real-time communication. It is the access to this rich data and this deep vehicle level of access that is also at stake in the industry. It does not include any aftermarket telematics devices.

According to Berg Insights, embedded OEM telematics are growing with a CAGR (compound annual growth rate) of 16% per year, having in 2022 about 202 million subscribers[28], which implies for the European region about 14% of the car park in the European region, of which half have advanced telematics, so we assume that:

*in 2023 about **7%** of the car parc is equipped with advanced OEM embedded telematics*

According to McKinsey research, in 2022 circa 50% of the new cars produced by OEMs are connected, and this attach rate reaches 95% by 2030[29]. Given that half of those is advanced connected, about 19% of the whole car park will thus be connected via OEM embedded telematics by 2030 in the European region. The BCG study is more sceptic and projects by 2030 about 11% of the car park to be equipped with advanced type telematics. For this study, we will therefore adopt the average, namely:

*In 2030 about **15%** of the car parc is equipped with advanced OEM embedded telematics*

This implies our study assumes a modest CAGR of 10% (about a doubling every 7 years thus). Likely this pace will increase, but we remain conservative with an embedding close to 100% in Europe circa 2050.

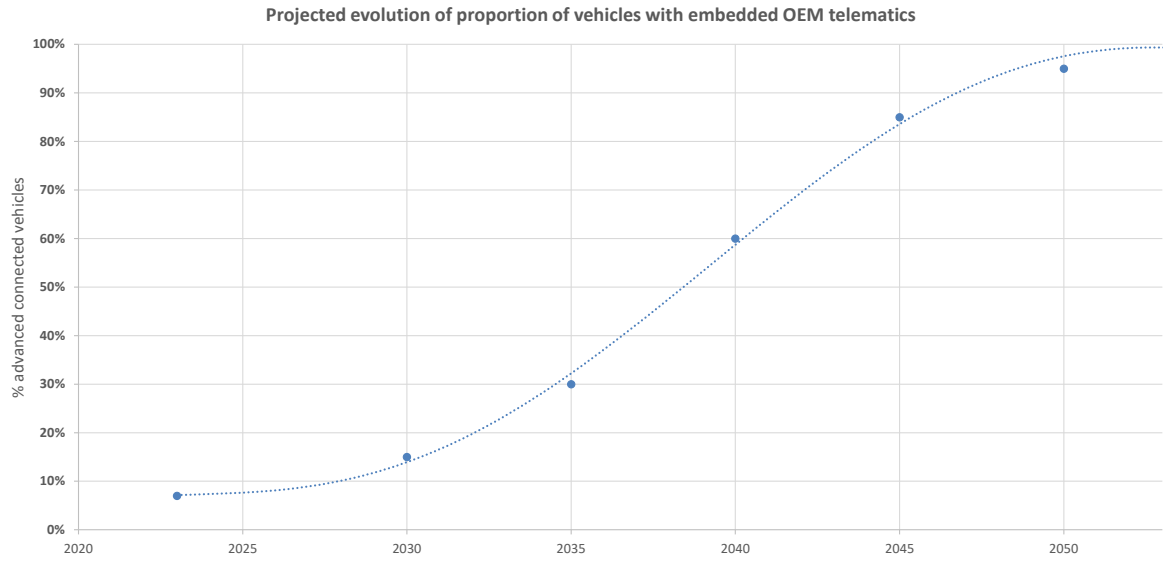

Figure 6b: Advanced connected car market penetration in Europe, assuming a conservative ±10% CAGR.

We expect rather telematics attach rates rather high in the premium segment throughout the twenties, trickling down only near 2030, due to various looming economic depressing forces, like low BEV incentives, geopolitical decoupling, stagflation, recession. This baseline forecast of Figure 6b of telematics penetration will be used further in this study, to make projections about economic impacts.

[28] Berg insight, Embedded car OEM telematics subscribers exceeded 200 million in 2022, article, June 2023

[29] McKinsey, Unlocking the full life-cycle value from connected-car data, article, 2021.

2.6 New business

New vehicle sales have experienced a significant drop in 2020 due to the COVID-19 pandemic and resulting supply chain squeezes. Experts estimate the total loss of vehicles during 2020–2022 to amount to 10 million vehicles in Europe.

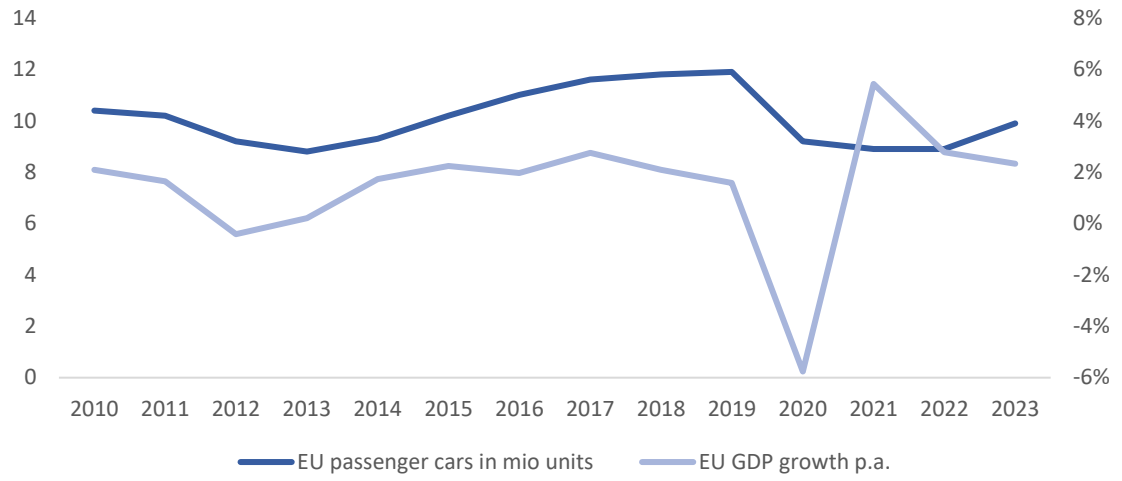

Figure 7: New passenger car registrations and GDP growth in the EU 2010-2023[30]

While the economic outlook continues to be uncertain, institutions such as ACEA, Dataforce or S&P Global agree that new vehicle sales are expected to improve as of 2023, while the degree of expected improvement varies. However, pre-pandemic levels of new car production and sales levels are not expected to be reached again before 2028.

New vehicle sales give an indication of the health of the automotive economy overall, but the size of the car park is more relevant for the aftermarket as these services are provided during the various lifespans of a vehicle where a life usually begins and ends with a change of the owner of the car.

Depending on the primary purpose of a vehicle, i.e., private use or use as a (commercial) fleet vehicle, the first life can last between several months and several years. We estimate that on average a European car has 4 to 5 owners. Every owner, be it a commercial fleet owner or a private person, has specific requirements and preferences for an aftermarket services provider. Generally, the older the vehicle is, the more likely it is being serviced in the Independent Aftermarket (IAM), and the larger the fleet owner is, the more focus is being put on Total Cost of Ownership (TCO).[31]

New vehicles sales in Europe are dominated by European OEMs who hold more than two thirds of the market share.

[30] ACEA, DG ECFIN, IHS Markit

[31] Ageing Car park in Europe Paves Way for the Evolution of OEM and Independent Aftermarket (IAM) Relationship, Frost & Sullivan, article, December 2016

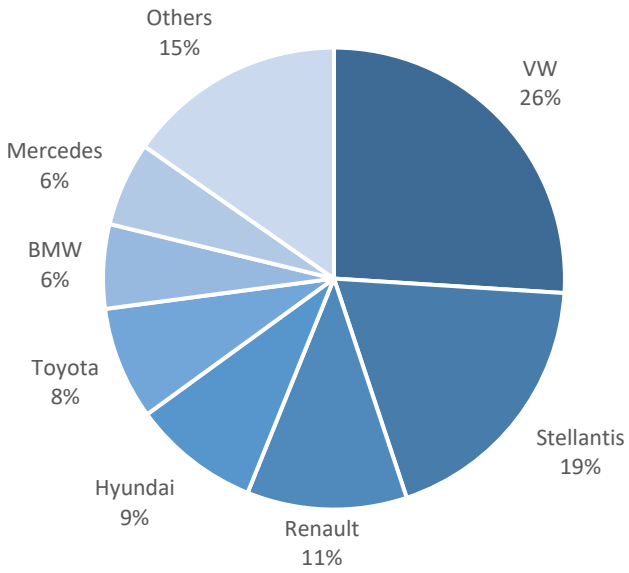

Figure 8: Share in passenger vehicles sales February 2023 ytd. In EU - mass producers holding ca.3/4 of the market[32]

Offering add-on services helps to mitigate the cyclical nature of selling vehicles and provides a more stable revenue stream. While premium OEMs such as BMW and Mercedes as well as software defined car producers like Tesla have advanced in offering embedded connectivity and subscription services, mainstream OEMs are following suit and connected services will see further adoption into entry level models. The largest automotive groups in Europe (see figure 9) have announced ambitious margins and revenue expectations for software and services-based offerings in 2030, e.g.

- Stellantis - €23 billion, software
- Renault - 20% of revenue, data, mobility, energy services
- Volkswagen - €1.2 trillion in revenues from software and mobility services[33][34]

In 2022, record-high operating margins have been achieved, which provides OEMs with a solid basis for investments into a phase of expected lower demand in new vehicles. Add-on features and services are believed to generate margins exceeding 70%.

The transformation of OEMs and Tier 1 and 2 suppliers from hardware to software producers, or at least towards a mixture of both is characterizing the industry and the seamless connectivity of motorists inside and outside their cars, is one of the main technological trends. Many OEMs and Tier 1 suppliers have started to build connectivity platforms such as ZF ProConnect for connecting vehicles with the cloud and with the traffic infrastructure. Other significant technological developments include the reorientation from ICE vehicles towards EV and most notably BEV as well the constant rise of the degrees of autonomous vehicles towards Levels 3 and 4 now. Globally, the US American Tesla and the Chinese OEM BYD are dominating new BEV sales with only one European OEM in the Top 5, see Figure 9.

[32] ACEA

[33] S&P global, AutoTechInsight's Talking Heads Series: Key themes for 2023, blog article, 2023

[34] The Economist, The race to reinvent the car industry, article, 2022

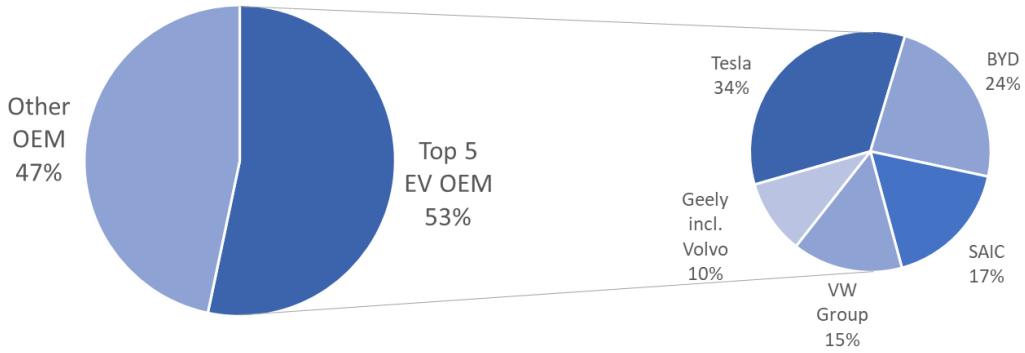

Figure 9: Top Five Global BEV producers by share, 2022[35]

2.7 Total Value

From a more quantitative perspective, the automotive value chain comprises of the cumulative value over one year of every company's revenue for its intermediation in the vehicle lifecycle after sales point.

The total sum of those revenues in a year represents a market volume, a useful metric to assess size and growth. In general, the aftermarket size in literature is defined as the total of annual gross worth of direct and indirect sales generated by the automotive aftermarket industry per year. Gross income is the total income recorded before any taxes and expenses are deducted. There are also other metrics e.g., job count, profit, value added, but the revenue metric is most prevalent in automotive literature and moreover it has the advantage that it allows for a meaningful comparison with other industries.

The *European* aftermarket itself represents[36] about 30% of the global worldwide aftermarket. According to ACEA, the turnover of the European automotive industry[37] was €1,115 billion in 2019, representing 7.6% of the region's GDP. This is about €880 billion for the EU and €235 billion for non-EU, so roughly a quarter of the sector's overall revenue is generated outside the EU bloc.

According to a recent EU study[38], the automotive sector generates a turnover that represents over 7% of the EU GDP, which totalled around €936 billion in 2020. Non-EU follows suit with about €250 billion, which brings the total automotive industry size in 2020 at €1.200 billion for the European region. The aftermarket is about one fifth, thus circa €240 million valued in 2020.

In 2022, the European aftermarket value amounted to €243 billion, and it consists of revenues for parts (ca. 54%, including chemicals) and labour (ca. 46%)[39]. This volume only slightly diverges from the value we assumed as the basis for our previous report, which was €242 billion in 2017[40], which can largely be contributed to a dip caused by COVID-19 and supply chain disruptions during 2020/21.

[35] EV-volumes.com, created with Datawrapper

[36] Ready for Inspection – The Automotive Aftermarket in 2030, McKinsey & Company, report, June 2018.

[37] ACEA 2022/2023 pocket guide

[38] Policy Department for Economic, Scientific and Quality of Life Policies , The Future of the EU Automotive Sector, study, 2021

[39] Aftermarket perspective and latest observations, FIGIEFA conference 2023, McKinsey & Company, February 2023

[40] Ready for Inspection – The Automotive Aftermarket in 2030, McKinsey & Company, report, June 2018.

In a different portrayal (namely excl. VAT) of the European aftermarket value (see Figure 10), the total volume was estimated at €175 billion in 2020, which confirms the COVID-19 dip as volumes were at €195 billion in 2019 and would have been estimated to reach €203 billion in 2020 if COVID-19 would not have occurred.

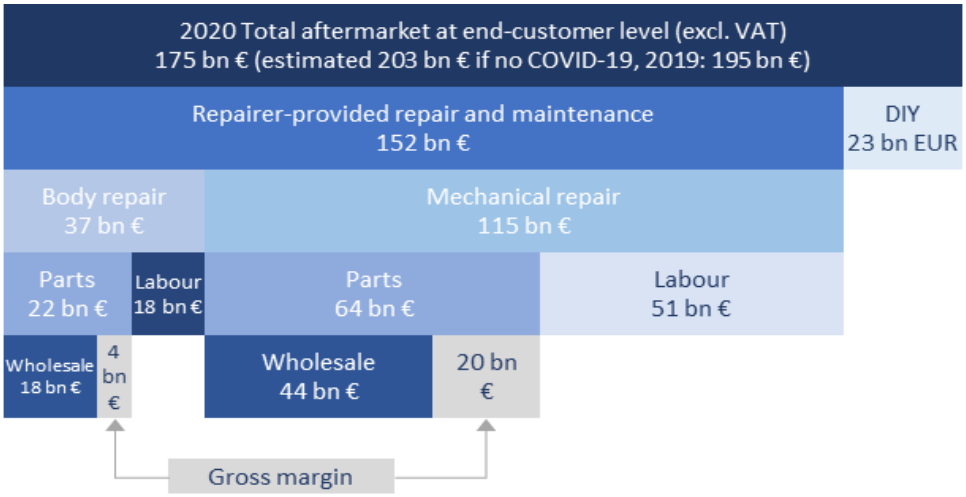

Figure 10: Value of the European automotive aftermarket in 2020[41]

The IMF estimate for 2023 for European GDP comes in at €20 trillion[42]. Assuming prudently that no more than 7% is generated by the automotive sector, then automotive industry value stands today around €1.400 billion. The aftermarket is about one fifth, thus circa **€280 billion**: this is the baseline figure that is being used for 2023 in this study.

When compared to other heavy industries, the aftermarket may not seem so large on an annual basis. However, when viewed from the perspective of the motorist, and considering accrued cash flow value stream over the 12 years lifetime of a vehicle in Europe, then only 40% stems from the sale price, while 60% is spent in the aftermarket[43]. The relative importance of the aftermarket thus depends on the eye of the beholder.

2.8 Latest aftermarket challenges

Since the time of our first study, the European aftermarket has seen tremendous challenges but has by and large kept its structure as shown in Figure 2. However, ongoing developments have started to cause shifts in business models, profit pools and sales channels. Some of the most relevant topics are these:

[41] ICDP

[42] International Monetary Fund. International Monetary Fund. Retrieved 12 April 2023. We have left out Russia, accounting for about 13%.

[43] The Aftermarket in the Automotive Industry: How to Optimize Aftermarket Performance in Established and Emerging Markets, Capgemini Consulting, University of St. Gallen, report, 2010

- Rise in raw materials prices – During 2021/22 prices for wholesale electricity have surged and during the peak in Summer 2022 they reached up to 4 to 5 times compared to 2020 levels in some European Countries. Other raw material prices impacting the automotive aftermarket were aluminium, the price of which tripled between 2020 and 2022, steel and rubber, the prices of which doubled in that period. By now, prices have been coming down to pre-pandemic levels, but uncertainties remain. The European Court of Auditors as recently assessed that "access to raw materials remains a major roadblock, along with rising costs and fierce global competition[44].
- Shipping/logistics bottlenecks – Between 2020 and 2023, costs for shipping goods as indicated by the Shanghai containerized freight rate for example, oscillated and quintupled caused by the COVID-19 pandemic and subsequent zero-lockdown in China. By now, prices have returned to pre-pandemic levels.
- E-commerce/online-to-offline – The proliferation of online sales has increased, moving from the B2C into the B2B segment. Pure e-commerce players have made visible inroads, e.g., vehicle spare parts provider AutoDoc (set up in 2008) has developed into a leading European player who cracked the €1 billion turnover mark in 2022 benefitting from its price competitiveness compared to established wholesale channels (see Figure 11). The customer purchasing journey has largely been digitalized and online processes and channels have been integrated with offline ones.

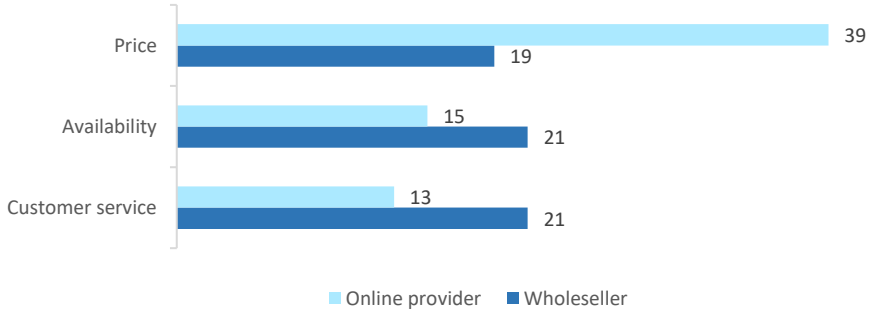

Figure 11: Unique selling propositions (USPs) Wholesale vs Online aftermarket (in %)[45]

- Rise in SUVs – Over the past decade, the SUV segment has gained considerable market share in Europe's car park, which has been accompanied with the use of larger, more expensive parts and components. This increase in value is also reflected in the aftermarket which benefited from this trend.
- Shrinking repair and maintenance demand– less mileages driven in connection with home office and sustainability considerations, longer durability of components, extended warranties periods by non-European OEMs have caused the frequency of maintenance and repair events per car and year to sink.
- Change in service requirements of BEV vs ICE – The rise in EVs is expected to result in different service intervals (e.g., increased wear of tyres, reduced wear of brakes) and less components than with ICE resulting in ca. 50% less visits for service and maintenance per vehicle (see Figure

[44] European Court of auditors, Special report 15/2023, "The EU's industrial policy on batteries: new strategic impetus needed"

[45] McKinsey, Die Online-Revolution im Kfz-Aftermarket, report, July 2022

12). On the other hand, new opportunities such as ADAS calibrating services offer new income opportunities.

	Brakes	Tyres	HVAC	Suspension	Engine, air and oil filter	Spark plugs	Oxygen sensors	Fuel manage-ment	Timing and drive belts	Engine coolant	Battery coolant
ICE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	×
PHEV/ HEV	✓-	✓+	✓	✓	✓	✓	✓	✓	✓	✓	✓
BEV	✓-	✓+	✓	✓	×	×	×	×	×	×	✓

✓ Required service × No service required

Figure 12: Service requirements for ICEs vs EVs[46]

- New service chain brands focusing on EV – incumbent aftermarket players have started to set up service chains that focus purely on EVs, e.g., Alliance Automotive Group (AAC) with NexDrive
- Partnerships of tier 1 suppliers with new EV and battery aftermarket players – While OEMs have increasingly been outsourcing traditional activities to tier 1 suppliers, many of the tier 1 suppliers have started to extend their aftermarket activities forming new partnerships, e.g., Bridgestone (e.g., Pitstop, Speedy) to offer aftersales for Fisker in Germany, and France or CATL and ZF joining forces to optimize aftermarket service in e-mobility and energy storage.
- Consolidation of aftermarket players – during the past years, the consolidation of aftermarket players has accelerated. One very active example is the IAM parts distributor Alliance Automotive Group (AAC), the European subsidiary of the US-American Genuine Parts Group, which has acquired 20+ entities over the past three years in Europe, e.g., Lausan Group in Spain, Knoll in Germany, and several entities in the UK, Ireland, France, Belgium, The Netherlands. While the US is leading the consolidation with the top 10 IAM distributors accounting for 75-80% of market share, Europe is following suit. Here, the top 10 IAM distributors represent 30-35% of the market.[47]
- Car dealer network consolidation and shift to agency model – with the advance of EVs, many European and American OEMs have started to shift their distribution model towards a form of the agency model, where the commercial, credit and residual value risks of selling a vehicle stay with the OEM and not the dealer in exchange for a fixed fee or a combination of a fixed and variable compensation by the OEM. This shift is expected to result in a reduction of authorized dealers and an inflow of former authorized dealers and workshops into the IAM causing a sharp increase in competition. In addition, we have seen an increasing number of dealer takeovers in recent months. In Germany alone it is expected that the number of dealers will reduce by 24%-64% by 2040, depending on the scenario. At the same time, the number of non-franchised dealers and workshops will ultimately reduce by 25%-70% by 2040.[48]

[46] Roland Berger, The Automotive Aftermarket in 2035, April 2022

[47] Roland Berger, The Automotive Aftermarket in 2035, April 2022

[48] Institut für Automobilwirtschaft (IfA), Beschäftigungseffekte im Kfz-Gewerbe 2030/2040, studie, January 2023

3 Vehicle technology trends

The most important trends in the automotive industry include the shift towards electric and autonomous vehicles, increased connectivity, flexibility and digitalization, an increased focus beyond the vehicle on auxiliary services, and the adoption of sustainable and environmentally friendly manufacturing processes.

Over the past years, the focus of OEMs and suppliers has continued to markedly shift away from traditional topics such as vehicle lightweighting to new powertrain technologies, autonomous software and hardware, connected vehicle technologies and other advanced computing (Figure 13).

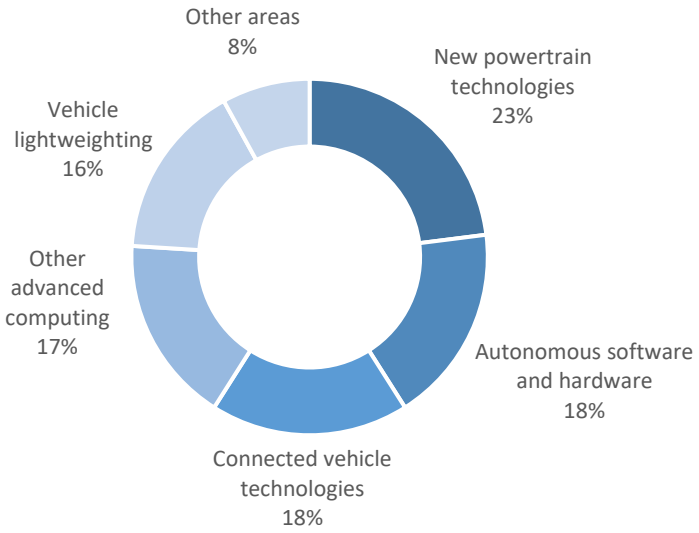

Figure 13: Allocation of additional R&D funding in the vehicle technologies (global average based on survey respondents)[49]

3.1 Vehicle architecture – Software defined vehicle (SDV)

Traditionally, cars were built to perform mechanical functions such as steering, accelerating, and braking. However, the development of SDV is transforming the automobile industry by incorporating advanced software systems that can control and coordinate various functions of the vehicle, such as infotainment, driver assistance, and connectivity, among others. This has led to the creation of sophisticated and complex electric/electronic (E/E) architectures that can adapt to changing requirements and enable new capabilities in modern vehicles.

[49] KPMG Global Automotive Executive Survey 2023

	E/E Patterns	User Experience	Updatability	Connectivity	S/W Architecture
Vehicle 1.0 Functional	Zonal	Personalized	Vehicle Software Updates	5G with Edge	Edge Container Runtime
	Functional Domains	Connected IVI	Firmware Updates	Multi-Channel	Service-Oriented Architecture
	Functional Bandwidth	Smartphone Integration	Phone App Updates	4G Cockpit	S/W Apps
	Multi-CAN	Static IVI	No Updates	None or eCall only	Tightly Coupled
Vehicle 2.0 Digital	Zonal	Personalized	Vehicle Software Updates	5G with Edge	Edge Container Runtime
	Functional Domains	Connected IVI	Firmware Updates	Multi-Channel	Service-Oriented Architecture
	Functional Bandwidth	Smartphone Integration	Phone App Updates	4G Cockpit	S/W Apps
	Multi-CAN	Static IVI	No Updates	None or eCall only	Tightly Coupled
Vehicle 3.0 Updateable	Zonal	Personalized	Vehicle Software Updates	5G with Edge	Edge Container Runtime
	Functional Domains	Connected IVI	Firmware Updates	Multi-Channel	Service-Oriented Architecture
	Functional Bandwidth	Smartphone Integration	Phone App Updates	4G Cockpit	S/W Apps
	Multi-CAN	Static IVI	No Updates	None or eCall only	Tightly Coupled
Vehicle 4.0 Software-Defined	Zonal	Personalized	Vehicle Software Updates	5G with Edge	Edge Container Runtime
	Functional Domains	Connected IVI	Firmware Updates	Multi-Channel	Service-Oriented Architecture
	Functional Bandwidth	Smartphone Integration	Phone App Updates	4G Cockpit	S/W Apps
	Multi-CAN	Static IVI	No Updates	None or eCall only	Tightly Coupled

Figure 14: Software-defined Vehicles - Levels to Principles[50]

Most existing cars have a distributed E/E architecture and there are several, in some cases up to 100 ECUs in the vehicle, one for every function, such as braking, steering, windows, seats, door locks etc. This is also called a distributed architecture and it is characterized by significant wiring harnesses. With the advent of the SDV as technically convincingly demonstrated by BEV pioneer Tesla, the E/E architecture of vehicles has started to change from a distributed architecture via the stage of a domain architecture with ECUs grouped by function (e.g., functional domains for ADAS, chassis, brakes, HMI) ultimately to a zonal architecture where ECUs are grouped by their location in zones inside the vehicle (see Figure 15). The zonal E/E architecture is the latest technical E/E evolution that leverages a high-performance central gateway allowing for faster communication (lower latency, faster response times) between multiple ECUs, and reducing proximity between ECU thus saving space and vehicle weight, improving processor speed, and optimizing power distribution inside the car. While domain architectures are point-to-pint, rigid and expensive, zonal architectures are networked, intelligent, secure, and scalable and thus significantly more efficient.

[50] SBD Automotive, The Software-defined Vehicle, report, July 2021

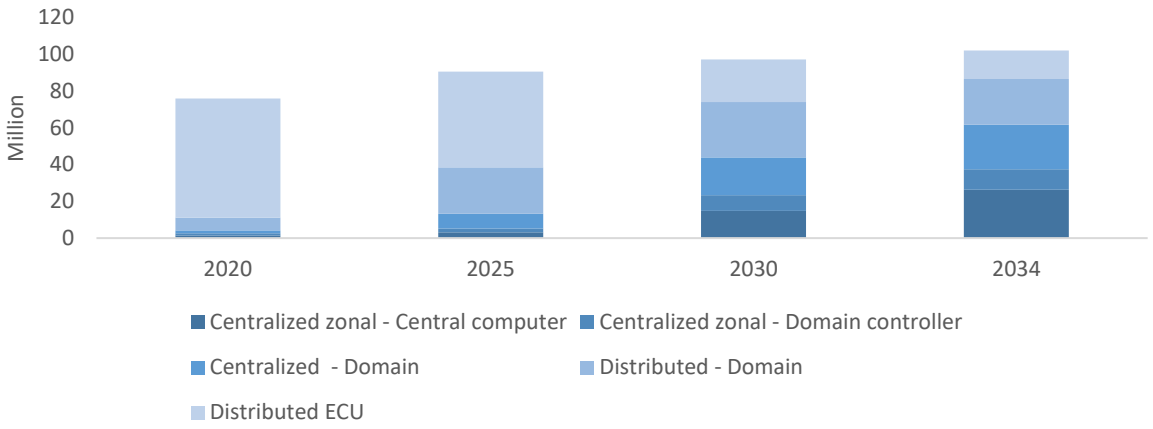

Figure 15: Light vehicle production forecast by E/E architecture, 2020-2034[51]

In 2022, about 2 percent of produced vehicles had a zonal architecture and by 2034 the share is expected to increase to 38 percent, driven by the accelerating penetration of BEV and autonomous vehicles where OEMs will apply a fresh, advanced zonal architecture rather than a legacy system and where lighter weight through less cables and wiring is relevant for battery performance.[52] Incumbent OEMs are expected to be lagging in this development due to their legacy systems, e.g. the VW MEB is today still domain centric, but most have started to move towards a zonal architecture already. Tesla was the first mover in this field, Chinese and other US American brands are faster followers than European OEMs (see Figure 16).

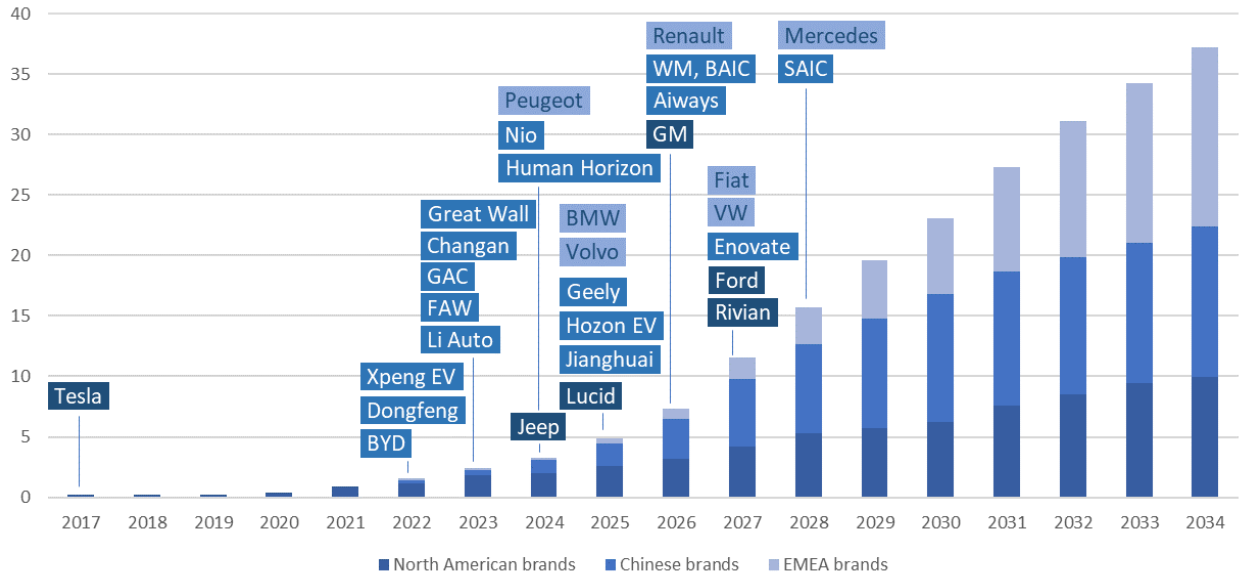

Figure 16: Adoption of zonal E/E platforms by region of brand[53]

[51] S&P Global Mobility, E/E Architecture Platforms Forecast, article, January 2023

[52] S&P Global Mobility Blog, Richard Dixon, 10 February 2023

[53] S&P Mobility Global, EE Architecture Platforms Forecast, January 2023

The control over the vehicle architecture enables OEMs to exert control over access to vehicle data and feature consolidation in the cockpit leads to the cockpit becoming an ever more important Human Machine Interface (HMI). In addition, smart materials, and interior designs to control functions such as the infotainment system, seats, windows, and appearance of the vehicle means that the control over the vehicle design allows OEMs as well to control access to vehicle data. While the term SDV is an abstract term, it is important to consider that an SDV can adapt to changing customer needs during its lifetime and thus changes the concept of vehicle lifecycles as known from conventional cars by providing substantially more intervention and interaction opportunities for the data controller. The speed of developing new features will be measured in days rather than years while existing cars can be updated in their functionalities during their lifetime.

There is an increasing trend of cooperation in this field, such as AUTOSAR (AUTomotive Open System Architecture), which is a global development partnership of automobile manufacturers, suppliers, and other companies in the electronics, semiconductor, and software industries founded in 2003.

3.2 Tech giants in automotive

Apple, Amazon, Google, and other tech giants are increasingly interested in the automotive industry and are investing heavily in research and development of autonomous vehicles, electric cars, and other automotive technologies.[54] While they have yet to launch a production line ready vehicle, they are collaborating with traditional OEMs and suppliers to bring their expertise in software, artificial intelligence, cloud, and other areas to the automotive space. Typically, OEMs define a different kind of cooperation strategy in areas such as infotainment, vehicle and comfort functions, driving and charging, and autonomous driving. In infotainment, the earliest stage of vehicle operating systems as displayed in Figure 17, most OEMs have decided to cooperate with tech giants such as Google.

While the strategy of OEMs towards the degree of cooperation with tech giants from the software and consumer electronics industries differs, most OEMs cooperate with them to varying degrees. Some established OEMs (e.g., VW, Mercedes, GM, Toyota, Hyundai) have tried to develop their own operating systems in addition to collaborating with tech giants on specific topics. Others are fully integrating with tech giants (e.g., Ford/Google, Volvo/Google). In addition, tech players are entering the market with their own vehicles (Apple Car) or cooperating with incumbent OEMs to enter the market (Sony/Honda). Many new entrants rely on their own operating system for their BEV (e.g., Nio, Rivian).

Figure 17: Evolution of vehicle operating systems

[54] CB Insights, The Big Tech in Auto & Mobility Report- How Google, Amazon, Microsoft, and Apple are betting on automotive and transportation, article, November 2022

OEMs pursue different operating system strategies in the automotive industry ranging from a basic auto OS, custom-made auto OS, read-only memory (ROM) auto OS to applying super auto applications. Basic auto OS refers to basic auto operating systems such as AliOS, QNX, Linux, including all basic components such as system kernel, underlying drivers, and virtual machine. Custom-made auto OS is developed and tailored based on the basic operating system (together with OEMs and Tier-1 suppliers) to eventually realize a cockpit system platform or an automated driving system platform, such as Baidu In-Car OS and VW.OS. ROM auto OS is a customer-specific development based on Android (or Linux) instead of changing the system kernel. MIUI is the typical system applied in mobile phones, while Benz, BMW, NIO, XPeng, and CHJ Automotive often prefer the development of ROM auto OS. In addition to these OS approaches, all OEMs offer the opportunity to connect a smart phone and mirror it via the infotainment system of the car, e.g., CarPlay by Apple, Android Auto by Google.

