Deliverable **D1.6** /

Deployment strategies and business models for ADFs

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List of abbreviations and acronyms

Abbreviation	Meaning
5G	5^{th} generation of mobile communication
ACEA	Association des Constructeurs Européens d'Automobiles (European Automobile Manufacturer's Association)
AD	Automated Driving
ADAS	Advanced Driver Assistance Systems
ADF(s)	Automated Driving Function(s)
ADS	Automated Driving Systems
AI	Artificial Intelligence
ARCADE	Aligning Research & Innovation for Connected and Automated Driving in Europe
AV(s)	Automated Vehicle(s)
B2B	Business to Business
B2C	Business to Consumers
BM	Business Model
BMW	Bayerische Motorenwerke
bn	billion
C-ITS	Cooperative Intelligent Transport System
CAD	Connected and Automated Driving
CAGR	Compound Annual Growth Rate
CCAM	Cooperative Connected and Automated Mobility
CCAV	Centre for Connected and Autonomous Vehicles
CEO	Chief Executive Officer
COVID-19	Corona Virus Disease 2019
D1.5, D1.6	Deliverable 1.5, Deliverable 1.6
DSSAD	Data Storage System for Automated Driving
EC	European Community
EDR	Event Data Recorder
EICT	European Center for Information and Communication Technology
ERTRAC	European Road Transport Research Advisory Council
ETP(s)	European Technology Platform(s)
EU	European Union
FIA	Federation Internationale de l'Automobile
G5	Vehicle communication via WLAN (Wireless Local Area Network)
GDP	Gross Development Product

Abbreviation	Meaning
GDPR	General Data Protection Regulation
GPS	Global Positioning System
HD	High Definition
HW(x)	Highway related milestones
IPR	Intellectual Property Rights
IT	Information Technology
ITS	Intelligent Transport Systems and Services
L1, L2, L3, L4, L5	Level 1, Level 2, Level 3, Level 4, Level 5
LR(x)	Law and Regulation related milestones
LTE	Long Term Evolution (4th generation of technology standard for cellular networks)
MaaS	Mobility as a Service
MB.OS	Mercedes-Benz Operating System (for cars)
ODD	Operational Design Domain
OEM(s)	Original Equipment Manufacturer(s); (here: car manufacturer)
OTA	Over-the-air
PA(x)	Public Acceptance related milestones
PP	Platform Provider
ppt	Powerpoint
PU	Public use
PWC	Price Waterhouse Coopers
RDW	Rijks Dienst Wegverkeer (Netherlands Vehicle Authority)
SAE	Society of Automotive Engineers
SDBM/R	Service-Dominant Business Model Radar
SoC	System-on-Chip
SN(x)	Sensors related milestones
SRIA	Strategic Research and Innovation Agenda
SW/HW	Software/Hardware
TNO	Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek (Netherlands Organization for Applied Scientific Research)
TV	Television
UK	United Kingdom
U.S.	United States
UNECE	United Nations Economic Commission for Europe
USD	US Dollar
V2V	Vehicle-to-vehicle communication

Abbreviation	Meaning
V2X	Vehicle-to-X (X like infrastructure, other vehicles, …) communication
VDA	Verband der deutschen Automobilindustrie (Association of German Car Manufacturers)
VR	Virtual Reality
VRU(s)	Vulnerable Road User(s)
VW	Volkswagen
WP	Work Package

Executive summary

The present L3Pilot Deliverable "*D1.6 - Deployment strategies and business models for ADFs*" is a deliverable of work package 1.4 *Exploitation and Innovation* and deals with future business opportunities for automated driving.

Research objectives of D1.6 have been (a) to understand the viability of AD-related business models that drive the demand for new service- and data-driven mobility solutions, (b) to understand the collaborations required from the different actors across the AD ecosystems, and (c) to identify key challenges for OEMs and other stakeholders.

Based on different business environment scenarios for automated driving in 2030 (as developed in Deliverable D1.5), four business model archetypes for automated driving have been elaborated, analysed, and evaluated, with the results being used to identify enablers for deployment strategies. First, **In-Car Services** are targeted to make the driving time more useful by offering a broad variety of services that can be consumed inside the car while the driver is released from the driving task. Second, with the **Data+ Platform** a trustful and secure B2B car and user data marketplace to provide valuable data for mobility-related and personal services. Third, the widely discussed **RoboTaxi** is one of the most ambitious and challenging AD-related business models that offer convenient private and urban commutes to customers with door-to-door service. Fourth, **Mobility as a Service (MaaS)** provides a seamless on-demand mobility experience by integrating public and private transport modes with automated sharing vehicles as well as RoboTaxis.

The ADFs tested in L3Pilot are necessary enablers for these business models. The SAE Level 3 functions Traffic Jam Chauffeur, Motorway Chauffeur, and Urban Chauffeur are entry functions to provide In-Car Services and enable the first step into automated sharing vehicles as a part of MaaS. RoboTaxis depend on SAE Level 4 functions like Urban and Suburban Pilot, and Highway Pilot, while the Data$^+$ Platform can benefit from every single ADF.

The four future business models for automated driving elaborated here follow a service-dominant logic and require strong collaborations of different stakeholders from various sectors (OEMs, tech players, service content providers, municipalities, telecommunication providers, payment providers, etc.), which is diverse to the established business models of automotive players (producing and selling cars with vehicle-related after-sales services). Accordingly, with the Service-Dominant Business Model Radar (SDBM/R) approach an appropriate methodology for the design of collaborative and service-dominant business models has been applied to describe and analyse future business models.

For the evaluation of the business models, a multi-step procedure has been carried out with assessments from project internal and external experts. The results have been used iteratively to refine the business models and understand key stakeholder requirements and major challenges concerning desirability (customer acceptance), technological feasibility, and viability. Based on an assessment of how existing European roadmaps for automated driving address the identified business model requirements and challenges for the involved stakeholders, recommendations for promising deployment strategies have been derived for OEMs and other stakeholders. These recommendations are to be understood as well-founded options for future actions by the various stakeholders, which were formulated based on the research work carried out including the intensive involvement of internal and external experts.

In the **In-Car Services** business model, OEMs will hardly be able to compete for the role of the focal organisation, being the service platform provider, with the big tech companies and their already existing comprehensive ecosystems. Two newly suggested roadmap milestones for this business model have been identified: Develop concepts and classifications to ensure personal confidentiality in the verbal communication with the driver against the other passengers and create concepts and devices for inspiring presentations of available service offers to the driver. Based on the methodology presented in the deliverable, OEMs are recommended to focus their deployment strategy on two specific topics:

- The development of attractive vehicle interior concepts and devices that provide an outstanding environment for an inspiring in-car service experience, using their key competencies in vehicle design.
- The development of own data-based services to be offered to the drivers as in-car services.

The **Data⁺ Platform** business model as a B2B model contains the acquisition, analysis, and processing of a vast amount of data (Big Data) related to vehicles, drivers, and the environment. OEMs and suppliers are recommended to find their role in this business, big tech players are strongly ahead. Three newly suggested roadmap milestones for this business model have been identified: the access and usage of enriched data have to become easier and more convenient, reliable data-based services have to be developed and maps have to be enriched with context information data. The most important recommendations following from the analysis for a promising deployment strategy focus on

- A concerted action of all relevant stakeholders to define rules and regulations for data access and usage that consider the needs and requirements on data privacy and data protection as well as the conditions for viable business models to create value for the different stakeholders.
- The OEMs to create their own data-based viable services not only to vehicle users but also to third parties (public authorities, private companies).

In the **MaaS** business model, the AV complements or competes with other modalities. The MaaS provider, if not the OEM, is controlling the customer's interface and thus the customer relationship, potentially diminishing the visibility of the OEM. Moreover, the MaaS business model requires intensive local configurations, dealing with city-specific conditions. This potentially hampers the scaling up of this business model. Three newly suggested roadmap milestones for this business model have been identified: the MaaS business model must prove to realize emission reduction and reachability and establish seamlessness, flexibility, and reliability for multi-modal journeys through real-time asset control. The most important recommendations following from this analysis for deployment include the following:

- Unite the interests of cities, focusing on societal value creation, and those of OEMs, and establish collaboration to create the organizational leverage needed to create scale and societal value combining a more prominent role for OEMs.
- Ensure the interoperability of AD vehicles in the context of the MaaS business model. This includes establishing proper data interoperability and sharing.

In the **RoboTaxi** business model OEMs might compete with big tech players for the role of the RoboTaxi service provider that is controlling the customer interface and thus the customer relationship. RoboTaxi as the most ambitious business model (requiring AD on SAE level 4) is very intensively discussed inside and outside the automotive industry. Unsurprisingly, current roadmaps are covering the requirements of RoboTaxis very well. Nevertheless, the most important recommendations following from the analysis for OEMs' deployment strategies are to:

- Create a viable concept for the integration of RoboTaxis into a sustainable and effective urban transportation system, taking into account the needs of all participating stakeholder groups.
- Develop as a RoboTaxi service provider the capability to scale up this business model under strongly varying local conditions and regulations.

The service-dominant and collaborative approach applied in D1.6 led to a comprehensive and in-depth analysis and evaluation of four highly relevant AD-related business models, which provide a meaningful contribution to deployment strategies and the business impact of L3Pilot and will foster the market dissemination of automated vehicles. In the follow-up project Hi-Drive, the business model analyses will be further detailed and quantified related to effects on transportation systems and financial benefits.