Google with its open-sourced Linux kernel-based Android OS uses three approaches in vehicles: Android Auto (2014 launched, 2015 in first car model Hyundai Sonata, 2019 UI overhaul, 2023 second UI overhaul), Android Automotive OS (AAO), and Google Automotive Services (GAS). GAS was announced in 2017, is built on top of the Android Automotive OS and is sold through a licensing model to OEMs. It provides best-in-class navigation and digital assistant without end users having to connect their phone or switch between these features and the embedded system. GAS has made considerable inroads since then as Google succeeded in providing a seamless experience of all information and connectivity that is infused with the driver's identity and their digital life. Polestar was the launch vehicle for AAO with GAS and by now it has been integrated in 13 vehicle models with many more to follow. Still, not all OEMs simply integrate GAS. BMW has recently joined the group of OEMs that use GAS. However, as opposed to Volvo/Polestar who have fully integrated GAS Stellantis, who recently announced the same, BMW has taken a more cautious approach and only integrated parts of GAS thus keeping control over key customer data and the user experience. [55] On the other hand, Volvo decided in 2021 to develop its own VolvoCars.OS while still applying subsystems such as GAS, QNX, Autosar and Linux. For infotainment it continues to use Google. And yet again other OEMs such as Stellantis have started to cooperate with Amazon and their cloud services Amazon Web Services (AWS).[56]

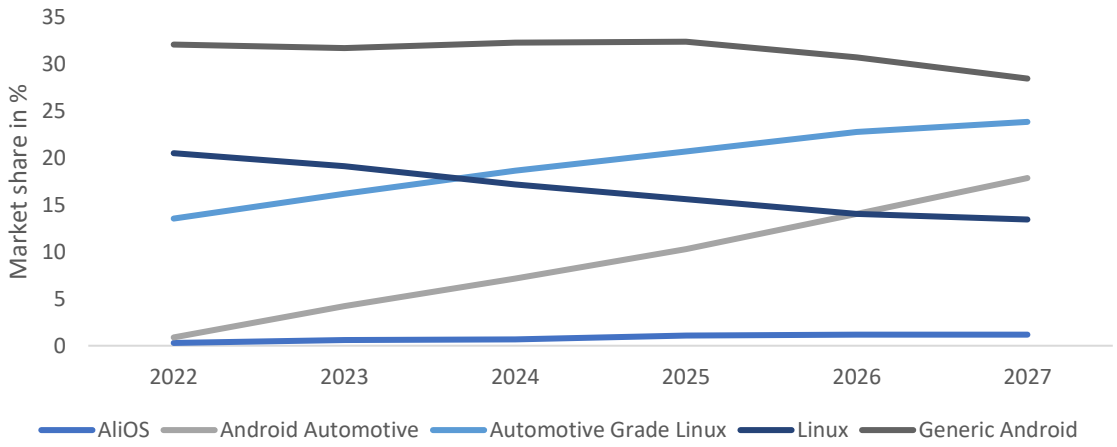

Figure 18: Predicted global evolution of vehicle head unit operating systems [57]

[55] BMW takes a guarded view of third-party apps, Automotive News Europe, 5th January 2023

[56] Stellantis holt sich Amazon ins Cockpit, Auomobilwoche, 5th January 2022

[57] IHS Markit

Already today, the market of vehicle infotainment OS is dominated by open-source Linux and Linux kernel-based Android and for both OS their specific automotive OS (Android Automotive and Automotive Grade Linux) are expected to continue that domination in the future (Figure 18).

3.3 Connected vehicles and V2X

Connected cars, also known as smart cars, are vehicles equipped with internet connectivity and various sensors that allow them to communicate with other vehicles, their drivers, owners, the cloud, infrastructure, and devices. Since 2017, virtually every vehicle manufactured has 4G communication capabilities, enhancing safety, efficiency, and user experience. End to end latency including latency in the cloud is still a challenge but continuously improving as providers aim for ensuring parity of the software stack and software in the cloud. Connectivity is an integral part of every SDV and forms the backbone for updates, information, steering, adaptation, live feedback loops from the road etc. Figure 19 outlines the different connectivity types of Vehicle-to-Everything (V2X).

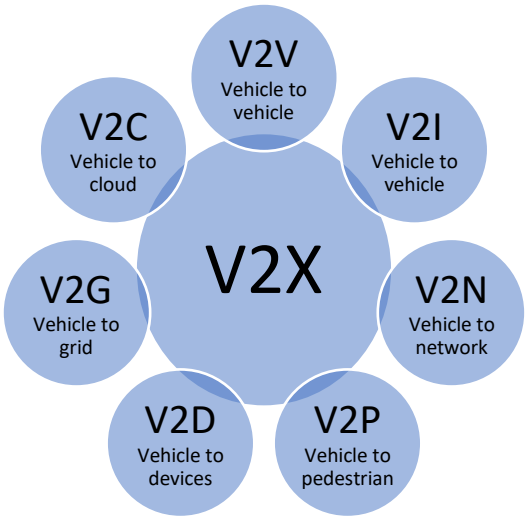

Figure 19: Overview of different types of Vehicle to Everything (V2X) connectivity

At the time of our last study, the rate at which connectivity penetration of the European car park was developing was estimated to be much higher than we observe today. Back then it was estimated that by 2025 70% of the European car park would be connected either via embedded or retrofitted (OBD2 dongle, smart phone) connectivity.[58] Today, it is expected that by 2030, 49% of the European car park will have basic or advanced connectivity.[59]

McKinsey estimates, that connected-car use cases will reach a total value of $550 billion by 2030, up by 24% p.a. from ca. $64 billion in 2020.[60]

[58] Roland Berger, Connected car App based dongle solution as shortcut to connectivity, report, September 2016

[59] BCG, CLEPA, Wolk, At the Crossroads: The European Aftermarket in 2030, report, March 2021.

[60] McKinsey, The future of automotive computing: Cloud and edge, Article, October 2022

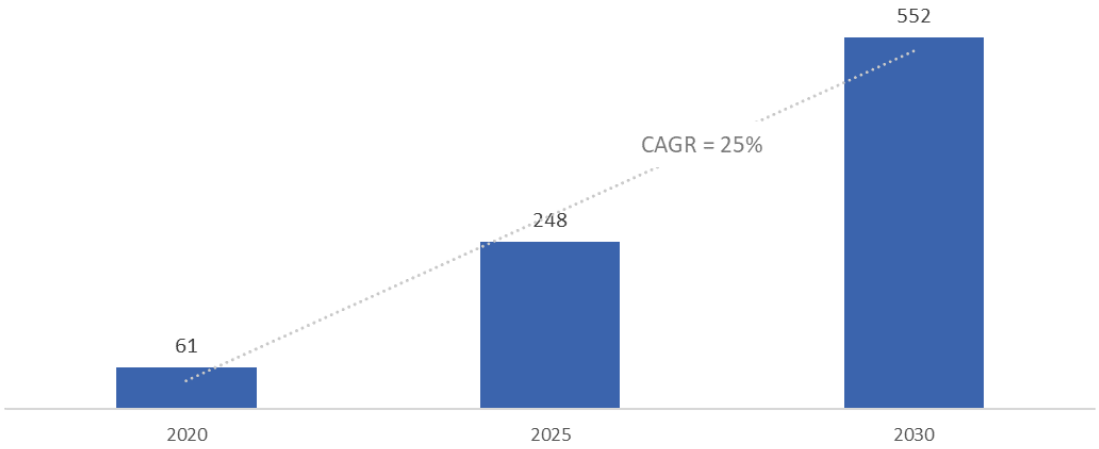

Figure 20: Forecasted global value creation in billion USD from 5G and Edge, aggressive scenario[61]

3.4 Features on demand, Over the air (OTA) updates

The frequency of updates required for car software has risen and is now comparable to those required for mobile devices. However, most vehicles still require physical visits to workshops to receive these updates. Currently, only one third of new cars have the capacity for remote wireless updates, or OTA updates.[62] OTA-capable models are most commonly available in the SUV and mid-size segments, with small and compact cars currently offering this functionality less frequently. There are also differences between manufacturers, with premium brands such as Mercedes and Jaguar offering more OTA-capable models than volume brands. The frequency of OTA updates varies by OEM from most conventionally a few times a year, two times per month in the case of Nio to multiple updates per day in the case of Cruise. They are delivered through cellular or Wi-Fi connections, often during the night when the vehicle is parked and not in use. Experts anticipate that OTA-capabilities will become increasingly common across all vehicle segments and brands.

An OTA serves OEMs like an insurance as the vehicle can be enhanced further and additional features and functionalities added. Hardware is not upgradeable, but the performance of the hardware is quickly improving thanks to SoC (system on chip) components and more memory. This will allow more frequent OTA updates that will include partial upgrades. Like in the software industry, it is essential to drive fast updates based on a centralized software and small but frequent product increments.

The example of BMW asking 18 USD per month for an additional function on demand of heated seat in the US has made the headlines and exemplifies that OEMs are still in a trial-and-error phase of finding the right balance between supply and demand for connected services. Notwithstanding this, the heated seats feature is currently being offered in Belgium, for example, for €18 per month.[63] Traditional premium OEMs have started to offer some features on demand, such as Audi connect with a camera based traffic sign recognition for €67 per year in Germany.[64] They are still struggling to make an attractive offer of additional features on demand to their customers but are constantly adapting

[61] McKinsey, The future of automotive computing: Cloud and edge, Article, October 2022

[62] Auto service Praxis, Software-Updates: Nur jeder dritte Neuwagen aktualisiert sich per Funk, Article , 2023

[63] BMW, seat heating, shop item, 2023

[64] Audi, functions on demand, website, 2023

their offering to meet customer demand by e.g. adding a “try-before-you-buy” period either for free or for €1 per month. More tech-oriented OEMs like Tesla, Nio, Xpeng achieve more traction with their customers for additional features. Even here, the uptake rate of such features is estimated to be 10 to 15% only. There is still unclarity on how to treat safety relevant features that can be added on demand as such change in features would require a new homologation of the vehicle. Beyond safety features, most add-on options, especially those affecting engine performance have an impact on the WLTP value of the vehicle. While Mercedes expects to generate revenues of ca. €1 billion by 2025 with functions on demand, experts expect the topic to still take years or even decades to become commonplace.[65]

3.5 In-car commerce – Share of screen

The development of in-car commerce has been fuelled by advancements in technology, such as mobile payments, voice assistants, and in-car infotainment systems. Infotainment has become a substantially more common vehicle component over the last years, see Figure 21.

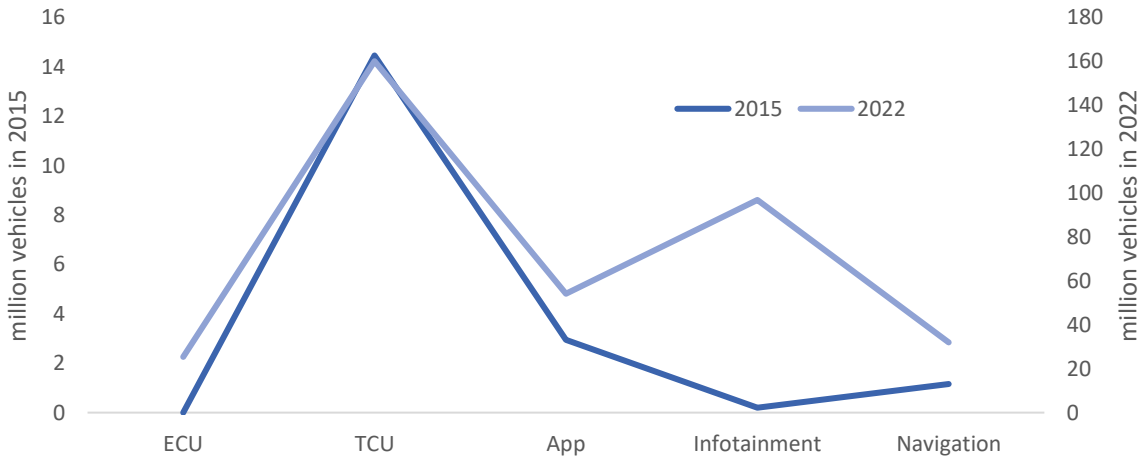

Figure 21: Electronic components in new vehicles 2015 vs 2022 showing the increase in popularity of infotainment systems[66]

One of the most notable developments of in-car commerce has been the integration of payment capabilities into vehicles. This allows drivers to pay for goods and services, such as fuel, tolls, and parking, without leaving their car. Some car manufacturers have even partnered with payment providers to offer this feature, such as Jaguar Land Rover's partnership with Shell to enable in-car payments for fuel. Another trend in in-car commerce is the integration of voice assistants, such as Amazon's Alexa and Google Assistant, which allow drivers to make purchases and place orders without taking their hands off the wheel. For example, drivers can use Alexa to order food from certain restaurants or purchase items from Amazon. Car manufacturers have also been exploring

[65] Automobilwoche, Warum der Markt mit Zusatzfeatures nicht vom Fleck kommt, article, 2023

[66] S. Halder, A. Ghosal, M. Conti, Secure over-the-air software updates in connected vehicles: A survey, paper, Computer Networks, Volume 178, 2020

opportunities to monetize the time spent in vehicles by offering entertainment and services through in-car infotainment systems. Recently, more, and larger in-car screens are appearing, both in the front and rear part of the vehicle and embedded entertainment app allow streaming of audio and video content. Adding charging and fuelling functionalities, service and maintenance, food and drinks etc. to what can be ordered and consumed in the car, it is easy to imagine why some estimate the total in-car commerce market to be worth €537 billion by 2030.[67] Within this context, tech companies have recognized the potential and started to develop specific infotainment platforms such as the recently announced cooperation between Nvidia (graphics processing units and artificial-intelligence software technology) and MediaTek (semiconductors for wireless communications) with the objective to offer more options to OEMs on Nvidia's Drive platform that is already in use by Mercedes for example.

3.6 Maintenance-free vehicles

During the transition from ICE to electric vehicles, many components and modules of a vehicle are being reengineered to gain cost and energy efficiencies. One way of doing so is to replace mechanical systems with electric ones, such as the braking system. The Japanese company Hitachi Astemo, for example, is developing a 100% brake-by-wire system to be launched in 2028. This system will no longer require brake fluids, brake pipes, brake boosters or an Electronic Stability Programme (ESP) unit.

3.7 Autonomous driving

According to McKinsey, 106 billion were spent on autonomous driving between 2010 and 2021 and only $62 billion on electrification.[68] This illustrates the importance given by the industry to autonomous driving capabilities. Whereas Europe clearly lags the developments in the US and China in terms of autonomous miles driven, European OEMs and suppliers have recognized the topic as an exciting and crucial R&D area. The partnership between Mercedes Benz and Nvidia, for example, has resulted in the first level 3 autonomous vehicle with regulatory approval in the US and expects that Level 4 handsfree driving technology is realistic before 2030.

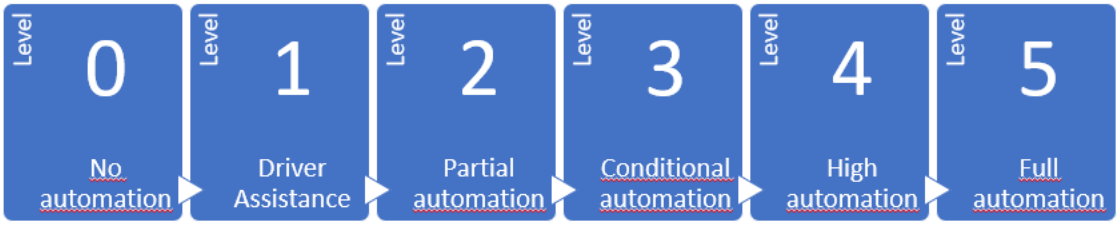

Figure 22: Levels of autonomous driving

[67] Ptolemus, The Connected Vehicle Payments Global Study, Report, 2023

[68] Automobilwoche, Solo-Player geraten ins Abseits – MHP studie , article, 2022.

Upon reaching level 4, the global market value generated by ADAS, and autonomous technology is expected to reach between 300 and 400 billion by 2030[69]. The move to autonomous vehicles brings an unprecedented change in business and operating models for all automotive players, e.g., mastering hardware and software integration, artificial intelligence, data science and dealing with competition from new tech players. In the context of this study, it is not easy to imagine a direct consumer relationship of existing third parties in the sector, unless also with autonomous vehicles a fair, reasonable, and non-discriminatory access to data is ensured.

3.8 Some general technological developments

As the automotive industry is undergoing the described transformation towards an increased software focus and ever improving hardware technology, it is helpful to consider certain general technological developments. The tech sector has most recently been undergoing a consolidation phase with advertising revenue down, shares being sold off and value reductions between 30-70%, accelerated by an increasing interest rate environment. During these distortions, some tech giants suffered more than others, with Meta dropping out of the top 20 biggest companies in terms of market value or Alibaba moving from a ranking as number 9 in the past to number 36 in 2022.

The business model of tech companies such as Apple, Google, Amazon, or Meta, is largely either advertisement based or a subscription model (Anything-as-a-service or XaaS). While those companies relying on advertisement-based income generation are highly dependent on network effects and suffer from relatively low barriers of entry, others, such as Apple and Google have formed a powerful iPhone/Android duopoly based on fees and commissions for app subscription. Their power has increased immensely by the recent end of third-party cookies and limitations on using mobile-device identifiers for ad targeting, which ultimately contributed to the value loss of Meta and others. In Europe, this duopoly has further consolidated its position compared with the timing of our last study with Google's Android holding two thirds and Apple's iOS one third of the market, see Figure 23.

In the automotive industry it is expected, that by 2028, 70% of all vehicles sold globally will have an Android Automotive operating system, up from less than 1% in 2022.[70]

[69] McKinsey, Autonomous driving's future: Convenient and connected, Article, January 2023

[70] Gartner Identifies Top Five Automotive Technology Trends for 2022, article, February 2022

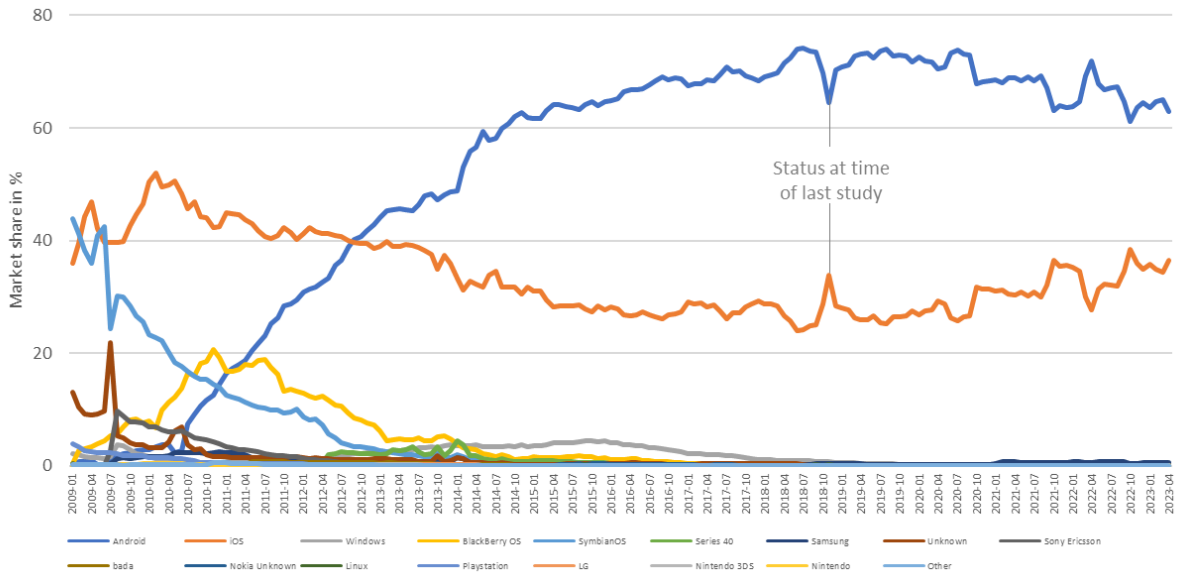

Figure 23: Mobile Operating System market share in Europe 2009-2023 showing the consolidation of a duopoly between Android (blue) and iOS (orange)[71]

The Apple/Google duo closely followed by Amazon is expected to enter the market with their own branded electric vehicles, see Figure 24. Digital giants such as Amazon Web Services (AWS), Google, Alibaba or Tencent will continue to expand their presence in the automotive systems and try to integrate the vehicle into their own ecosystems. This is posing a relevant threat to incumbent players as this new market entrance will most certainly build on the tech companies' successful market domination and customer stickiness strategies.

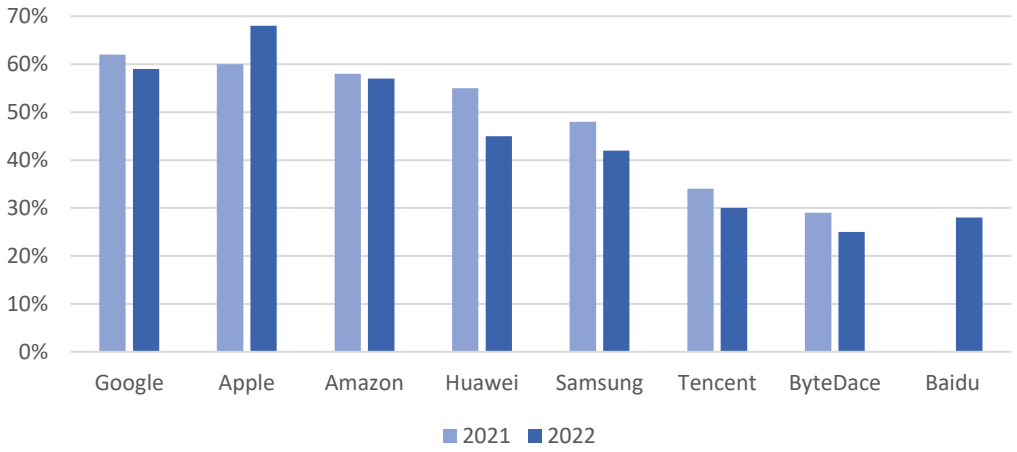

Figure 24: Do you think the following major technology companies will enter the automotive industry with their own branded vehicles? Yes answers in %.[72]

[71] Statcounter

[72] KPMG, Global Automotive Executive Survey 2023.

3.8.1 Open Source

In our last study, we argued for the benefits of open vs closed systems in general and in automotive systems. Globally, this has been confirmed by Android keeping its two thirds of market share in web usage or mobile OS. Furthermore, since our last study, open-source kernel Linux has become the leading OS in the cloud where most applications and workloads are running on it and most Unix and Windows applications expected to migrate to it. In container management software, the open-source software Atop Kubernetes is emerging as the industry standard and in software-defined storage open-source solutions are increasingly common. Companies that are not per se Free and Open-Source Software (FOSS) companies such as Google have started to open some of their code and have the open-source developer community contributing to it. Traditionally closed source companies acquired significant open-source players, e.g., Microsoft/GitHub, IBM/RedHat. Microsoft now broadly uses open source, e.g., Azure on Linux.[73] However, controversies between open-source defendants and proprietary system providers will continue to occur. This was exemplified in the fact that the Software Freedom Conservancy (SFC), an organization we quoted in our last study for getting Tesla to open its code, has left GitHub in 2022 claiming that GitHub has been contributing to the development of a proprietary service that exploits FOSS. Despite these ongoing tension between FOSS and proprietary software followers, also the automotive industry has opened more and more for open-source approaches and the winning streak of Automotive Grade Linux and Linux kernel-based Android Automotive is expected to endure (Figure 23).

3.8.2 Software

In addition to the SDV developments described earlier, several software trends coming from the broader technology industry will influence vehicle technology, these are super apps, adaptive AI and the metaverse. Gartner estimates, that by 2026, “more than 50% of the global population will be daily active users of multiple super apps. By 2027, enterprises that have adopted AI engineering practices to build and manage adaptive AI systems will outperform their peers in the operationalizing AI models by at least 25% and over 40% of large organizations worldwide will be using a combination of Web3, spatial computing and digital twins in metaverse-based projects aimed at increasing revenue”.[74]

In addition, many challenges are already being addressed such as the crucial speed of iteration in software development to achieve the perfect circle, simulation at scale and emulation in virtual environments, co-innovation, real time systems in the cloud, a well architected stack, defining differentiating vs non-differentiating functionalities and decoupling hardware from software with separate releases (example iPhone and iOS where this is already the case), the growing complexity of applications, the need for clear interfaces (API) to decouple hard and software to master the alignment of the relatively short software life cycle with long and in view of sustainability even longer or circular lives of hardware.

[73] BCG, Why you need an open software strategy, article, April 2021

[74] Gartner, Top Strategic Technology Trends 2023

3.8.3 Hardware

SDVs have a complex system of hardware and software that work together seamlessly to bring the car to life. At the heart of it all is the HW layer, made up of a powerful in-car infotainment computer, an advanced ADAS computer, controllers for both the exterior and interior, a central driving controller, and a connectivity module.

ADAS, connectivity and autonomous driving will further drive the need for high-tech hardware elements such as DCU/ECU, sensors, radars, lidars and cameras. The total global market of advanced driver-assistance systems and autonomous-driving hardware is expected to increase tenfold between 2021 and 2030 and add up to $55-$80 billion by 2030.[75] In addition to these hardware components, the need for semiconductors and microprocessors will surge and is forecast to reach $111.5 billion by 2029 (including semiconductor-based sensors).[76]

In 2021, Tesla was the latest non-traditional chip maker to join the ranks of other tech companies (Google, Apple, Amazon, Intel etc.) that have turned to developing their own microchips to handle the increasing performance requirements from AI algorithms and to overcome supply chain issues. It is expected that OEMs will review their just-in-time (JIT) principle and Gartner "predicts that by 2025, 50% of the top 10 automotive OEMs will design their own chips and establish direct, strategic, long-term working relations with chip companies, while giving up JIT inventory management practice."[77] New players like Cruise already pursue that strategy today as they load several petabytes per day on the AWS cloud and have their own silicon and their own sensor processing chips.

A mix of factors will continue to make the fulfilment of automotive semiconductors demand hard to achieve: challenging automotive requirements, several components that are still based on process nodes older than 28nm, e.g., 40nm or the long tail of conventional ICE semiconductor requirements.

3.8.4 Cloud services

Since our last study, cloud computing has continued to evolve and expand at a rapid pace. One major trend has been the increasing adoption of multi-cloud strategies, where organizations use multiple cloud providers to meet their diverse needs. Another development has been the growth of serverless computing, which allows developers to focus on writing code without worrying about the underlying infrastructure.

For automakers and industry suppliers, cloud computing is becoming an essential tool, as they partner with leading cloud service providers like Amazon (AWS), Google (Google Cloud), and Microsoft (Azure) to power their critical operational and R&D activities. Cloud-based solutions offer significant cost savings compared to traditional on-premises infrastructure, as they eliminate the need for expensive hardware investments and ongoing maintenance and upgrades. Additionally, cloud providers offer a wide range of powerful tools and services that can be customized to meet the unique needs of

[75] McKinsey, Autonomous driving's future: Convenient and connected, January 2023

[76] Strategy Analytics, The Beginning of the End of the Automotive Industry Semiconductor Shortage by Asif Anwar, 26th October 2022

[77] Gartner, Top Strategic Technology Trends 2022

automotive companies, from machine learning and data analytics to cybersecurity and compliance management.

The use of cloud computing in the automotive industry is set to continue growing in the coming years, as the use of artificial intelligence and machine learning to extract insights from the massive amounts of data being generated by cloud-based systems require significant computational power and AI-specific tools and services to process and analyse. Additionally, the rise of edge computing - where processing occurs closer to the source of the data - will bring continue to be more and more established.

3.8.5 Artificial Intelligence (AI)

The global AI market size was valued at $137 billion in 2022 and is expected to grow at a compound annual growth rate (CAGR) of 37.7% to $1.812 billion by 2030.[78] The global market value for AI in the automotive industry is expected to reach $19 billion by 2030, growing at a compound annual growth rate (CAGR) of 23.3% from 2022 to 2030.[79] This growth is being driven by increasing demand for autonomous vehicles, rising focus on driver safety, and growing investments in AI technology by major automotive manufacturers. It is expected that the AI development in mobility will never plateau as connected and autonomous vehicles represent a continuous learning machine.

AI (that is Computer Vision, Context Awareness, Deep Learning, Machine Learning, and Natural Language Processing) will be applied in virtually every aspect of the automotive value chain in hardware, software and services and the use cases are endless. The recent surge of large language models and generative AI applications such as Open AI's ChatGPT (GPT-4), Google's Bard and Microsoft's Bing impressively indicates the opportunities. Recent developments such as Nvidia's new AI supercomputer platform DGX GH200 will help build more powerful generative AI models and open opportunities to non-technical people who can simply speak to a computer without knowing any code – the end of the digital divide.

3.8.6 Quantum computing (QC)

Quantum computing is based on the rules of quantum mechanics and can solve complex problems faster than classical computers. Calculations are performed on quantum bits, or qubits, that capture a more complex state of information (binary values such as 0 and 1 plus the superposition of both) than bits (only binary values such as 0 and 1). QC has the potential to revolutionize the automotive industry by enabling more advanced simulations of complex molecular systems, optimizing supply chain management, and improving the performance of self-driving cars. Currently its application is still limited to such topics as route and traffic optimization, but many OEMs are already exploring the use of quantum computing in areas such as battery chemistry and materials science to develop more efficient and sustainable vehicles and next generation fuel cell or hydrogen technology. Key

[78] Grand View Research, Artificial Intelligence Market Size, Share & Trends Analysis Report By Solution, By Technology (Deep Learning, Machine Learning), By End-use, By Region, And Segment Forecasts, 2023 - 2030

[79] Precedence Research, Automotive Artificial Intelligence (AI) Market - Global Industry Analysis, Size, Share, Growth, Trends, Regional Outlook, and Forecast 2022-2030

applications will be quantum simulations, complex optimization problems and complex quantum AI/ML. The global economic impact of QC for the automotive industry is $2-$3 billion by 2030.[80]

Initially, only tech giants will be in the position to possess large scale quantum computers. Later, regular users might get access to QC via cloud services. While QC will enable leap frogging vehicle R&D, it also poses an unprecedented risk on the cybersecurity of connected and autonomous vehicles, as cryptography is widely used to ensure data security. QC can break many of the encryption algorithms that currently secure digital communications and transactions.

3.8.7 Cybersecurity

To comply with regulations such as ISO/SAE 21434:2021[81] UN regulation no. 155[82], car manufacturers are designing in-vehicle systems that prioritize cybersecurity and setting up vehicle security operations centres (VSOCs), a concept adapted from general IT security operations centres (SOCs). The complexity of modern E/E architectures and API can make it difficult to identify and secure all potential entry points for cyberattacks. Additionally, vehicles are increasingly connected to external networks, such as Wi-Fi, cellular networks, or EV charging infrastructure, which can expose them to external threats.

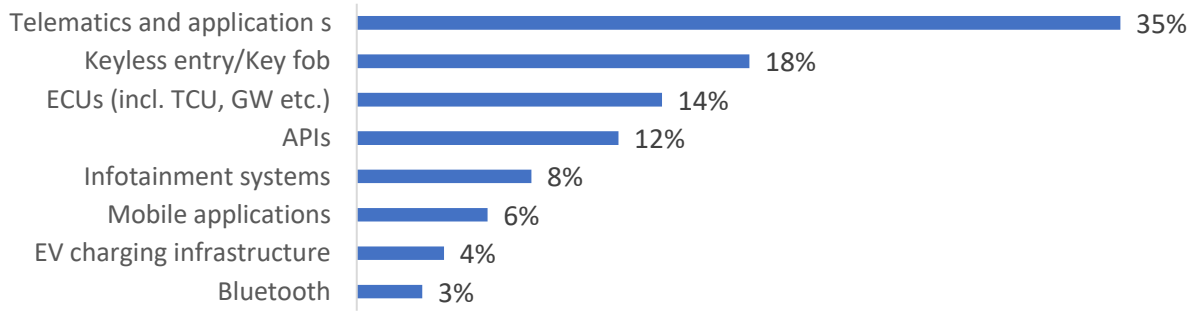

Figure 25: Connected vehicles' most common attack vectors 2010-2022[83]

With regards to the subject of this study it is noteworthy that attacks on telematics and application servers have been the most common ones in 2022 (see Figure 25) and that threats regarding back-end servers related to vehicles in the field represent one third of threats and vulnerabilities reported in 2022 (see Figure 26).

[80] McKinsey, Will quantum computing drive the automotive future?, article, September 2020

[81] Road vehicles — Cybersecurity engineering

[82] UN R155 requires the presence of a cybersecurity management system (CSMS) in vehicles

[83] Upstream, 2023 Global Automotive Cybersecurity Report

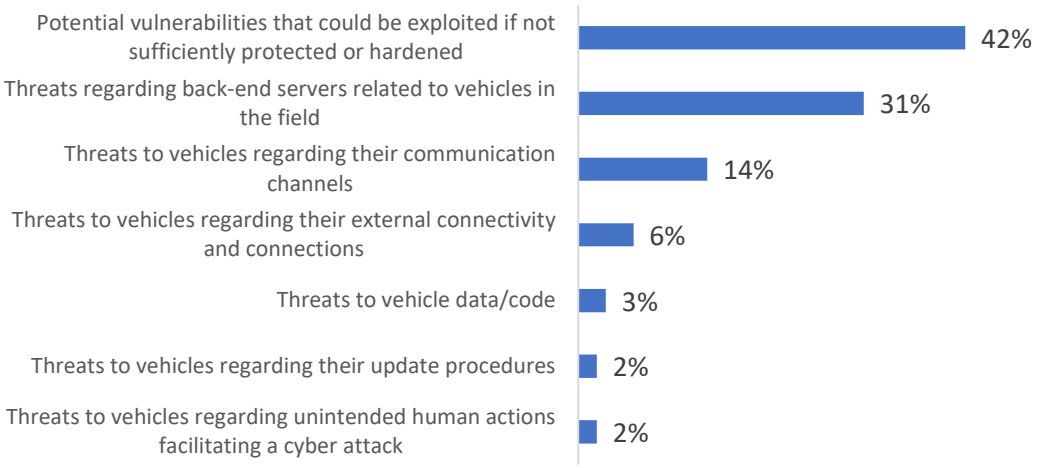

Figure 26: 2022 cyber incidents categorized by R155 threats and vulnerabilities[84]

To mitigate these challenges, manufacturers implement robust security measures, including strong encryption protocols, secure software updates, secure access controls to vehicle data and regular security testing and risk assessments to identify and address vulnerabilities. These measures need to be taken across the entire value chain, as publicly reported Common Vulnerabilities & Exposures (CVEs) affect not only OEMs but also Tier-1 and Tier-2 suppliers as well as software and hardware service providers (see Figure 27).

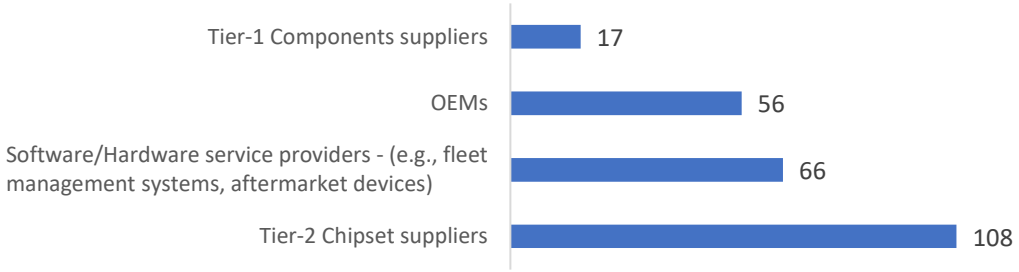

Figure 27: Breakdown of publicly reported automotive related vulnerabilities[85]

There is a growing network of cybersecurity providers for the automotive industry and collaboration between all market players including ISPs is required to establish the VSOC and associated protocols. As the abovementioned regulations do not outline specific solutions and processes such as e.g., Digital Twins, the establishment of those processes and solutions is expected to lead to more effective safety and security, see Strong Customer Authentication (SCA) and Two factor Authorization (2FA) in payments.

[84] Upstream, 2023 Global Automotive Cybersecurity Report

[85] Upstream, 2022 Global Automotive Cybersecurity Report

3.9 Data marketplaces, aggregators, hubs, and platforms

In our last study, we mentioned the important role we believe that data marketplaces or data aggregators would play in the monetization of in-vehicle data, and we showed the development of Otonomo and Caruso as examples of two data platforms with very different backgrounds. Since then, Otonomo has been listed on the NASDAQ in 2021 following the acquisition by a special purpose acquisition company (SPAC) valuing Otonomo at ca. $1.4 billion. At the time of writing this report, the market capitalization of Otonomo was ca. €63 million, which means a reduction of ca. 95%.

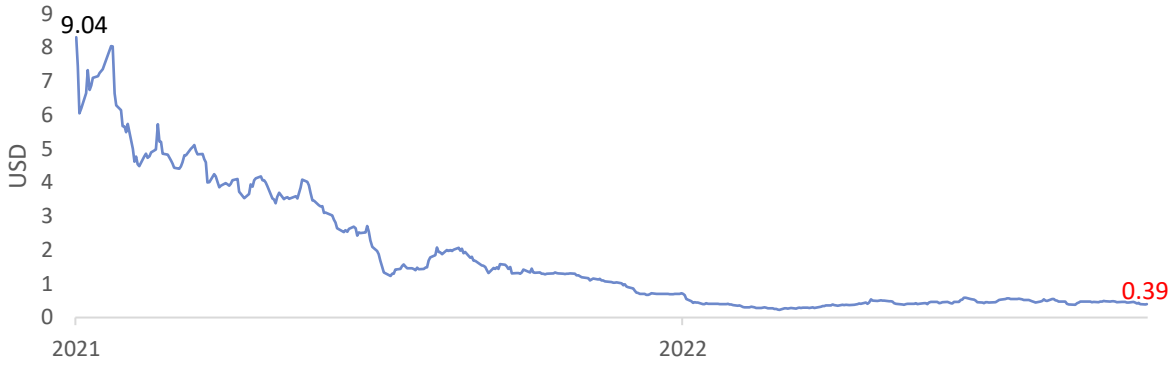

Figure 28: Share price development Otonomo 7.10.2020-23.5.2023

In February 2023, Otonomo announced a reverse merger with Urgently, a digital roadside assistance provider from the US that was founded in 2013 with investors including BMW I Ventures, Porsche Ventures, Jaguar Land Rover's InMotion Ventures, and American Tire Distributors, with an estimated revenue of $185 million in 2022. The proposed merger is expected to be finalized in Q3 2023 and aims to create an "end-to-end platform for a new generation of mobility services and experiences for automotive OEMs, insurance, transportation, rental and fleet partners and their customers".[86] The development of Otonomo clearly demonstrates the struggles that vehicle data start-ups encounter in reaching critical business dimensions.