1 Introduction

1.1 L3Pilot project

1.1.1 Motivation for the L3Pilot project

Over the years, numerous projects have paved the way for Automated Driving (AD). Significant progress has been made. However, the technology is rapidly advancing and today in a stage that justifies automated driving tests in large-scale Pilots.

L3Pilot is taking one of the latest steps before the introduction of automated vehicle functions in daily traffic. Drivers are used to Advanced Driver Assistance Systems (ADAS), and numerous vehicles are equipped with ADAS. However, automation is not solved simply by integrating more and better technology. This topic needs a focus on user behaviour with automated driving functions. User acceptance is a key to the success of AD on the market as well as the legal and technical challenges on shared operational responsibility that first need to be discussed and solved on a broad level. The legislative processes need to be put in place and assist with policies, regulations, and practices which means understanding the technology, how it operates, and what that means for the users involved. In parallel with Piloting, the project also addresses legal and ethical issues related to the operation of automated vehicles.

The idea of the vehicle controlling itself by a computer can create uneasiness among the global populous akin to the first impression in the 1800s when a motor vehicle was first introduced. The lack of acceptance may hinder the introduction even of the lower levels of automation, like for driver assistance systems, despite their obvious benefits for safety and efficiency. To overcome public concerns, automated vehicle functions need to be designed according to user needs; otherwise, they will not be accepted.

1.1.2 Objectives

The overall objective of the L3Pilot project is to test and study the viability of automated driving as a safe and efficient means of transportation, to explore and promote new service concepts to provide inclusive mobility.

AD technology has matured to a level motivating a final phase of road tests that can answer the key questions before market introduction. These newly attained levels of maturity will ensure an appropriate assessment of the impact of AD, what is happening both inside and outside the vehicles, how vehicle security can be ensured while evaluating societal impacts and emerging business models.

Recent work indicates how driver assistance systems and AD functions can be validated through extensive road tests with a long operational time, to allow extensive interaction with the driver and the functions. The project uses large-scale testing and Piloting of AD with developed SAE Level 3 (L3) functions (Figure 1.1) exposed to different users, mixed traffic environments, including conventional vehicles and vulnerable road users (VRUs), along with different road networks. Level 4 (L4) functions have also been assessed in close distance/parking scenarios.

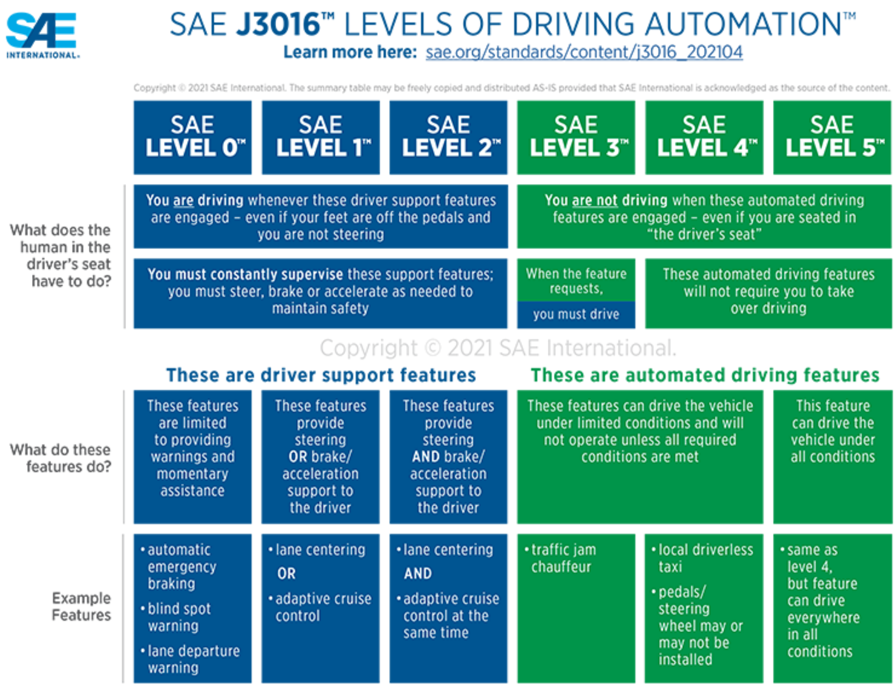

Figure 1.1: SAE Levels of driving automation J3016^{TM} (Copyright 2021 SAE International).

The data collected in the Piloting sessions supports the following L3Pilot goals:

- Lay foundation for the design of future, user-accepted L3 and L4 functions to ensure their commercial deployment. This will be achieved by assessing user reactions, experiences, and preferences of the AD functionalities.
- Enable non-automotive stakeholders, such as authorities and certification bodies, to prepare measures that will support the uptake of AD, including updated regulations for the certification of vehicle functions with a higher degree of automation as well as incentives for the user.
- Create unified de-facto standardised methods to ensure further development of AD applications by creating a Code of Practice (CoP) for designing and developing automated vehicles.
- Acquire a large dataset to enable simulation studies of the performance of AD over time which is not possible to investigate in road tests due to the time and effort needed.

The consortium addresses four major technical and scientific objectives, listed hereafter:

1. Create a standardised Europe-wide Piloting environment for automated driving.
2. Coordinate activities across the Piloting community to acquire the required data.
3. Pilot, test and evaluate automated driving functions and connected automation.
4. Innovate and promote automated driving for wider awareness and market introduction.

1.1.3 Approach and scope

L3Pilot focused on large-scale Piloting of ADFs (Automated Driving Functions), primarily L3 functions, with additional assessment of some L4 functions. The idea in Piloting was to ensure that the functionality of the systems is exposed to variable conditions. Furthermore, the aim was to show that the automated system performance is consistent, reliable, and predictable. This would allow a successful driving experience for the users. A good experience of using AD will accelerate acceptance and adoption of the technology and improve the business case to deploy automated vehicles.

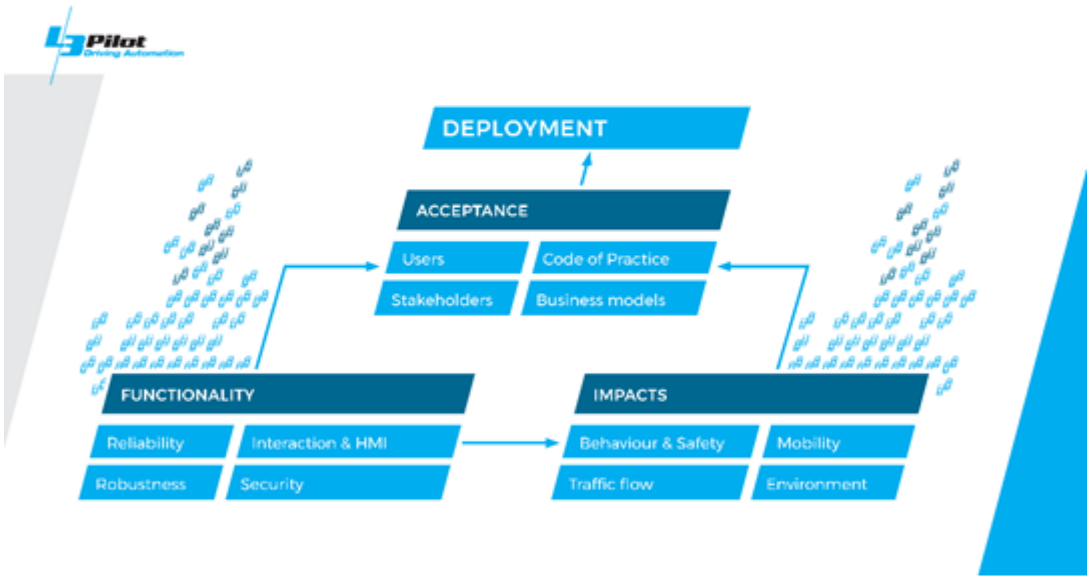

Figure 1.2: L3Pilot approach and the mechanism for deployment.

The L3Pilot consortium brought together stakeholders from the whole value chain, including OEMs, suppliers, academic institutes, research institutes, infrastructure operators, governmental agencies, the insurance industry, and user groups. More than 750 users tested 70 vehicles across Europe in 7 Countries, including Belgium, France, Germany, Italy, Luxembourg, Sweden, and the United Kingdom, as shown in Figure 1.3. The project lasted for 50 months, road tests started in April 2019, and piloting on variable road conditions took two years.

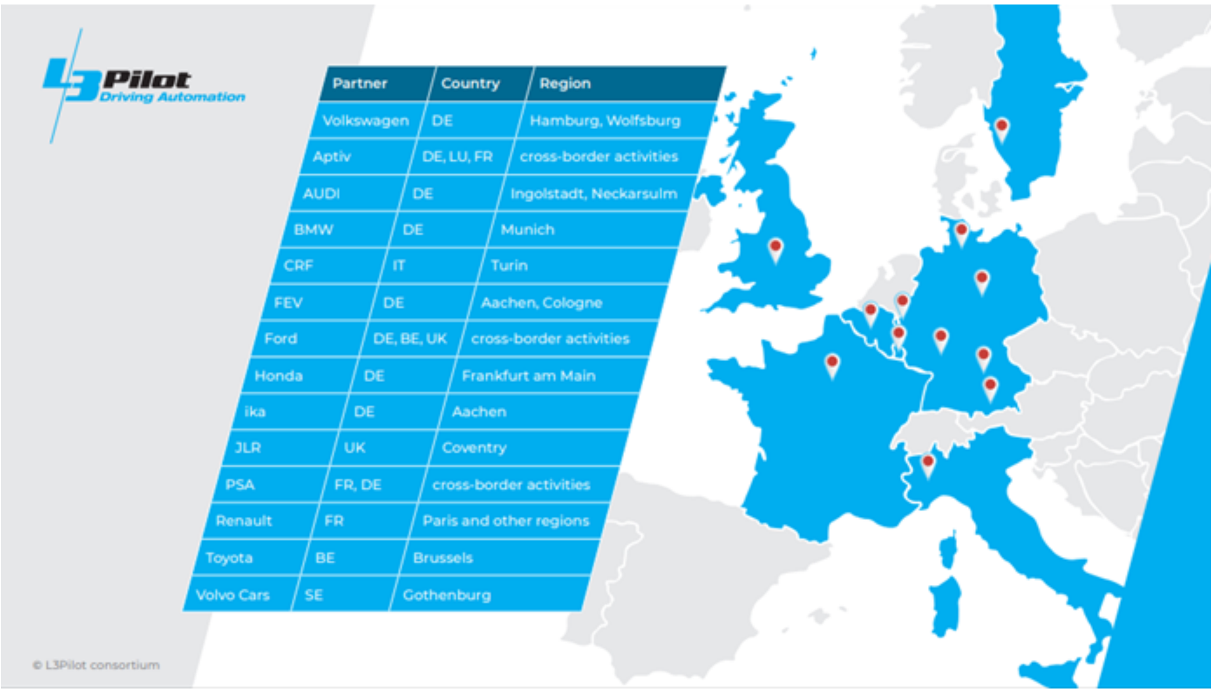

Figure 1.3: L3Pilot Piloting Maps.

1.2 Role of exploitation and innovation work package in L3Pilot

Since the SAE L3 functions tested in the project are relatively mature AD technologies, the work package *Exploitation and Innovation* aims to explore and promote new service concepts providing new mobility solutions, and studies the deployment potential for the market introduction of AD. The large European consortium of key players along the automotive value chain will accelerate the progress of automated driving functions. However, AD technology beyond SAE L2 is not yet on the market, and the large majority of people do not have any experience with vehicle automation, even though new vehicles are increasingly equipped with ADAS of SAE L1 and L2. Therefore, the future of AD market introduction and user acceptance is still uncertain. The exploitation approach applied in L3Pilot deals with this uncertain future for the deployment of automated driving technology. In deliverable D1.5 four different but plausible business environment scenarios have been developed to describe and analyse possible alternative future developments and recommendations for action, how to prepare for these possible futures, have been derived. Thus, a knowledge base and orientation have been provided for private and public decision-makers to jointly design viable and sustainable future mobility solutions.

1.3 From trends and business environment scenarios to business models and deployment strategies for automated driving

The business environment scenarios target a time scope of one decade. In the next decade, major changes will take place in the automotive industry. Besides automated driving, digitisation, connectivity but also electrification, and the sharing economy are expected to be the strongest influencing factors driving the transformation of the industry. Thus, a broad market implementation of SAE level 3 and also level 4 functions are expected until 2030. Even though the mobility market is a global one, the regional focus of the scenarios is on the European context, i.e. the European society, market, and infrastructure, which is in line with the project scope. Given this long-term perspective, even with a clear subjective and regional scope, there is still a high uncertainty concerning the acceptance of the new technology and breakthroughs in technological development. The four different business environment scenarios (as described in D1.5 (Beuster et. al, 2020)) map a wide range of possible future developments from a broad societal acceptance, with strong political support, and technological progress (like in the AD Paradise scenario) to prevailing scepticism and restrained market implementation (like in the Slowly but Surely scenario).

The selected business models for automated driving - In-Car Services, Data$^+$ Platform, Mobility as a Service (MaaS), and RoboTaxi - reflect the wide range of business opportunities in the various possible futures and show a spectrum of business models closely related to the current OEM business to completely new business fields for the automotive incumbents. In-Car Services (already offered to passengers) for drivers and Data$^+$ Platform are two business models that will be feasible very soon with the realisation of AD on SAE level 3 (e.g. with the in L3Pilot tested functions Traffic Jam Chauffeur, Motorway Chauffeur, and Urban Chauffeur). While MaaS needs more intensive preparation for the integration of ADV in mobility services, RoboTaxis, the most prominent business model discussed concerning AD, requires AD on SAE level 4 (e.g. with functions like Urban and Suburban Pilot, and Highway Pilot). The order of description and analysis of the four business models follows this logic.

These four business models are understood as archetypes with many different versions that can appear in the future. Thus, while being archetypes, the business models are further outlined and analysed on a generic level. The business environment scenarios indicate that the development of the full business model potential depends among others mainly on technological progress and user acceptance. The demand does not necessarily immediately unfold but will increase with positive development of the major driving forces. For each business model type, an assessment of its fit to the different business environment scenarios and an expert evaluation concerning desirability, feasibility, and viability are provided.

As enablers for deployment strategies of OEMs and other commercial project partners, the authors carried out the following analyses (see chapter 4):

- Existing European roadmaps for automated driving have been analysed whether they cover all relevant requirements for the deployment of the four business models, or if new roadmap items have to be added.
- Deployment challenges, especially for OEM, but as well for other stakeholders, have been identified based on the previous analyses and evaluations.

- Recommendations to OEM for promising deployment strategies - to realise the potential of the business models - have been formulated.

1.4 Exploitation contribution to L3Pilot final project report

In addition to the business environment scenarios for automated driving in 2030 (Deliverable D1.5) and the AD-related business models (Deliverable D1.6) *WP 1.4 Exploitation and Innovation* will further provide a detailed overview and discussion of the partners' exploitation perspectives in L3Pilot which will be part of the L3Pilot final project report. The future deployment perspectives will be structured and presented according to the major stakeholder groups involved in the project: 1) OEMs and suppliers, 2) academia, 3) public authorities, and 4) others. In *D1.7 – Final Project Results* the L3Pilot stakeholder group-specific exploitation plans will be linked with the business model types developed in D1.6.

1.5 Content and structure of the deliverable

This deliverable, *D1.6 Deployment strategies and business models for ADFs*, is the second deliverable of work package *WP1.4 Exploitation and Innovation*. D1.6 extends the business environment scenarios for AD in 2030 developed in D1.5 (Beuster et al. 2020) and presents the design and evaluation of four viable business model types for automated driving.

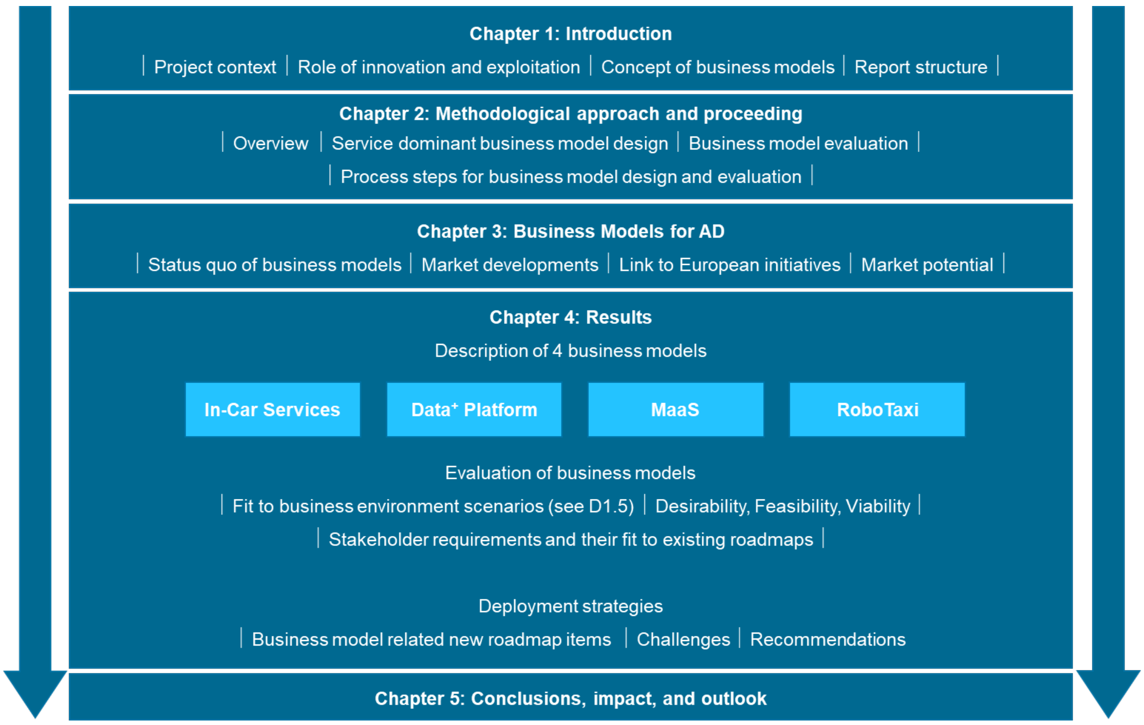

Figure 1.4: Report structure

The present deliverable is structured as follows: After the introduction, Chapter 2 describes the methodological approach that has been applied for the generation, analysis, and evaluation of the business models. This also contains an assessment of their fit to the business environment scenarios on the one hand and with currently widely discussed roadmaps for automated driving on the other hand. In Chapter 3 an overview of current and new vehicle automation-related business models of incumbents and new players including an analysis of the market development for AVs until 2030 is given. Chapter 4 (Results) provides a detailed description, analysis, and evaluation of four business models - In-Car Services, Data^{+} Platform, Mobility as a Service (MaaS), and RoboTaxi - including roadmap evaluation and analysis of key deployment challenges for OEMs for each business model and from a comparative perspective. Based on the identified challenges, recommendations to deployment strategies will be given to address crucial topics for the market implementation of AD. The focus will be on OEM but also recommendations for further stakeholders will be derived. The final chapter 5 contains general conclusions, an assessment of the contribution of D1.6 to the different impact areas, and an outlook to the exploitation approach in the follow-up project Hi-Drive.