Caruso, on the other hand, has continued the development of its data platform based on ExVe or ADAXO and has extended the number of OEMs and other partners with which it cooperates. Caruso, founded in by TecAlliance (900+ members) serves as a strategic investment to a group of shareholders active in IAM business activities who want to assess the validity and performance of data access via OEM back-end servers. Lately, use cases such as First Notification of Loss (FNOL) have been implemented for insurance providers, e.g., Zurich or Allianz. Other use cases are refuelling and charging behaviour for PHEVs, behaviour of individual vehicles, or vehicle service dates. It is difficult to judge the commercial success from public sources and there is also no indication available as to how many patents the company holds. It appears that the degree of innovation is lower than that of Otonomo which published 50 patents and currently holds 39 active patents.[87]

[86] Otonomo, Otonomo and Urgently to Combine to Create Leading Mobility Services Company, article, 2023

[87] Insights by Greyb, Otonomo Patents – Key Insights and Stats, article, 2023

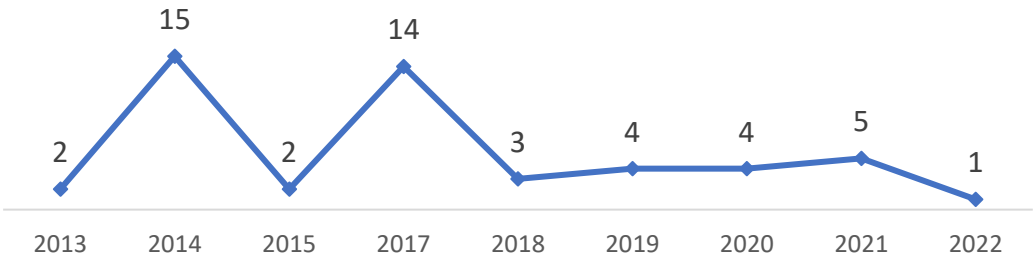

Figure 29: Otonomo patent portfolio (year of publication)[88]

Nevertheless, by conducting a second large scale Connected Vehicle Field Test 2.0 in 2021/22, Caruso published important and relevant findings, such as

- Data is now available across multiple countries and for more OEMs.
- The coverage of connected cars is lower than anticipated.
- B2B consent is still not available from all OEMs.
- A common data set across all OEMs still not available.
- Mileage is only data point that is 100% available from all OEMs (out of 529 data points relevant for known services).

The number of data platform players has not changed much over the past five years, with High Mobility (API first data platform from Berlin, Germany, founded 2013, not yet using data from VW and Tesla) being one example of a startup that has benefited from the shift to API by European OEMs. The location platform provider Here (successor of Navteq, owned by consortium including Audi, BMW, Mercedes, Mitsubishi and Bosch, based in Amsterdam, The Netherlands) and Wejo (Smart Mobility for Good™ cloud and software analytics for connected, electric and autonomous mobility, founded in UK in 2013, currently in second merger deal with a SPAC) are the only other two significant European companies involved in the in-vehicle data topic, albeit with a distinctive focus beyond OBD2 data.

3.10Telematics providers

The vehicle telematics market in Europe has experienced growth followed by consolidation over the last decade, with many small and medium-sized players being acquired by larger companies. This consolidation has been driven by several factors, including the need for scale and resources to invest in new technologies and the increasing competition in the market.

Some vehicle telematics providers have managed to survive the latest consolidation phase. These providers have expanded their offerings and capabilities, driven by the increasing demand for connected vehicles and data-driven insights in the automotive industry. Rental and leasing providers in Europe are the key drivers for growth of telematics equipped vehicles BergInsight estimates the installed base of telematics solutions for rental and leasing companies to double in the next five

[88] Insights by Greyb, Otonomo Patents – Key Insights and Stats, article, 2023

years.[89] However, OBD2 as the basis for connectivity is rapidly losing its appeal, in particular for the B2C and passenger car business. Pioneers in OBD2 dongle-based telematics such as Canadian Geotab, (founded in 2000, entered Europe in 2014, 100.000 subscriptions in Europe in 2021) maintain a leading position but have fine-tuned their focus on becoming the first choice open-source platform provider and offering IoT solutions and services to fleet managers.

Munic SA, a French telematics provider, has continued to develop its platform to offer a wider range of services, including real-time tracking, predictive maintenance, and driver behaviour analysis. The company has also expanded its partnerships with automakers and fleet management companies to increase its market reach. Financial markets, however, have not favoured telematics stocks over the past 5 years, as the example of Munic SA illustrates (see Figure 30)

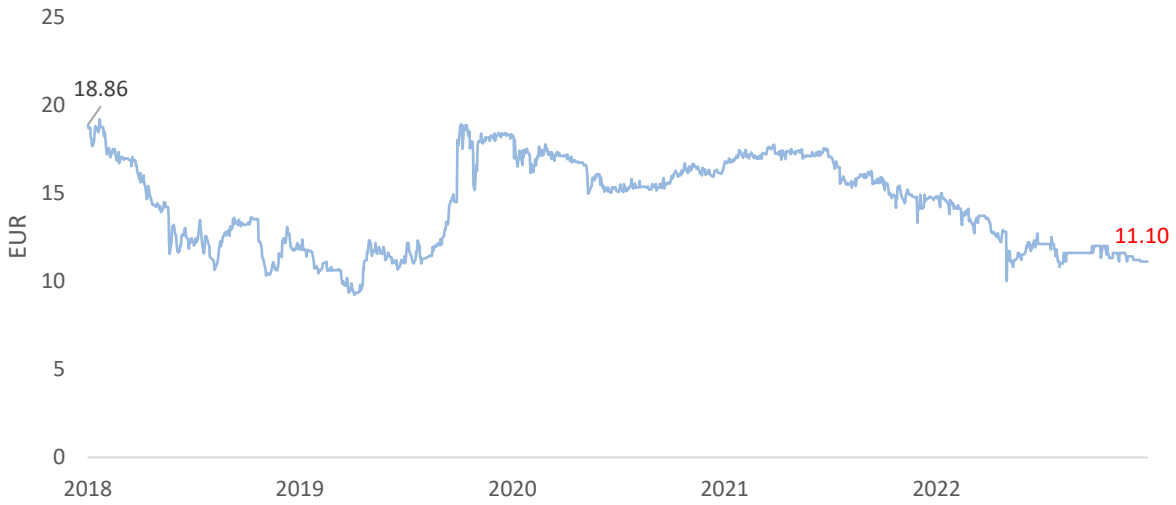

Figure 30: Share price Munic SA over past 5 years until 22 May 2023

Pace Telematics GmbH, founded in 2015 in Germany, moved from diagnostics to the more promising in-vehicle payment solutions for fuelling services. Pace is the market leader in Europe with their Connected Fuelling platform for mobile payment when refuelling.

Overall, the growth of vehicle telematics providers in Europe has been driven by the increasing demand for connected vehicles and the need for data-driven insights to optimize fleet management and improve driver safety. These providers are expected to continue to develop new technologies and services to meet the evolving needs of the automotive industry.

One notable example of consolidation in the European telematics market is the acquisition of Masternaut by Michelin in 2019. Masternaut, a UK-based telematics provider, was acquired by Michelin to strengthen the tire manufacturer's position in the connected mobility market. The acquisition also helped Michelin to expand its offering of data-driven services for fleet managers.

Another example is Verizon's acquisition of Fleetmatics in 2016. Fleetmatics, an Irish telematics provider, was acquired by Verizon to expand the company's presence in the fleet management market. The acquisition helped Verizon to offer a comprehensive suite of telematics services to its

[89] Berg insight, The rental and leasing car telematics market is expected to grow at a CAGR of 17.6 percent in the next 5 years, article, 2023

customers, including GPS tracking, driver behaviour analysis, and fuel management. Like Verizon other US companies have started to expand into Europe, such as telematics giants Geotab and PowerFleet.

In addition to acquisitions, there have also been several partnerships and collaborations between telematics providers and other companies in the automotive industry. For example, TomTom, a Dutch location technology provider, sold its telematics unit to Bridgestone in 2019. It now operates as a Bridgestone subsidiary called Webfleet and has partnered with several automakers to offer connected car services, such as route data, fleet reporting, GPS data, and predictive maintenance.

3.11 Cross-industry alliances

There are several organizations, alliances or consortia that have started to tackle the topic of creating standards in the increasingly connected mobility sphere. Examples are COVESA (Connected Vehicle Systems Alliance), AUTOSAR (Automotive Open System Architecture), Gaia-X with its lighthouse project Catena-X, SOVD (Service-Oriented Vehicle Diagnostics), MOBI (a global non-profit alliance to create standards and build the Web3 infrastructure for connected ecosystems), to name just a few. The work of these groups must be taken on board when defining a legislative vehicle data access framework with the objective to provide clear guidance on cross-industry specifications, definitions, mandatory elements, and formats.

4 Data access

4.1 Current issues

During the time of our last study, the most common way for third parties to obtain in-vehicle data was the On-Board-Diagnostic (OBD) interface (now OBD2) providing independent, direct, real-time, and free of charge access to in-vehicle generated data. It formed the basis of many new business activities in the automotive aftermarket and the number of startups developing business models based on OBD2 data was enormous. According to industry insiders, the expectations of these startups could not be met, and their number dropped drastically over the past years as they went out of business or turned to new business models. It is a commonly held view, however, that the OBD2 port will remain an Important data access source for the existing car park and to a certain extent for SDV and connected vehicles as well.

OEMs continue to base their business models on data generated in connection with the vehicles they manufacture. As they are turning from hardware to software companies or at least towards a strong combination of both businesses, they focus on harnessing the value of data. A recent example for this extension of activities is Stellantis' launch of a data business unit named Mobilinsights with the purpose "to harness sensor and other data from 10s of millions of connected vehicles as well as that from IoT/connected devices from external sources to build data products and services that can power hundreds of brand-new b2b and b2c applications, services, and decision-making across industries".[90]

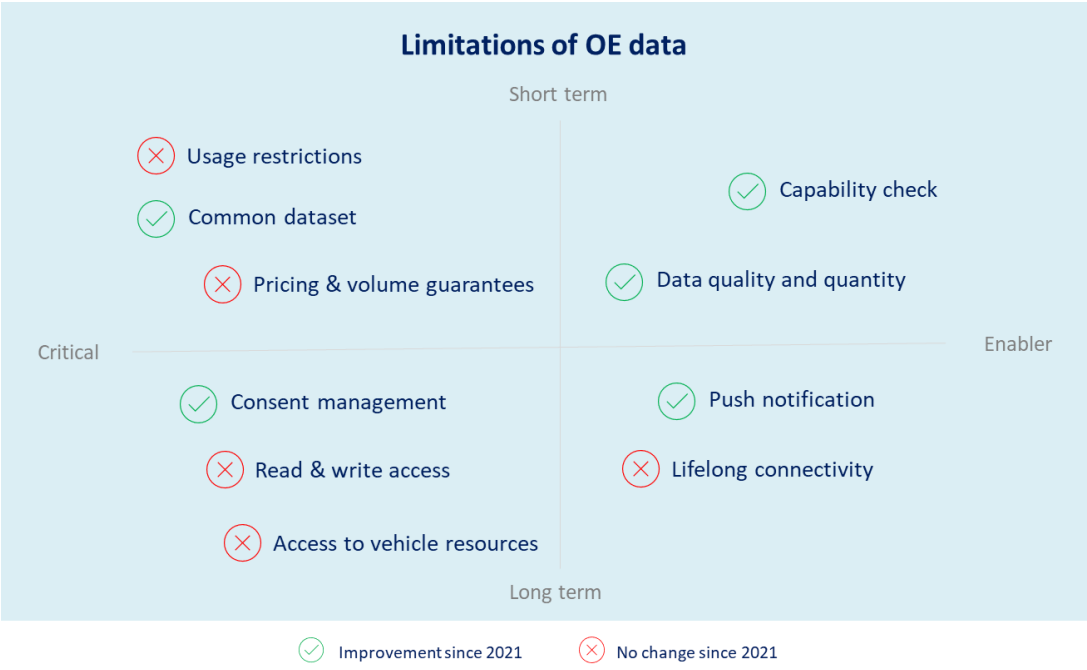

Figure 31: Limitations of OE data[91]

[90] LinkedIn, stellantis, job post, 2023

[91] Caruso Dataplace, 2022

The main form of access provided to third parties by OEMs happens via OEM backend servers with the Extended Vehicle approach, called ADAXO (automotive data access, extended and open) since 2022 and OEMs prioritize diagnostics entry points to be off-board and remote (Figure 32). However, other access forms are considered valid options, such as via a web client or app as well as extensions of wireless access such as WLAN.[92]

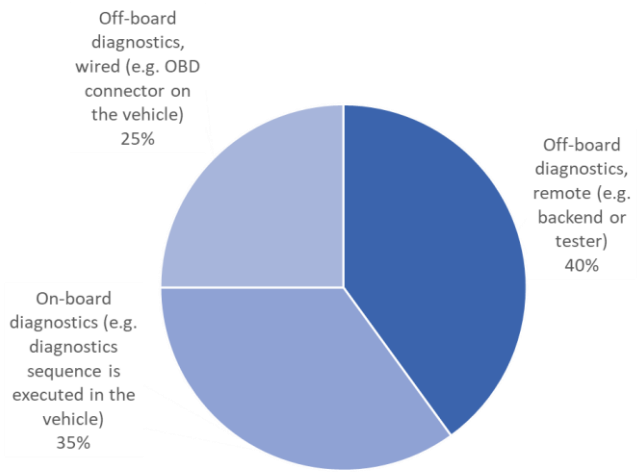

Figure 32: Relevance of application scenarios for future vehicle diagnostics[93]

While some progress has been made, the downsides of this approach have not materially changed and become even clearer since then:

- Lack of consistency between data elements of different OEMs and in data quality.
- Different data refresh rates by each OEMs and by brand and model year.
- Limited number of available data sets.
- Different connected platform architecture for each OEM, i.e., data streaming vs. REST API.
- Different consent management process for each OEM, e.g., synchronous vs. asynchronous.
- No real-time data as access is only via off-board platform.
- Inconsistent and often insufficiently substantiated pricing schemes hugely varying in value, need for tedious negotiations and clarifications.
- No opportunity to interact with the driver via HMI in real-time for confirmations, clarifications etc.
- Lack of standardization of data formats between OEMs.
- Differences in access methods for same/similar data points (event based, time based etc.).

Given the above shortcomings, the ExVe/ADAXO data access model approach is not deemed to be successful as it cannot ensure that third parties can develop successful business models based on a reasonable cost vs. benefits ratio and it does now consider alternative access models.

[92] Bickelhaupt, S., Hahn, M., Nuding, N., Morozov, A., et al., «Challenges and opportunities of future vehicle diagnostics in software defined vehicles», SAE Technical Paper 2023-01-0847, 2023

[93] Ibid.

4.2 Legal framework

As of the early 2000s, the Commission has tried to ensure a level playing field for authorized and independent aftermarket service providers (e.g., EU regulations no. 1400/2002, 715/2007, 692/2008, 595/2009, 461/2010, 64/2012, 758/2015). With the introduction of eCall legislation in April 2018, every newly manufactured vehicle was by default equipped with a SIM card and the ability to remotely connect to wireless data-services, enabling the development of a myriad of new types of services for all vehicle segments. However, these same innovations in vehicle and communication technology have been disrupting business models across the automotive value chain at a rapid pace, so much so that the regulatory frameworks that have served the sector until now are no longer fit for purpose.

This sea change was first recognised in the update to the Motor Vehicle Block Exemption Regulation regime ("**MVBER**") (which was set to expire on 31 May 2023) and now has been prolonged until 2028. The MVBER relates to the sale or resale of spare parts for motor vehicles or the provision of repair and maintenance services for motor vehicles, where it provides that Article 101(1) of the TFEU does not apply, so long as these agreements fulfil the requirements for an exemption under the general regime. The regime until 2023 noted that independent operators have "unrestricted access to essential inputs"[94] with the question remaining unanswered, how to define essential inputs. Moreover, the MVBER was originally built to address non-wireless datalinks. On this, the Commission noted that the limited prolongation will allow it to react in a timely manner to possible market changes, such as those resulting from vehicle digitalisation, electrification, and new mobility patterns.

The updated supplementary guidelines:

- *"Clarify that **data generated by vehicle sensors may be an essential input for the provision of repair and maintenance services. Therefore, to comply with Article 101 of the Treaty on the Functioning of the European Union ('TFEU'), authorised and independent repairers should have access to such data on an equal footing.** The existing principles for the provision of technical information, tools and training necessary for the repair and maintenance services have been extended to explicitly cover vehicle-generated data.*

- *Specify that vehicle suppliers must apply the **proportionality principle** when considering whether to withhold inputs, such as vehicle-generated data, based on potential cybersecurity concerns.*

- *Warn that **Article 102 TFEU may be applicable** where a supplier unilaterally withholds from independent operators an essential input, such as vehicle-generated data."*[95]

In similar vein, at international level, ISO standard 18541-1, 2021[96], aims to specify the minimum set of technical requirements related to a vehicle manufacturer's RMI system. It also defines requirements for granting access to security-related RMI in Annex A following the SERMI scheme.

The ISO 18541 series includes the requirements to be fulfilled by repair and maintenance information (RMI) systems as applied by the European and relates to the EC type-approval system for vehicles

[94] Commission Regulation (EU) No 461/2010 of 27 May 2010 on the application of Article 101(3) of the Treaty on the Functioning of the European Union to categories of vertical agreements and concerted practices in the motor vehicle sector

[95] Supplementary guidelines on vertical restraints in agreements for the sale and repair of motor vehicles and for the distribution of spare parts for motor vehicles

[96] ISO 18541-1:2021 Road vehicles — Standardized access to automotive repair and maintenance information (RMI) —

falling into the scopes of Directives 70/156/EEC (replaced by 2007/46/EC [8]), 2002/24/EC [replaced by (EU) 168/2013 [6] and 2003/37/EC [replaced by (EU) 167/2013 [7]] and, in particular, to requirements for access to vehicle repair and maintenance information by independent operators. The purpose of the EC Mandate M/421 is to develop a standard or set of standards which specify the requirements to provide standardized access to automotive repair and maintenance information (RMI) for independent operators.

With regards to the more general issue of fair access to in-vehicle data, the European Automotive value chain has been calling for years for dedicated legislative action on this issue. The access to in-vehicle data via the vehicle On-Board Diagnostic port (OBD) is regulated since 2007[97] in the vehicle type approval regime. However, this does not adequately address the new possibilities brought by wireless connectivity and the development of new services beyond emission control and diagnostics. For this reason, the European Parliament called upon the Commission, in its resolutions of 13 March 2018[98] and 15 January 2019[99] to make a legislative proposal to ensure fair access to in-vehicle data and resources to enable the entire automotive/mobility ecosystem and end users to benefit from digitalization.

For some time, there has been a belief that this could be addressed via more horizontal legislation, most notably the Data Act[100]. However, the provisions in the Data Act regarding which the Parliament and Council reached a provisional political agreement on 27 June 2023 are by no means sufficient to guarantee a fair access to car generated data. This conclusion was by the Transport Research Laboratory Studies, conducted on behalf of the Commission in 2017 and 2021[101]. More importantly, the draft impact assessment, as presented by the DG GROW services last December, also reached the same conclusion.

More specifically, in the draft IA[102] the Commission notes that *"the Data Act may need to be complemented for the automotive/mobility ecosystem specific aspects, such as vehicle data standardisation or access to vehicle functions[103] and resources[104] which is also key to deliver data driven services, or the capacity of public authorities to carry out certain tasks under national or Union legislation. Furthermore, the Digital Market Act[105] (DMA) will help to ensure fair competition between digital platforms and other market players but will not solve the problems resulting from control over vehicle data and resources by entities which do not reach the DMA thresholds."*

[97] Regulation (EC) No 715/2007 of the European Parliament and of the Council of 20 June 2007 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information, see also Annex 6 p. 135.

[98] European Parliament resolution of 13 March 2018 on a European strategy on Cooperative Intelligent Transport Systems (2017/2067(INI))

[99] European Parliament resolution of 15 January 2019 on autonomous driving in European transport (2018/2089(INI))

[100] REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCI on harmonised rules on fair access to and use of data(Data Act), 2022/0047(COD)

[101] Study on Access to Data – Lot 1, 17 September 2021

[102] Commission staff working document, draft Impact Assessment Report

[103] Access to vehicle functions can be defined as the ability to send commands to the vehicle, it is also referred to as "writing" access. Examples of such functions include e.g. remote door locking/unlocking, uploading software, or diagnostic test routines such as data trouble code.. Access to vehicle functions is indispensable to provide many services (e.g. diagnostic routines or re-coding parts for repair/maintenance services, remote door unlocking for car rental services).

[104] Vehicle resources should be understood as the technical infrastructure of the vehicle (both hardware and software), which can be used to process data (computing resources, such as ECUs and actuators/sensors), to access data, to communicate data off-board or to interact with the driver (communication resources). Such a vehicle resource is notably Human-Machine Interface (dashboard or HMI screen).

[105] COM(2020) 842 final.

following a similar logic, the provisional agreement of the Renewables Directive[106] also establishes in Art. 20a.2, that:

"In addition to the requirements in [the proposal for a Regulation concerning batteries and waste batteries, repealing Directive 2006/66/EC and amending Regulation (EU) PE-CONS No/YY 2021/0218(COD) XYZ-AB/OP-QR 79 No 2019/1020], Member States shall ensure that manufacturers of domestic and industrial batteries enable real-time access to basic battery management system information, including battery capacity, state of health, state of charge and power set point, to battery owners and users, as well as to third parties acting, with explicit consent, on the owners' and users' behalf, such as building energy management companies and electricity market participants, under non-discriminatory terms, at no cost and in compliance with data protection rules.

Member States shall adopt measures to require that vehicle manufacturers make available, in real-time, in vehicle data related to the battery state of health, battery state of charge, battery power set point, battery capacity, and as well as where appropriate the location of electric vehicles, to electric vehicle owners and users, as well as to third parties acting on the owners' and users' behalf, such as electricity market participants and electromobility service providers, under non-discriminatory terms and at no cost, in compliance with data protection rules, and in addition to further requirements in the type approval and market surveillance regulation."

It is quite clear that the Commission, Parliament, and Council recognise the need for regulated access to battery management related data of EVs, where the same logic applies to access to in-vehicle data at a more general level.

Finally, it is worth noting that on 5/4, on behalf of Commission President Ursula Von der Leyen, Commissioner Breton wrote to an alliance of Independent Service Providers that "*we fully recognise the importance of the issue of access to vehicle data, functions and resources, with a view to stimulating the development of connected vehicle services, ensuring competition, boosting competitiveness of the European automotive ecosystem (including independent service providers) and preserving safety and security for the users. […] In fact, we are preparing a sector specific initiative to complement the Data Act to address this important issue".* In an exchange in the European Parliament's TRAN Committee, in April 2023, Commissioner Breton reconfirmed publicly the need for the Commission to propose Sector Specific legislation.

[106] Directive amending Directive (EU) 2018/2001 of the European Parliament and of the Council, Regulation (EU) 2018/1999 of the European Parliament and of the Council and Directive 98/70/EC of the European Parliament and of the Council as regards the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652

4.2.1 Relevant legislative domains and political activities

Figure 33 provides a schematic historical overview.

Date	Body/ Organisation	Policy/Study	Type	Relevance for direct in-vehicle data access	Relevance for IAM	Relevance for consumers	Legally binding
June 2007		Regulation 2007/715 on type approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (**Euro 5 and Euro 6**) and on access to vehicle repair and maintenance information	Legislation	Unrestricted access to essential inputs such as spare parts and technical information for IO Common technical requirements for the type approval of motor vehicles and replacement parts with regard to their emission and lays down rules for in-service conformity, durability of pollution control devices, on-board diagnostics (OBD) systems, measurement of fuel consumption and accessibility of vehicles repair and maintenance information	Easy and clear access to information on vehicle repair and maintenance for IO	Indirect, as charges to IAM for accessing such information are permitted if they are reasonable and proportionate	Yes (to be replaced by a Regulation which will be applicable as from 1 September 2020)
May 2010	EUC DG COMP	MVBER Commission Regulation (EU) 461/2010	Regulation	MVBER applies to vertical agreements relating to the motor vehicle aftermarket, which includes the purchase, sale or resale of spare parts or provision of repair and maintenance services	High, ensures that independent repairers have access to the brand-specific repair tools on the same terms as members of the authorized network	High	Yes
June 2011	EUC DG COMP	Commission Regulation (EU) No 566/2011	Regulation	Access to vehicle repair and maintenance information	High	High	Yes
October 2014	EUC DG GROW	RICARDO Report	External study	Demonstrated that IAM are hampered in their competitiveness due to a series of obstacles and refusals to grant access to Repair and Maintenance Information (RMI)	Detailed focus on Repair and Maintenance aspects that need improvement	Indirect strengthening of competition and market quality	No
April 2015	EUC and EUP on eCall	Regulation (EU) 2015/758 concerning type-approval requirements for the deployment of the eCall in -vehicle system	Regulation	Precedent for interoperable, standardised, secure and open-access platform for possible future in-vehicle applications or services	High	High	Yes
January 2016	EUC DG MOVE	C-ITS (Cooperative Intelligent Transport Systems)	Recommendation	All stakeholders agreed on 5 principles for access to „in-vehicle data“ (a) Data provision conditions: Consent (of car drivers) (b) Fair and undistorted competition (c) Data privacy and data protection (d) Tamper-proof access and liability (e) Data economy	Provides principles for vehicle data access	Security and interoperability are adequate to key consumer requirements	No
October 2017	EUC DG GROW	GEAR 2030	Recommendation	• Connected and automated driving (CAD) acknowledged as one of two key development routes for EU automotive industry • Report identifies opportunities for the Commission and EU countries to support the sector in this transition	Services perspective must be represented	Consumers perspective must be represented	No
2017	EUC DG CONNECT	Building the European Digital Single Market	Public consultation	• Commission intends to support the creation of a common European data space — a seamless digital area with the scale to enable the development of new products and services based on data • Data should be available for re-use as much as possible, as a key source of innovation and growth	Indirect	Indirect	No

2017	Free Flow of Data	Proposal for a Regulation on a framework for the free flow of non-personal data in the European Union (COM(2017)495)	Proposal for a Regulation	This Regulation introduces the principle of the free flow of non-personal data across borders into EU law thereby establishing the free movement of non-personal data	Indirect	Indirect	TBD
May 2018	EUP and EUC	General Data Protection Regulation 2016/679 (GDPR)	Regula-tion	Rules concerning the protection of personal data. As most driver and vehicle data are considered personal data, these rules are relevant	Indirect	High, e.g. right to data portability	Yes
April 2018	EUP	OBDII port to stay open and be included in new Type Approval		Provisions for onboard diagnostics, including the OBD port have to be included in the new regulation	High	High	TBD
Novem-ber 2018	EUP	Own Initiative Report	TRAN Com-mittee of the EUP	EUP's Committee on Transport called on the European Commission for a second time in the same year to come forward with binding legislation on how vehicle data is accessed	High	High	No
2021	ISO	ISO standard	ISO Commit ee	Standardized access to automotive RMI, specifies the minimum set of technical requirements & specifies all functional user interface requirements related to a vehicle manufacturer's RMI system	High	High	Yes
2021	EUC DG GROW	Draft Impact Assessment on an initiative to enable the development of data driven services in the automotive/mobility ecosystem.	Internal draft Impact Assessment	Evaluation of different legislative solutions to address market imbalances resulting from non-regulated access to in-vehicle data	HIgh	High	No
2022	EUC DG COMP	Vertical Block Exemption Regulation	Regulation	Application of Article 101(3) of the Treaty on the Functioning of the European Union to categories of vertical agreements and concerted practices	HIgh	Low	Yes
2022	EUC DG GROW	EU Design Directive and Regulation	Regulation, Directive	Allow the reproduction of original designs for repair purposes of complex products (such as cars) with an EU-wide "repair clause"	High	High	Yes
May 2023	EUC DG COMP	Prolongation of the Motor Vehicle block Exemption Regulation	Regulation)	The sale or resale of spare parts for motor vehicles or the provision of repair and maintenance services for motor vehicles	High	High	Yes
2023	EUC DG CLIMA	Directive on the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652	Directive (to be adopted)	Focus on increasing share of renewables in EU's energy mix, in order to achieve 2050 targets. Special attention given to access to battery related data.	High	High	Yes
2023	EUC DG GROW	Data Act	Regulation (to be adopted		High	High	Yes

Figure 33: Overview of relevant legislative domains and political activities

4.2.2 Right to repair

The "Right to Repair" movement originating from the US where it has become part of the legislation, has meanwhile become a global movement and with the increasing popularity of personal and mobile devices has spread from vehicles to consumer goods, such as smartphones where there are similar

complaints of consumer groups about the limitations of consumers to be able to repair their electronic devices.

Manufacturers of devices such as smart phones or tablet computers, use digital protection measures to safeguard their intellectual property. However, in the US, consumer activists have been defending the position that these protection measures make it impossible for consumers to repair their own personal devices and expose users and repair professionals to the risk of violating copyright law simply by amending the software of the devices.

Since October 2018, there is a new exemption[107] in place in the US according to which consumers have a legal right to repair a device they own and that such repair does not infringe upon the copyright protection afforded to the manufacturer."[108] In 2021, President Biden directed the FTC to draft new farther reaching right-to-repair regulations, and various US states have passed some version of right-to-repair legislation[109]. Taking things a step further, in 2022 the New York state legislature passed a "right to repair" bill[110] that will require digital electronics manufacturers to make parts, tools, information, and software available to consumers and independent repair shops.

Finally, in November 2022, the European Commission published proposals for the revision of the EU Design Directive (COM(2022) 667) and the EU Design Regulation (COM(2022) 666). Which incorporate the introduction of an EU-wide Repair Clause in the Design Directive (Art. 19) and the confirmation of a permanent Repair Clause in the Design Regulation (Art. 20a).

These legislative proposals aim to balance safeguarding of manufacturers' design rights with regards to their products (such as a vehicle), whilst at the same time avoiding uncompetitive behaviour in after-sales markets on visible spare parts (such as vehicle body panels, headlights, and windscreens) by excluding those for the purpose of repair and replacement from such protection. Today such Repair Clauses exist only in some Member States. The harmonisation of rules for design protection and exemptions would simplify the EU regulatory framework, increase competition, and improve consumer's choice for visible spare parts.

4.2.3 Competition

Ample research and studies, including the Transport Research Laboratory studies conducted on behalf of DG GROW, have highlighted fundamental flaws with the Extended Vehicle model as it allows for the creation of competitive imbalances by enabling OEMs to monitor and control access to in-vehicle data.

The new 2023 MVBER supplementary guidelines clarifies that *"particular attention should be paid to three specific types of conduct which may restrict such competition, namely preventing access of independent operators to essential inputs, misusing the legal and/ or extended warranties to exclude*

[107] Exemption to Prohibition on Circumvention of Copyright Protection Systems for Access Control Technologies, Library Of Congress, U.S. Copyright Office, 37 CFR Part 201 [Docket No. 2017–10]

[108] 'Right-to-repair' advocates claim major victory in new smartphone copyright exemption, The Washington Post, 26 October 2018

[109] Executive Order on Promoting Competition in the American Economy

[110] S4104A - Relates to the sale of digital electronic equipment; requires original equipment manufacturers to provide diagnostic and repair information.

independent repairers, or making access to authorised repairer networks conditional upon non-qualitative criteria".

In the Commission's as of yet unpublished Impact Assessment, it recognises that *"There is also a structural risk for competition on data-based services markets due to the privileged role of the entity controlling access to data[111]. This is usually the vehicle manufacturer or/and the data platform administrator. The remote access to vehicle data, functions and resources must be controlled for cybersecurity and safety reasons. However, this gives the access controlling entity an important market power. There is a risk that such access controlling entity could abuse this privileged position to the detriment of its customers and competitors on the downstream market – in particular if this entity also competes with other service providers on the same market. Most commonly reported problems refer to barriers to entry related to the refusal or unfavourable conditions of access to data, functions and resources by independent services providers[112]. This could lead to potential negative impacts on the take-up of such services, on consumer welfare and on innovation. More than 80% of the non-OEM respondents in the public consultation (including services providers, component suppliers, NGOs and citizens) considered that how vehicle data can be technically accessed should be regulated to ensure a secured, fair and non-discriminatory access.*

This privileged role of the controlling entity was well identified in previous consultations and studies, in particular the one prepared by JRC[113]. The access controlling entity decides which data, functions and resources can be accessible remotely and can monitor the data traffic of its competitors[114]. The access to the relevant data, functions and resources is crucial for other economic actors, yet these have no influence on the data, functions and resources that can be made accessible on a vehicle. This imbalance cannot be effectively addressed by competition rules."

Indeed, the Data Act does not include ex-ante competition provisions deemed essential, in multiple EC and JRC reports, to enable unfettered access to vehicle-generated data needed for sustainable innovation in the mobility market. While the proposed Digital Markets Act does include a set of ex-ante set of rules, its application is limited in that vehicle manufacturers' role as gatekeeper over vehicle-generated data is not likely to qualify, nor is it covered under the contemplated core platform services.,

4.2.3.1 Monitoring competitors' activities

There is one competition aspect that until now insufficiently been analysed and reviewed in studies dealing with the Extended Vehicle, which is the fact that under the Extended Vehicle scenario, OEMs could monitor the activities of their direct competitors, in this case the activity of IAM who are competing with the services arms, leasing subsidiaries or captive workshops of forward integrated OEMs.

[111] See Carballa-Smichowski, B., Sobolewski, M. & Duch-Brown, N. (2023). The economics of connected vehicle's ecosystems: a market failure perspective. *JRC Digital Economy Working Paper 2023-01*.

[112] Annex 2, p. 61

[113] JRC Digital Economy Working Paper 2018-06, Bertin Martens, Frank Mueller-Langer, 2018.

[114] Annex 2, p. 60

Like DPs like Google, Amazon or Apple, OEMs would be in the position to exclusively access and amass enormous data not only of their customers but also – and this would be the disturbing part - of their competitors.

Concerned stakeholders expect to incur significant damage to their business because of this, therefore it has been included in modelling the economic impact of the Extended Vehicle on the IAM. Considering all the technical options reviewed, legislation must ensure that rather than OEM's or DP's proprietary operating systems, truly independent and standardized operating systems will be applied as indicated in below overview in Figure 34.

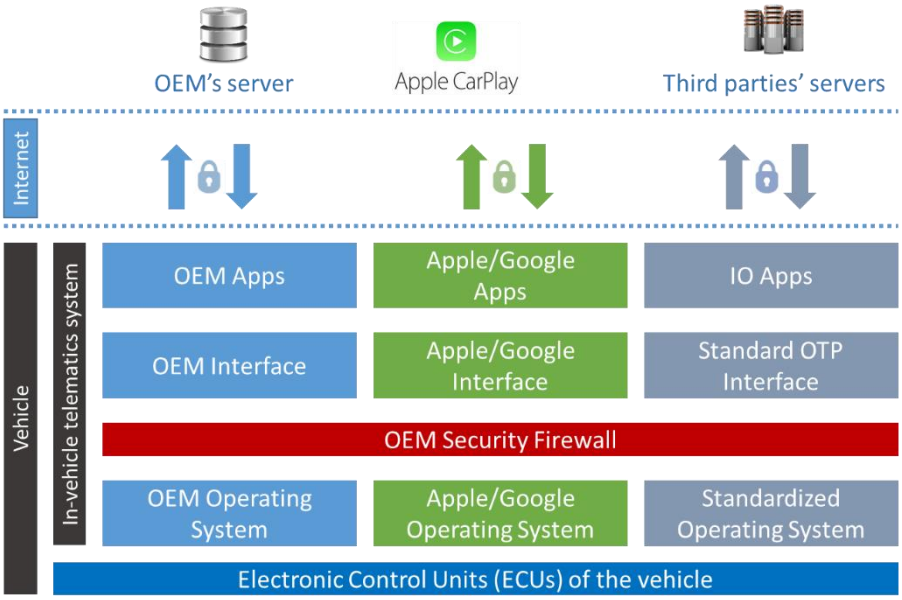

Figure 34: Access to vehicle ECU by different operating systems (illustrative). Source: TH Köln.

4.2.3.2 Effects on vehicle distribution chain

Most OEMs in Europe have started to restructure and digitalize the distribution of its vehicles, a development which was accelerated during COVID times. The agency model is gaining in popularity, with EV, and this mostly impacts European consumers by steering them increasingly to online showrooms and direct internet sales, where the dealership essentially becomes a delivery location or RMI base. This model is now being applied, or in the process of being applied, by most major manufacturers. Overall, carmakers are considering significant reductions in network size. [115]

In terms of the impact on dealers, they will become more dependent on payments for OTA upgrades even though these will be performed centrally by the OEM and not by the dealer. This is meant as a compensation for expected lower dealer revenues due to a lower intensity of maintenance services by allowing these "preferred service partners" in the customer cloud to access revenue streams from OTA features chosen by drivers to upgrade their vehicle.

The newly extended MVBER aims to address the ability of independent dealers or garages to continue to be able to offer any similar services RMI services, although it is questionable whether the upgrades to the text will prove to be sufficient in this respect.

[115] Automotive Logistics, Carmakers look to restructure European dealer network, article, 2022

4.2.4 Other regulations, developments and movements concerning data

While there is a strong consensus about the suitability of Type Approval and the Block Exemption Regulation to address the access to in-vehicle data, there are two regulations that are frequently mentioned in this context and therefore we would like to briefly comment on them, PSD2 and GDPR.

4.2.4.1 PSD2, PSD3 and Payment Services Regulation (PSR)

Since January 2018, bank customers have the right to use third party payment providers or access their bank account information through them.

This is based on the revised Payment Services Directive (PSD2), in force since 2018, with the aim to drive competition and foster innovation by reducing entry barriers for new entrants to payment services thus challenging incumbent banking institutions to open and share data. It had been revised as the original PSD had led to impaired consumer protection and competitive distortions in several areas.

Updated definitions now ensure a level playing field between different providers and address in a more efficient way the consumer protection needed in the context of payments. A common, freely available, high quality and resilient open application programming interface (API) platform provides the basis for all participants. It also ensures security as it regulates that FinTech companies must have adequate cyber risk insurance.

With only 5 years since the last version, the EC has published on 28th June 2023 a draft proposal of a revised Payment Services package PSD3 which is expected to replace PSD2. It consists of two legislative acts - the proposed draft Payment Services Regulation (PSR) and the proposed draft Directive on Payment Services and Electronic Money Services (PSD3). The objectives of the revised legislation confirm its original intentions to provide consumers with choice and competing payment parties with a level playing field. The objectives are to:

- Combat and mitigate payment fraud.
- Improve consumer rights, e.g., by providing more transparency on their account statements and on payment charges.
- Further levelling the playing field between banks and non-banks.

Overall, the functioning of open banking should be further improved by removing remaining obstacles and improving customers' control over their payment data, enabling new innovative services to enter the market.

At the time of our last study, many believed that a sector specific regulation similar to PSD2 should govern in-vehicle data access as it could address the mobility data needs of a wider stakeholder group in light of the evolving V2X and V2I questions (e.g., municipalities, cities, infrastructure providers). As PSD is continuing to evolve, the lessons learnt remain valid, such as:

- API use must be made mandatory, and the use of alternative APIs should be penalized.
- API should be extended beyond current accounts to all accounts and depots.
- Customers should be able to opt out from their data being accessible via API.

- No free of charge use of banking infrastructure by direct or indirect competitors, charge based rules of use like the telephone network.
- Option to vary the authentication depending on type of service or transfer authentication from bank to TTP for the stationary point of sales to benefit as well.

We tried to summarize some findings on the progress of PSD2 from some banking specific literature according to which PSD2 has led to several positive developments in the EU payments market since its implementation, for example:

- Increased competition: PSD2 has facilitated the entry of new players into the market, such as FinTechs and third-party providers, which has increased competition and lowered costs for consumers.
- Improved security: PSD2 has introduced stronger security measures for online payments, such as two-factor authentication, which has reduced the risk of fraud and improved consumer confidence.
- Enhanced consumer protection: PSD2 has given consumers more control over their payment data and made it easier for them to switch between payment providers.
- Innovation: PSD2 has spurred innovation in the payments industry, with new payment methods and technologies being developed to meet the evolving needs of consumers.

Overall, the results suggest that it has been a positive development for the EU payments market, with benefits for both consumers and businesses. One way of judging the progress made, is by analysing the evolution of APIs being offered per bank. This number was in 2022 on average 17% higher than in the previous year. Figure 35 indicates the latest application areas of APIs in open banking.

Another way of more generally assessing innovation in open banking is by referring to the number of FinTechs in the EU, which has been rapidly increasing over the past few years. For example, according to a report by Statista, there were approximately 5,000 fintech companies in the EU in 2017, and this number is estimated to have grown to over 9,000 by 2020. Another report by Dealroom.com suggests that the number of fintech companies in Europe increased by 35% in 2020 alone, despite the economic impact of the COVID-19 pandemic. It is worth noting that these figures may not capture the full extent of the fintech ecosystem in the EU, as they may not include smaller or less well-known players. Nonetheless, they provide some indication of the significant growth that has been taking place in the sector over the past few years.

PSD3 and PSR together with the Financial Data Access (FIDA) proposals have been developed to continue to support innovation within the European financial services industry. It is worth noting that the FIDA proposal provides banks with the option to charge for access to data. This option has been intentionally included to avoid too radical changes and a subsequent destabilization of the banking system. It is obviously being criticized by new entrants to the payment scene who consider this clause the result of lobbying efforts by the incumbent banking industry.

Despite these shortcomings, we renew our recommendation to follow the financial services industry and establish similar rules for the automotive industry.

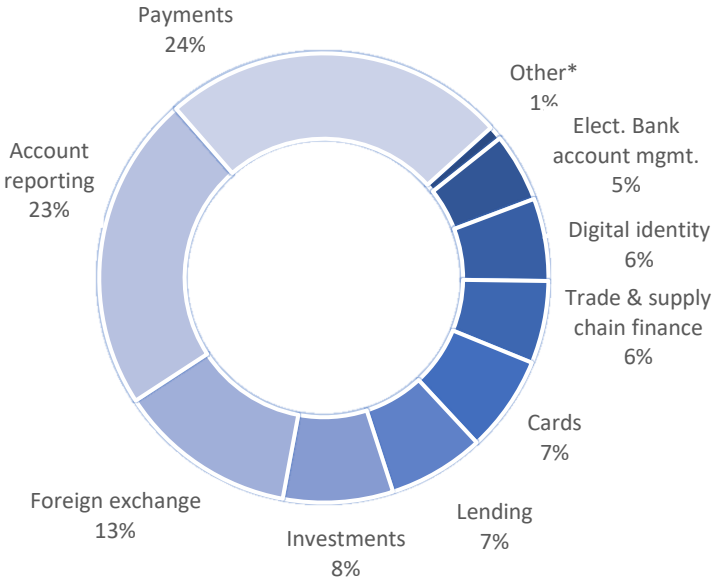

*Figure 35: APIs in the developer portals of the 15 largest multinational banks. *Other: Domain overview is not exhaustive. APIs are also being developed in other areas such as sustainability, cashpool management and virtual account management. The share of liveAPIs in those domains is however very low at the moment the analysis was conducted* [116]

4.2.4.2 GDPR

The General Data Protection Regulation (GDPR) has been introduced in 2018 with the objective to give control to individuals over their personal data and to simplify the regulatory environment for international business by unifying the regulation within the EU.

It significantly increases the penalties for companies that fail to protect the data they hold. Article 20 of the EU GDPR makes personal data portability mandatory. However, it does not provide any further details on whether this needs to happen in real-time and how often. It stipulates only that the data should be provided "in a structured, commonly used and machine-readable format" and "the right to have the personal data transmitted directly from one controller to another". Theoretically, this clause provides the ground for consumers to freely move their (vehicle) data from one service provider to another. However, even if this would be technically possible, the fact that only OEMs have control over the in-car interface with the driver, any other service provider would still suffer from significant disadvantages in providing in-vehicle services.[117]

As a side note and following up on important remarks during an interview with a start-up company active in the vehicle mobility sphere, there is a noteworthy issue that needs to be ensured by any car rental, leasing or sharing company. As every driver needs to give his or her consent to the collection of personal data during the use of the vehicle, it must also be ensured that these data remain private,

[116] Innopay Open Banking Monitor Report 2022

[117] Access to digital car data and competition in aftersales services, Bertin Martens, Frank Mueller-Langer, Joint Research Centre of the European Commission, September 2018

i.e., are deleted from the vehicle upon return to the vehicle and cannot be tracked back and that the driver may request portability of his or her data.[118]

In the past years, many cases of personal data that could be retrieved from rented or leased vehicles or from vehicles sold as second-hand cars were reported on in automotive media. As awareness for such issues amongst drivers grows, we expect the pressure for stricter compliance and transparency relating to it to increase.

4.2.4.3 Promoting innovation

The European Commission has clear priorities for innovation and launched numerous initiatives to support it. In this context, the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs supports innovation development in priority areas and in SMEs, mainly through Horizon 2020.

It aims to improve regulatory conditions for innovation with measures for start-ups, entrepreneurship, access to finance, digital transformation, Single Market, intellectual property and standards, and develops sector policies to modernise the EU's industrial base and accelerate the market uptake of Key Enabling Technologies [119].

In addition, the European Commission has made €450 million available under the Connecting Europe Facility to support digitization in transport and support to automation.[120]

It would be contrary to the European Commission's own goals to limit innovation in the IAM as this sector has recently seen new opportunities to innovate and has embraced this opportunity. For example, the OBD port and the decision of the European Parliament to maintain access to it beyond 2020[121] had given start-ups in all European countries a cause to pursue fresh business ideas.[122] To now cut it off from this opportunity would be counterproductive to the longstanding efforts.

[118] https://www.theregister.co.uk/2018/09/07/connected_cars_privacy/

[119] https://ec.europa.eu/growth/industry/innovation_en

[120] Communication from The Commission to The European Parliament, The Council, The European Economic and Social Committee, The Committee of the Regions, On the road to automated mobility: An EU strategy for mobility of the future, COM(2018) 283, European Commission, 17.May 2018

[121] '[the European Parliament] recommends that the Commission rapidly establishes an adequate legal framework to achieve EU-wide cross-border interoperability, as well as a framework laying down rules on liability for the use of the various forms of connected transport; calls on the Commission to publish a legislative proposal on access to in-vehicle data and resources by the end of the year; recommends that this proposal should allow the entire automotive value chain and users to benefit from digitalization and guarantee a level playing field and maximum security with regard to access and storage of in-vehicle data for third parties, which should be fair, timely and unrestricted in order to protect consumer rights, promote innovation and ensure fair, non-discriminatory competition on this market in respect of the principle of technological neutrality'. If approved by the European Parliament, the new regulation will come into play from 1 September 2020.

[122] While this statement cannot be supported by statistics, it is derived from the author having had multiple insights in start-ups basing their idea on the free access to the OBD port.

5 The consumer perspective

Numerous studies[123] [124] have delved into the consumer perspective concerning data protection, and privacy in the context of connected vehicles. These studies have explored how consumers are informed about vehicle-generated data and information. They have consistently revealed significant issues, including:

- **Lack of transparency**: consumers often lack clear and transparent information about how their data is collected, used, and shared in the context of connected vehicles.
- **Deficiencies in EU consumer law and GDPR:** existing consumer protection laws and the General Data Protection Regulation (GDPR) have been found to have limitations and gaps when it comes to addressing the unique challenges posed by connected vehicles.
- **Need for substantial improvements**: the consensus among these studies is that significant improvements are required to ensure adequate consumer protection in the connected vehicle ecosystem.

This report takes on the crucial task of capturing the consumer perspective, focusing on driver preferences and attitudes concerning aftermarket requirements, and it aims to shed light on consumer viewpoints in this evolving landscape.

5.1 Scope

As part of this study, a Statista survey[125] was conducted between 22 May and 5 June 2023. The survey was based on an online questionnaire and aimed to gather insights from a specific target group. This group includes individuals of both genders aged 18 to 70 who own or lease a car and are responsible for the aftercare of their car, either personally or on behalf of someone in their household.

The survey encompassed 11 countries, namely Germany, Italy, France, Spain, Austria, Belgium, Czech Republic, Denmark, Finland, Netherlands, and Poland. To ensure the statistical representativeness of the findings, approximately 1,000 respondents were included from each country.

[123] Expert study on: 'GDPR application in the context of car connectivity', EY, FIA, study, November 2021

[124] Study on the provision of information to consumers about the processing of vehicle-generated data, Final report, Ipsos and Time.lex for DG JUST, January 2023

[125] Statista, UNDERSTANDING DRIVERS' PREFERENCES& ATTITUDES IN EUROPE, independent survey, June 2023

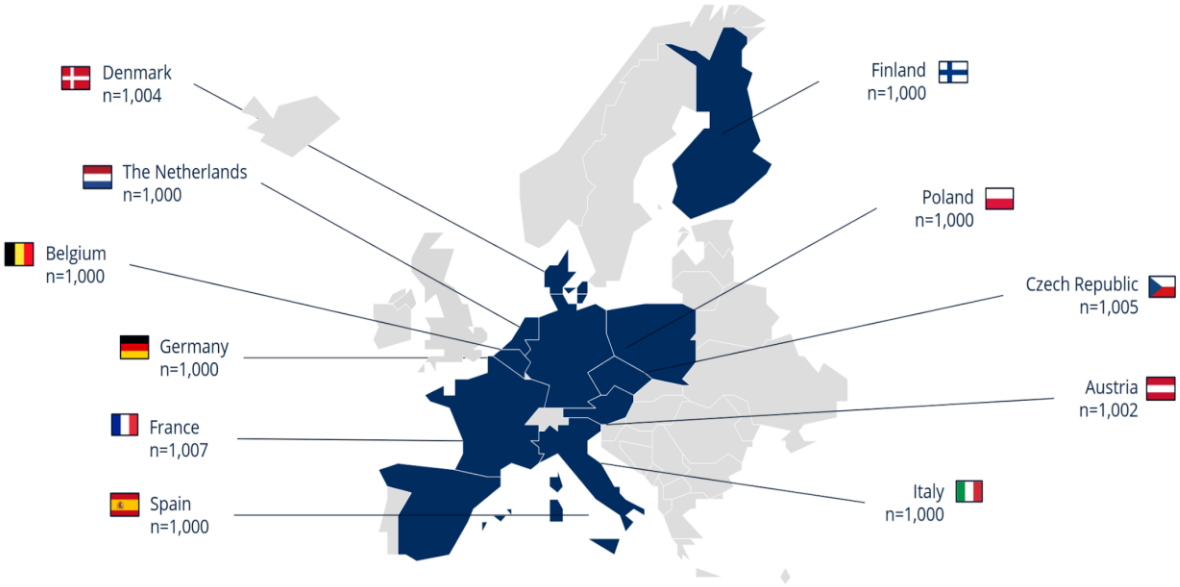

Figure 35: Overview of the EU countries where the Statista survey was held in 2023.

The survey's uniform sampling approach, spanning various sociodemographic factors such as gender, age, and region, was meticulously designed to enable robust and representative insights that can be generalised to the broader EU population.

5.2 Population

Approximately two-thirds (63%) of the survey sample indicated that they were the first owner of their vehicles. Among those, about 73% opted for an outright purchase. This percentage significantly increased to 86% among second-hand vehicle buyers.

Figure 36: Almost 80% of people purchase with own funds. Half of the population spends between €10K to €25K.

Notably, the purchase prices of these vehicles exhibited substantial variability, resulting in a considerable disparity between the mean and median values. This disparity is particularly evident when examining the price distribution among first owners, as illustrated by the histogram:

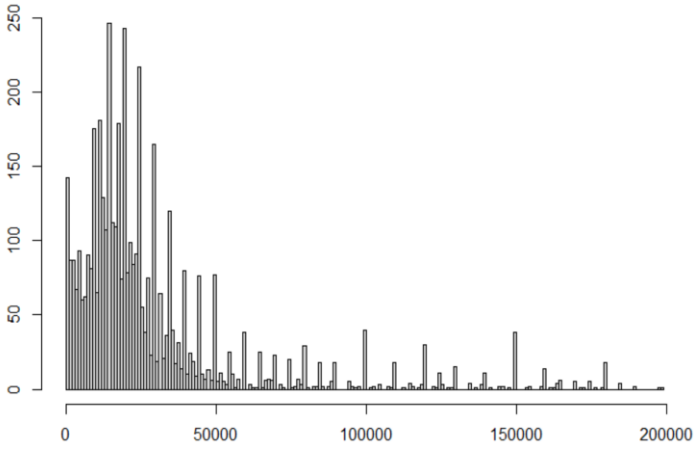

Figure 37: Purchase price sampled from the population.

For new cars, the median purchase price stood at €20.000, while for second-hand vehicles it was €15.000. Interestingly, the average price of a new car was reported to be €30.000, and for second-hand cars it was €29.000. This data suggests that the second-hand market has experienced heightened demand and price increases since 2020.

5.3 Usage

The average annual mileage has shown a decline, decreasing from 14.000 to approximately 12.000 kilometres. This shift can be attributed to several factors, including the integration of teleworking into work culture and a heightened sense of discipline in response to high energy costs.

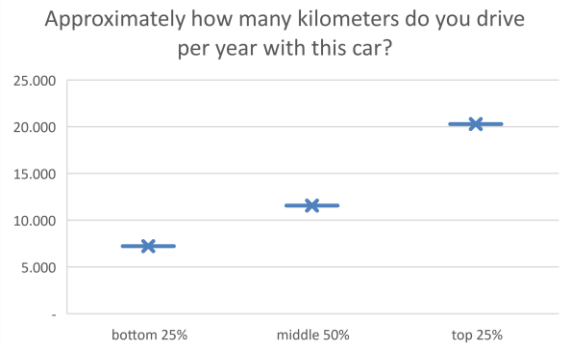

Figure 38: half of population makes between 7 000 and 20 000 km annually.

In terms of **road assistance**, the survey indicates that the need for such services has diminished, occurring approximately once every five or six years. It's noteworthy to mention that OEMs often reject providing roadside assistance when maintenance records cannot confirm exclusive servicing at authorized dealerships. Consequently, it is usually motorist clubs that come to the aid of drivers in such situations, highlighting the importance of these organisations in ensuring driver support and vehicle maintenance.

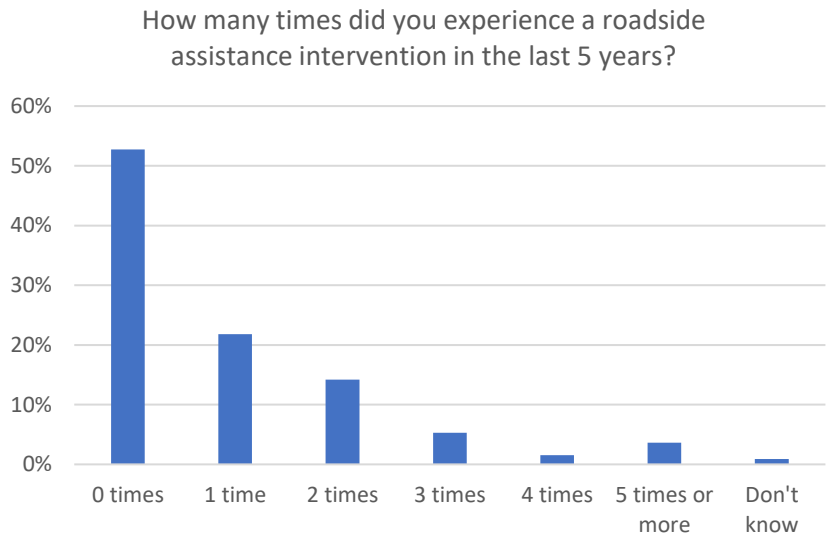

Figure 39: Chance for the need of roadside assistance grows by about 18% cumulatively per year, more than motorists expect.

5.4 Workshops

The average number of visits to a workshop for service, maintenance, or repair (SMR) among the survey is approximately 1.27 times per year. Interestingly, only 15% of respondents reported making more than 2 visits annually.

The survey results suggest that most individuals have convenient access to their chosen workshop, with a median distance travelled of 8 km (on average 12 km). This proximity is often a result of the high degree of urbanisation.

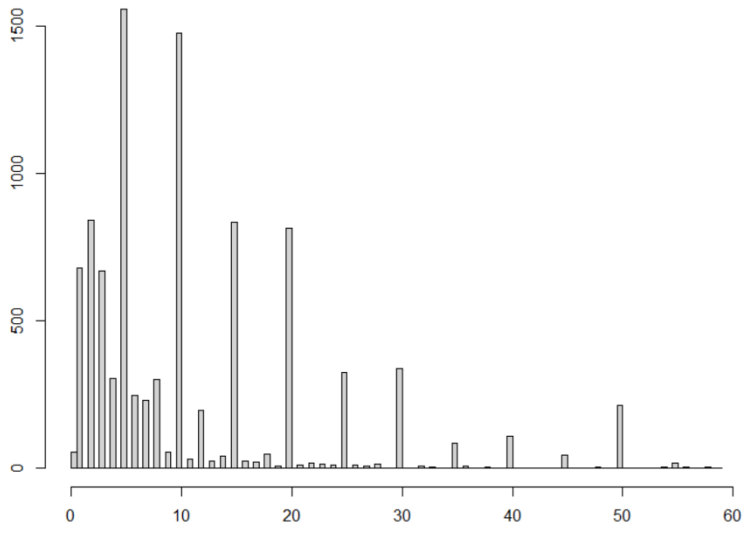

Figure 40: Proximity remains an important factor for workshops location.

When examining workshop preferences across the 11 EU countries, it's observed that 4 out of 10 respondents opt for authorized workshops for regular maintenance or in case of a breakdown.

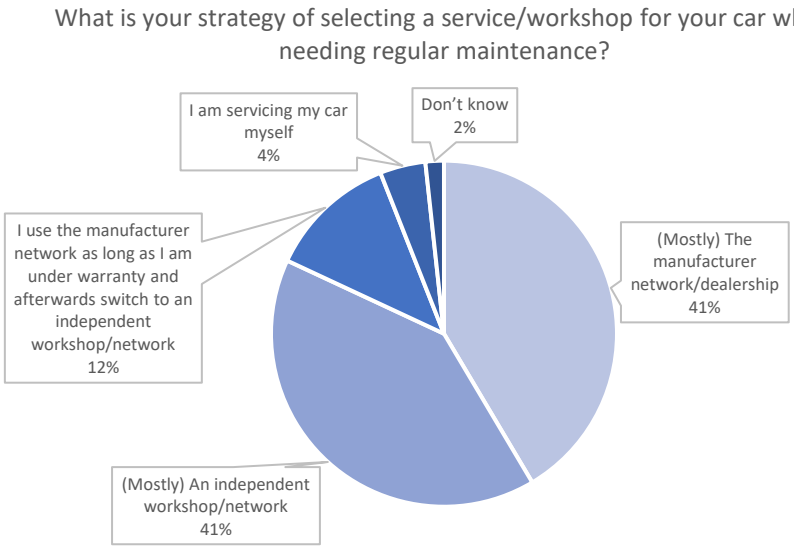

Figure 41: The eauillibrium between IAM and OEM, but warranty tips the balance in favor of OEM.

Among those whose vehicles are under warranty, a substantial 68% prefer to stick with OEMs. However, after the warranty period expires, more than half of these individuals migrate to independent workshops. This shift is likely influenced by the persistent belief that having maintenance outside the authorized network voids the warranty, a perception held by about 55% of the sample.

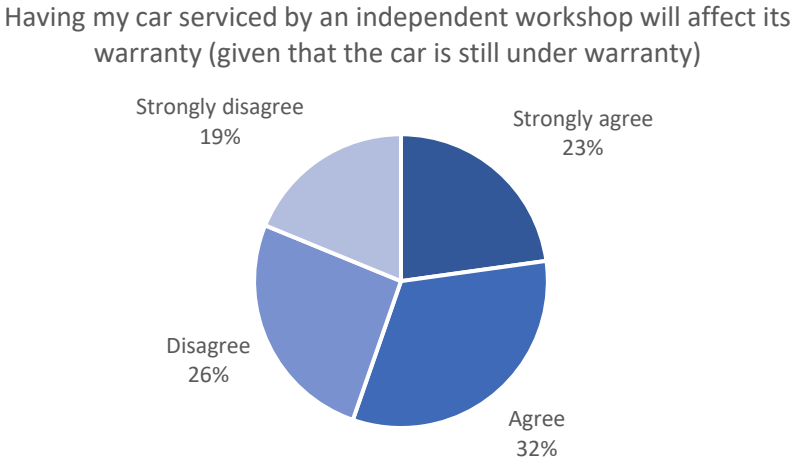

Figure 42: Most of people still believe that warranty is void if they get maintenance outside of the authorized channels.

Despite this warranty-related misconception, there is notable confidence in the independent network. Warranty considerations play a significant role in workshop choice, with 2 out of 10 respondents expressing a strong belief in better OEM quality, even if 8 out of 10 respondents agree that OEMs tend to be more expensive.

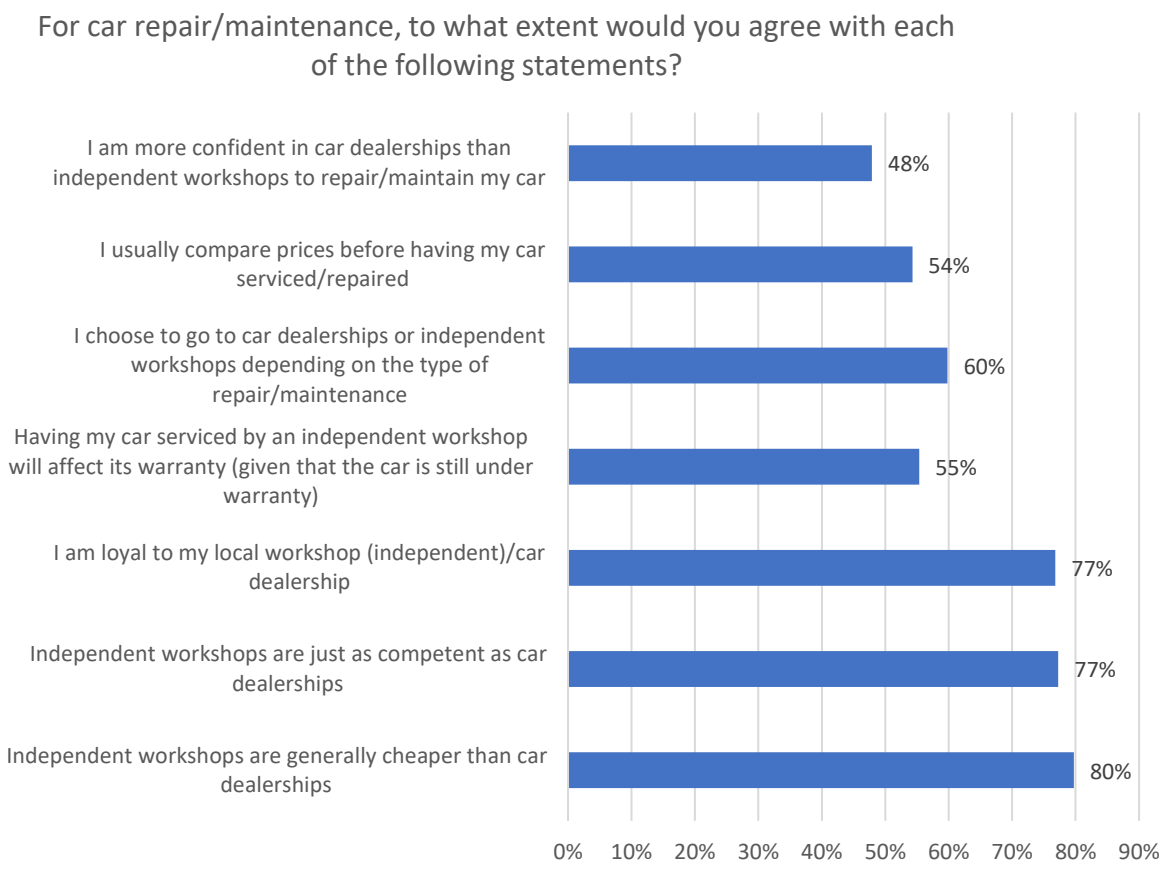

Figure 43: Overall, motorists find independent workhops quite comparable, but with better pricing.

It's important to note that, compared to the pre-COVID times of 2019, there has been a noticeable decrease of approximately 10% in the perception of price and quality of independents workshops. This may be due to the temporary impact of reduced car sales on dealership price hikes when inflation corrections were applied.

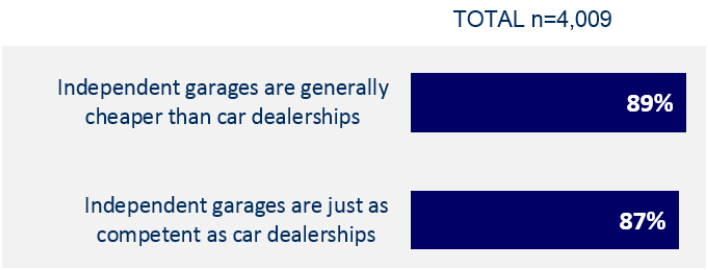

Figure 44: A result from the previous survey, indicating that the difference was more contrasting 5y ago.

The survey underscores the high price sensitivity associated with choosing a workshop, with 24% of OEM clients being highly mobile in their choices. In contrast, IAM (Independent Aftermarket) clients exhibit even greater price sensitivity, with 42% being notably responsive. However, on both sides, there's a consistent 10% who remain loyal to their chosen workshop, regardless of external factors.

This observed churn readiness aligns with the market share sensitivity curve derived in our previous study, highlighting the dynamic nature of workshop preferences in response to various factors.

5.5 Insurance

On average, motorists pay an annual premium of approximately €550 to insure their vehicles. Notably, about 4 out of every 10 individuals have opted for a full insurance type. This choice is often associated with either having a relatively new car or driving fewer miles.

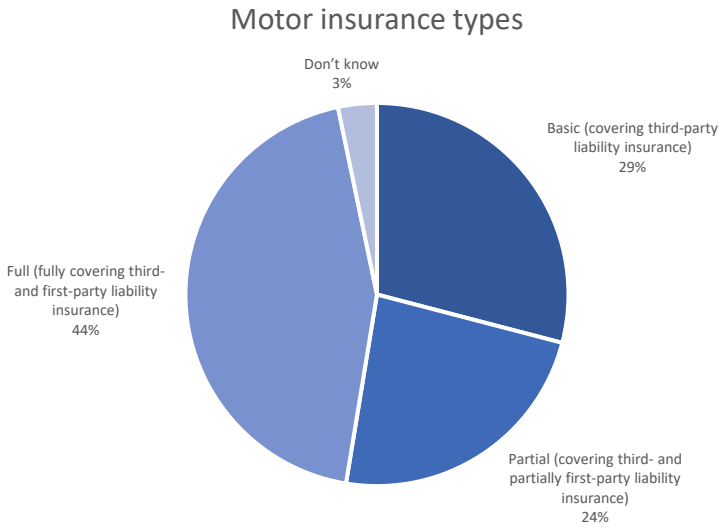

Figure 45: Full insurance is relatively prevalent in the EU.

Surprisingly, the occurrence of out-of-pocket expenses, rather than utilising insurance coverage, is more common than one might expect. These expenses also contribute to aftermarket expenditure.

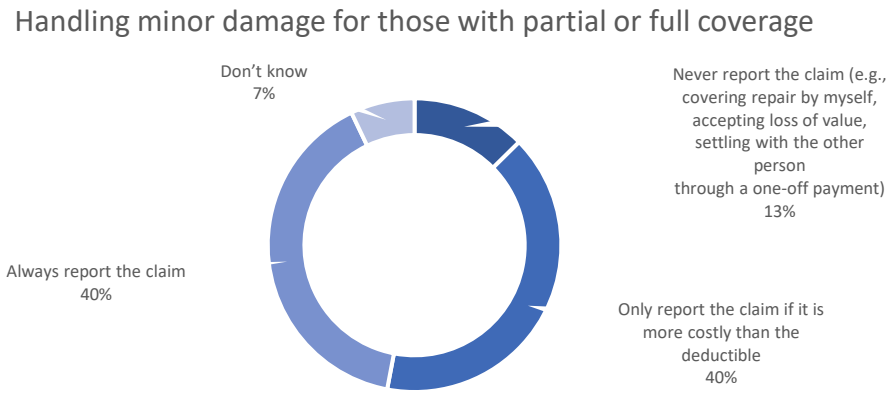

Figure 46: Minor damage is more frequent than insurance statistics tell, as many are unreported.

A substantial majority, around 85%, prefer to purchase or seek insurance online through a broker or directly from an independent provider. Bundling insurance, either at the point of purchase or as part of a motor club subscription, is relatively rare, with only 1 out of every 10 respondents reporting such a practice.

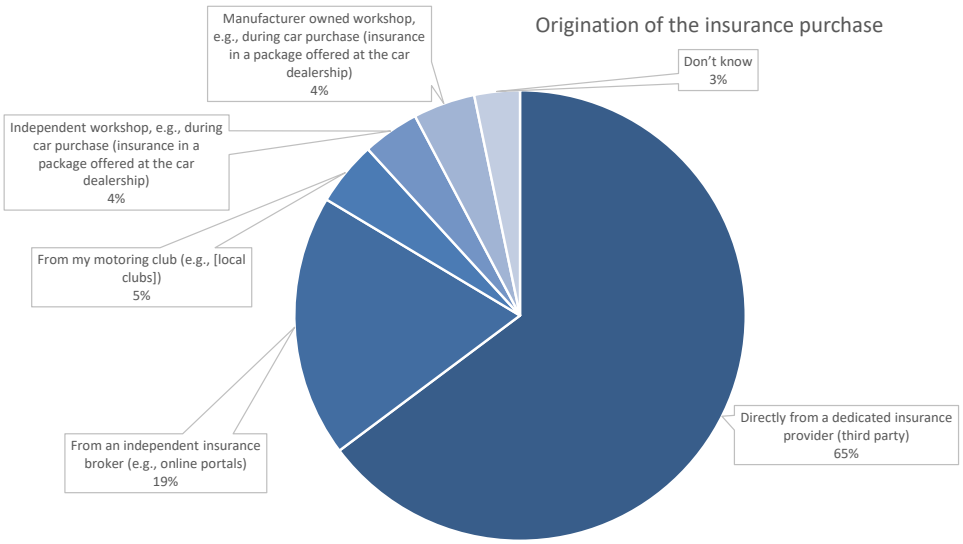

Figure 47: retail car insurance remains strongly connected to brand names.

Interestingly, loyalty to insurance providers appears to be relatively high within this sample. Respondents exhibit a price sensitivity ranging between 1 and 1.5, indicating that they are somewhat responsive to changes in insurance pricing but are not overly sensitive.

5.6 Infotainment

Around half of the respondents already spend more than €50 per month on utility or entertainment apps for smartphones, tablets, or subscription services, with average expenditure of approximately €100 per month.

However, when it comes to dedicated in-vehicle applications, the willingness to pay is notably lower, with only 3 out of every 10 respondents expressing a willingness to pay for such applications.

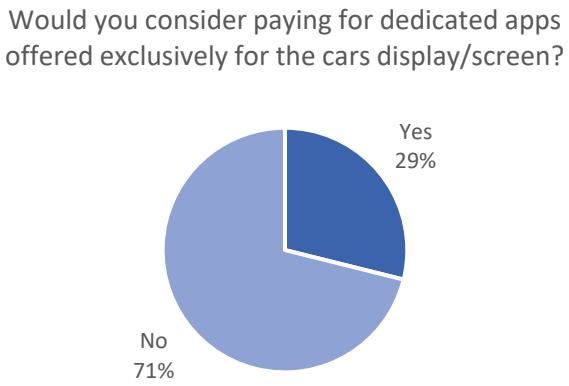

Figure 48: The appetite for paid car-only apps is relatively low.

Instead, most respondents expect to be able to project their existing apps from their smartphones into the vehicle interface. Additionally, nearly 7 out of 10 consumers anticipate encountering the same business model in their car's platform as they do on their smartphone platform. This model typically involves a freemium version that provides access in exchange for data collection or ads.