2 Methodological approach and proceeding

2.1 Overview

To address the research objectives a) to understand the viability of AD-related business models that drive the demand for new service- and data-driven mobility solutions, b) to understand the collaborations these require from the different actors across the AD ecosystems and c) to identify key challenges focused on OEMs, a multi-stage approach was set up to identify, select, detail and evaluate four service-dominant business models described as In-Car Services, Data+ Platform, Mobility as a Service and RoboTaxi, along with the evaluation dimensions desirability, feasibility, and viability.

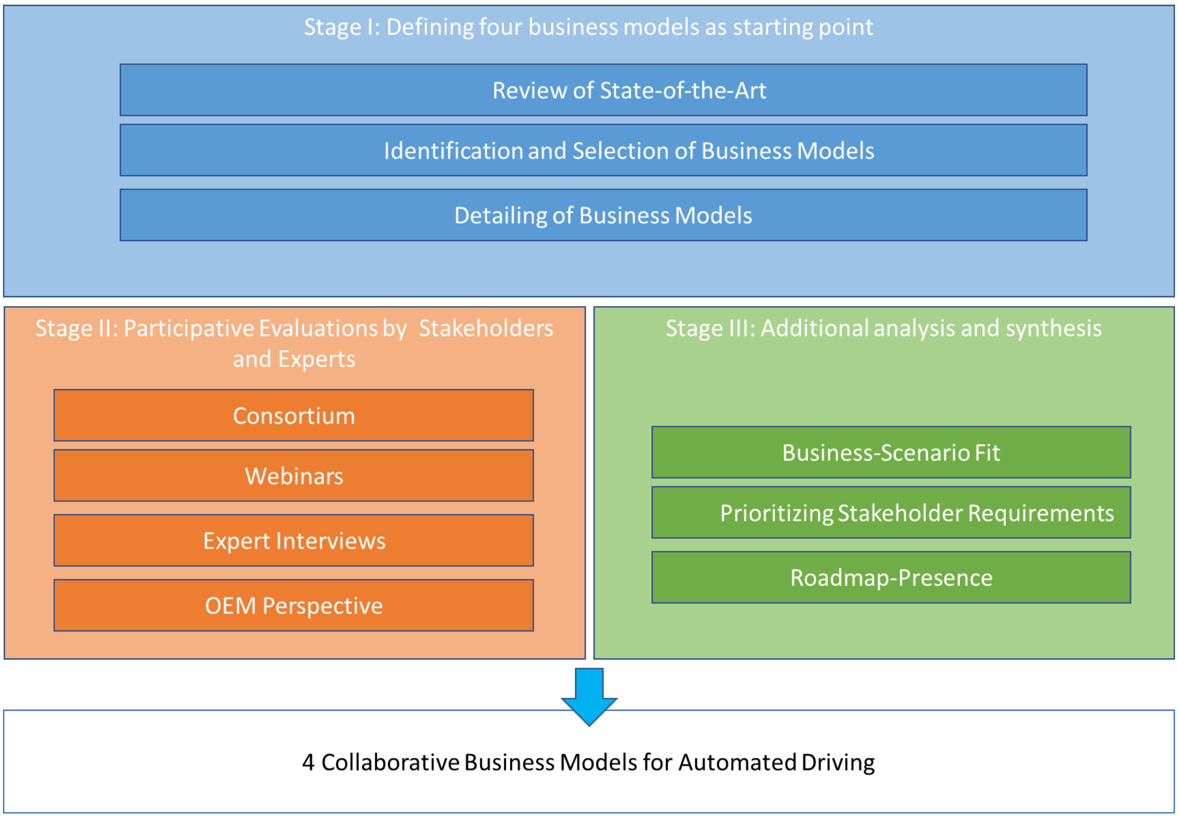

Figure 2.1: Methodological approach and proceeding.

The methodology consists of the following three stages. The first stage (I) was desk research on academic, project, and popular literature on business models related to automated driving (see chapter 3). This led to the identification of prominent business models and the selection of the four business models In-Car Services, Data+ Platform, Mobility as a Service, and RoboTaxi. Next, the business models were detailed in several iterations by the project team (the authors). These descriptions, along with additional insights can be found in chapter 4.

The Business Model Radar (Grefen, 2015) approach has been applied and will be described below in section 2.1.

In the second stage (II), the models were iteratively evaluated and improved based on the criteria desirability, feasibility, and viability. The evaluation itself was executed in four iterations with different groups of experts and stakeholders. In the first sub-stage (II.1), project-internal feedback was gathered by a group of 20 technical experts as part of an L3Pilot consortium meeting in November 2019. Evaluation cards were filled out and in-depth group discussions were performed. The second evaluation sub-stage (II.2) targeted external experts and was executed online through four consecutive L3Pilot webinars on business models[1] in June 2020 with 20-40 participants each. In this sub-stage, online voting and discussion tools were used along the same evaluation dimensions. In the third sub-stage (II.3), in-depth interviews of 1-1.5 hours with nine external experts in total were conducted between July and December 2020. Next, in the fourth stage (II.4), the OEM-perspective on these business models was elicited in an OEM-perspective workshop in April 2021.

The third main stage (III) was executed by the project team and consists of an analysis of the fit of the business models to the business scenarios (III.1) defined in *D1.5 Trends and business scenarios* (Beuster et al. 2020). The second sub-stage (III.2) contained the detailing of requirements for each of the actors identified for the business models and prioritisation based on necessity and difficulty. The last sub-stage (III.3) was to identify to what extent these requirements are already addressed in prominent roadmaps, to observe whether open issues would be remaining.

In the next sections the concepts of first, the Service-Dominant Business Model Radar (SDBM/R) approach (Grefen, 2015) that has been used to describe and detail the collaborative and service-dominant business models, will be introduced, and second, the primary approach for evaluating the business models. In the third part, the steps that have been taken to derive the results presented in chapter 4 will be outlined.

2.2 Service-Dominant Business Model Design

As discussed in the section on the evolution of business model theories, the emphasis on customer demands for integrated, value-oriented solutions, in the context of increasing specialization and interdependence between organizations, and driven by digitalisation, is highly applicable to the future of automated driving. These elements coincide with the so-called service-dominant logic. It finds its origin in marketing science and builds forward on an observed trend that in many industries customers have increased focus on the value they derive from the actual use of a product, rather than the product itself. Consumer examples are streaming music or video subscriptions, or the use of car sharing. In business settings also the ‘as-a-service’ paradigm is gaining attention, e.g. as logistics services are now

[1] https://l3pilot.eu/news/events/l3pilot-online-expert-talks-on-business-models

providing complete coordination of warehousing, handling, logistics flow, administrations, tax, et cetera, and all based on data. The context or the situation of actual usage becomes the focal point, and many organizations will have to align and integrate their offers to jointly create value. Products become a mere carrier of the service. The car is a product to manifest the service of transportation. This is referred to as value in context (Vargo 2006) and consequently, ownership is less relevant. In the mobility domain, digital technologies are emerging under the umbrella of C-ITS, and this enables the creation of values in a wide range of traffic, safety, and security applications. However, these technologies require the interoperation of vehicles, data, and intelligent infrastructure. And consequently collaboration of multiple service and technology providers. The service-dominant logic supports this network and value centricity.

For the construction of the business models, the Service-Dominant Business Model Radar (SDBM/R) approach (Grefen, 2015; Turetken et al., 2019) has been applied. This approach implements service-dominant logic, in which organizations and the user together co-create the so-called value-in-use. This philosophy emphasizes that the context in which a user uses the service offering determines the value thereof, and consequently it puts more emphasis on organizing the preconditions for usage in a coordinated way. This is particularly of interest, as automated driving indeed appears valuable and applicable in certain and specific contexts that may benefit from the participation of organizations other than the OEM, e.g. roadside infrastructure or lane identification, digital services, connectivity, et cetera. Such considerations could not be expressed using the conventional Business Model Canvas (Osterwalder, Pigneur 2010).