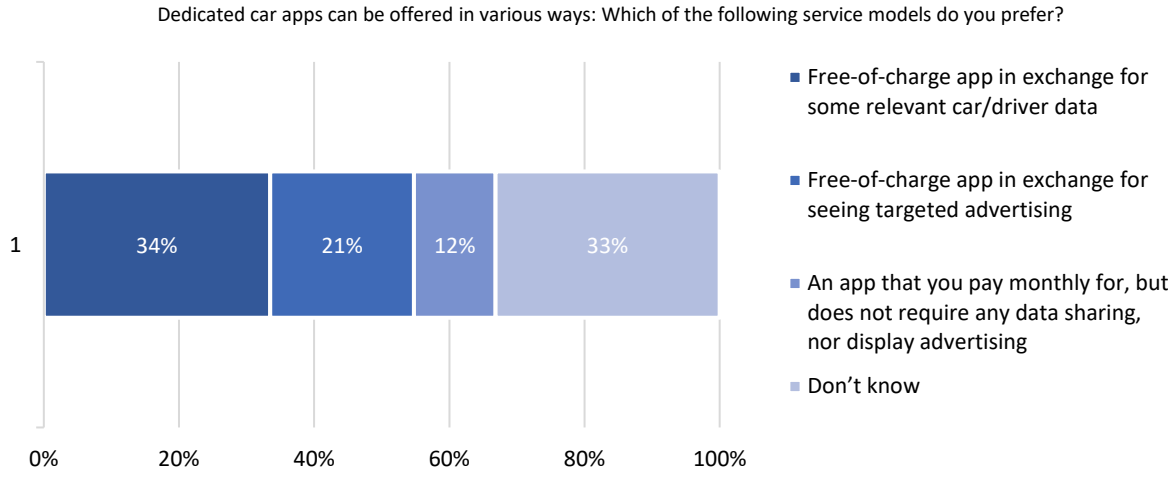

Figure 49: Charging for data or for presence on the vehicle dashboard will not easily happen on expense of the user.

In general, 4 out of 10 respondents believe that the seamless integration between their smartphone and the vehicle interface is a critical factor when choosing a car. However, when specifically asked about social media integration, a substantial 7 out of 10 respondents consider it important when purchasing or selecting a car. This underscores the growing significance of connectivity and digital integration in the automotive industry.

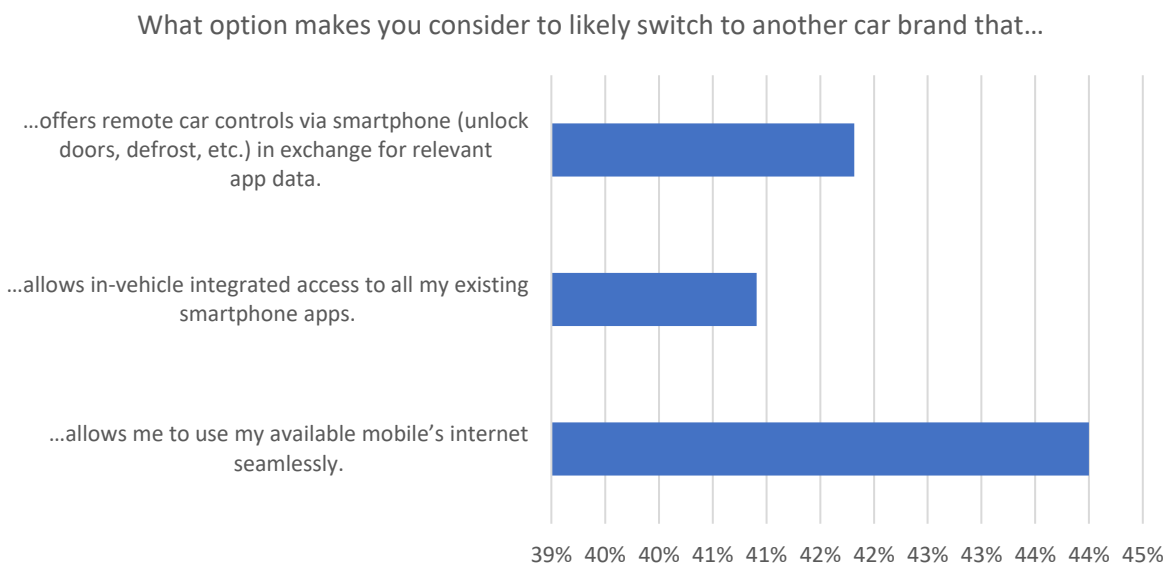

Figure 50: Car and smartphone integration seems not to be a must.

5.7 Awareness

In this sample, only a quarter of respondents have their vehicles connected through some form of telematics. Half of the respondents appear to be unaware that data is being collected or shared, which aligns with the fact that roughly half of the population seems unfamiliar with this technology.

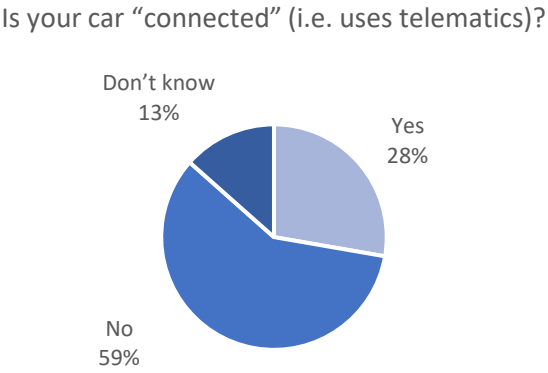

Figure 51: Simple connected devices are penetrating the market.

However, when the telematics is explained and the *option* for connectivity is offered, a significant shift occurs. Six out of every 10 consumers become engaged to the extent that factors like content, management, portability of the provider, and provider choice become important considerations.

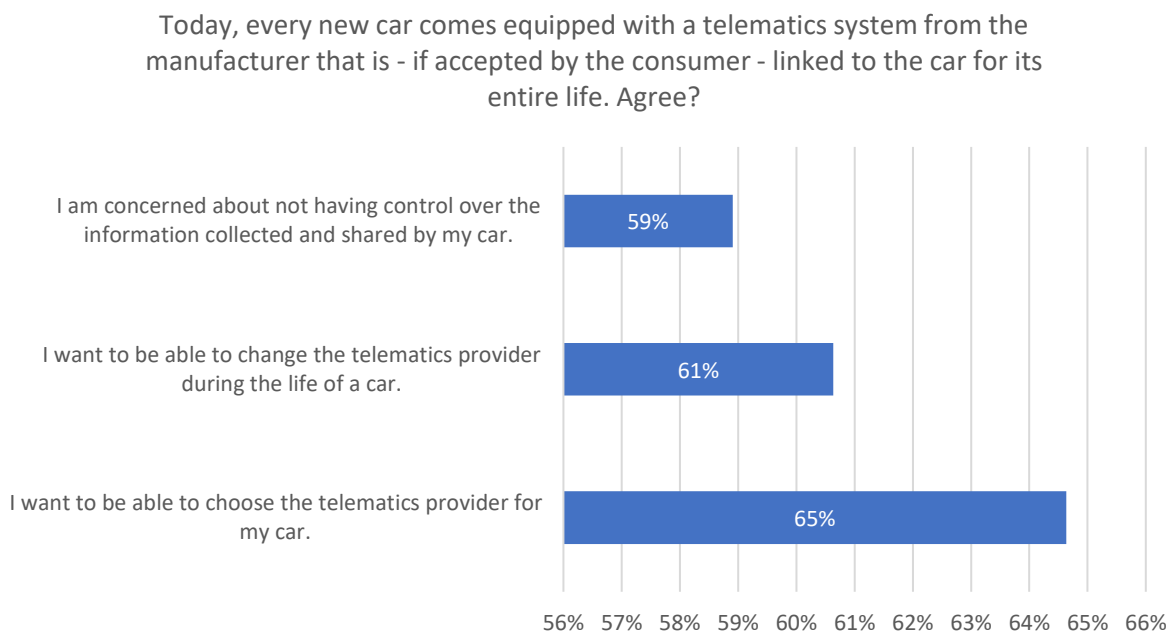

Figure 52: About 6 out of 10 is in favor of control over the data generated with their car.

Furthermore, when it comes to control over the *portability* of data from telematics, including the ability to switch managing parties, grant permission to third parties, and gain insight into the data themselves, almost 5 out of 10 respondents consider these aspects as potential dealbreakers in their choice of a car.

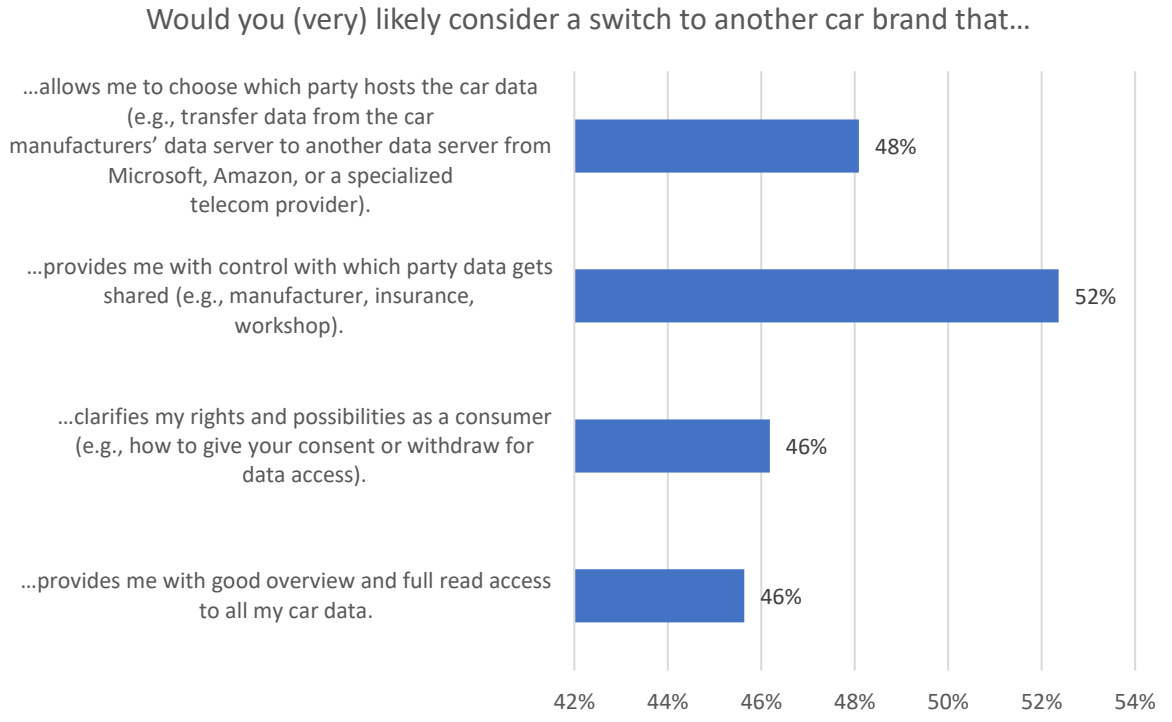

Figure 53: Half of motorists favour freedom of choice in telematics provider.

The perspective on automotive EU legislation appears to be somewhat pessimistic within this sample. Only 4 out of 10 EU consumers believe in societal benefits arising from regulatory intervention, beyond financial aspects. Meanwhile, 4 out of 10 respondents do not believe that regulatory intervention will bring about any substantial change, and 1 out of 10 expects nothing but worsening conditions. These sentiments underscore the complex landscape and varying perspectives surrounding regulatory changes in the automotive industry.

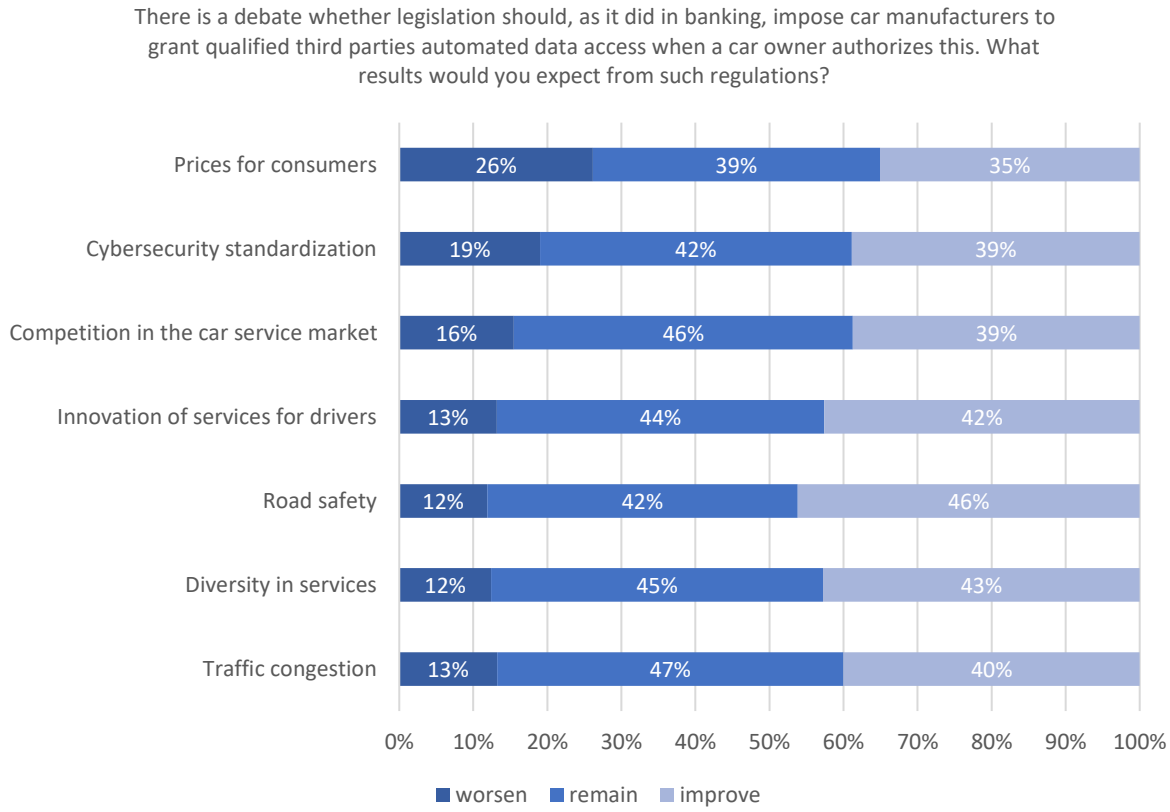

Figure 54: The motorist remains sceptic vis-à-vis benefits by regulatory intervention.

Some other survey results are used in the remainder of this study, as a basis for impact calculations or as illustrations of a trend.

6 Economic impacts

Electrification, digitalisation, and connectedness are marks of evolution in all production sectors. For example, mechanical typewriters became electric, then electronic, to evolve into laptops with documents stored in the cloud. Car connectivity represents another example of a durable good undergoing the IoT technology wave.

Access control and ownership are usually regulated in other sectors: for example, the laptop gets some updates from the maker, while the user owns the documents. However, in the automotive sector, OEM have acquired an exceptional position since early 2000: OEM self-proclaim all-encompassing ownership[126]over machine generated data, user generated data, data storage location, access, etc. In this logic, any third party that need to read your document will be billed per word or picture by the laptop maker.

This one-sided entitlement led to heated debates on the scope of the relevant rights and responsibilities for the main stakeholders, as consumers see their rights ignored[127] and independents oppose the anti-competitive behaviour[128]. Despite the turmoil and proof of infringements, this loophole has not been closed by the law makers.

There are abundant *qualitative* causes and effects analysed in literature, which are often brushed aside in legislative talks in Brussels as 'hand-waving'. However, in this study, we provide an objective and fully transparent analysis that allows an estimate of the monetary value of the privileged OEM position in Euro currency, under conservative assumptions estimated with reasonable accuracy.

In this section, a *quantitative* view is provided through five use cases with significant consequences of the lack of data/driver access control, for market share disruption and consumer spending.

6.1 Wear-and-tear

A significant part of the automotive aftermarket is comprised of services, maintenance and repair (SMR), which help customers to keep their vehicle in a roadworthy state. It accounts for 'normal' *wear-and-tear* maintenance, for necessary inspections according to usage guidelines, repairs, replacement of parts, all of which are a requirement to keep a vehicle *operational.*

SMR includes (i) standard vehicle service based on OEM interval schemes (e.g. changing engine oil, brake fluids, filters); (ii) wear-and-tear maintenance (e.g. replacing brake pads, lightning, disks, windscreen wipers, battery); (iii) mechanical/technical repairs (e.g. gearbox, tyre, turbo issues); (iv) vehicle inspection/tests (e.g. laboratory or labour, equipment, special tools).

SMR excludes (i) damage repair (non-mechanical/technical replacements or treatment of body parts) caused by accidents (cfr. next section); (ii) replacements or adaptations due to production issues that

[126] ISO 20077-1:2017, Road Vehicles -- Extended vehicle (Extended Vehicle) methodology -- Part 1: General information, and ISO 20077-2:2018, Road Vehicles -- Extended vehicle (Extended Vehicle) methodology -- Part 2: Methodology for designing the extended vehicle

[127] FIA, Independent service providers call for a swift adoption of sector-specific legislation on access to in-vehicle data, article, 2023.

[128] Bertin Martens, Frank Mueller-Langer, *Access to digital car data and competition in aftermarket maintenance services*, Journal of Competition Law & Economics, Volume 16, Issue 1, March 2020, Pages 116–141.

are covered under warranty or extended warranty, as the costs are born by the manufacturers, and performed by experts of their choice.

6.1.1 Workshop SMR expenditure

The actual annual SMR expenditure per vehicle in a workshop depends on many factors (e.g. age, mileage, driving style, use, location, power).

A study by Roland Berger[129] for German vehicles investigated the expenses versus the age of the vehicle. Unsurprisingly, younger cars need less SMR than older ones, and typically within the first 6 years, the annual average cost ranges in €200 to €300, while older cars €550 to €650. An average of €450 for yearly maintenance was valid in Germany in 2015.

Fast forward, after the pandemic and including peak inflation, as well as prolonged car usage, the average spending has gone up tremendously in northern Europe.

- The German Volkswagen states €690 per year for the average ICE vehicle[130]
- For the UK, 2023 data gives an average of €696 for SRM (but including MOT)[131]
- The Netherlands reports an average of €641 in 2023[132].

In Northern Europe, SMR expenses are in the range of €500 to €800 annually. Based on the price index, the average for the whole of Europe is lower.

In our previous study we conservatively assumed a cost of 3 €cent/km for SMR, based on an EU TREN study[133]. Taking inflation into account, the average SMR price is extrapolated to 3.5 €cent/km[134] in 2023. This is a conservative estimate, based on the low-end range, as the range goes up to 8 €cent/km[135]. The fact that consumers hold on to their cars for longer also leads to an increase of SMR costs: vehicles older than eight years increased from 50% in 2011 to 65% in 2019. The sector estimates that if this trend continues, vehicles older than 8 eight years could reach 75% by 2030[136]. This will result in higher SMR spending, as older vehicles are more expensive to maintain.

For the purposes of this study, we do not consider any potential lowering in SMR expense per km due to EV growth, as inflationary pressures would be expected to nullify this reduction over the coming years. Leaseplan reports that SMR is lower for EV by about 11% over its entire European fleet, as compared to ICE[137], which they attribute to fewer moving parts. Moreover, the difference with ICE is expected to reduce, as older EVs will also be subject to higher SMR costs.

[129] Roland Berger, Online automotive parts sales: The RISE of a NEW CHANNEL, report, 2016

[130] Volkswagen newsroom, The big cost comparison: e-car vs. combustion engine, report, 2023. Also in Germany, CG Car-Garantie Versicherungs-AG also reports that a €618 average SMR cost was already reached in 2022.

[131] Money Helper, a UK government-approved online advice service, article, 2023.

[132] BOVAG, Aftersales monitor, article, 2023

[133] Maibach, M.; Peter, M.; Sutter, D. (2006): Analysis of operating cost in the EU and the US. Annex 1 to Final Report of COMPETE Analysis of the contribution of transport policies to the competitiveness of the EU economy and comparison with the United States. Funded by European Commission – DG TREN. Karlsruhe, Germany.

[134] Stefan Gössling et al., The lifetime cost of driving a car, journal paper, Elsevier Ecological Economics, 2022.

[135] ibid.

[136] BCG, CLEPA, Wolk, At the Crossroads: The European Aftermarket in 2030, report, March 2021.

[137] Leaseplan, Total cost of ownership: How electric vehicles and ICE vehicles compare, article, Joel Wetterhahn, Feb. 2022

According to ACEA[138], in 2018 a single passenger/LCV vehicle mileage was on average 14.000 km per year. During the pandemic of 2020-2022 this amount decreased by 15% to circa 12.000 km annually[139], and these statistics are expected to persist, as structural home office arrangements have come to be widely accepted and growing energy prices result in more mileage discipline.

Combining the cost per km (3.5 €cent) with the average annual distance (12.000 km), we estimate the annual SMR for European vehicle owners:

Average annual workshop wear-and-tear maintenance expenditure per vehicle in Europe ≈ 420€

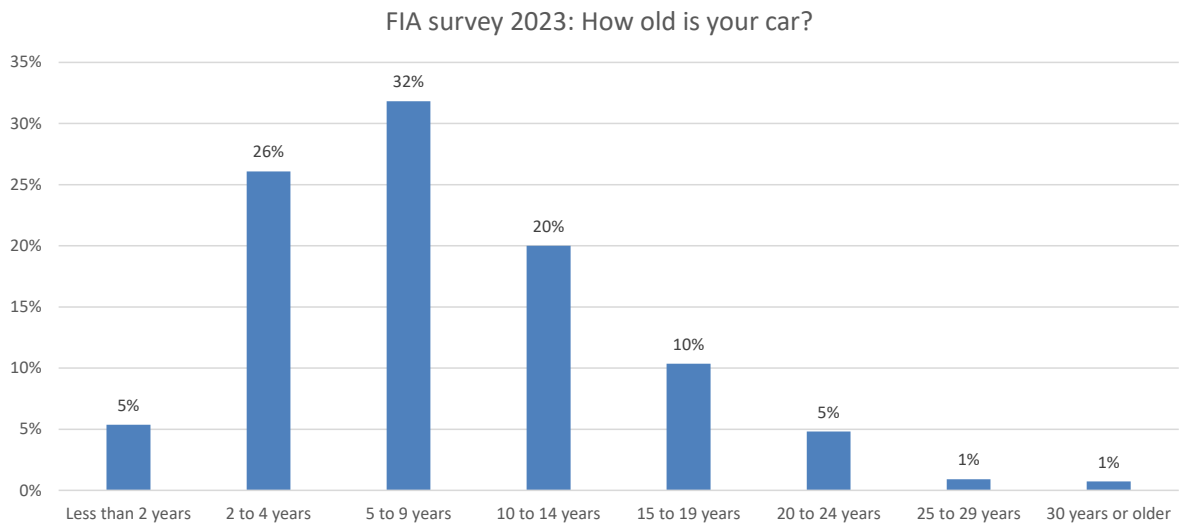

Figure 55: In the Statista survey, the average of the vehicle age was about 8 years for the 11 EU countries.

Based on the European fleet (360 million vehicles) in use in the European region, the total estimated revenue generated in workshops is:

$$360\ M * 420 \approx €150\ B€$$

Therefore, SMR in workshops is estimated at about half of the total €280 billion aftermarket value. Based on findings in our previous study[140], applying that OEM prices are about double at OEM SMR, an average SMR thus costs €310 at IAM, compared to €630 at OEM.

6.1.2 Workshop market

Workshops or garages make up most typical aftermarket intermediaries: they repair, replace parts and perform the maintenance of the vehicles. As per Wolk After Sales Experts GmbH data from 2022,

[138] ACEA, Vehicles in use in Europe, report, 2018.

[139] Ibid.

[140] Quantalyse Belgium, Schönenberger Advisory Services, (2019) "The automotive digital transformation and the economic impacts of existing data access models", Technical Report.

there are approximately 468.000 workshops in Europe (not EU, Europe)[141]. Excluding Russia and Turkey, 410.000 units or aftermarket workshops in the European region for 2023.

Regarding the partitioning in number of physical outlets, the report mentions there are on average about 19% OEM affiliated vs 81% IAM in Europe.

Thanks to -both- larger car park per workshop size (on average factor 2) and higher pricing (on average factor 2), OEMs can generate half of the revenue of workshops, by means of only one fifth of the workshops, servicing only one third of all vehicles in operation[142].

6.1.3 Data charges impact

Currently OEMs are claiming full ownership of the vehicle (and driver) data. Their profit margin on data access tariffs is considered large compared to the actual cost, and the investment costs are included in the list price of a new vehicle and is paid indirectly by the consumer, so the consumer pays twice when visiting IAM.

Contrary to other IoT products, in the automotive sector seems to have gained acceptance for consumers to pay to access data they themselves generate during vehicle use, annually at service, maintenance and repair (SMR) visit. This is exceptional, as legislation already imposes OEMs to share “information”, but it does not keep pace with technology and omits to specify that also vehicle generated data and communication with the driver are considered “information”. This major loophole in regulation is actually creating a profound imbalance in the sector.

The current legislative void, as outlined in previous sections, provides opportunities for OEMs. There are a number of ways that OEMs create a steady revenue stream from data-based services from the independent aftermarket workshops network:

- The static data charge- about 340.000 IAM workshops pay about €3.000 annually for accessing repair manuals, diagnostic code definitions/procedures, and RMI database lookups, which represents €1 billion annually (€5 per vehicle). OEMs can and effectively do systematically increase one-sided their rates beyond indexation without any improvement or change in the service or content[143], such that the publisher companies are expecting prices at least to double by 2030, amounting to €2 billion annually.

- Realising more and more that good SMR needs accurate information concerning parts and serviceable elements, companies want to enrich their offering -in a first step- with anonymised raw data and simple analytics bought from the OEM. It is an insignificant revenue today, as OEMs are foot-dragging, but is expected to amount to €2 billion annually by 2030[144].

[141] Databook, *Garage Structure in the European Car Aftermarket 2022*, Wolk-aftersales research, 2022

[142] Quantalyse Belgium, Schönenberger Advisory Services, (2019) "The automotive digital transformation and the economic impacts of existing data access models", Technical Report.

[143] Wolk Aftermarket Experts, On the impact of the various Policy Options of the EU initiative for access to vehicle data, functions and resources, research paper, ADPA, 2022.

[144] Cap Gemini, The vehicle data big bang - How to turn theory into reality, study, may 2022.

- Instead of a connector to the vehicle via a diagnostic tool (OBD2 connector via connected area network (CAN) bus protocol), modern protocols like e.g. Diagnostics Over Internet Protocol (DOIP) introduce the OEMs as a middle man with an obligation for recurrent payments for dynamic data to access the advanced connected vehicle, e.g. during the process of OTA updates. Overall, OEMs charge an additional amount of between €2 to €10 per vehicle required per workshop visit, depending on the brand and depth of the inspection. For example, BMW[145] charges €5 per month to access a limited vehicle data set. If this assumption is applied to the entire IAM car park of circa 240 million units, this would cost consumers about €1 to €3 billion annually if all cars were advanced connected vehicles (around 2050).

Many independent workshops would like to carry on using their traditional aftermarket diagnostics and information tools, but these are increasingly becoming ineffective. Diagnostic tools are failing[146] to keep up with vehicles built after 2018 (incompleteness of makes, many workarounds, security bottlenecks, multiple logins, difficulty in reverse engineering aftermarket tools etc). Hundreds of thousands of users in Europe have already turned to OEMs or dealer diagnostic solutions giving them faster and more reliable fixes, despite the cost being significantly higher. The increasing charges relating to accessing data imposed on IAM companies is a major driver of client conversion to OEM captives.

6.1.4 Predictive SMR impact

Because OEMs can capture the client relationship through their level of control over communication and data access, they are able to increase the capacities of their workshops, as they can direct those customers to their own workshops. The diagnostic and prognostics feature represents for OEMs one of the most valuable advantages in client conversion to their own network. We see two scenarios that will develop:

Scenario 1: Do nothing.

- Surveys demonstrate the strong pull that remote diagnostics exert. The feature of preventive maintenance is overwhelmingly appreciated by about 92% of those who have utilised it (40%), as was found in the SSI survey[147] in 2018. Moreover 42% indicated that they would immediately respond to a remote diagnostics alert message by going to the OEM. In the recent Statista survey, this proportion is lower, with 34% of respondents indicating that they would react, of which 10% were *very* likely to switch to OEM upon dashboard communication.

- OEMs can expect to increase their current customer base by about 24 million additional clients (10% switches of 2/3 IAM customers of the total 360 million units), increasing turnover related to SMR at OEMs by €8 billion annually (24 million at €310/y) at the expense of IAMs. Paradoxically, these consumers miss out on €8 billion of savings in doing so. The stakes are high maintaining a monopoly over predictive maintenance and prognostics: it is estimated to be an annual source of revenue of approximately €16 billion EUR.

[145] BMW, BMW CarData price model, price list, accessed jul 2023.

[146] Maverick, Diagnostics Terms Explained, publication, 2023.

[147] Assessment of the potential consumer response to the Extended Vehicle approach, Global report I Research Now SSI, December 2018.

- Advanced connected cars have a minor presence today and the cost to consumer and IAMs is estimated to be €1 billion EUR. However, this increases to €2 billion by 2030. The slow pace of client conversion allows for authorised garages to steadily attract more clients from the independent network or acquire their portfolio via mergers.

Scenario 2: emulation of prognostics

- To compete with OEMs, an IAM workshop must 'emulate' predictive maintenance, assuming a lower frequency of every two months, as compared to daily, to save costs but remain relevant. An IAM would have to pay OEM data charges of about €30 (€5/month times 6) per year per client on top of the €310 annually to follow-up and make a phone call or send an SMS to his client (not via the vehicle HMI) whenever his data analysis indicates the need for SMR.

- That is an enormous increase in cost for independents, circa 10% on their SMR revenue. There is no way for an IAM to absorb this cost and remain competitive, as the OEM data charges altogether coincide with the average IAM profit margin on SMR. Therefore, IAM prices will go up, and they will lose clients, who paradoxically will pay more at OEM.

- Despite the low supply demand elasticity of 0.6 for workshops (elaborated in our previous study), an extra 10 percentage point shrink in the price difference, would imply a 6-percentage point market revenue churn to OEM, so €9 billion loss. Moreover, motorists would be subject to higher pricing at OEM of the same order, resulting in a total of €18 billion loss.

Without a legislative level playing field, the independent workshops are unable to compete with OEMs in the field of predictive maintenance at current prices. Note that we have not considered a scenario where the workshop installs aftermarket telematics devices or share that cost with insurers (which is impractical with all kinds of different systems to keep oversight). The reality will result in a mix of the two above scenarios, but in both cases losses in market share and increasing expenses for consumers are inevitable.

Mind that we ignored the cost of hosting data, software and maintenance of the system or costs of third-party facilitator companies to realize the emulation of predictive maintenance scheduling. Also costs of consent, support, training, cybersecurity etc are ignored. Yet, all these additional complexities exacerbate the significant friction in the aftermarket.

6.1.5 Warranty impact

In Europe, about 15 million new vehicles (of type PV and LCV) are purchased annually. The most common source of claims against a vehicle warranty concern safety feature, followed by issues with the powertrain, the chassis, and -increasingly- the electronics[148].

[148] Berylls, How OEMs could save millions in warranty costs by making full use of vehicle data, study, 2021.

The MVBER regulation stipulates that manufacturers cannot invalidate the end users' guarantee for using a dealer that is not a franchisee for Service Maintenance and Repair (SMR) – as long as the garage of their choice (i) does not carry out the work faulty; (ii) follows the maker's service schedule and (iii) uses original equipment parts for replacements covered under warranty.

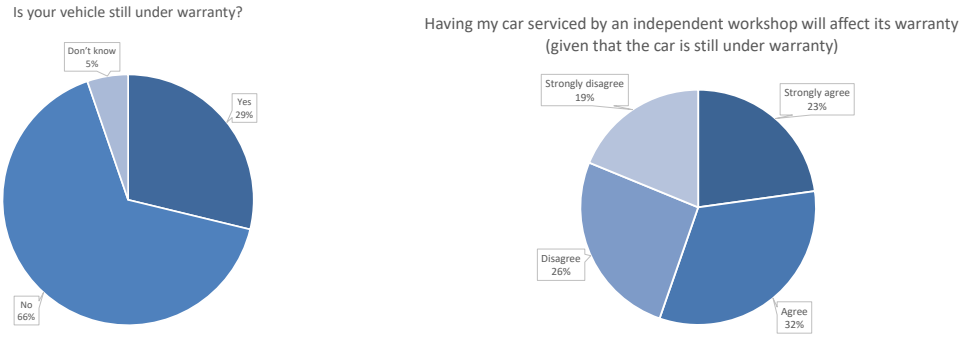

Figure 56: about one third of vehicles is under warranty, and 55% of people thinks that they lose warranty if they don't go to an authorized workshop. Source: Statista survey

New car owners typically receive a warranty period of on average 4 years when they purchase their vehicle, so new vehicles are under warranty for one third of their average lifetime[149]. From the Statista survey, 55% of motorists choose an OEM for SMR during the warranty period, as they believe the warranty would otherwise be voided. Clearly, information asymmetry still means that, despite legislation, IAM has very limited access to the new car park.

Without that bias, consumers would stick to the "usual" proportion of 33% OEM share, so 22 percentage points (55% minus 33%) of this warranty segment could churn to IAM. That corresponds to about 22 million units that would normally be a customer at IAM. This imbalance leads to an annual revenue loss for IAM of €7 billion, and the consumer misses out on €7 billion of savings in paying more at OEM. Thus, information imbalance brings revenues to OEMs in the height of €14 billion annually and have a strong incentive to keep a monopoly on direct communication with drivers via the HMI.

Evidence gathered throughout the value chain, however, indicates that infringements on warranty rules still occur on a large scale, such as refusal by OEMs to refund warranty costs if SMR took place at Independent Service Provider (ISP) workshops; or refusal by OEMs to repair a vehicle under warranty unless a service history in an OEM workshop can be submitted. As such, experts are very critical about the locked-in warranty segment: there are multiple infringements by OEMs (eg rejection of road assistance if vehicle is not maintained in the authorized network) that reinforce the pattern. Unless regulation allows equal driver communication access for independents, there is no change to be expected at all.

Mind that we do not count the specific expenses *covered by warranty labour/parts itself* as loss for IAM, simply because it is a cost already paid for by the buyer of the vehicle at sales point. OEMs set aside sales revenue to cover these expected future expenses due to their production faults: for the European region OEMs accrue about €10 billion annually (circa €700 per vehicle) [150].

[149] Statista, Understanding Drivers' Preferences & Attitudes in Europe, survey, FIA, July 2023.

[150] Warranty week, Worldwide Auto Warranty Expenses, publication, 2022.

6.1.6 Total impact

In the above sections, we demonstrated that the data charges of OEM embedded telematics consume much of the profit margin otherwise available to IAMs.

Without equal access to communication with the customer/ driver, IAMs are disadvantaged in three ways: (i) the OEMs place themselves as middle man between the motorist and his vehicle monetizing any use of data; (ii) IAM suffer a major client conversion towards OEM in the realm of prognostics and predictive maintenance; (iii) IAM are denied access to a significant part of the newer aftermarket vehicle segment.

The following table summarizes the impact estimations in a time perspective, depending on the penetration of the advanced connectedness.

Independent Aftermarket Loss Impact [€Bn/y]	**2023**	**2030**	**2040**	**2050**
advanced connected	7%	15%	60%	100%
Data charges	1	4	5	6
OEM predictive SMR	1	2	10	16
OEM warranty	1	2	8	14
Anticompetitive advantage in repair/maintenance	**3**	**8**	**23**	**36**

Independent workshops are significantly disadvantaged: they are bound to lose clients over the next decade due to the lack of access to the driver and the vehicle data. The €5 billion revenue shift this decade implies a market share shift of 3 to 5 percentage points revenue towards OEMs. It affects about 10.000 to 20.000 independent workshops: and it is estimated that by 2030 these either close or will be taken over by OEM agents.

6.2 Insurance repair

The insurance market is an industry of its own, but it overlaps with the aftermarket services sector for motor vehicle insurance. This section deep dives in this interaction.

A major revenue source in the aftermarket comes from insurance salvage, based on savings that can be made on costs to get a vehicle back into operation after collision or crash related services or parts, excluding full reimbursement in case of a total loss.

6.2.1 Relevance

Motor third party liability (MTPL) insurance covers, at a minimum, the cost of material damage and bodily injury caused *to a third party* by the policyholder. Additional motor insurance cover provides, in addition to MTPL, insurance to varying degrees for injury to the *policyholder himself*, and the cost of damage to or loss of the policyholder's own vehicle.

The insurance industry is one of the key actors in the aftermarket spending premiums to bring vehicles back to roadworthiness after a *random* event, as compared to the normal wear-and-tear case.

6.2.1.1 Motor insurance premium

Consumer pay an annual motor insurance premium, both for the mandatory third-party liability cover and additional damage cover, should they wish to cover claims for vehicle collisions or damage for other reasons.

Typically, the minimal type, compulsory Motor third party liability (MTPL), accounts for 55% of total motor premium[151], and optional covers (damage caused by car glass break, fire, hail, freezing, etc.) account for the rest.

Europe accounts for about one third of the global world motor (gross written) insurance premium volumes, which in 2020 amounts to circa €150 billion, according to the most recent report by Insurance Europe[152]. Correcting for inflation post pandemic (15%)[153], allowing for 2% growth and an additional correction allowed for any underrepresentation of 94% of the market, leads us to an estimated motor premium level of circa €175 billion in 2023.

[151] Insurance Europe, European motor insurance market, report, February 2019.

[152] Insurance Europe, European Insurance Key Facts, report, 2022. Remark we exclude turkey, but include Belarus and Ukraine.

[153] Compare the market, UK report, 2023.

6.2.1.2 Motor insurance claims

The typical motor insurance average Loss Ratio (LR) is about 80% (and on the higher side due to more increase in expenses than premium[154]), which implies a total of motor claims[155] of circa €140 billion in 2023.

Only about half of reported claims are spent in the aftermarket, since the following elements need to be deducted:

- Firstly, only material damage to the vehicle is considered[156], for which insurers outsource the repairs and handling, to return the vehicle to an operational state. This involves replacement of parts, bodywork, storage, expertise, labour costs, etc. While the typically much higher claims of bodily injury are largely reinsured (ceded to a reinsurance company), the insurer still shares part of this. The aftermarket services are not related to these bodily injuries[157], which means about 30% of the total motor compensation needs to be deducted.

- Secondly, the motor claims amount includes heavy and special vehicles costs, which are about ten times higher than for passenger vehicles, although the frequency is only half as there are relatively much less of those on the road. We infer from these facts that this segment accounts for roughly 4% of the claims, to be deducted as well.

- Thirdly, when a vehicle is deemed a total loss, insurers typically auction the vehicle through a salvage vehicle marketplace, which decreases the official claim cost. Moreover, insurance companies reduce their claim costs by increased use of recycling parts from total loss vehicles, which is not officially reported. Yet, to account for total loss, and also for vehicle theft, we deduct overall about 15% of claims due to 'total loss' vehicle direct reimbursements, since this is money that is not spent in the aftermarket.

From the Insurance Europe data, with some adjustments specific to the aftermarket part, we arrive at a *reported* total operational spending by insurers of about €44 billion annually to get the vehicle back on the road after random events involving the passenger/LCV motorist in Europe. This corresponds to an average damage claim amount of €122 EUR per insured risk in 2023.

6.2.1.3 Out-of-pocket expenses

However, there are some significant costs that are incurred by motorists, but not incurred by insurers. Such expenses are underrepresented in the statistics of the insurance industry, but should be included, as they are substantial in the aftermarket portion linked to random events.

- Firstly, the excess amount that the policyholder is responsible for paying towards the cost of a claim, also called deductibles or franchise, is not part of the claim reported by the insurers.

[154] McKinsey, Global Insurance Report 2023: Closing the personal P&C protection gap, march 2023.

[155] The reported technical claims figure excludes the insurers's operating expenses, like expenses for underwriting, administration, claims handling, marketing, cost of capital, taxes or reinsurance cost. Therefore, we avoid double counting, recognizing that it is revenue belonging to another industry.

[156] We ignore the expenses to property damage (e.g. fences, lamp posts, car ports or other infrastructure), as these are considered negligible in the reported breakdown of claims severity by insurers (usually only injury and damage).

[157] European Insurance and Occupational Pensions Authority (EIOPA), Market Development Report, 2020.

One can determine that with a 10% annual average *damage* claim frequency[158] on 360 million motor risks, that about 36 million will annually report an insurance claim in Europe. Taking a conservative amount of €500 EUR deductible per claim into account, this leads to an add-on of circa €18 billion annually[159].

- Secondly, the consumer's cost due to the so-called betterment clause is not reported (eg pay extra for receiving a new part for an aged car). As this loss is also publicly underreported, we make our own conservative estimate at a mere 10% of the above deductible, which amount to circa €2 billion annually.

- Thirdly, there is a substantial amount related to 'roadside assistance' expense (e.g. towing, roadside tyre/engine repairs/parts, lockout, fuel delivery, but excluding rental or persons transport), which is also aftermarket revenue. In general, assistance insurances are thinly reported, but are estimated[160] to represent a market volume of circa 7 B€ annually in Europe. On average about 1 out of 5 motorists require breakdown assistance annually[161]. The premium is about €100 EUR for most offerings, and we estimate claims of about €60 on average. Therefore, we can estimate an additional €4 billion annually spent in the aftermarket.

- Fourthly, about 20% of the European population chooses MTPL only[162]. This implies that they must pay out of their own pocket for their own vehicle damages. Such costs are not reported by insurers. Having an average damage claim frequency of 10%, and an average damage claim cost of €1.222, we assume that about €9 billion is spent on own vehicle damage uncovered.

- Fifthly, many vehicle incidents are unreported. Policyholders are not reporting damage to their insurance and paying out-of-pocket, for fear of rates being increased, losing the no claims bonus or the company refusing to insure them. For example, when there is no injured, and the damage is minor, both parties may settle in agreement without reporting to the authorities or without filing claim to insurers. Not reporting is especially the case when there is no third party involved, but vehicle damage has occurred. We assume that the number of unfiled accidents without fatalities is typically about double the number of filed claims[163]. Thus, we assume annually 10% of vehicles experience small damage accidents. If each cost about €250 (we conservatively assume half of the deductible as this is a trade-off point for reporting), which comes to roughly €9 billion annually.

From our own conservative estimates, we arrive at an ***unreported*** cost estimate of circa €42 billion annually for the passenger/LCV driver in Europe. As a rule of thumb, in terms of damage only, motorists cover out of pocket expenses for repair in the *same order of magnitude* as the official claims amount paid via insurers.

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[158] Insurance Europe, European motor insurance market, report, February 2019.

[159] Forbes Advisor, Car Insurance Facts and Statistics, article, 2023. Premiums would be between 7% to 28% higher on average, if deductibles are included, which confirms our estimate.

[160] Precedence Research, global and regional roadside assistance market report, 2023.

[161] Most European assistance clubs (ADAC, VAB, ANWB, etc) report technical interventions between 10% to 30% of members annually. As a rule of thumb, a technical intervention happens to each vehicle once every 5 years. In the Statista survey a 6 years interval is reported.

[162] Assessment of the potential consumer response to the Extended Vehicle approach, Global report I Research Now SSI, December 2018.

[163] Driverless car market watch, article, 2020. "*The RAND report points out that many accidents are not reported. The relationship of actual to reported accidents is not clear; some scientific studies have shown that it may be in the range between 2 and 4. The US Census uses the factor of 2 to estimate the number of accidents from the number of crashes.*"

6.2.1.4 Aftermarket volume

In total, the aftermarket expenditure due to 'random events' (as opposed to the ongoing wear-and-tear volume), amounts to circa €86 billion annually for passenger/LCV segment drivers in the European region.

This calculation demonstrates that, all in all, random events drive about one third of annual expenditure in the aftermarket, with equal contributions from insurance schemes and motorists' expenses.

Although consumers ultimately pay the claims via the premium, insurance companies are the intermediaries who have a major impact on the decision *in which network* the salvage/repair may take place.

Independent car insurers keep professionalising and optimising their claims management, not least by routing accidents to the independent repair shops and independent parts suppliers. On top of that they are issuing more and more motor insurance policies with binding repair shop and replacement parts stipulations. It is an economic decision, in favour of both insurer and consumer, which keeps the premium low.

OEM captives put the OEM first, through exclusive repair servicing in the OEM-authorised network with OEM-certified parts, even if this turns out to be more expensive for the consumer and costs them market share. In the next sections, we will demonstrate how the OEM captive insurers can simultaneously gain market share and grow this business, by leveraging on the exclusivity over driver/data access and digitalisation of the vehicle sales process (where insurance becomes just like any another vehicle option to select at purchase point).

6.2.2 Usage Based Insurance (UBI)

6.2.2.1 Definition

In the past, insurance premium discounts were given for having the seatbelts, when they were not yet obligatory, as they led to less injury and thus less claims. Today, consumers can benefit from premium discounts if their vehicle is equipped with active safety systems.

However, driving behaviour remains by far the major driver of claims/premium. Modern vehicles are electronically controlled and are equipped with many of sensors. For example, they measure hard acceleration or braking, recognize the distance to the next vehicle, how often automatic braking or other safety features are triggered, distance travelled, time of day driven, harsh cornering, etc. Access to such data would allow them to develop individualised pricing.

Under the current static model of motor insurance pricing, policyholders pay the same premium per driven year, collectively within their driver's class and segment grouping, typically using around 13 inputs. This ignores dynamic data like mileage or customer-specific behaviour variables. Consequently, current pricing generates an implicit cross-subsidy[164] from low-mileage drivers to high-mileage drivers, and from the safest drivers to the less-safe drivers. The societal benefits of UBI are tremendous: more

[164] Cross subsidy cannot be eliminated fully, as there is indirect cross subsidy, usually through a fund, where insurers contribute proportionally to cover motorists that are not able to obtain motor insurance, or to indemnify victims of an uninsured claims case.

fairness, incentives to drive less and encouraging safer driving style, leading to many lives saved and disabilities avoided.

6.2.2.2 Types

Usage based insurance (UBI) allows to estimate[165] the risk individually on behaviour (speeding, accelerating) instead of over pools of static customer characteristics (e.g. age, location). There are two main types of UBI products in motor insurance;

- Pay-As-You-Drive (PAYD) policies, the premiums are based on the number of kilometres driven by the motorist; it corrects the fact that standard policies cost is equal for those who drive 50.000 km/y vs those driving 5.000 km/y.
- In Pay-How-You-Drive (PHYD) policies, consumers receive a driving score depending on their real-time driving behaviour (e.g. the time of the day, the average speed, acceleration, braking, etc.); it accounts for the driving style and risk taking behaviour.

For insurers, a more accurate customer risk profile allows to correct risk misclassifications, attract more favourable risks, fight fraud, enhance customer retention, reduce claims, decrease overhead costs and ultimately result in superior pricing.

To offer individualised and dynamic pricing, insurers depend on access to the data of each customer before and during the coverage time period. Data is a broad term that covers past and real-time information about the vehicle, driver and environment. There are currently more than 300 useful data parameters identified as significant for the actuarial pricing assessment, for example:

- Mobility parameters like vehicle ID, trip distance, odometer, ignition, engine status, geolocation, speed, trip time, and vehicle category.
- Behavioural parameters include speed excess, blinker status, brake pedal pressure, wheel position, accelerometer, horn status, parked and unlocked, outdoor-indoor temperature, windshield wiper status and media-infotainment status.
- Diagnostic parameters cover engine temperature, RPM, pressures, oil level, gear position, fuel level, EV battery level, coolant temperature and DTC (Diagnostic Trouble Codes).
- Safety parameters involve airbag status, door status, seatbelt status, ADAS status, hard braking, harsh acceleration, ignoring traffic lights, lane changes and sharp turns.
- Environmental parameters like humidity, weather type, road type, steepness, outside temperature, number of accidents per location, works, infrastructure problems, congestion, etc.

A key element in UBI is that the vehicle data must be equally transparent and accessible to the insured, as to the insurer party. In the small print, OEM insurers currently add a waiver of such right by the insured.

Allowing access to the driver (ideally real-time HMI communication) helps to correct or alert at dangerous situations, provide status and feedback info regarding his UBI program, or safeguarding regularity of maintenance that would result in lower accident rate. Up to 2% of accidents[166] are due to failure or degradation as a result of neglect in maintenance. Better maintenance can lower that

[165] Verbelen R. et al., Unraveling the predictive power of telematics data in car insurance pricing, Kuleuven, journal, 2017.

[166] US transportation dept., Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey, report, 2015.

frequency by about half[167], which means about 100.000 damage accidents in Europe could be prevented or mitigated annually through better maintenance alone.

Overall, UBI reduces accident frequency by 24% and road fatality by 40%[168]. Since a human life spends a worth of about €1 million, society can generate annually €10 billion in human life capital by simply promoting UBI, by the stroke of a pen. The societal benefits in preventing human suffering and death are so tremendous, that one may naively wonder why regulation is not facilitating the unlocking of this potential.

6.2.2.3 UBI growth

The general perception and acceptance of UBI is today overall positive around 80%, especially the younger generation[169]. This attitude has improved even compared to 2015, when about 60% to 80% of consumers was comfortable with behaviour-based pricing[170].

According to EIOPA[171], in a sample of 222 European insurers in 2019, only 15% of the European motor insurance firms offered some kind of UBI product (<10% of their total GWP), of which 65% had data internally obtained (e.g. a dongle, mobile phone app, GPS, emergency message plug, forward facing cameras ("dash cams"), windshield tag), while the other obtained it externally from OEM or third parties. For 2023, taking into account the increasingly connected vehicles and the upcoming introduction of 5G mobile technology, 50% of the motor insurance firms expected these UBI products to represent up to 10% of their total GWP.

Insurance based on telematics data is on the rise at a fast pace[172] and covers about 10% of total policies in the West (US and EU) today, with strong CAGR of about 30%. In 2020 UBI was only present in 5% of policies[173], and fewer than 10 insurers globally with a portfolio bigger than one million telematics-based policies illustrates the increase of the market share with slight exponential growth, accelerated likely due to introduction of connected cars.

[167] Bair et al, Can Vehicle Maintenance Records Predict Automobile Accidents?, Journal paper, Wiley Journal of Risk & Insurance, vol 79(2), 2012.

[168] Ptolemeus, UBI Global Study 4th Edition: Connected Auto Insurance, 2022.

[169] Swissre, Customers are ready for telematics - evidence from IoT Insurance Observatory & Swiss Re survey, survey, aug 2022.

[170] Lexisnexis, Consumer Intelligence research, survey, 2015.

[171] Big Data Analytics in motor and health insurance: a thematic review, Eiopa report, 2019

[172] Insurance Telematics in Europe and North America, M2M Research Series, Berg Insight,2021;

[173] Connected Insurance Observatory, Auto Insurance in the Hyperconnected World, article, 2020

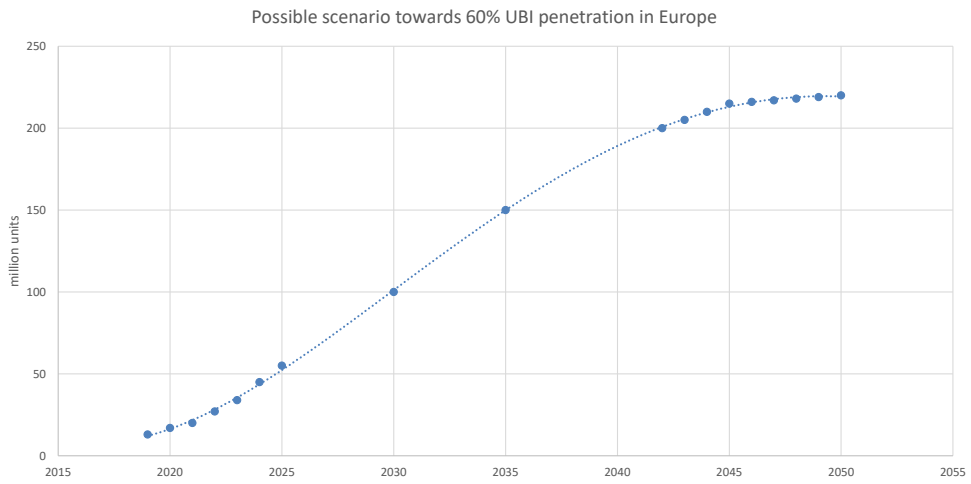

Figure 57: Insurance telematics policies in force in Europe, data till 2025 from Berg, remainder is own extrapolation.

Unfortunately, embedded OEM telematics remain inaccessible for independent insurers, due to the high-cost vs the limited data offered and lack of cross-brand standardisation. OEM data is reportedly diluted and does not meet the requirements outlined by actuaries (and regulation), as there is a lack of quality, consistency, granularity, frequency and latency. As much as 100.000 hours of data is required for having any statistical usable model[174]. Although suboptimal, the weaker external UBI allows already significant optimisation measurable with data from TSPs or in-house at a lower unit cost, which drives demand of non-embedded devices. Yet, decline of this tethered solutions market is expected[175] sometime beyond 2030, when embedded OEM telematics will reach critical market mass.

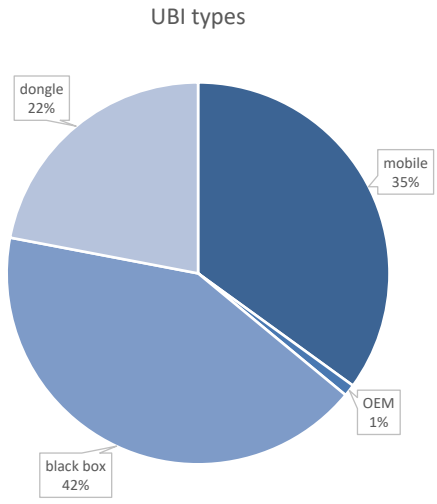

Figure 58: Since 2016 the smartphone is growing enormously, as insurers realize that communication with the driver is indispensable. Source: Ptolemus.

The surge in non-embedded telematics devices is telling, as UBI minded insurers need communication with the driver and better risk estimation. Because OEMs claim ownership of the vehicle/driver data,

[174] Meyers, G., & Hoyweghen, I. V. (2020). 'Happy failures': Experimentation with behaviour-based personalisation in car insurance. Big Data & Society, paper, 7(1).

[175] Ptolemeus, UBI Global Study 4th Edition: Connected Auto Insurance, 2022.

and have the most granular and real-time data, they dominate the relationship with the motorist and can estimate the risk profile more accurately than any competitor.

OEMs know this[176], and they have recently made great strides: OEM-led UBI programs[177] increase from 10% to the total in 2018 to 40% in 2023. OEM's de facto ownership of vehicle/driver data provides exclusive, *incremental* benefits on the cost side of their annual results, both in overhead and indemnification, as detailed in the next sections.

6.2.3 Margin on operating expenses

The first area where the OEM-based insurers can realise a relative incremental advantage is on the decrease of operating expenses:

- Firstly, UBI can lower advertising costs due to the communication[178] with the policyholder, which unanimously voiced as the biggest strength of UBI. "*Insurance is sold, not bought*", meaning that insurance is hard to sell. Insurers therefore carry a very high customer acquisition cost (CAC), circa 12% of gross premium. Marketing is roughly one third of the CAC, so UBI saves at least 4% of premium.

- Secondly, UBI enables improved claims processing. For example, first notice of loss, notifying emergency services, determining accident causation, determining who is at fault in an accident, estimating damage extent. All these aspects allow the overhead involved in a claim case to be automated and enhanced in efficiency/accuracy, consequently yielding reduced claims handling expenses. Moreover, less (fraud) investigation or litigation time is spent, so it will reduce claims handling closing times[179], resulting in better customer satisfaction, and thus higher customer retention. We conservatively estimate that in general UBI yields a saving potential of 50% in claim overhead expenses, which is about 6% of premium.

- Thirdly, OEM insurers do not bear the cost of an external retrofitted UBI solution like their insurance competitors must do. Moreover, the cost for accessing the OEM embedded data is pro forma paid by captives too, but OEM captives are compensated for this cost in other ways.

  An often-overlooked fact is that the expense of embedded OEM telematics has already been paid by the consumer at purchase of the vehicle. Moreover, every vehicle equipped with OEM telematics, and gets into a non-OEM UBI program, receives actually a redundant device.

  The average cost of external telematics varies a lot on type of device, infrastructure for (de)installing, repair and maintenance, storage, processing. Based on an average 5-year customer retention, we estimate that it costs the independent insurers 7% of premium.

[176] Milliman, Car manufacturers are challenging traditional auto insurers: Who will win the tech race?, article, 2020

[177] Ptolemus, The influx of OEMs into connected insurance is the tip of the iceberg for the global UBI industry, article, 2021.

[178] Due to the existing relationship with the OEM at purchase, also other advantages are available, like name, domicile is known for postal mail, they possess the telephone number, email. From interview, we understand that the main reason for smartphone UBI type growing so fast and being preferred, is to obtain equal motorist access like OEM captives have, even if this means to give up accuracy. Instead of the traditional negative situation interaction in case of damages, insurers pursue positive touch points with the driver, as these are key to retention and impact the acquisition cost very significantly.

[179] Ptolemeus, UBI Global Study 4th Edition: Connected Auto Insurance, 2022. Claims handling lead times are reduced with 75%.

Regarding advertising, the OEM insurer has currently de facto exclusive communication via the HMI, which is deemed superior to the smartphone interface. This can be very subtle e.g. at annual maintenance intervals or while providing safe driving style reward messages. And secondly, it provides an entry point into new client acquisition after the sales point[180].

Regarding claims handling, OEM insurers have exclusive access to a *larger* and deeper dataset (than obtainable via dongle or other), which enables superior claims processing**.**

Following the Pareto principle, it is reasonable to assume that OEMs can benefit from the exclusivity, granularity, depth, and extent by an incremental margin of 20%, as compared to what is obtainable by weaker instruments that allow UBI (smartphone, box, OBD dongle, etc are still largely effective at 80% of the potential). As such, we assume a 2% relative premium advantage of OEM embedded telematics (20% of a 4%+6% effect) when it comes to policy administration overhead. UBI delivers benefits, but experts confirm that OEM embedded type delivers incrementally more than any other.

We conclude that, these 3 effects of OEM's vehicle/driver data access exclusivity on operating expenses, yield 9% (=7% on the device + 2% on superior policy administration) of incremental premium discount that OEM insurers can offer, whereas their peers cannot, due to the handicap of data/communication limitations. For example, OEM are able to provide a 19% discount on premium, as compared to independent competitors, who would only be able to provide a maximum 10% discount, as they use a weaker device and their device bear a cost.

All other operating expenses (like underwriting expenses, marketing, claims settling, administration, customer service, regulatory capital/fees and overhead costs, cost of capital or infrastructure costs) are considered unaffected by OEMs limiting access to vehicle, driver or environmental data.

We conclude that, relative to their peers, OEMs captive motor insurers can, in the realm of UBI, obtain a competitive incremental advantage up to 9% of premium via reductions in operating expenses, due to privileged data/driver access and no need for retrofitting of telematics.

6.2.4 Margin on claims

The second area where the OEM captive insurers can realise a relative advantage is on the claims reduction itself. According to several reports[181], the implementation of UBI can reduce claims, coming from three main effects:

- Firstly, OEM insurers have exclusive access to a *larger* and deeper dataset (than obtainable via dongle) and are owner of *real-time* data/communication access, which enables to detect post-insurance crime, like fraud, suspicious activities, theft and false claims more accurately, resulting in reduced losses for the industry and therefore lower premiums. According to several reports[182], the implementation of UBI has the effect to reduce the frequency of suspicious claims by 9% and the severity of suspicious claims by 30%. We infer from the

[180] There is a tremendous advantage of cross selling at sales point, but we do not consider that as an advantage related to data or driver access limitations.

[181] EY, Usage-based insurance (UBI): welcome to the new normal, article, 2020; Forbes Advisor, How Usage-Based Car Insurance Works, article, 2022.

[182] LexisNexis Risk Solutions, U.S. Auto Insurance Trends, Study, 2016

Europe[183] fraud study, that detected and undetected fraud in motor accounts for about 10% of claims. UBI has an effect to lower motor claims thus by circa 4% (±36% of 10%).

- Secondly, OEMs today still enjoy exclusive bi-directional communication with the driver and keep to themselves a deeper dataset and monitoring than they make available to third parties in the market. And most importantly, the most relevant data is in real-time during coverage. This provides a significant edge to actively encourage safer driving behaviour[184]. Raising awareness on the dashboard in real-time of increased risk, e.g. preventive push-notifications or alerts (e.g. blackspot roads or bad weather conditions, travel statistics reports, driving coach recommendations) or reward programs (e.g. bonus incentives, treats and vouchers), or by imposing restrictions (e.g. preventive maintenance alerts, geofencing, and driver curfews) for safe driving practices, reduces frequency of claims in accidents[185] by about 22%.

- Thirdly, OEMs have a larger dataset over the whole of their connected vehicle park than over the client base as for the independent insurer. The OEM insurer can base its underwriting analytics on a larger sample (more behaviour and covered environmental detail) than independent competitors and therefore derive superior statistics required for pricing. This edge puts OEM insurers in a better position to counter adverse selection, by simple denial of insurance to high-risk drivers (transfer risks to competitors) or compensate the increased risk by add-ons to premium (transfer risks to client). These passive forms of risk transfer lower claims significantly of the order 12%.

Summing up the above three UBI effects, it enablesinsurers to reach an absolute reduction on the claims component, of the order 40%. Since claims is about 75% of the premium, this means a 30% lower premium can be reached, in general. But having superior in-vehicle data, the exclusivity over bi-directional driver communication and vehicle sourced environmental data access, allows OEM captive insurers to create a relative competitive advantage over their peers, on top of this gain. The lack of regulation allows OEM captives to exploit this information asymmetry gap with their insurer peers.

Following the Pareto principle, it is reasonable to assume that OEMs can benefit from the exclusivity, granularity, depth and extent by a margin of 20%, as compared to what is obtainable by weaker instruments that allow UBI (smartphone, box, OBD dongle, etc are still largely effective at 80% of the potential). As such, we conclude that lower reported claims for UBI policies via embedded OEM telematics, provides OEM insurers a relative 6% reduction of premium discount, beyond the one of independent competitors. For example, it means that OEM is able to offer 36% reduction in premium based in the OEM device, when independent insurers can offer maximum 30% premium discount by alternative UBI devices, considering all things the same (ceteris paribus).

UBI delivers benefits, but experts confirm that OEM embedded type delivers incrementally more accuracy than any other types, its superiority is significant. It is only the 360 degrees view of embedded OEM that is able to classify e.g. if a situation of hard braking is a reckless move, or one of safety where

[183] Insurance Europe, Insurance fraud: not a victimless crime, report, 2019. Approximately 7% of motor claims are treated as "dubious" in Germany. In Belgium between 1% and 3% of claims are investigated for fraud. Fraudulent claims tend on average to be higher than the average genuine claim. The extrapolated total fraud claims figure for 2023 in the whole European region amounts to circa 20 billion euro, where it is estimated that undetected proportion is 5x higher than the detected. Motor accounts for about 30% of fraud claims.

[184] Imke Reimers & Benjamin R. Shiller, "The Impacts of Telematics on Competition and Consumer Behavior in Insurance" (pg. 616, 629, 630), journal, 2019. A 50% reduction in crashes (total losses); retention rate up with 40%, etc.

[185] Ptolemeus, UBI Global Study 4th Edition: Connected Auto Insurance, 2022.

a collision was being avoided due to a car in front of you that stopped unexpectedly. Moreover, various V2X innovations are only increasing this gap in the future.

We conclude that, relative to their peers, OEM captive motor insurers can, in the realm of UBI, gain a competitive incremental advantage up to 6% of premium via reduction in claims, due to privileged and superior data/driver access.

6.2.5 Supply and demand elasticity

When the motor insurance market is in equilibrium, the market share of independent vs OEM players remains constant. As such, the inflow and outflow towards each other's segment is close to equal.

Regulatory intervention, technological changes, or some 'game changing' factors introduced, can disrupt the segments and a shift (gradient) in market share will be brought about, until a new equilibrium is reached. In this section, we assess this 'flow' under the force of data/driver access being only or more fully available to OEM insurers.

All insurers have policyholders that lapse and change provider, a fixed proportion that changes for various reasons, (bad experience, promotion elsewhere, etc). the netting with new business determines if the portfolio shrinks, stagnates or grows. In insurance, this movement in either direction, churning, is largely due to price as the most dominant factor.

According to Swissre[186] and Deloitte[187], the insurance consumer is highly cost conscious: consumers named price as the top factor when choosing an insurer.

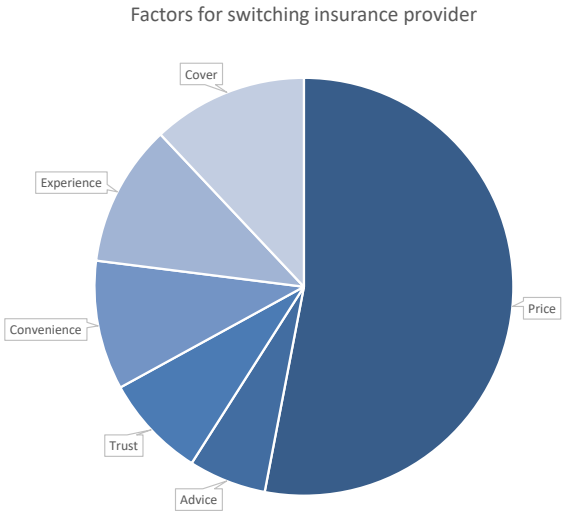

Figure 59: Unsurprisingly, price is the main driver in insurance. Source: Deloitte survey.

[186] Swissre, Global COVID-19 Consumer Survey 2022, survey report

[187] Deloitte, European motor study-ready for the switch?, report, 2015.

The price sensitivity (or churning elasticity) of consumers is in most literature[188] on motor insurance portfolios situated between 0.5 and 5. The churning elasticity (CE) is the ratio of churning rate change over price rate change (just the slope of the two).

$$CE = Churning\ Elasticity = \frac{\%\ churn}{\%price\ change}$$

If CE < 1 (inelastic), then this consumer will lapse less than proportional to a price increase, and vice versa in case CE > 1 (elastic). Typically, insurers try to find out the elasticity per policyholder and refrain often to apply price increase on elastic clients (often also determined with other variables besides price alone) as to obtain customer retention.

Since the Motor insurance sector is very competitive, notably on collision cover and MTPL segment, the average elasticity is often on the high side (while it is not on the bodily injury cover for instance). For example, in the UK[189], the elasticity is often high: if the competition is relatively 10% cheaper, then a proportion of 30% lapse is experienced; the UK motor market experiences[190] elasticity 3 or sometimes even 4. For the overall European region, we assume CE=1.5, to remain on the conservative side as volatility in CE is large among countries.

The previous sections concluded that OEM insurers have an exclusive potential to reduce premiums via lower operational expenses (-9%) and claims (-6%) on UBI programs, which frees up to 15% premium discount, on top of the typical 30% what their peers can offer within the UBI realm (50% is considered a maximum bound[191]). With an elasticity factor of 1.5, the 15% potential in premium difference brings about a potential churning of circa 22 percentage points from the independent insurers to the OEM captive insurers.

In terms of aftermarket volume impact, 22pp churning of the €44 billion insurance funded aftermarket comes down to a volume shift of about €10 billion away from independents. Moreover, because those repairs at OEM workshops will be twice as expensive, the total impact is of order €20 billion annually.

It is however a maximal potential, which is slowly realizing under two constraints:

- Not every vehicle owner today has UBI, but surveys[192] indicate that about 60% accepts the idea. Strong adoption figures in the most insurance developed regions indicate that UBI will penetrate the European region in 2030 close to 59% of the whole motor insurance market,

[188] Roel Henckaerts, Katrien Antonio, The added value of dynamically updating motor insurance prices with telematics collected driving behavior data, journal paper , Elsevier, Insurance: Mathematics and Economics, Volume 105, July 2022, Pages 79-95.

[189] GlobalData's 2022 UK Insurance Consumer Survey

[190] Car Insurance Renewal Price Rises Double, Consumer Intelligence, article, 2016; "Average price rises for drivers renewing their car insurance have doubled in the past year as shopping around hits a three-year high, exclusive independent data from insurance market research experts Consumer Intelligence shows. Its independent data — used by the Government's Office of National Statistics to calculate official inflation statistics — shows average renewal quotes have increased £22 on average compared to an £11 increase last year. The price rises — driven by Insurance Premium Tax rises and wider market movements — have boosted shopping around to a three-year high with up to 11 million drivers expected to move insurer this year. Consumer Intelligence's data shows around 40% of motorists will switch and it advises all motorists to shop around at renewal to try to secure a more competitive deal."

[191] Insurance Europe, report, 2019. *In France, only one insurance company has started to offer products linked to in-vehicle telematics, with a premium discount of up to 50%. These products quickly attracted young drivers, who usually pay high premiums. Compared to standard policyholders, customers who opt for this technology receive, on average, a 20% discount and register a 20% reduction in claim frequency and cost; "Voiture autonome: une réglementation à reconnecter", L'Argus de l'Assurance, February 2018.*

[192] EY, How auto insurers can grow as a decade of disruption approaches, EY-Parthenon survey, 2023. It reports that 60% of consumers said they would use telematics solutions from carriers in exchange for discounted premiums.

according to Ptolemus research[193]. We conservatively assume a constant penetration rate of 60% up till 2030, but not increasing beyond.

- Not all vehicles are equipped with advanced telematics, by 2030 about 15% of the car park will be fitted with embedded OEM telematics in the European region.

If the regulatory environment does not change on open access to data and driver, the advantage of OEM insurers is expected to yield almost €2 billion per annum in 2030 (= 15% connected of 60% willing of the potential €20 billion churned revenue).

Today, advanced UBI is merely active in about 7% of the European insurance market and the relative market share gain of OEM captives is currently estimated to be of order €1 billion annually, but growing in the same pace with OEM embedded connected vehicle growth.

When around 2050 circa 100% of the car park will be OEM embedded connected, the OEMs are expected to capture €12 billion annually in aftermarket revenue churn (and increase).

One might argue, whilst IAM loses business, the consumer seems to win as he pays a lower premium. But the consequences of lack of competition by independent players, leads to OEM oligopoly position or collusion, and the customer is worse off in the long term.

The extra cost of alternative UBI instruments on connected vehicles is a growing market inefficiency, due to lack of automotive open access regulation and the unwillingness of OEM to standardize for use across brands, or for portability to a telematics provider of choice.

6.2.6 Redundancy

OEM captive insurers work only with OEM authorized workshops or services, and exclusively use OEM parts and labour rates, which are known to be about double as expensive. This is often the explanation for the more expensive premium that OEM insurance is perceived at, even though non-OEM parts and services are well-established as equal in quality. Independent insurers will usually prohibit the use of OEM parts/service as it increases claim amount, therefore some offer an optional add-on cover to purchase, or policyholders must pay the extra price.

Of the €44 billion annual insured damage claims, about 30% is owned by OEM. Older cars above 7 years are usually not eligible (circa 40%) to new OEM parts, or sometimes OEM parts are not produced any more (in 10% of cases). So about 15% of claims is involved in using new OEM parts, which is about €6 billion. The fact that this cost is double of the IAM level, we have a friction cost of about €3 billion today per annum at the expense of the consumer. Yet, it is not linked to telematics, so we disregard.

OEMs will want to keep that business and significant profit margin intact. Moreover, it is a main sales argument in the premium segment. This persistence represents an OEM setback in pricing for about 7% on the premium. It is one of the reasons for the smaller market share of OEMs.

However, we see this pricing handicap disappear over the next decade: since 2021, OEMs have begun to eliminate the middleman OEM dealerships regarding sales[194], as the pandemic and the breakthrough of EV created critical mass for digitalization of the vehicle sales. Commission fees are

[193] Ptolemus, Usage-based insurance is growing globally but its dynamics are still regionally specific, article, 2022.

[194] Press release announcements by Stellantis (25% in 2030), Daimler (50% in 2030), and many others confirm this strategy of moving new car sales fully online.

traditionally paid to captive or independent insurance agents, representing sales expenses (or distribution costs), on average 9% commission fees (about 75% of the CAC[195]). Dealership commissions are typically lower[196] than the agents of the commercial insurers, estimated at about 7%. It is rather this disintermediation that is going to offset the cost of more expensive parts/service, as more and more dealerships are forced to turn to the agency model.

Next to the telematics advantage, disintermediation of OEM dealerships is a second force that will come into play in the expected growth of OEM captives, but we will disregard its impact, as it is not linked to the telematics monopolisation.

The cost of equipping vehicles with retrofitted UBI devices, while there is embedded telematics present, represents a redundant cost. About 70% of the total insured car park is covered by independents, were about 60% are willing to adopt UBI, and the cost is around 7% of the premium per year, so this leads to almost €6 billion annually wasted on redundancy in 2050. As more and more vehicles become embedded, this waste simply grows, for example: by 2030 it amounts to an unnecessary annual cost of €1 billion.

6.2.7 Total impact

The insurer that knows the most about motorist behaviour, is in the best position to create an accurate risk profile. Data access is key to offer ultimately the lowest price, which leads to attraction, and retention of the best risks in the market. In this chapter, we demonstrated that entities with the best access to vehicle data/driver, has a major competitive advantage in the insurance market.

The COVID-19 pandemic, combined with the breakthrough of EV, gave OEMs a new impulse to revisit the strategy of their captives, besides their extensive specialized financing services at point-of-sale. OEMs have sought new sources of revenue in the aftermath of the pandemic and their struggle with electrification. As such, their attention is focused on the aftermarket: after maintenance in workshops, the second biggest revenue is the spending on vehicle insurance. As the above sections demonstrate, there is a strong business case to leverage on their privileged vehicle data/driver access, and vertically integrate the motor insurance within this decade of the twenties.

The OEM embedded telematics data is established as a key strategic asset by the OEMs and their captives. In a clear statement of intent[197], 50% of all OEM in-house UBI programs now use connected car data only, removing insurers or TSPs from the equation entirely. There is abundant evidence collected in this study, that this captive insurance scenario (*active monopolist model*) is realizing.