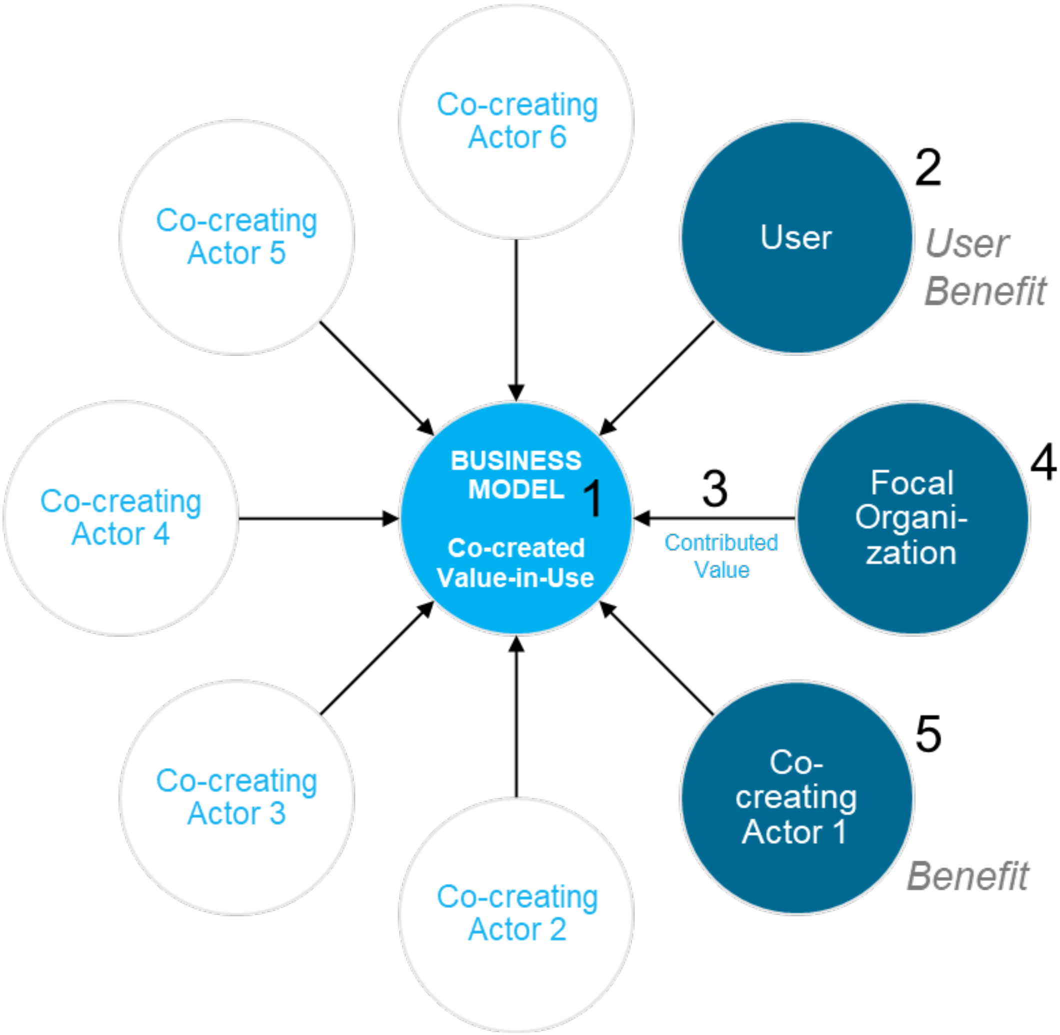

Figure 2.2: Modified version of the Business Model Radar.

The original SDBM/R (see Figure 2.3 below) has been adapted for presentation and simplicity reasons into the format displayed above. The following explanation corresponds with the numbers in the figure above: (1) In the centre is the co-created value-in-use. This is what the user experiences from the total offering. (2) This is the targeted user, the main beneficiary of the co-created value-in-use. The user herself does also contribute value to the central proposition, e.g. by sharing data, fees but also certain behaviour. There is always an exchange and often explicit preferences and data are needed from the user. (3) All actors contribute value. (4) Oftentimes, a business model is designed for a focal organization. This organization coordinates the offers of other organizations. (5) The other actors are referred to as co-creating actors to reflect that all actors collaborate to create the value. This simplified representation does not illustrate what these actors do (activities) and how they do it, like in the original SDBM/R On the positions where the numbers 2, 4, and 5 are positioned the figures in the next chapter will also display the main benefits for each organization for participating in this business model.

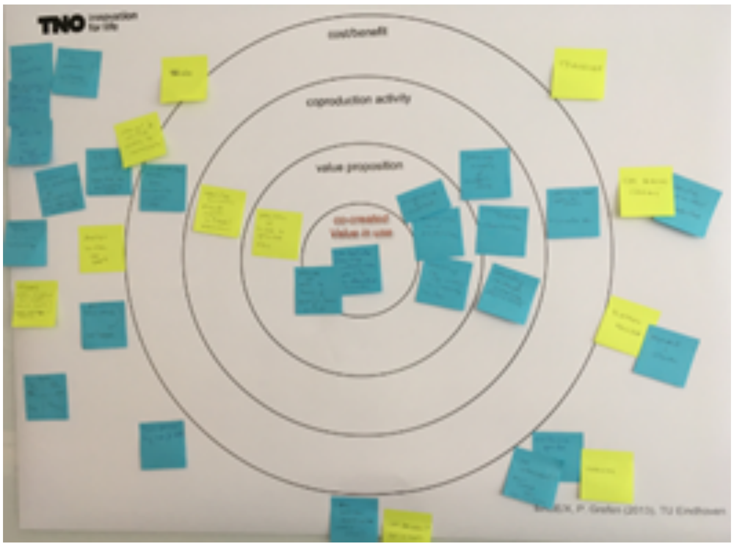

Figure 2.3: Photo of initial business model design results.

For each of the chosen business models, the project team started to specify the simplified radar in a face-to-face workshop, April 2019. These versions were reviewed gradually improved and digitized.

2.3 Business Model Evaluation

In the light of the research objectives, a lens is needed to assess the characteristics of the future business models that have been defined. An evaluation approach popular in innovation contexts is the IDEO “innovation sweet spot” model. It originates in design thinking, which is defined by Tim Brown, IDEO’s executive chair as ’a human-centred approach to innovation that draws from the designer’s toolkit to integrate the needs of people, the possibilities of technology, and the requirements for business success’. In other words, ‘it brings together what is desirable from a human point of view with what is technologically feasible and economically viable.’ (https://designthinking.ideo.com/). A set of requirements, that are very much applicable to the strong technology-driven AD industry (Orton 2019).

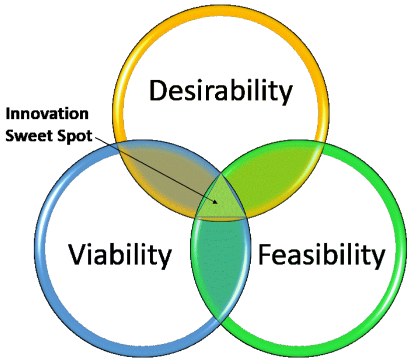

Figure 2.4: The ideal innovation process: the trifecta of desirability, feasibility, and viability (source: Orton 2019)

For the evaluation of the business models, three evaluation dimensions have been detailed following along the subsequent statements:

- *Desirability*: It is expected that there is a demand for it, people want it. The end users are identified, and the value proposition is perceived as desirable. The value proposition relieves pains and creates gains for the customers.
- *Feasibility:* The services in the business model can be delivered. It is expected that this whole system will be working technically and legally. The key components are available, and the different system components of the different parties are interoperable.
- *Viability*: Participation in the business model will allow partners to earn. The actors for the different roles in the business model are identified and the actors are familiar with this role. There is sufficient incentive for each actor to play that role.

To put these dimensions in practice, evaluation cards to be used in workshop settings have been developed. These cards depicted below were handed and explained to people that evaluated the design of a presented business model. Participants were asked to mark a numerical response (on the Likert scale), but also to provide motivation. Participants could volunteer to evaluate 1, 2, or 3 dimensions they felt comfortable with.

Figure 2.5: Writable front side of the Business Model Evaluation cards (own source).

The following explanations were given for each of the three cards. The questions were meant to trigger thoughts that could help the participant to evaluate and concretise the motivation.

Feasibility: WE CAN ACTUALLY DO IT

- Can we expect that this whole system will be working technically?
- Are there key components not yet available?
- Are the different system components of the different parties interoperable?

Desirability: PEOPLE WANT IT

- Are the end-users identified?
- Is the value proposition desirable?
- Does it relief pains?
- Does it create gains?

Viability: WE DON'T GO BROKE

- Are there clear actors identified for the different roles in the business model?
- Is each role something that this actor is used to doing?
- Is there sufficient incentive for each actor to play that role?

Below the printed cards are depicted. The right-hand shows some filled cards on brown paper. Group participants filled the cards in silence (“brain-writing”) and then presented their findings to the group.

Figure 2.6: Workshop impressions – Business Model Evaluation cards. (own source)

2.4 Proceeding of the methodology in practice

2.4.1 Stage I: Defining four business models as a starting point

Beginning with Stage I (Business model definition), followed by Stage II (Participative Evaluation) and Stage III (Additional analyses and synthesis) (see also Figure 2.1) the chronological steps that were executed to achieve the result are described in the following sections.

The results of a desk study to scientific, project, and industry reports on AD-related business models are summarized in chapter 2. Based on the business model examples identified in the desk research, the project team discussed the differences, overlaps, and relations along with the following themes. Business models focusing on vehicle features, business models on servitisation, and business models focusing on data sharing were found. The "solution space" describing all the different identified and imaginable business models quickly became too large to handle meaningfully. Consequently, a small set of business models that would *together* form a set of reference business models along the following requirements was selected: The business models must relate to AD (the context of this study) and not represent common practice today (given the focus on 2030). The models must be substantially different, yet related. Further, the business models should be generic and configurable to many settings and represent the following aspects that were identified in the study: vehicle (product) centric, data and digitisation, mobility service, and time-value dominant offerings. The following reference business models were selected for further detailing:

- *In-Car Services*, a time-value-dominant offering (enabled by in L3Pilot tested SAE level 3 functions Traffic Jam Chauffeur, Motorway Chauffeur, and Urban Chauffeur). When travelling in an automated vehicle, spending the driver's and passengers' time on work or leisure activities would then be fulfilled by several In-Car Services.
- *Data^{+} Platform*, a data-dominant offering (supported by every single ADF). As data sharing and enriching is crucial in AD, this business model organises data as a service for the ecosystem.
- *MaaS*, a mobility service-dominant offering, in which AVs could be a crucial modality in the modality mix that jointly fulfils traveller's needs (entry into shared automated vehicles by the in L3Pilot tested SAE level 3 functions Traffic Jam Chauffeur, Motorway Chauffeur and Urban Chauffeur, stronger enabled by the ADFs Urban and Suburban Pilot, and Highway Pilot). The share of AV-based transportation can gradually increase by new AD functionalities and where and whenever AVs are made available.
- *RoboTaxi*, a vehicle-centric offering (depending on SAE level 4 functions Urban and Suburban Pilot, and Highway Pilot). A relatively clear example of how a highly automated vehicle can be exploited as a service.

In several workshops, these business models following the SDBM/R format were further detailed and specified.

2.4.2 Stage II: Participative evaluations by stakeholders and experts

This section reports the four consecutive evaluation stages that have been performed on the business models design in stage I. In between evaluations, the definition and presentation of business models were improved based on evaluation results and team discussions.

2.4.2.1 Group

The first iteration was executed face-to-face with a group of 20 participants of the L3Pilot consortium in November 2019. During the workshop, the evaluation method and business models were explained in detail. After questions for understanding, the participants were asked to take some time in silence to fill out the feasibility cards. These were put on the brown paper, then discussed with the group. This was repeated for desirability and viability. Additionally, the participants were asked to further identify not yet mentioned barriers and points for improvement.

Figure 2.7: Evaluation workshop impressions (own source)

Due to the number of participants two subgroups of around 10 persons have been built. The first group looked at the business models RoboTaxi and In-Car Services and the second looked at the business models Data+ Platform and MaaS. Preceding the workshop, a sequence of brief introductory pitches was held to interest participants to join the workshop. In the plenary, the purpose and outline of the workshop were explained. Specifically, the different cards, Viability, Desirability, and Feasibility were explained. In each workshop evaluation cards were offered to participants, the business model was explained in detail, evaluation was written in silence to ensure independent individual opinions and finally discussed. The session was closed by a plenary tour in which each facilitator provided a summary of the business model findings. After the workshop, the business model 'owners' (team members of L3Pilot-WP1.4) engaged in the discussion to identify the key findings and considerations to update the business model. The workshop process and outputs were documented in a project internal report available on the project platform.

2.4.2.2 Webinar

The second iteration was online in four consecutive L3Pilot Expert Talks on Business Models.[2] They were set up as four short webinars to disseminate the work so far, briefly evaluate the business models, and raise interest in the expert interviews for the third iteration. Around 10-20 experts participated in the webinars. Participation was based on personal invitation and social media communication. The structure of the webinars covered the introduction, explanation of the business model, using Mentimeter[3] with a 5-point Likert scale for the three evaluation dimensions and on an open question to capture weak points and improvements.

2.4.2.3 Expert interviews

The third iteration evaluated each business model in expert interviews using an online videoconferencing setting with one or two experts. The interviews built upon the webinars as they introduced the business model and the previous evaluations before deep-diving into the three evaluation dimensions. Nine external experts participated, based on follow-up from the webinars and personal invitations, in total. The interview sessions took 1 – 1.5 hours and were conducted between July and December 2020. The meetings were facilitated by a presenter (the ‘owner’ of the business model) and a moderator (guiding the process and taking notes).

2.4.2.4 OEM perspective

The fourth iteration evaluated the OEM perspective on the four business models in two-hour online workshops with OEM experts. Clearly, the development of AD vehicles is driven to a large extent by OEMs. Although a specifically collaborative (and thus multi-actor) approach has been adapted to business modelling, it is justified to expose the perspective of OEMs in the evaluation. The OEM perspective is composed of the following sources:

- In three separate iterations (group, webinar, and expert interviews) each of the multi-actor business models was evaluated on feasibility, desirability, and viability. In these evaluations, no deliberate focus was placed on the OEM perspective.
- A workshop with experts from the automotive industry specifically on the OEM perspective has been conducted.
- The perspective of the OEMs is engrained in many of the roadmap documents, as OEM representatives participate in the responsible working groups or participated as interview sources.

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[2] https://www.eict.de/en/news/news/l3pilot-partners-present-webinars-on-business-models-for-automated-driving
[3] An interactive polling and feedback platform, available at www.mentimeter.com

The agenda of the workshop covered introductions, objectives and a business models overview, and the methodological approach. After each business model discussion, the participants were asked to identify roles they perceive interesting for the OEMs, as well as a top 3 of challenges. These responses were recorded using Mentimeter and qualitatively discussed. A concluding question and discussion were focused on a virtual investment exercise in which the participants were asked to indicate which business model would get their funds.

2.4.3 Stage III: Additional analysis and synthesis

This section reports the additional analyses and synthesis that were performed alongside the participative evaluations described above.

2.4.3.1 Business environment scenario fit

The first additional analysis was the evaluation of each of the business models in the context of the business scenarios to identify to what extent the business model is 'robust' or performs exceptionally good or bad in a given scenario. Such insights can aid to shape strategies when actual scenarios start to unfold.

Four different scenarios for the business environment of automated driving in 2030 were developed as part of the L3Pilot project. These are described in detail in the report "*D1.5 - Trends and business scenarios*" (Beuster et al. 2020). An overview of the four scenarios is given in Figure 2.8.

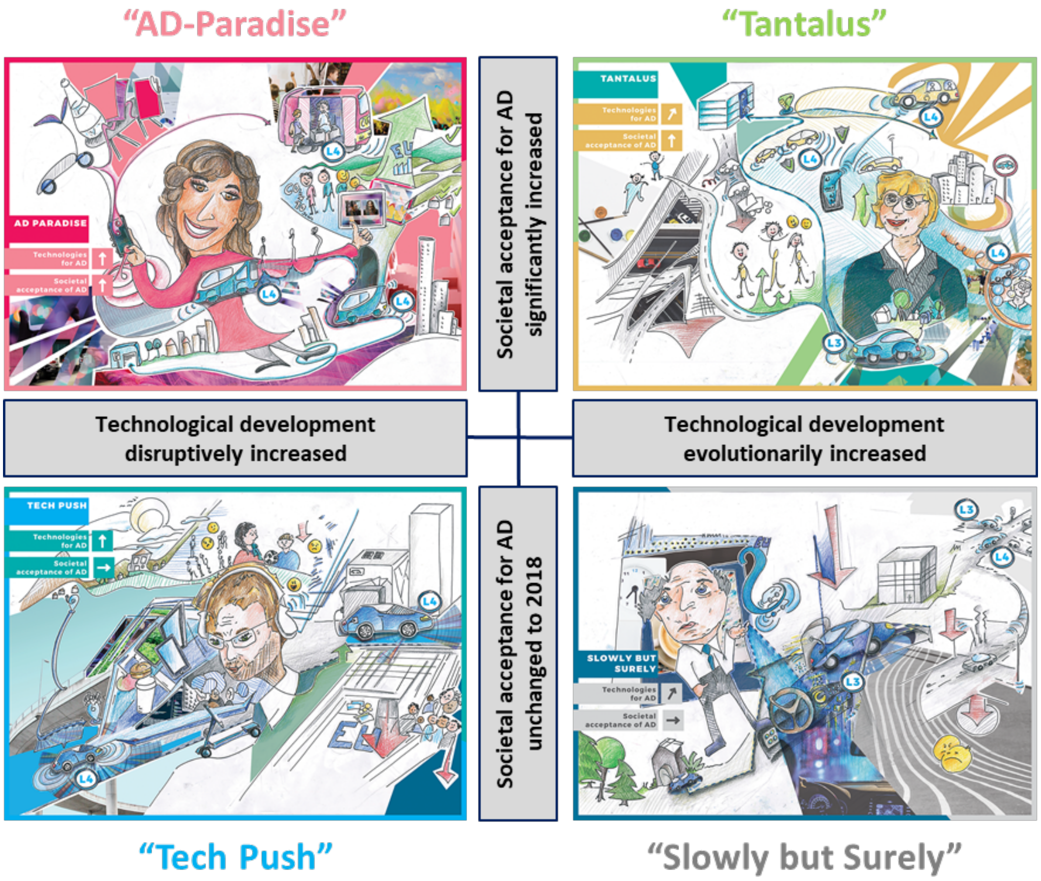

Figure 2.8: L3Pilot Business Environment Scenarios.

The scenarios are positioned alongside the dimensions of low to high technological development and low to high societal acceptance. Each scenario reflects however a larger set of dimensions (explained in "*D1.5 - Trends and business scenarios*" (Beuster et al. 2020)). The importance and uncertainties related to these dimensions were evaluated consulting a large group of experts in the consortium. The main dimensions shown in the picture (technological development and societal acceptance), stood out as most affecting the future scenario. The scenarios were developed for different purposes. On the one hand, they should generate different but still plausible future scenarios against the background of uncertainties in the future development of the business environment for automated driving. With these future images, a possibility space is opened up, which should be inspiring and equally framing for the development and evaluation of possible AD-relevant business models. On the other hand, the explicit awareness of different futures offers the opportunity to distinguish between desired and undesired futures and to generate recommendations from them, the consideration of which makes the occurrence of desired futures more likely. While comprehensive recommendations for "shaping the future" have already been developed and described in D1.5, in this report D1.6 an assessment of the described business model types is made against the background of the different scenarios. This is referred to as "fit to business environment scenarios" and will be reported for each business model. This assessment was performed using the following table and the following procedure. For each of the business models a fit score 0 (no fit); + (some fit), ++ (good fit) or +++ (excellent fit), along with argumentation (i) was prepared. These scores were discussed in the research team and scores were 'calibrated' such that the number of pluses has similar meaning across the business models. Results are presented in chapter 4.