As long as regulation is not creating a level playing field for the European citizens' freedom of choosing a telematics provider (true portability of vehicle/driver data to any carrier like telephone number), then OEMs will inevitably leverage the endorsed monopoly position, and it is demonstrated that in this scenario the independents lose competitiveness and market share in total up to €3 billion per annum from 2030 onwards. Consumers will face increased market inefficiencies, due to economic consequences like redundant costs and less competition.

[195] FCA, General Insurance Pricing Practices Market Study, Interim Report, oct 2019.

[196] The lower commission fees for EM captives are not accounted for in this study, since they are not a result of a difference in data/driver access limitations, although they are an advantage for OEM captives vs independent players.

[197] Ptolemeus, UBI Global Study 4th Edition: Connected Auto Insurance, 2022.

The following table summarizes the potential of these losses beyond 2030.

Independent Aftermarket Loss Impact [€Bn/y]	2023	2030	2040	2050
advanced connected	7%	15%	60%	100%
OEM benefit from lower operational & claims cost	1	2	7	12
Competitors' redundant telematics devices	0.5	1	4	6
Anticompetitive pricing in motor insurance TOTAL	**1**	**3**	**11**	**18**

In a second captive insurance scenario (*broker model*), this market transformation is less strong, where experts believe that not all of the OEMs have the appetite for overtaking the whole operational insurance chain (underwriting, claims handling, regulation, etc.) and might use their privileged position to negotiate individually determined, but large, commissions instead and require OEM parts coverage in the subcontract with third parties, as they are primarily interested in the customer relationship and let insurers 'pick up the tab'. It is possible that the loss for independents is smaller in that case as there are alliances formed, yet also that a considerable fraction of that IAM loss would be transferred to the consumer in the end.

In a third captive insurance scenario (*passive monopolist model*), OEM captives are not entering insurance, but hold on to the data monopoly role. Then market inefficiencies persist, leaving the demonstrated substantial potential of UBI (consumer savings, avoiding fatalities, lower accidents, etc) unrealised, and it is the consumer and society as a whole which lose most.

The 'active monopolist model' is the most likely captive insurance scenario, as evidenced by several recent insurance initiatives (Totyota, Stellantis, tesla, GM Onstar) and OEM subscriptions having even insurance bundled[198]. And not in the least, because Level 3 autonomous vehicles, introduced publicly in 2022, are bringing OEMs inevitably into insurance, as the liability will shift to the OEM, which is currently redefining itself as a software developer. Soon, responsibility will become split between the driver and car, and one needs automatic charging customers only for the actual driving risk taken. Traditional insurance won't be able to cope with the fluidity of this process.

The autonomous car is touted to be highly disruptive for the insurance industry. Studies[199] predict several evolutions: for example, a decline of 90% of accidents by 2050, which will shrink the insurance industry market volume to 40%; in-vehicle data and connection will become the new fuel of the car-as-a service model.

However, because autonomous vehicles (i.e. with level 5 capacity) are assumed not significantly present on the medium term until 2040, they are not considered any further, although their economic impact on the aftermarket is presumably very significant as well.

[198] "The Future of Auto Insurance: Connected, Embedded & Subscribed" from Insurance Evolution Partners, study, April 2022

[199] The chaotic middle, The autonomous vehicle and disruption in automobile insurance, white paper, KPMG, June 2017;

6.3 Leasing services

A third large revenue component in the aftermarket is driven by the fleets market: operational lease, hire purchase, rental, and car subscriptions, which explicitly include contractual service agreements to keep the -more intensively used- vehicles operational (thus e.g. purely financial leasing types are excluded).

6.3.1 Relevance

Today, almost half of new cars (circa 15 million annual registrations in Europe) are acquired through a leasing and rental companies. These channels provide the used-car-market with new inflow as these are kept for a relatively short period (3 to 4 years).

Over the whole car park, fleet vehicles, not directly owned (by individuals), having from 1 to several thousands in portfolio, account for about 15% to 20%[200]: circa 1 out of 8 PV, and 1 out of 3 LCV. This means 50 to 70 million vehicles are so-called fleet owned in 2023.

Yet, only the operational private/company lease, hire purchase and subscriptions, which include contractual service agreements are generally considered in scope of the aftermarket (thus e.g. purely financial leasing types are excluded): there is a lot of variation per country, but overall in Europe, about 50% is operationalised[201]. We infer from Leaseurope statistics that about 8% of the PV and LCV park, or circa 28 million units, are under service management, and about half of those are under rigorous service by professional fleet management companies (circa 11 million PV and 3 million LCV).

According to Leaseurope, the leasing companies in the European region accounted in 2021 for about €662 billion in outstanding value in to-be receivables on their books[202]. Factoring in normal growth, we estimate in 2023 for about €670 billion outstanding. Circa 53% of that book value is of type PV, of which half is operationally serviced, and accounting for an estimated average four-year usage period, we arrive at €44 billion annually. Adding LCV vehicles in scope, which represent about 25% of that value (€11 billion), yields an estimated annual aftermarket volume of circa €55 billion in 2023. Thus, the European leasing market contributes circa 20% to the €280 billion aftermarket.

6.3.2 Loss in savings

Fleet management requires close follow-up on all vehicles. This subsegment has therefore already -for decades- the most experience with telematics. They are one of the key aftermarket benefactors of telematics innovations.

One of the reasons is that enormous savings can be realised with data access to fleet vehicles. Several studies showcase the benefits. By sheer measurement and comparing with benchmarks, fleet managers can identify cost sinks and setup programs to remedy on the level of driving behaviour to

[200] BCG, Aftermarket 2030—the fleet imperative, study, 2023. EY, Accelerating fleet electrification in Europe, study, nov 2022, mentions about 20% of car parc is fleet.

[201] Leaseurope, full-service leasing or a variation of finance leasing bundled with servicing varies per country ranging 30%-70%, statistics communication, 2022.

[202] Leaseurope, Facts & Figures of 2021, brochure, 2022.

save fuel, avoiding accidents, limiting speeding, stricter maintenance follow-up, remote diagnostics, prognostics, route optimization, reduction of blameworthy collision claims, combat vehicle crime, optimize fleet size, composition and allocation, reduce idling, etc.

For example, the US Marine corps NREL[203] study concludes that for the government fleet of light- and medium-duty vehicles the savings amounted up to €2.000/year (including the optimization of the type of vehicle to be utilized for the different purposes). The findings from such independent studies are found to be aligned with figures from telematics software companies that promote the use of vehicle data for realising savings, and an anonymised report across their client database of millions of vehicle averages demonstrated the savings obtained. Geotab has reported[204] the savings for light-duty vehicles of about €140/month, close to circa €1.500/year, which scales up with the size of the vehicle (trucks gain much more, but are out of scope). We assume conservatively that for PV about €1000 can be saved on average.

These figures only consider today's effective benefits. But when advanced telematics adoption rates become very high (say 60% to 80% of total car park), then peer-to-peer (or V2X) vehicle communication could improve road congestion and accident prevention, with even larger benefits for the fleets as well, beyond 2030, but we conservatively ignore these effects in our estimates.

nr of PV	€11.000.000
nr of LCV	€3.000.000
average annual telematics saving per PV vehicle	€1.000
average annual telematics saving per LCV vehicle	€1.500
total annual telematics savings in PV segment	€11.000.000.000
total annual telematics savings in LCV segment	€4.500.000.000
Total savings that can potentially be generated in 2023	€15.500.000.000

Just like in the section above on insurance, we assume the 80/20 rule applies to the quality of the telematics type. Thus, over the 70% IAM market segment, 20% of the full potential (namely the €15 billion total from above table) cannot be realised by independents, due to inferiority of non-OEM telematics solutions, or the lesser quality offered to independents from OEM telematics (downscaled data for competitors: inaccuracy, incompleteness, less granularity, time delay, no driver access, etc).

This 20% loss amounts to a loss of €2 billion annually if the whole car park is equipped. Today the penetration rate in fleets is about 45% and extremely rapidly growing[205]. So already today in 2023 annually circa €1 billion is lost due to the lack of high-quality OEM telematics access.

6.3.3 Redundant telematics

Proprietary aftermarket such as OBD dongles plugged into the vehicle's onboard diagnostics port or black boxes under the hood come with some painful challenges. Aftermarket solutions impose significant upfront and recurring expenses in operating medium to large fleets.

[203] Cabell Hodge and Mark Singer, Telematics Framework for Federal Agencies: Lessons from the Marine Corps Fleet, National Renewable Energy Laboratory, study, 2017.

[204] Geotab, How to use telematics to reduce fleet costs and increase savings, article, 2022.

[205] Berg insight, The rental and leasing car telematics market is expected to grow at a CAGR of 17.6 percent in the next 5 years, article, 2023.

Due to either costly or limited vehicle connectivity solutions offered by OEMs in recent years, independent fleet managers have increasingly equipped their vehicles with aftermarket OBD port or other dedicated retrofit devices. This bears an annual cost of circa 250 Euro/vehicle[206] (including device, installation, connectivity, maintenance, repairs, software, analysis, services, cloud, etc.) over the short lifetime of fleet vehicles.

Over the total fleet of 14 million vehicles, of which IAM market operates 70%, there is a theoretical redundant cost of €2 billion annually (if all their vehicles would have embedded OEM telematics). In 2023, with a telematics penetration rate of 45% in the fleets, about €1 billion is being spent on non-OEM devices that becomes more redundant as more OEM embedded vehicles are produced.

If we take into account market dynamics, then actually there is again a churning of customers to be expected from the IAM to the OEM segment for this difference in pricing. The leasing market is highly competitive: pricing between IAM and OEM is very similar, so price sensitivity is very high (an 'elastic' market): only a little bit of a price delta will induce a large transfer of customers. If only OEM fleets will realize the full 100% savings and bear no cost for dongles, they are able to offer a better fleet price as well. However, we ignore this effect at this instance, as the OEM captives are obliged to utilise OEM parts and services, which increases their operational cost.

6.3.4 No driver access

Today, non-safety related vehicle software updates are only available at official dealership network repair shops, and access to these by independents are either hindered explicitly through pay walls, or not provided at all. In doing so, OEMs push clients of independent leasing companies to the official dealership network by their privileged communication with the driver about (over-the-air) updates, prognostics, service appointments for SMR[207].

By closing access to the human machine interface (HMI) for vehicles owners, independent leasing companies would effectively be cut off from in-vehicle communication with their own customer (e.g. by dashboard or apps). Given that circa 50% to 60% of customers continue leasing[208], and 9% are willing to switch[209] lessor firm, the independent leasing companies risk to systematically lose about 5% (=55%*9%) on new business, due to the inability to get fair in-vehicle driver access.

To derive an estimate, we take the new business volume in vehicles, as there is a client conversion involved from independent leasing companies to OEM captives. Every year, a whole batch leaves the fleet, but new business brings in new ones, so about a quarter of the 14 million serviced units are being renewed annually. Theoretically, the whole segment of IAM lessors is subject to this

[206] Pricing of all-inclusive fleet telematics solutions vary, depending on complexity, in the range of 8eu/month to 35eu/month. But fleets tend to use the higher-end devices.

[207] We refer to the warranty section on the detrimental market effects of having SMR channeled to OEMs only, as the order of magnitude of loss of around €1 billion is the same, as we want to avoid double counting effects.

[208] J.D. Power, *Recapturing Lease Customers Will Be Critical as Auto Dealers and Lenders Navigate Downturn*, survey, 2020. Figures from the mass market and luxury segment were taken.

[209] Direct Marketing Association, *Response Rate Report: Performance and Cost Metrics Across Direct Media*, report, 2018. We extrapolate from the house mail, which is highly conservative, given that around 41% responds directly to in-vehicle messages and appointments (FIA study).

disadvantage, which comes down to about €3 billion losses annually, calculating with average prices and a conservative response.

Total operational new business annually in nr of vehicles	3.500.000
Market share IAM	70%
Price per vehicle	€28.000
Loss of customers due to new captive OEM lease contract	5%
Annual cost of anti-competitive driver communication access (2030)	€3.000.000.000

The driver access, pointing drivers towards the OEMs is already embedded in unconnected vehicles, and at least €1 billion is already directed annually to OEMs through the vehicle interface advantage in 2023.

Privileged communication access between OEM (captive) and driver, leads to annual client losses that will cumulatively build up for independent leasing companies with each new batch of connected vehicles. Increase in OEM parts sales and services will reinforce their position, and consumers will, at the bottom line, fit the higher bill.

6.3.5 Blocking innovation

Leasing/rental companies are owners of the car and they need access to very deep in-vehicle data to optimize costs. They provide fuel cards, but for EVs they will need insight in when smart and bidirectional charging is activated. They need to innovate, but haven't got the access to the data allowing innovation.

Likewise, charge point operators (CPOs)[210] and emobility service providers (eMSPs) need access to deep in-vehicle data (eg ISO 15118-20) to provide smart load management, offer transparency to consumers and accelerate sustainable demand-side flexibility for EVs. Overall, the EV owners are suffering most under the European automotive data space OEM monopoly: insufficient investments in EV charge points roll-out, V2X innovation, and e-mobility services.

According to a McKinsey study [211], monetization of data with connected vehicles has following potential of generating annual incremental value (eg e-commerce) and cost savings by 2030.

Value generation per vehicle in terms of revenue	€ 262
Cost savings per vehicle due to data use	€ 152

The leasing industry is investing in R&D to leverage on data use cases for better servicing its clients. Applied to the independent IAM network vehicle parc operated, it has the following corresponding potential:

Revenue generation by independent leasing firms	€ 2.500.000.000
Cost savings by independent leasing firms	€ 1.500.000.000

[210] ChargeUp Europe, State of the Industry, report, 2023.

[211] McKinsey, *Unlocking the full life-cycle value from connected-car data*, report, 2021.

However, the lack of regulation led to an innovation vacuum: from interview, we estimate that 50% of the IAM internally proposed business cases or planned mergers and acquisitions are not finding funds or (external) investors due to lack of OEM data/driver access and two decades of status quo in legislation.

Even if telematics projects based on OEM telematics are developed, interviewers are afraid that about 50% will not survive on the long term: any unicorn will be met with data traffic analysis by OEMs, and will face a competing data service from OEMs, such that lessors will very likely be pushed out of the market. As one interviewer stated: "*start-ups in overarching multi-brand fleet solutions like Otonomo or Caruso -that are fully based on OEM embedded telematics- are no real success and serve as a daily demonstration to all the independents the hard truth of no data, no business*".

Against these 50% investment drop and 50% outcompete odds, we still assume a stronghold of 25% success rate for IAM which can break through due to not being data rich/intensive via a telematics device. We conclude that the €4 billion potential value creation that IAM can contribute in 2030, if OEM data was a common good, shall for circa three quarter be lost, as only €1 billion is realizable: €3 billion annually is blocked.

A 2021 McKinsey study[212] points out that vehicle data value generation for the ecosystem players was much slower than anticipated in their 2016 study[213] - almost 50% less. Closed data/driver access acts as a major *frictional force* in the automotive aftermarket: therefore, globally about $200 billion to $350 billion annually will simply be lost in innovation and savings by 2030. This frictional force would amount to circa €70 billion annual loss in Europe.

Firstly, instead of reporting this loss explicitly, realisable gain projections are rather adjusted downward. As such, it is 'forgotten' that these benefits are a result of unnecessary friction. Applied to this perspective of the innovation by the leasing industry, in fact an *additional* €4 billion is lost.

Secondly, it is 'forgotten' that virtually all innovation/saving in telematics that *did* realise, came from the independent and tech players, despite two decades of lawmakers being deaf to the cry for open data/driver access rights. If regulation persistently skips a *third* decade in a row, we confidently bet on the next drop of innovation/savings value in 2030, of order €35 billion (the European 25% of half of the global $325 billion assumed benefits) lost annually in the European region.

6.3.6 Total impact

Almost a quarter of the aftermarket is driven by fleets, and commercial line is expected to grow vis-à-vis the private line according to BCG. This sector has an inherent incentive to advance in fleet telemetry, as the intensively used vehicles benefit at the fullest from savings (eg fuel, style, purpose) and prevention (eg crime, maintenance, speed). Limited access to the high-quality embedded OEM telematics lies at the heart of this significant loss for the independents.

Moreover, they bear redundant costs for alternative devices, as the potential of the advanced on-board telematics is currently unusable. The fact that solutions to multi-brand fleets must be resolved to manage and analyse uniformly, is the least of concern for the sector, it is about quality not being up to par.

[212] ibid.

[213] McKinsey, Monetizing car data - New service business opportunities to create new customer benefits, study, 2016.

Anti-competitive driver communication access systematically reduces the leads in new business. Although lessors are owner of the vehicle, the OEM still owns the relationship with the driver through the dashboard interface, which yields prospective leads into its captive network.

Furthermore, new value propositions and savings through innovation are -to a major extent- blocked and unrealized, as potential R&D by independents remain unfunded due to lack of level playing field, and OEM's lack of agility/entrepreneurship.

From the above loss impact discussions, we derive following overview of projections:

Independent Aftermarket Loss Impact [€Bn/y]	2023	2030	2040	2050
advanced connected	45%	75%	100%	100%
Loss in savings	1	2	4	4
Redundant telematics	1	2	2	2
Biased lead generation due to no driver access	1	3	3	3
Blocking innovation	1	3	3	3
Cost of limited data/driver access in operational lease	**4**	**10**	**12**	**12**

Leasing and rental companies still cannot access in-vehicle data fairly[214]. The sector underlines that the existing three decades old rules are no longer equipped to address the reality of today's technology-driven environment. If left unchecked, the OEM captives are in for tremendous growth, acquiring a fifth of the independents leasing share of the aftermarket. It implies that the independent leasing segment will shrink significantly, with less market players, less competition, driving up leasing prices for European business and consumers with fleet.

The fact that OEM are deeply aware of this endemic friction of anti-competitive behaviour, is demonstrated by a most promising post. It signifies a major precedent for an open access initiative, made for the first time in automotive history, by TESLA. On Linkedin[215], a first public post and verified open github teslamotors/fleettelemetry codebase was released by a Tesla senior software engineer, which truly could shake the connected vehicles world:

> *"…at Tesla we've created a framework that enable customers to share data with 3rd party directly with them, bypassing any middleman, including Tesla. It's the most Privacy and Security centered framework ever created in the IoT space, opt-in only, customers can choose who they onboard if anybody. I'm hopeful it will create a new era of transparency and privacy for smart devices."*

If this is realized, the door opens for true fairness in vehicle data, and also for IoT in general. Just like citizens have the free choice for their smart devices from Telecom service providers (ISP), motorists could go with a Telematics service provider (TSP) *of their choice*. The right to hosting the vehicle data management with any third party is a most profound solution that solves many, if not all, problems of anti-competition in automotive.

[214] Leaseurope, Workshop on possible legislative options for in-vehicle data access, newsletter, 2021.

[215] LinkedIn, teslamotors/fleettelemetry, post, July 2023.

6.4 Digital cockpit

Another source of revenue in the aftermarket comes from 'optional' add-ons spending. Examples are hardware (like dongles or navigation, security systems, sound), software (mobility apps), motor club or road assistance memberships, but also car wash, parking space, winter tyres, engine enhancements, luxury accessories, aftermarket instruments, vehicle entertainment or utility items, etc.

There is a growing part of the aftermarket that deals with optional add-on services and parts specifically adapted for the vehicle. The most notable and established ecosystem in this segment is the in-vehicle infotainment (IVI) platform market, that represents about half of this segment.

6.4.1 In-vehicle infotainment

Automotive infotainment is an in-vehicle device that provides entertainment and information to the driver and passengers. The system includes the integration of audio/video interfaces, touchscreens, keypads, etc., for offering navigational services, hand-free phone connections, vehicle voice control, parking assistance, speech recognition, climate control, two-way communication tools, access to the internet, and other security services. These features help in increasing the operational efficiency of vehicles and improving safety and driver experience.

IVI grows strongly, due to the rising demand for entertainment, safety & security, in vehicle payment capability, navigation services, and rear-seat entertainment. In Europe, regulatory mandates (ADAS) are the prime factor that drives this embedded system market growth.

The major automotive OEMs now invest heavily in new software platforms[216]. E.g. Volkswagen Group launched a new business unit called CarSoftware in 2020 (now called CARIAD); General Motors is set to roll out Ultifi in 2023; Mercedes-Benz developed a proprietary operating system branded MB.OS to power its connected car models from 2024. The current data sovereignty allows OEMs to establish a monopoly to monetize vehicle/driver data to the full extent: not only in magnitude, but also *in time* via e.g. renewal periods. The continuous-time subscription-based nature of the cash-flow is the most attractive aspect of the quest for vehicle data monetization.

6.4.2 Total impact

The IVI market of apps for drivers and passengers through the vehicle interface, is growing at a CAGR of 10% (i.e. doubling every 7) reached about €4 billion in 2023 when considered over Europe, and is expected to reach almost €8 billion by 2030, according to Bloomberg[217]. Embedded systems are estimated to be the largest in-vehicle infotainment contributor, and there is a trickle-down effect ongoing from premium to mid-range makes.

[216] Berg insight, Automotive OEMs are doubling down on investments in software development as cars become increasingly connected and software-reliant, article, 2022.
[217] Bloomberg, In-vehicle Infotainment Market worth $31.4 billion by 2028, report, 2023.

From the Statista survey[218], only one third of motorists is spending on infotainment, and since most of the services cost around €300 per year, it is rather coming from the luxury segment that is about a tenth, circa 12 million vehicles over Europe currently, of which half are advanced connected.

Currently, two thirds of motorists are not into spending on exclusive vehicle dedicated apps. This is not surprising, as the smartphone manufacturers did not claim that all data you produce with your phone is their property, as vehicle manufacturers do. In all other IoT sectors, people use services typically offered free of charge, in exchange for their data, while the developer earns by offering advertisements in their application.

Android Automotive is said to register the fastest growth of all in-vehicle infotainment operating systems. Large tech companies, such as Amazon, Apple, Google seek to extend their existing large ecosystem into the mobility space of the connected car market in the past years, with e.g. Android Auto, Android Automotive OS, Google Automotive Services (GAS), as layers of its connected car stack, that require deeper in-vehicle data and driver access. Tech players reduce the role of the IVI platform to being a 'projector': just another interface next to mobile and desktop. They compete for the ability to dominate the many potential services that are so important to business plans and revenue streams that are yet to come. In other IoT sectors, joint international standardization forums usually solve the frictions.

Independent players in the IVI realm, eg like Pioneer, Harman, Alps Alpine, Garmin, are working around the embedded platform, with a focus on hardware, but they remain limited to the top OEM software API level.

If regulation does not allow for equal access to data and driver, OEMs are likely to behave like big tech and exercise their sovereignty: offering a highly curated boutique approach through a car-centric Application Store/Platform for any third parties to develop on, taking a 30% share of the revenue generated via fees and in-app purchases. In current projections of revenue, the consumer is then confronted with a €1 billion markup in 2030 for OEM intermediation in IVI via their monopoly on the advanced connected platform. Strong growth and inclusion of lower vehicle segments will only add revenue beyond 2030.

Independent Aftermarket Loss Impact [€Bn/y]	2023	2030	2040	2050
advanced connected	7%	15%	60%	100%
IVI - In vehicle infotainment fees on luxury segment	**0.5**	**1**	**3**	**5**

Beyond IVI, there is a plethora of other use cases in this automotive digital segment, e.g. as estimated by McKinsey[219], in the order of €100 billion in 2030 for Europe, from e.g. R&D optimization, on-demand hard/software, fleet health monitoring, MaaS, HMI wallets (comparable to mobile wallets), in-vehicle commerce purchases (e.g. Visa), advertisements. If these trends also realize as projected, the OEM gains scale similarly: a markup of the order €30 billion annually flows towards OEM in 2030 if regulation keeps the OEM sovereignty over data and driver communication intact. Being conservative however, we consider these use cases beyond IVI, as not sufficiently established or even regulated yet, to include already as an impact in this study.

[218] Statista, Understanding Drivers' Preferences & Attitudes in Europe, survey, FIA, July 2023.

[219] McKinsey, *Unlocking the full life-cycle value from connected-car data*, study, 2021.

6.5 Monitoring

Vehicle data has undoubtedly major potential, like any data. But IAM investors analysing use cases in the realm of automotive e-commerce hold back, as the limitation is an entry barrier. Based on interviews, we came across 4 'business case killer arguments', that blow up the start-up risk:

- OEM exclusive control: the vehicle/driver data/access is not available, or on purpose offered too low in quality.
- OEM price setting power: the data tariff wall handicaps every competitor's application, except the OEM's application.
- OEM platform exclusion power: even when one has reached a unique successful service that OEMs cannot copy, there is the precedent of Epic vs Apple[220], that puts up a second wall of a 30% cut of any e-commerce purchase further made. Likewise, OEMs can set platform policy to not bypass any purchases outside their platform. There is huge uncertainty about the fine print of the legal contract.
- OEM look-through: the OEM monopoly can outcompete the e-commerce development due to disproportional monitoring benefits

This section addresses specifically the fourth argument of the OEM's unique monitoring capability of competitors, and we try to benchmark impact.

6.5.1 Monopolistic position

In 2020, the Commission took issue with Amazon systematically relying on non-public business data of independent sellers who sell on its marketplace, to the benefit of Amazon's own retail business, which directly competes with those third-party sellers. Secondly, the Commission also opened a second formal antitrust investigation into the possible preferential treatment of Amazon's own retail offers [221]. At end of 2022, Amazon settled two antitrust cases, avoiding a fine of €47 billion[222].

Likewise, at present, the OEM data platform offers them extensive non-public insight on the business activity of third parties, such that OEMs can act as a competitor with an upper hand to these third parties, and can create a preferential treatment, or even sole offering, of their service/product.

Currently, the OEM has relatively much more access, which enables them to monitor the third party and take advantage of that in product/service development, tariffication or strategy. For example, OEMs can establish a more optimal timing, a better place in the ranking, or price undercutting on basis of real time information than a third party. OEMs have access to non-public business data of third parties such as the number of vehicles serviced, type of information accessed, the sellers' revenues when in-vehicle payments take place, the number of visits to sellers' applications, to sellers' past performance.

As shown in the emerging trends section above, Automotive As-a-Service models are at an early stage of innovation and development and continue to grow in popularity and revenue. But getting the most from them includes a vital caveat: the ability to track how customers use your services. This

[220] New York Times, Apple Largely Prevails in Appeal of Epic Games' App Store Suit, article, 2023.

[221] European Commission, Antitrust: Commission sends Statement of Objections to Amazon for the use of non-public independent seller data and opens second investigation into its e-commerce business practices, Press release, 2022.

[222] Forbes, Amazon Alters Business Practices To Avoid Possible $47bn European Fine, article, December 2022,

information is critical to revenue management, customer experience and ultimately innovation. OEMs have usage monitoring capabilities far beyond their competitors, and information far beyond competitive intelligence and this lack of a playing field withholds investors[223].

Without regulation, there is a fundamental information, risk and capability asymmetry between the OEM and IAM, which prevents innovation. This issue only arises when the OEM has a dual role, as (i) data/platform owner and (ii) service provider.

6.5.2 Competitive intelligence

Competitive intelligence is the result of a company's efforts to gather and analyse information about its industry, business environment, competitors, and competitive products and services. The information-gathering and analysis process can help a company develop its strategy or identify competitive gaps. As such, the company is making those data part of its control processes.

It is a strategy that links information about competitors to business decisions. It helps businesses understand how their competitors fit into the big picture of their goals, and how to drive actions in the competitive landscape for gaining a market advantage.

Competitive intelligence is exploring the boundaries on knowledge gathering on competitors, and although it remains legal, it is close to going through a competitor's garbage to look for clues about their plans and activities. It is however different from corporate espionage, which often involves outright theft of IP.

In a study, PWC[224] consultants observe that such monitoring firms increase gross margins:

> "*42 percent have increased their margins over the past year, while 25 percent decreased them--for a net of 17 percent increasing. For all other businesses, 34 percent increased their margins; 26 percent decreased them--for a net of only eight percent increasing*."

Thus, OEM that apply professionally organized intelligence practices are on average able to gain a relative 9% additional gross margin. Thanks to intensive CI, OEM can make strategic better investments (e.g. Mergers and Acquisitions, strategic decisions) or develop e-commerce applications with better design or lower cost.

Clearly, the OEM, claiming exclusive ownership of the telematics platform, has more tactics and analytics at its disposal than what is achievable by CI. The OEM data platform, combined with strong analytics, is a tool way more powerful than CI, which explains why competitors commonly call it the OEM weapon of automotive e-commerce.

6.5.3 Total Impact

We approximate the monetary benefit by assuming that OEMs could -hypothetically- offer this full potential 9% discount to consumers, to breakdown their large pricing difference with independents.

[223] Wolfgang Kerber, Data-Sharing in IoT Ecosystems from a Competition Law Perspective: The Example of Connected Cars, paper, Journal of Competition Law & Economics, Volume 15, Issue 4, December 2019

[224] http://www.barometersurveys.com/vwAllNewsByDocID/03295DF410AE990A85256BA6000013AC/index.html

According to the IAM market share sensitivity relation[225] (applying the elasticity coefficient of 0.6) this reduction of the pricing gap will cause a churning of 5% market share from IAM to OEM. Given the aftermarket value of €280 billion, the *full* potential impact for the IAM segment is a loss of circa €14 billion. These churned consumers can profit from the OEM discount, but will still end up paying 41% (=50%-9%) more on the bottom line, which adds circa €10 billion annually for consumers.

Independent Aftermarket Loss Impact [€Bn/y]	2023	2030	2040	2050
advanced connected	7%	15%	60%	100%
Non-public insight and preferential treatment	**2**	**4**	**14**	**24**

The fines by the EU are typically quantified as 10% of the worldwide revenue[226], which applied in the automotive sector, amount in the range €8 to €30 billion *for each single* OEM, depending on its size. Put in perspective, the seemingly draconian *one-off* fines imposed by the EU are merely minimal corrections which only compensate the OEM gains at the lower bound value considered over the sector and cumulatively in time.

[225] Quantalyse Belgium, Schönenberger Advisory Services, (2019) "The automotive digital transformation and the economic impacts of existing data access models", Technical Report.

[226] EU commission, Antitrust: Commission seeks feedback on commitments offered by Amazon concerning marketplace seller data and access to Buy Box and Prime, press release, 2023

6.6 Conclusion

Since the onset of OEM embedded telematics, for two decades, vehicle manufacturers hold sovereignty over the data that the user generates with his vehicle, and exclusive control over communication with the driver through the display. Consultancy firms tout how to monetise and derive gain from the sole ownership that they have been able to claim. On the other hand, academia point out the negative consequences on the automotive aftermarket ecosystem, news outlets report about OEM anticompetitive behaviour and consumers and independent players push -in vain- for regulatory reforms to address the growing lack of a level playing field.

In this chapter, an assessment was made of some of the economic impacts for the aftermarket from a consumer perspective. Based on two decades of standstill in regulation, we assume for our projections that the current legislatory situation will not fundamentally change, despite revision moments with cosmetic 'updates'. Although assumptions and complexities had to be stylized, approximations were made in a best estimate mode, but conservatism was applied when uncertainty on data inputs was higher. We assume a static market balance, where second order effects are ignored for both conservativeness and simplicity. As such, the impacts are estimated on a top-down basis with the use of basic, public data inputs, to demonstrate the order of magnitude of potential effects for the independents segment and consumers in Europe.

There are six main ways in which OEMs leverage or monetize on the self-proclaimed data/driver ownership: (i) to induce client conversion from competitors to the OEM authorised network, (ii) to create additional (redundant) revenue streams on clients and competitors, (iii) to block realisation of gains, savings, or innovation for consumers or competitors (iv) to downscale granularity, frequency, speed, availability, timeliness, accuracy, or completeness of data for competitors and drivers, (v) monopolize bidirectional driver communication and vehicle command control, and (vi) to make use of non-public monitoring data of competitors to gain advantage on the same or similar services and products.

This study assesses the top five common use cases of aftermarket vehicle spending where OEMs make use of these means, whereby consumers and independent business suffer loss at the bottom line. Loss is a general term that covers transfer of existing business to OEM, or newly created cash-flow to OEM.

<u>Use case 1.</u>

About half of the aftermarket expenditure goes to service, parts, maintenance and repair as a result of simply usage (wear-and-tear). Workshops from both IAM and OEM compete for this major revenue stream over the lifetime of a vehicle.

OEMs sovereignty in the advanced connected vehicle enables to capture the client relationship. Through their monopoly on communication and data access, OEMs generate significantly more leads to their own network upon each SMR instance. Slowly, but surely, OEMs are able to increase the productivity of their workshops and outcompete IAM.

Likewise, the exclusivity of the communication with the driver is a major leverage for the OEM warranty fallacy (warranty is void if one has SMR performed by a non-authorized workshop). There is no possibility for IAM to inform drivers of the choice when there is a call for maintenance on the dashboard, and OEMs succeed to maintain the lock-in.

Furthermore, as self-entitled owner of vehicle/user data, OEMs make their entry as indispensable middleman into the IAM network, where they monetize access to diagnostic codes, battery status, and services to analyse repairs, on top of the static data on parts and manuals. This represents a transfer of annual cash-flow from independents and consumers to OEM.

Use case 2.

Random events drive about one third of annual expenditure in the aftermarket, of which half is paid by people out of their pocket and half through insurance coverage, to get their vehicle roadworthy again. Independent insurance companies or OEM captive insurers are the intermediaries who have a major impact on the decision *in which network* the salvage/repair may take place.

The detailed calculations show that OEM captives, with their exclusivity over advanced embedded telematics, have an anti-competitive advantage to significantly undercut the independent insurers via two major asymmetries.

Firstly, only OEM insurers can leverage on lower operational expenses, as they need relatively less advertising costs thanks to the exclusive communication with the driver, have deeper insight in accident causation saving in claims processing overhead, and have no need to bear costs for lesser quality OEM server access or work with an inferior retrofitted device.

Secondly, only OEM insurers possess the advantage to lower claims, as they have deeper insight in crime events, can better implement safe driving practices with the best driver access, and can avoid adverse selection through their database ownership.

Moreover, the consumers in the accompanying market share that OEM obtain from independents will cost the consumer substantial in upselling of branded parts and services. And finally, there is the effect that the more vehicles with embedded OEM devices are entering the market, the more redundant the retrofitted telematics devices.

Use case 3.

Expenditure in the aftermarket is for almost one fifth driven by the fleet operators, like operational lease, hire purchase, and car subscriptions, which explicitly include contractual service agreements to keep the -typically more intensively used- vehicles operational. Telematics is very much penetrated into this segment due to the enormous savings that can be realized with data access to the fleet vehicles, which attracts more clients.

Several studies in literature showcase the benefits for fleets: save fuel, avoiding accidents, limiting speeding, stricter maintenance follow-up, remote diagnostics, prognostics, route optimization, reduction of blameworthy collision claims, combat vehicle crime, optimize fleet size, composition and allocation, reduce idling, etc

Limited access to the high-quality embedded OEM telematics represents a significant loss for the independents. Moreover, they bear redundant costs for alternative devices, as the potential of the advanced on-board telematics is currently unusable. Anti-competitive driver communication access systematically reduces the leads in new business. Furthermore, new value propositions and savings through innovation are to a major extent blocked and unrealized, as potential R&D by independents remain unfunded due to lack of level playing field, and OEMs lack the agility/entrepreneurship.

Use case 4.

There is a small, but fast-growing part of the aftermarket that deals with *optional* add-on services and parts specifically adapted for the vehicle. The most developed ecosystem is the in-vehicle infotainment (IVI) platform market. There is a fierce competition in this arena ongoing, where OEMs try to keep Big Tech out of the digital cockpit.

If regulation does not allow for equal access to data and driver, then OEMs are likely to behave like Big Tech and exercise their sovereignty: they offer a highly curated boutique approach through a car-centric Application Store/Platform for any third parties to develop on, taking a 30% share of the revenue by third parties, generated via fees and in-app purchases.

Use case 5.

The OEM telematics monopoly position represents a major friction force to the e-commerce development or any automotive start-up investment due to disproportional monitoring benefits by OEMs. The fact of extensive non-public insight by OEMs and imminent preferential treatment of similar products or services they launch, as constantly demonstrated by the various infringements by Big Tech players in the news, discourages many independent initiatives.

For example, OEMs can establish a more optimal timing, a better place in the ranking, or price undercutting on basis of real time information than a third party. OEMs have access to non-public business data of third parties such as the number of vehicles serviced, type of information accessed, the sellers' revenues when in-vehicle payments take place, the number of visits to sellers' applications, to sellers' past performance.

Based on competitive intelligence advantages, we conservatively estimate the market share setback of independents and extra costs for consumers, when confronted with the tolerated anti-competitive behaviour.

Summary

The breakdown of the average expected losses, in function of the degree of advanced connectedness of the vehicle park in Europe, identified per use case, is in summary as follows:

Independent Aftermarket Loss Impact [€Bn/y]	**2023**	**2030**	**2040**	**2050**
advanced connected	7%	15%	60%	100%
Service, maintenance and repair due to wear-and-tear	3	8	23	36
Insurance anticompetitive pricing, repair parts/services	1	3	11	18
Operational leasing unrealized gains and conversion	4	10	12	12
In Vehicle Infotainment fees on luxury segment	0.5	1	3	5
Non-public insight and preferential treatment	2	4	14	24
TOTAL	**10**	**26**	**63**	**95**

Estimated -annual- economic impacts for independents and consumers in case the regulatory framework fails to enforce equal access to data generated by the driver and communication through the in-vehicle display.

While pandemic and supply crisis have delayed rapid evolutions in the advanced connected vehicles growth, they will nonetheless materialise. The European aftermarket of circa €280 billion revenue can expect imbalance worth €3 billion, which does not stand out yet, as it compares to the volatility of the aftermarket, but it is a systematic trend.

In 2030, market share is likely to shift out of balance for independents and consumers when this loss climbs to a 9 percent points revenue impact in 2030 reaching a loss of €26 billion annually. The independents see clients attracted to OEMs, while consumer expenses increase.

Overall, our estimations are made with most conservative assumptions, and our projection of €26 billion loss by 2030 appears to be on the lower end when compared to literature. For example,

- A quantitative analysis conducted by Wolk Aftermarket Experts estimates an annual €43 billion loss per year over 7 major EU countries[227] in 2030, which is about €65 billion annually if extrapolated over the whole of Europe.
- In a 2021 McKinsey study[228], the consultants estimate that globally about $200 billion to $350 billion annually will simply not realize in innovation and savings by 2030. For the European region, this comes down to a loss of circa €70 billion annually.

Our impact projection independently computes to loss of the order €60 billion annually, but we expect this impact magnitude to realize up to a decade later, rather towards 2040. Mainly due to low attach rates of embedded telematics (supply chain interruption), the low European government incentives for electrical, and economically depressing geopolitical tensions throughout the Twenties.

[227] Wolk Aftermarket Experts, On the impact of the various Policy Options of the EU initiative for access to vehicle data, functions and resources, research paper, ADPA, 2022.

[228] McKinsey, *Unlocking the full life-cycle value from connected-car data*, study, 2021.

7 Appendix 1 – Aftermarket structure

7.1 The automotive value chain

A vehicle lifecycle passes through various stages, such as Research & Development (R&D), product development, sourcing, logistics, manufacturing, new vehicle sales, financial services, aftermarket services, used car sales and finally the end-of-life process of recycling. The automotive industry that sustains this lifecycle forms a complex interconnected network including many players distributed across various sectors, geographical regions and companies.

The 'automotive value chain' comprises a multitude of companies that deliver added value to the vehicle during its lifecycle. It is often[229] divided intuitively by activities relating to the point of sale of new vehicles into the 'upstream' (raw materials processing, manufacturing, chemicals, parts, etc.) and 'downstream' (repair, maintenance, information technology, mobility services, etc.).

This study focuses on the specific subsegment of the '***aftermarket***' within the downstream sector. It is the value generated by market players offering vehicle related services and parts, **after** a new vehicle sale has taken place. Figure 60 provides a schematic of the scope.

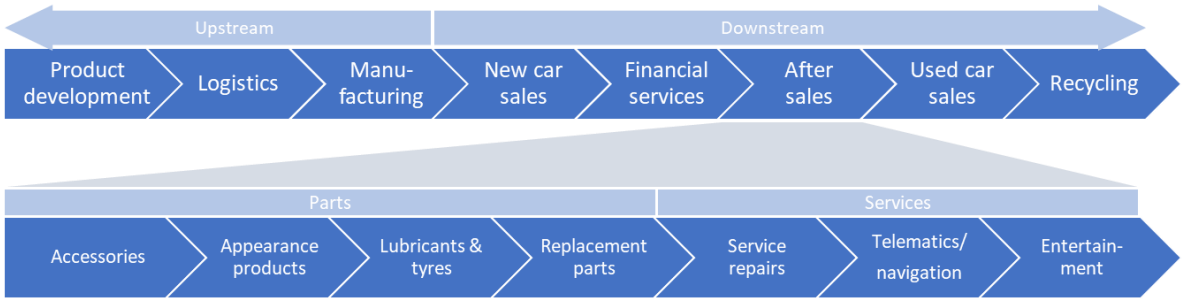

Figure 60: Scheme of automotive upstream and downstream activities with focus on after sales. Source: Capgemini.

The aftermarket refers to the market providing spare parts, accessories, and components for maintaining or improving the vehicle, encompassing all trades that support and improve the usage of a durable product. The aftermarket or "secondary market" refers to the whole market for complementary goods and services for the original products. All the automotive business-to-business (B2B) and business-to-customer (B2C) interactions and relationships together form an ecosystem of its own.

For clarity, the following revenue streams are not considered part of the aftermarket: e.g. vehicle purchase or depreciation costs, fuel cost (e.g. petrol, diesel, gas, electricity, hydrogen), any other transport cost (e.g. taxi service, rental), obligatory costs to authorities (e.g. drivers licence, taxes, inspections, registration, tolls), environmental/social costs (e.g. congestion, pollution, infrastructure, space use, subsidies).

[229] The Aftermarket in the Automotive Industry: How to Optimize Aftermarket Performance in Established and Emerging Markets, Capgemini Consulting, University of St. Gallen, report, 2010

7.2 Relevance

In Europe, over 12 million people are employed in jobs related to the global automotive and road transport sector, representing 7% of total EU employment.

The automotive *aftermarket* is a distinct and substantial component of the automotive value chain. Aside from the (concentrated) car makers, there are almost a million companies involved in the aftermarket, of which the overwhelming majority are small or medium-sized enterprises (SME), and the aftermarket sector employs circa 5 million people[230].

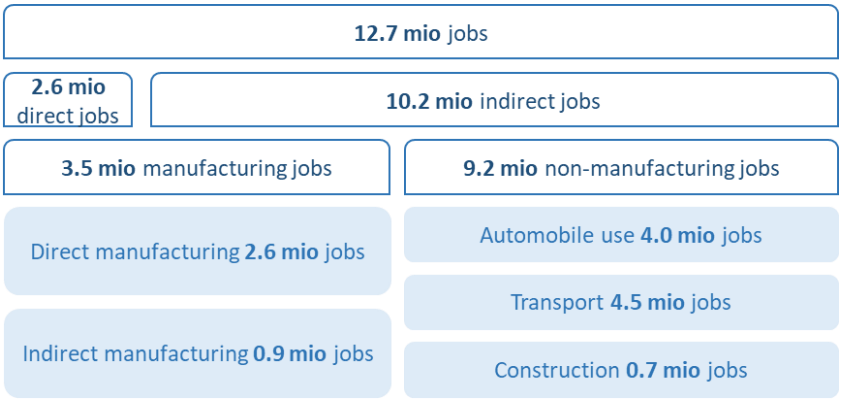

Figure 61: Overview of EU employment in the automotive sector. Source: ACEA 2022/2023 pocket guide.

Furthermore, about half of the EU's gross domestic product (GDP) is composed of household expenditure. As a share of it, the annual cost of EU citizens keeping their vehicle in operation (services, repair, parts, chemicals, maintenance, etc., but excluding fuel) is a sizable 3.2% of total household expenditure in 2021, which is about equal to the expenditure on purchasing new vehicles (3.6%)[231].

Therefore, the automotive aftermarket is a material part of the economy and is complementary to car manufacturing and is equally important in terms of overall economic value.

7.3 Vehicle types

The scope of this study is the aftermarket for Passenger Vehicles (PV) and Light Commercial Vehicles (LCV).

PV are road motor vehicles, other than a moped or a motor cycle, intended for the carriage of passengers and designed to seat no more than nine persons (including the driver). Included are e.g.:

- Passenger cars
- Light vans designed and used primarily for transport of passengers
- Taxis
- Hire cars

[230] www.clepa.eu

[231] Eurostat 2021, Household expenditure by purpose in the EU

- Ambulances
- Motor homes
- Micro-cars (needing no permit to be driven)

LCV are Light Commercial Vehicles with business design/purposes, which have a design gross vehicle weight (DGVW) or maximum authorised mass (MAM) not exceeding 3.5 tonnes. Included are e.g.:

- Jeeps,
- Carrier vans
- Moving trucks

Out-of-scope are medium and heavy commercial vehicles and buses, as the aftermarket structure for these larger specialized vehicles is significantly different and the distribution channel is separated from retail. As such, PV and LCV segments cover circa 96% of the European car park in use.

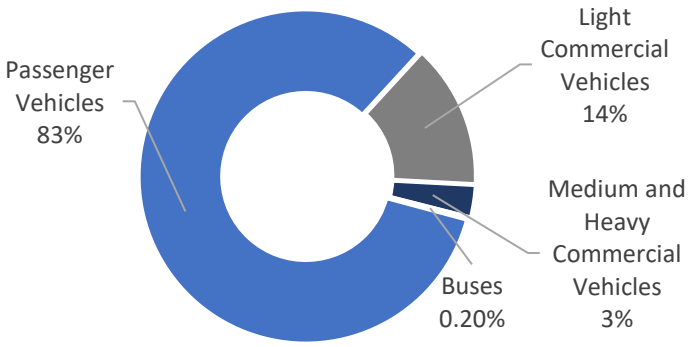

Figure 62: PV and LCV represent 96% of the EU car park. Source: ACEA.

7.4 Segments

The European aftermarket is comprised of two major segments: sales of replacement parts and services. On average, the aftermarket subsegment of parts[232] is slightly larger representing about 55% than the services segment with 45% in 2023 [233].

Figure 63 visualizes that segmentation. For this study we assume that this split is still valid today as both parts and services are similarly impacted by price increases due to the increasing technological complexity of both elements as well as economic developments such as inflation.

[232] The changing aftermarket game – and how automotive suppliers can benefit from arising opportunities, McKinsey, June 2017

[233] Aftermarket perspective and latest observations, FIGIEFA conference 2023, McKinsey & Company, February 2023

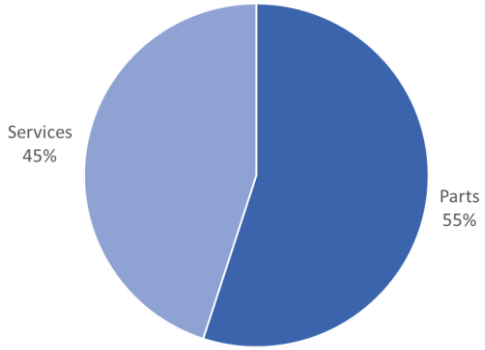

Figure 63: European aftermarket split into services and parts

The European aftermarket encompasses all parts and services purchased for passenger and commercial vehicles after the original sale. These services are repairs after an accident, repairs of wear and tear effects, repairs of mechanical and electronic failures, maintenance, tires services, diagnostic products, workshop equipment, accessories, and consumables such as lubricants or oil. The value of the aftermarket is driven by labour costs and the prices of parts.

We differentiate between the retail dealerships owned and authorized by car manufacturers also known as original equipment manufacturers (OEMs) (in our study referred to as OEM channel) and independent garages, retailers, and operators, referred to as the Independent Aftermarket (IAM) channel or Independent Operators (IO). In addition, there are other players at wholesale and retail level but for the purpose of this study we have not differentiated the different degrees of contribution at various levels of the value chain.

7.5 Main aftermarket players

The European aftermarket is divided into two notable groups of market players: OEM and IAM, as described in section 2.1.5 and 2.2.3. Overall, both share the market by circa 50%-50%, although on an individual country level deviations like 70%-30% or 40%-60% occur, depending on the presence of OEMs and their distribution network. Approximately 40% of the parts market is accounted for by the OEMs[234][235].

Recent studies identify a third camp, namely technology companies or Digital Players (DP), as described in section 3.2. Figure 64 visualizes the overall market shares of automotive market players.

[234] https://ww2.frost.com/frost-perspectives/ageing-car-parc-europe-paves-way-evolution-oem-and-independent-aftermarket-iam-relationship/

[235] The automotive aftermarket in 2025, Trends and Implications, Stern Stewart & Co., Qvartz, September 2018, commissioned on behalf of CLEPA

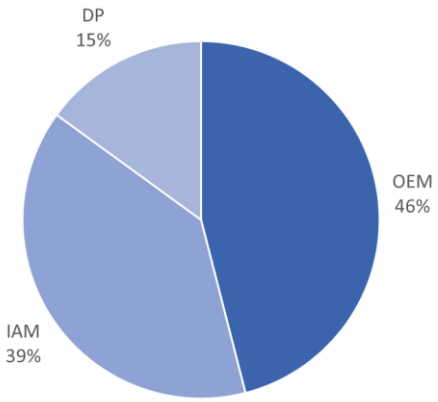

Figure 64: Revenue market shares of OEM, IAM and DP in 2023 for Europe.

Public market information or studies about the size of the DP segment are scarce. Only limited or partial estimates exist as to its size. Their percentage market share today may still be relatively small: at least in Europe the size is smaller than in the US, where it amounts to about 3% - mainly through online selling of parts[236]. Studies predicted at least 10-15% year on year growth by 2022 for B2C online part sales in the US and Western European markets. If we extrapolate the DP segment at that rate, it may evolve in the range of [7%, 10%] by 2030 for parts only. With services added, DP could acquire a market share in the range of [20%, 30%] in 2030.

In our last study, we assumed a low one-digit percentage market share for DP in Europe to be the baseline in 2018. Back then we predicted this share to rise to [7%, 10%] by 2030 for parts only and to [20%, 30%] including services. Based on additional information on the evolution of digital aftermarket business in Europe[237] and due to a general explosion of e-commerce activities in Europe following the pandemic, we assume a market share of 15% for DP in Europe in 2023. Given the accelerated activities of DP in the automotive aftermarket and the encroachment of tech players into the development of the modern vehicle, we raised our forecast of market shares in 2030 to 20-25% for parts and 40-50% including services.

Traditionally, both the OEM and IAM players have focused their competition for market share between themselves. As the current and future role of DP in the automotive value chain was difficult to quantify due to a lack of publicly available data back in 2019, their impact was excluded from the quantitative study. However, their growth has been steady over the past years and their impact can no longer be ignored.

[236] Strategic Analysis of eRetailing in the Global Automotive Aftermarket, Frost & Sullivan, research report 2016; https://www.forbes.com/sites/sarwantsingh/2017/07/18/amazon-ebay-step-up-their-game-plan-for-automotive/#3e117fa178f9

[237] McKinsey, Die Online-Revolution im Kfz-Aftermarket, Juli 2021

7.6 Car park

The European car park has been steadily growing since 2017 with annual growth rates showing a recent slowdown largely caused by the above-mentioned economic slowdown and drop of new car registrations.

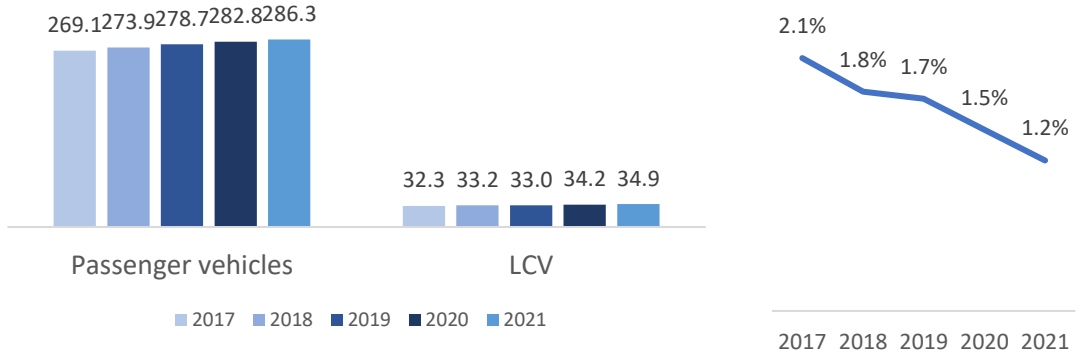

Figure 65: PV and LCV car parc in EU+UK [in million vehicles] showing a steady growth since 2017 at a declining annual growth rate[238]

Between 2017 and 2021, the registered car park in the European Union (27) + UK rose from 270 million PV units in 2017 to 286 million units in 2021 albeit at declining annual growth rates (Figure 65)[239], with an estimate of 295 million PV units in 2023.

The dip of 2020-2022 in new production during the pandemic and supply issues is not immediately noticeable in the overall size of the car park, as the registration of older cars was prolonged and vehicle replacement is expected to resume in 2023. Furthermore, a number of Green deal related policy initiatives are expected to bring about a stagnation or even decline in the steady growth rate in vehicles in the Bloc (cfr. chapter on legal framework).

For the purpose of economic analysis and in order to allow meaningful comparison with other public European region aftermarket figures available, we adopt the geographical scope to cover Europe as a whole (43 countries instead of EU27). We include e.g. Iceland, Norway, Switzerland, United Kingdom, Monaco, etc, but exclude Russia and Turkey.

Finally, besides the 295 million units of PV, the LCV part is estimated at 39 million units in the (EU + UK), while non-EU countries within region Europe account for an additional total of about 19 million passenger/LCV units in 2023[240]. Driven by demographic immigration and economic development in emerging markets, this leads to circa 360 million units in 2023 (circa 320 million PV plus 40 million LCV; it confirms the rule of thumb that there is about one LCV for every 8 PV). This total number for

[238] ACEA, vehicles in use in Europe, pocketbook 2023

[239] Eurostat, online database, 2023, ACEA

[240] BCG, CLEPA, Wolk, At the Crossroads: The European Aftermarket in 2030, report, March 2021.

the whole European region is indeed about 25% of the global car park size of 1.440 billion units, as estimated by the International Energy Agency (IEA)[241].

We use this key figure of **360 million Passenger/LCV units** in the Europe region as the baseline in this study in 2023.

7.7 Car park age

The second most important driver for the aftermarket is the age of the car park. While one would expect a rejuvenation of the European car park driven by regulation and technology advancements, the car park has continued to show a linear ageing progress and the average age of a passenger car stands at 12 years in 2021. This is an increase of 0.8 years since our last study.

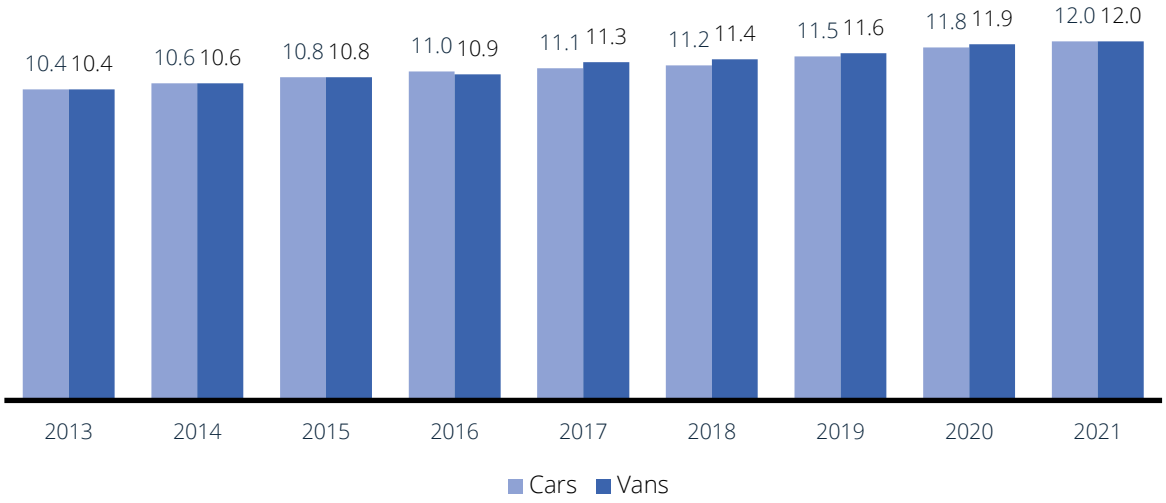

Figure 66: Average age of the motor vehicle fleet in the EU showing a linear increase over time[242]

There are vehicles on the road with lifetimes well beyond the average of 11 years, but it is a point where the occurrence diminishes. Figure 67 illustrates that median and mean are close.

[241] the International Energy Agency (IEA), global EV outlook, report, 2020; for comparison China has about 35% of the global car park, and the US 20%.
[242] ACEA

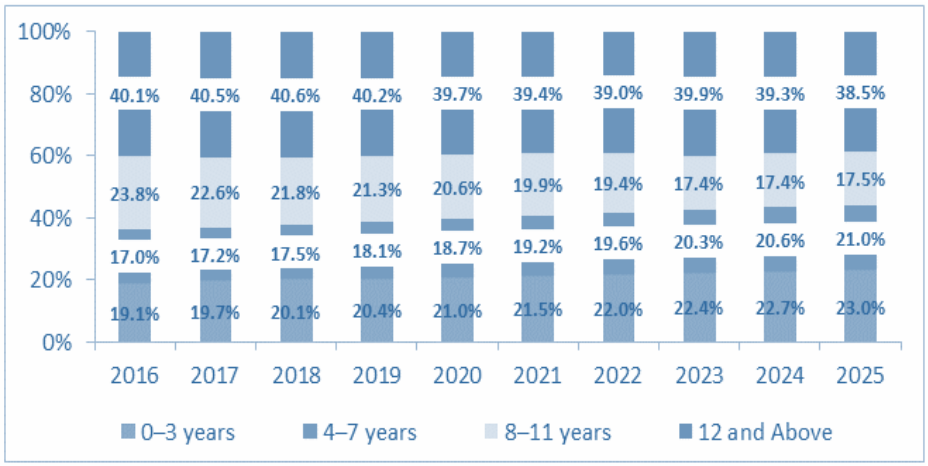

Figure 67: Typical distribution of vehicle parc over age segments [Frost]. Source: Frost & Sullivan.

Typically, OEMs dominate the aftermarket for the most part of the younger vehicles. A majority of customers believe that not using OEM parts and service during the warranty period may render it void, which is not true and is regulated by the Block Exemption Regulation, but explains this temporary price insensitivity of vehicle owners. With increasing vehicle age, price sensitivity returns to normal.

Overall, it can be observed that OEMs dominate the 0-3 years segment, compete with IAM players in the 4-7 years segment, level off in the 8-11 years segment and are mostly absent in cars above 12 years old.

While in our last study it was expected that the share of 12+ old vehicles would continuously decline, this segment is now expected to continue to rise in the next 5 to 10 years. However, the penetration of BEV and with it connected vehicles will increasingly penetrate each age segment starting with the young segments and arriving at the 12+ segment in ca. 10 years from now. If IOs are not given the chance to operate in the connected vehicles space, their basis for business operations will ultimately vanish (see Figure 68).

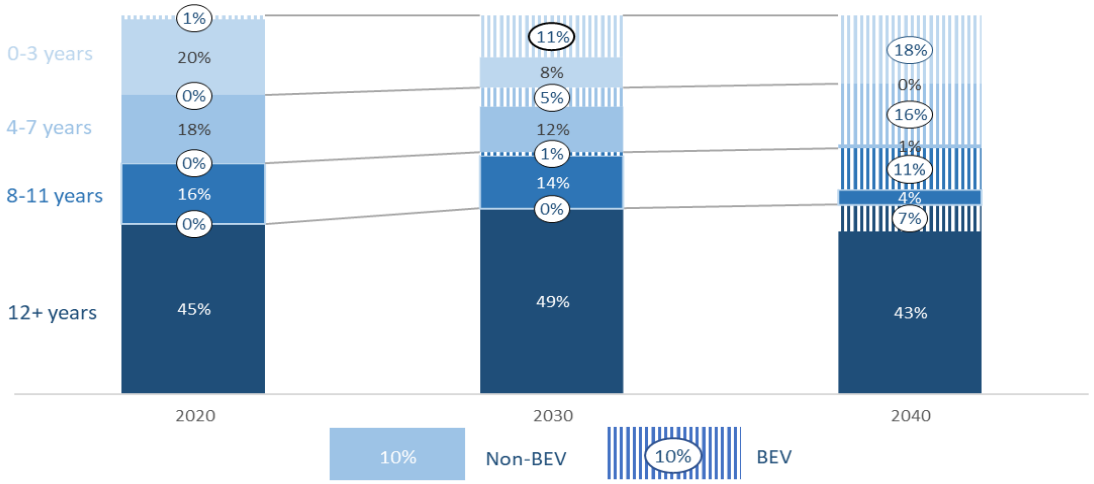

Figure 68: European car parc by vehicle age in percent, 2020-40[243]

[243] Electrification Of Light Vehicles - Boon or bane for the European aftermarket, CLEPA & Roland Berger for FIGIEFA, December 2022

8 Appendix 2 - Key stakeholders and third parties interested in fair data access

Prior to providing a brief description of the key stakeholders of the automotive aftermarket who have a particular interest in a competitive and transparent aftermarket, it is worth taking note that over the past decades, OEMs have entered many of the businesses of these stakeholders. They have set up captive organisations active in the same field of business with the intention to increasingly capture market value by moving up or down the value chain and to position the brand of the OEMs in the mind of consumers.

OEMs have expanded into automotive leasing (e.g. Athlon acquisition by Mercedes), fleet management (e.g. participation of VW in Fleetlogistics[244]), telematics (VW and WirelessCar[245]), automotive insurance (e.g. BMW and SwissRe), car rental (e.g. VW and Euromobil), car sharing (e.g. BMW/Mercedes and Car2Go, DriveNow), and used car trading (VW, Mercedes and Heycar). All OEMs have either via new venture funds or directly taken stakes in new connectivity and mobility ventures (GM and ride hailing company Lyft, Volvo and car valet start up Luxe, Ford and electric scooter sharing company Spin, Toyota and ride hailing company Grab). These developments are relevant when evaluating competition aspects.

8.1 Rental companies

Most rental companies have adapted their business model and are offering a multitude of mobility services today like car sharing or ride hailing, often referred to as Mobility as a Service (MaaS).

They benefit from their longstanding operational experience in managing large fleets of vehicles, keeping them and the services offered to their customers up to date and compliant with various regulations. Therefore, they are interested in offering innovative services in numerous areas including maintenance (fleet management, remote diagnostics, vehicle recovery etc.). Rental companies are the owners of their vehicle fleet and have over the past years increased the residual value risk exposure by remarketing the vehicles themselves.

Automotive OEMs have expanded their position in the value chain and no longer are merely suppliers of vehicles to rental companies but also direct competitors through their various mobility businesses. For example, Car2Go started out as a collaborative effort between Europcar and Daimler, with Daimler taking over Europcar's stake entirely in 2018. Shortly afterwards, Car2Go merged with BMW's Drivenow carsharing service. MaaS will serve cities and consumers' need for a flexible on-demand mobility which is environment-friendly and can deliver promised societal benefits. Data needed to develop the new services to be delivered are crucial to avoid anti-competitive transport monopolies.

Rental companies are concerned about potential abusive use of vehicle data access by OEMs in the following way:

[244] https://www.fleetnews.co.uk/news/fleet-industry-news/2019/02/08/volkswagen-fleet-services-buys-majority-stake-in-fleet-logistics

[245] https://www.reuters.com/article/us-volkswagen-digital-volvo/volkswagen-buys-volvos-connected-car-unit-for-122-million-idUSKBN1OI15H

- Excessive prices for data access
- Withholding data
- Manipulating transfer speeds or other performance criteria
- Impacting the running of competitors' applications by changing interfaces, delaying information etc.

As providers of clean and affordable pay-as-you-go road transport, vehicle rental operators will play a key role in any integrated mobility as a service platform and transport policymakers need to engage with them.

8.2 Leasing companies

"Globally, Europe is the leading market in both size and maturity with a very high penetration of operating leases, making this market the most attractive for the development of service-oriented solutions"[246]

In addition to rental companies, leasing companies are one of the key operators in the MaaS platforms ecosystem. Operating leasing companies provide not only financial services but also many other services related to a vehicle including service and maintenance, tyres services, fuel management, replacement vehicles, reporting, car procurement. The business model of operating leasing companies includes the lessor to take the full risk on Repair & Maintenance costs and/or tyres costs in addition to the residual value risk for the vehicle.

Therefore, it is in the leaser's interest to keep a tight control over these costs as well as minimum standards of quality, which many companies achieve by having established advanced sourcing, procurement and controlling processes as well as setting up a preferred network with clear Service Level Agreements (SLAs). These networks can – depending on location and vehicle brand – consist of captive or independent workshops.

With their in-depth knowledge of the vehicle market, leasing companies are able to take a comprehensive and long-term view of vehicle costs and performance. This allows them to determine precisely the total cost of using of a vehicle over a period of several years, ensuring the right vehicle for the client/consumer is chosen from a wide range of different brands.

While at the beginning of the continuous development of the European leasing industry bank owned and independent leasing providers used to be the norm, OEM or importer owned leasing companies, so called captive leasing companies, started to enter the market around the turn of the millennium. Since then, European captive leasing companies have seen a steady growth of their business in recent years and continue to play an important role in support their parent OEM's strategies to engage alongside to automotive value chain and turn from a car manufacturer into a mobility provider.

For example, Daimler Financial Services has been renamed to Daimler Mobility in 2019 and subsequently in 2022 to Mercedes-Benz Mobility and aims at "having the most data". It plays a crucial role in monetisingmonetizing vehicle data by developing and selling data-based mobility services. Its revenues doubled between 2009 and 2017 and flattened since the pandemic, as shown in next figure.

[246] Embracing the Car-as-a-Service model – The European leasing and fleet management market, Roland Berger, January 2018

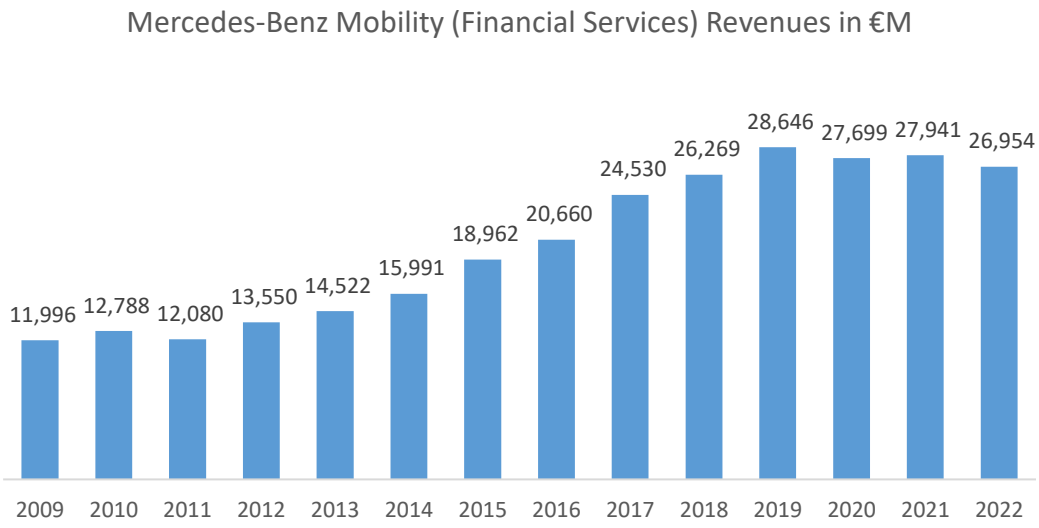

Figure 69: Rise of OEM captive financial services, example Mercedes-Benz. Source: Daimler Annual Reports, Mercedes-Benz Annual Reports

Both captive and independent operational leasing firms own and service multibrand fleets, including fleets of the fast-growing segment of car sharing or ride hailing providers. As such, the interoperability of data access is a basic requirement to avoid complexity costs. Captive companies play an important role in the envisaged mobility ecosystems of OEMs. They are less dependent on other vehicle brands than those of their parent OEM. So even when assuming a level playing field with regards to access to data, captive lessors will have a certain advantage over independent leasing companies because they simply need to set up less interfaces to be able to service their customers.

8.3 Insurance companies

With motor insurance (third party liability, collision damages) being a traditional product of incumbent insurance companies, in the past years also OEMs, dealer groups, leasing companies and other new entrants have started to offer insurance services and to manage the risks related to them.

Similar to the Financial Services industry with the rise of Fintech ventures, the insurance industry is facing increasing activity and disruption efforts by digital players and start-ups. On the other hand, vehicle data offers new possibilities for enhancing insurance services by adding driver tailored services, usage based insurance (UBI) premiums, digitalizing the claim handling process and making more educated risk assessments.

8.4 Roadside Assistance providers

These organizations provide fast and comprehensive support after a vehicle breakdown and thus are relying on efficient ways of data exchange in order to streamline communication as well as parts and tool provisioning processes. Real time and direct access to in-vehicle data would allow Roadside

Assistance companies to pre-empt breakdowns or at least accelerate the time it takes to provide breakdown support. At a time when customer experience is steeply growing in importance and increasingly based on data, Roadside Assistance providers will not be in the position to improve customer experience without fair and uncompromised data access.

8.5 Automobile Clubs

Automobile and Touring Clubs are organisations that aim to protect the rights and interests of all road users, to ensure safe, affordable and clean transport for all by maintaining the benefits of personal mobility.

These clubs are often involved in providing motorists with many of the services described previously either as the actual service providers or orchestrators of such services. They provide consumer information and advice about vehicles such as estimates about the total costs of ownership (TCO) or total costs of mobility (TCM) for motor transport as well as relevant trends and developments in the motor world.

FIA Region I represents 36 million members[247] all over Europe and is thus an important voice of the consumer, a topic that will be further explored in the next chapter.

As for the connectivity trend, European motorists support and welcome this trend as it makes driving safer and more convenient. However, they are keen to understand how their personal and their vehicle data are being shared and to be given a choice on whether or not to share their data and if so to decide with whom[248].

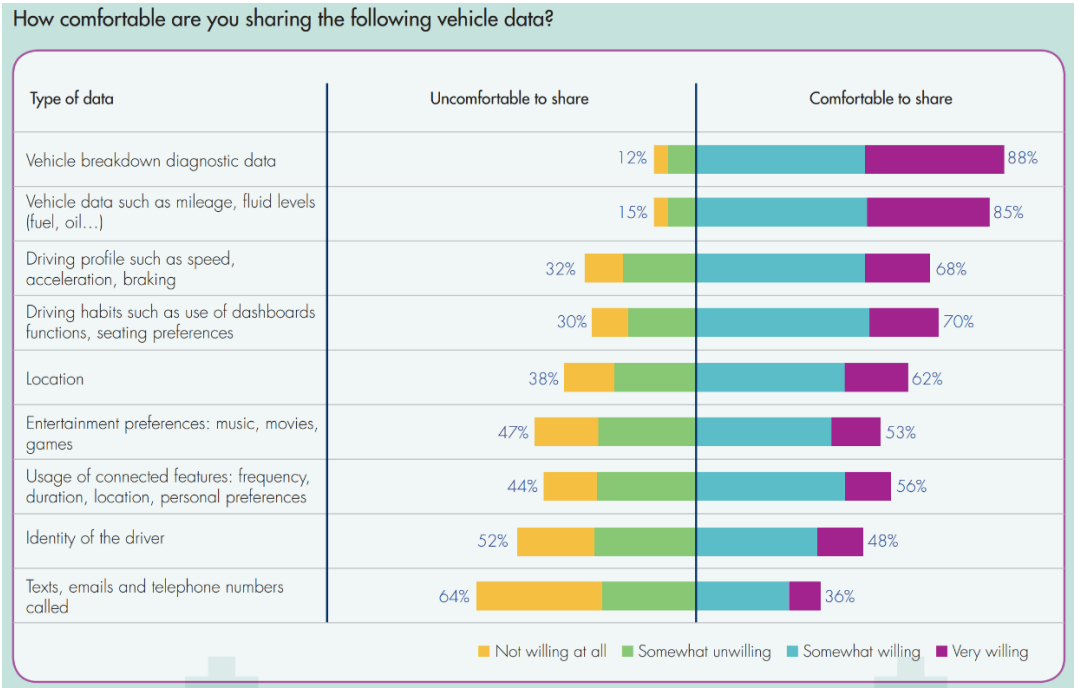

Figure 70: Survey results reveal that consumers are well aware and opinionated about the types of data. Source: FIA.

[247] https://www.fiaregion1.com/

[248] What Europeans think about connected cars, My Car May Data, FIA Region 1 with Research Now, January 2016

FIA Region 1 being the representative of the European automobile clubs has summarized their position with outlining three objectives:

- **Data protection**: drivers should retain ownership of data and give informed consent on its use
- **Free choice & portability**: drivers should have the right to choose their preferred service providers and freely consent to data being transmitted by their vehicle
- **Fair competition**: a variety of service providers should have the right to develop safe products & functionalities.[249]

FIA Region 1 has manifestly repeated and advocated these objectives in subsequent responses to developments with regards to fair in-vehicle data access.

[249] Policy position on car connectivity, FIA, April 2016

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About FIA European Bureau

The FIA European Bureau, based in Brussels, is a consumer body comprised of 66 Mobility Clubs that represent over 39 million members from across Europe. The FIA represents the interests of our members as motorists, riders, pedestrians, and passengers. We work to ensure safe, affordable, clean, and efficient mobility for all.

Learn more at www.fiaregion1.com.