Table 2.1: Template business scenario fit

	In-Car Services	Data+ Platform	MaaS	RoboTaxi
AD Paradise				
Tantalus				
Slowly but Surely				
TechPush				

2.4.3.2 Prioritizing stakeholder requirements

Based on the insights gained from the participative evaluations of stage II, the second additional analysis is the detailing of requirements from the perspective of each of the actors identified in the business models. To better understand the relevance of each of the business models for the actors involved, each business models owners derived requirements that should be fulfilled in the business model from the perspective of each of the participating actors, to be relevant (i). These requirements were then discussed in the research team (ii). Next, each of the requirements was assessed on necessity (Is the requirement nice-to-have or essential?) and realizability (Is the requirement easy or difficult to realize?) by the research team. As a fourth step, these assessments were discussed (iv) and eventually the assessments and the argumentation to derive a prioritization of requirements were consolidated (v). Prioritized requirements are considered both essential and difficult to realize. As an example, the figure below depicts the scoring of all requirements of one business model as well as the distribution of the scores. For each of the requirements, the motivations for scoring were discussed. The following Figure 2.9 shows the distribution of the team members' responses to requirement #3. It is centered in the upper-right quadrant, but individual opinions (connected small red dots) vary a bit. The different rationales were then discussed (iv) and consolidated (v).

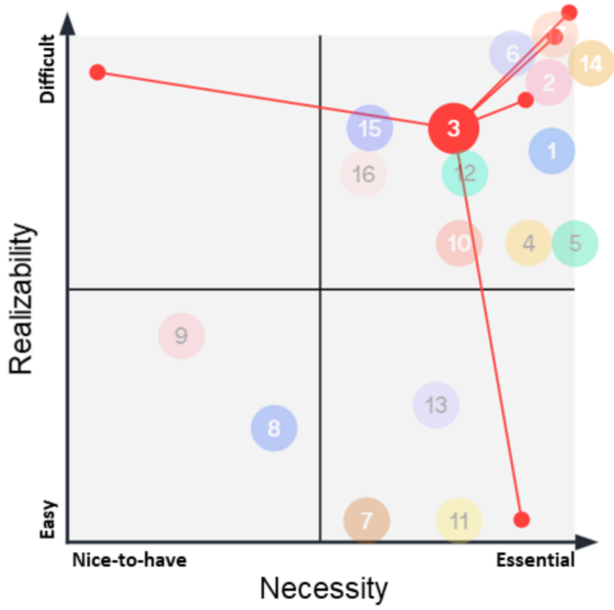

Figure 2.9: Assessment of stakeholder requirements (example).

2.4.3.3 Roadmap analysis and identification of new roadmap items

The third additional analysis is the investigation to which extent the prioritized requirements are already identified in existing AD-related roadmaps. If requirements that are necessary and difficult to realize are not already identified, then the implementation of the business model under consideration is at risk and thus may have negative impacts on the viability of AD as a concept.

Many projects and initiatives have released roadmaps and related documents that aim at identifying key challenges for realising a future with (C)AD to mobilize organizations to address these challenges. Typically, these documents focus on consensus from a given stakeholder group or specific theme. Looking at the L3Pilot business models from the individual perspective of each of the necessary actors may reveal new requirements. Such requirements may, if unaddressed, cause insufficient support from the given actor group and consequently limit viability, desirability, or feasibility of the business model, and consequently limit the exploitation potential of AD-related business models. To identify such as of yet unaddressed requirements, the following procedure was applied. First relevant roadmaps and documents were identified (i). Next, search words for the prioritized requirements were identified by each business model owner. Search words would contain synonyms and terms that are in other ways related to the requirement (ii). Next, the search terms were searched for in the documents, resulting in three potential outcomes per requirement per roadmap (iii):

- The requirement was not identified in the roadmap.
- The requirement was mentioned in the roadmap.
- The requirement was identified as a specific milestone and/or prominent on the roadmap.

Further, it was identified to what extent the requirement was covered across roadmap documents. If a specific requirement was not (1) or barely mentioned only in a few roadmaps (2), or only as a milestone in maximum one roadmap, it was marked as insufficiently identified (iv). Insufficiently identified requirements may point to an 'innovation risk' (1). This qualification was discussed in the research team (v). Eventually, a top 3 of insufficiently identified requirements were reported by the business model owner (vi).

The following roadmaps were used for the search:

- ERTRAC Roadmap (ERTRAC 2019)
- ACEA Roadmap (ACEA 2019)
- Arcade Roadmap (meta-analysis) (Rosenquist et al. 2019)
- VDA Standardization Roadmap (VDA 2019)
- ZENZIC Roadmap (ZENZIC 2019)
- Strategy& 2020 Digital Auto Report (Strategy& 2020)

2.4.3.4 Synthesis

The last step in the methodology is to synthesize all evaluations and analyses for each of the business models and to synthesize the findings over all business models. For each business model recommendations for deployment strategies reflect the new roadmap items and challenges. The synthesis highlights recommendations for OEMs that appear across business models and a few business model-specific recommendations to OEMs. Also, other stakeholder-specific recommendations are summarized. The methodology concludes with reflecting the fit to the business model scenarios for all four business models together.

3 Business models for automated driving

3.1 Status quo business models for vehicle automation

Brief sector evolution

This section begins by briefly touching on the evolution of the mobility sector in the last couple of decades and how the stakeholders in the mobility sector are organised resulting in the creation of value (and supply) chains. The developments in policy and regulations in the mobility sector and the demand which drives the potential uptake and technology development are also discussed in this section.

Sector developments

The business models of the automotive industry have been developing dynamically since the invention of automobiles. These are decipherable, as changes have taken place in every part of the automotive industry. To begin with, cars fundamentally changed the way how we see them as, for example, a sense of freedom to travel whenever and wherever needed, as a status symbol, basically as an enabler to fulfil and even explore activities. The automobile industry has grown constantly since then resulting in a large uptake (sales) of vehicles. The OEMs positioned their business propositions for every interest group (mass-market, luxury, sport, and in all combinations).

Over the decades, the number of OEMs and (tier 1 and tier 2) suppliers have grown and established themselves in the automotive industry. Constant innovation in the automotive sector was accompanied by regulations in the form of evolution towards a greener and safer transport. Also, the necessity to manage the scarcity of resources (space and road infrastructure), safety, and environment led to regulations managing car mobility. Particularly in dense urban areas with limited road infrastructure and high demand – especially in peak hours – car traffic leads to negative external effects such as congestion, accidents, and emissions. More urbanisation, increased welfare combined with population growth make these problems even more pressing. Also, technological developments result in the need for adjusted and new regulations. In the last couple of years, cars have become technologically advanced in terms of efficient powertrains, driving experience like power steering, alert systems for drivers like sleep detection, and a comfortable travel experience for co-passengers. In addition, automation towards increasingly higher levels of automation of the driving tasks is developing rapidly. Although these technologies are valuable to users, if not designed and implemented well, there can also be risks like driver distractions, technical failures, and security issues. Therefore, new technologies can also lead to new or updated policies. In short, digitalisation and automation have enabled a new range of opportunities that the automotive sector could provide. This has caused further (ongoing) changes to how business models are developed and more specifically which stakeholders are active in this field, which policies are in place and being developed, and the technological developments and the market uptake.

Stakeholders

To analyse and develop business models for the automotive sector, it is relevant to identify the main stakeholder groups within the sector. The main stakeholders can be divided into four groups: companies, public authorities (at various levels), users, and knowledge institutes. Within the automotive sector, the most prominent group of companies are of course the car manufactures. However, the services being offered in this sector extend far beyond car sales and are either offered by companies that also produce cars or by other companies with whom they have formal or more informal cooperation. Within the automotive sector, various ecosystems can be distinguished each comprising of many stakeholders. What started with just the sale of vehicles, expanded already at the beginning of the 20th century to the now-classic after-sales business including maintenance, repair, and spare parts trade, later followed by used vehicles' trade. The taxis were one of the original and literal as-a-service business models at the time. Currently, a range of new services is offered including financial and data services. Often the automotive sector is divided into different tiers.

Since a decade, there are new entrants that offer mobility services have actively entered the mobility system besides the vehicle manufacturers (OEMs), tier 1 suppliers and hardware suppliers. The underlying trend is "the transition from mobility as a commodity ("I purchase a vehicle to move around") to mobility as a service ("I purchase a ride to move around") (Araghi, et al., 2020). This development is also referred to as the sharing economy or access over ownership (Münzel, 2020)." (Vonk Noordegraaf et. al, 2020:13). Many companies in the automotive sector, therefore, focus and shift their services from vehicle ownership to mobility access. MaaS "is the integration of various forms of transport services into a single mobility service accessible on-demand" (MaaS Alliance, 2017). Two primary components of MaaS can be identified: transportation services (the wheels on the ground) and MaaS platforms (the apps integrating the services) which allow interoperability and easy use of multiple transportation services and modes.

In the 1980s, automakers began to develop a portfolio of financial services. From vehicle financing, leasing, and insurance to the establishment of their own banks. Today, for example, around 75 percent of new passenger car registrations in Germany are put on the road via leasing and financing models - and the trend is rising (VDA 2021). Financial services are now a key-value component for automotive OEMs. In recent years, many OEMs have invested in the development of mobility services, especially ride-sharing and ride-hailing services and, in some cases, multimodal mobility platforms. Examples are Daimler and BMW with their YourNow services or Volkswagen with MOIA. These services are still not profitable, as currently they have been hit strongly by the Corona pandemic when relevant shares of users avoided these services because of hygienic reasons.

Software

One of the key enablers for AD and AD-related new business models are high competencies in software development, where the big tech companies, as well as some non-European manufacturers such as Tesla, are strongly advanced. However, European OEMs and big supplier companies have recognized that need and started to evolve their skills. Volkswagen for example has recently created a subsidiary automotive software company (Cariad SE) with up to 5,000 employees to bundle all the vehicle-related software activities and to develop an own operating system for Volkswagen cars (Volkswagen 2020). Mercedes-Benz – as a second example - as well announced to develop the future vehicle operating system MB.OS in-house, creating more than 3,000 new positions for software developers (Mercedes-Benz 2021). Further car manufacturers and big suppliers are pushing comparable activities.

These big investments into additional software development skills combined with the strengthening of an internal software “culture” is creating a strong foundation for the future development of new software-based business models.

Policy and regulations

The development of vehicle automation is highly influenced by policies and regulations. (1). Related European policies are built on (a large part of) the policy framework in place for C-ITS (Cooperative Intelligent Transport Systems). Most of the policies and initiatives (including the ETPs – European Technology Platforms) discussed for C-ITS are therefore relevant for CCAM as well.

There are two different types of policy actions. The first is in the form of legislation, at the national level, based on the type-approval of new vehicle types. New vehicles that feature new specifications such as fuel type, safety systems, automation systems that are outside the existing framework need to apply for, so-called, type approval. The OEM usually has to show that the vehicles adhere to the admittance procedure, which the national vehicle authority, for example, RDW (Rijks Dienst Wegverkeer) in the Netherlands has drafted. Given the state of the art and the legal framework, only SAE Level 1 and 2 assistance systems are currently in broad commercial use.

The second type of policy action is the regulations. The regulations are generally at a national or even at a European level. Regulations are aimed at the long-term and wide-scale goals like emission reduction, mandatory safety features, GDPR (General Data Protection Regulation). The research and innovation roadmap to achieve these goals can be implemented through technologies like C-ITS, CCAM, or the use of shared mobility such as MaaS. Regulations can affect business models.

3.2 New AD-related business models of incumbents and new players

In this section, we discuss the technology advancements and the uptake of vehicle automation by users. In general, CCAM developments start at highways and evolve into the more complex urban environment, with exceptions being shuttles on a fixed trajectory (e.g. Navya, 2GetThere, EasyMile), RoboTaxis (e.g. Uber, NuTonomy, Lyft, Waymo), and freight in confined areas with no pedestrians or only dedicated staff (harbours, loading areas). Technologies emerge mainly according to the Sense-Think-Act functional chain (Schroten et al., 2020 p. 39)

L1/L2 technologies are hardly affecting business models. These are mainly marketed in the traditional business model (sale as optional equipment with the vehicle). However, individual manufacturers, pioneered by Tesla, already offer vehicle functions on-demand ("Vehicle-features-as-a-service"). Software-controlled functions, which are installed ex-factory including any necessary hardware, can then be booked and paid for at a later date or only temporarily. ADAS components are also marketed in this way. Performance updates provide additional appeal.

In different parts of the world, organizations are preparing business models to create value using AD. New ways of providing mobility services have shown the disruption potential of the traditional business models of car manufacturers: selling hardware (cars) for mobility.

Currently, hardware and software for AD are mainly sold as a product. A trend to increased partnerships between major car manufacturers and software start-ups with the latest AD technology can be observed (Ford and Argo AI, Toyota and Pony.AI). Some exceptions with this trend are the IT technology giants that attempt to create their own AD-based mobility service. In this case, the car manufacturers provide the hardware (also semi-automated), and the complete software package comprising complex technologies is provided and integrated by the IT tech companies into a fully autonomous product (Waymo, Amazon). As the software can be integrated into any hardware, this type of business model gives a competitive advantage to the IT tech companies through economies of scale, thus leading to fleets of automated vehicles (AVs) providing mobility services. The software package requires and implies continuous management and updates.

This includes new functionalities, better performance of the software, updated security of the software package, for example, with a logical step up to subscription rather than transaction sales.

Another trend observed is the shift towards sharing economy and shared taxi services (Uber, Lyft). With high automation technology, the increased associated costs are no longer a concern for the driver in a pay-as-you-go model, thereby providing a case for this business model. In combination with platformisation, apps, and rides being sold as a service to the customers, on-demand and door-to-door mobility services are scaled up quickly with minimum effort. A variant of this business model is crowd-sourced car fleet sharing services (peer-to-peer), where it will be possible for any individual (or group) with a highly automated vehicle to participate by renting out their vehicles to provide temporary access to a car.

This overview illustrates that big tech companies and automotive OEMs and suppliers are exploring ways to create value and make business with the increased levels of automation and digitalization in mobility. Little work has been done however on how these business models work together and how they could drive the demand for automated driving and complementing services in the future.

It is expected that higher levels of automation technologies (L3+) will affect the business models. The ability for automation functionality to be able to summon a vehicle on-demand at a location required by the user or even the vehicle to drive by itself makes it attractive for businesses to offer shared mobility services. Subchapter *3.4 Technology dissemination and market potential* highlights the market trends and technology dissemination potential. Based on the level of automation, different categories of policy instruments are expected (1).

Higher-level AD technologies enable different types of new business models: Product, service, and data-related business models. A vehicle interior as a luxury work or relaxing lounge is an example of a product-related business model. Service-related business models focus on mobility services (like ride-sharing or hailing) or other personal services to drivers and passengers (like travel, shopping, or food services). Data-related business models try to monetize the huge number and variety of vehicle data, environment data, and user data, gathered by the vehicle sensors, infrastructure, and the interaction with drivers and passengers. Example: apps that offer services based on personalised interests, behaviour, etc. Incumbents, majorly the OEMs, on the one hand, try to take benefit from their home field, the product-related business model. In addition, they see big opportunities in service and data-related business models. Those OEMs, which already are offering mobility services, try to enrich these services with AD functions (e.g. Volkswagen with MOIA). Others take AD technologies as an opportunity to enter this new business segment. Beyond that, a big share of OEMs is exploring opportunities for data-related business models.

New players, big tech companies like Google, Waymo, Amazon, are entering the market with data or service-related business models. In these segments, they can play to their strengths and use their already existing extensive ecosystems. However, beyond the competition in these areas, there are also manifold cooperation activities among OEMs and tech companies, e.g. between Volkswagen and Microsoft related to data and cloud solutions, Ford and Google on connected cars, Waymo and Stellantis on RoboTaxis or Daimler and Waymo on automated trucks. Also, new cooperations of tech companies with other stakeholders develop AD-related business models: As a recent example, the Intel subsidiary Mobileye and the car rental company Sixt announced during the IAA Mobility Fair in Munich in September 2021 their intention to offer a RoboTaxi service in Munich starting in 2022 (Automobilwoche 2021).

In the recent past, a slight change in the focus of AD-related business models can be seen at some OEMs. For example, in its recently published strategy, Mercedes-Benz increased the focus on (product) luxury and positions business models with automated vehicle fleets rather in the commercial vehicle segment than in the passenger car segment (Mercedes-Benz 2020). At BMW's newest strategy presentation, mobility services are represented but they do not play a prominent role (BMW 2020). In summary, it can be observed that in the area of

AD-related business models there is a mixture of cooperation and competition between established and new players and that OEMs are still in the process of positioning themselves strategically in this environment.

3.3 Market developments and European policy initiatives

Market developments affecting sector competitiveness

In *D1.5 Trends and Business Scenarios,* the following trends have been described related to their development and their impact on the automotive business (Beuster et al. 2020).

- **Artificial Intelligence and Big Data**
  Companies in the automotive sector increasingly view data as a competitive asset. This includes both, the data directly obtained from the vehicles as well as data gathered via partners in the data ecosystem.
- **Automated Driving**
  Automated Driving most prominently affects automotive business models strongly as it allows new ways of using vehicles and of using the driving time for other activities. Furthermore, it introduces new players, includes many different subsystems and services, and might have desirable and undesirable effects on urban transport systems.
- **Connected Mobility**
  Connected Mobility also holds that it introduces new players and includes new vehicle- and infrastructure-related subsystems (e.g. sensors, communication systems) and services. The value of connected mobility lies in increased improved travel experience for the users (e.g. higher comfort), improved safety, more reliable travel times, etc.
- **Shared Mobility**
  Shared mobility is mainly pushed by sustainability goals. This trend changes strongly the way how cars are used and has an impact on sustainability, comfort, driving experience, privacy, costs, etc.

The combination of shared mobility, electrification, and (in the future) automated cars can gear the development of MaaS. Strategy& expects that the business models will shift such that up to 11% of the profit in a growing automotive market will come from MaaS services (see Figure 3.1). For MaaS, Connected Mobility and Automated Driving holds that "the extent the potential will be materialised depends on its design and management by public authorities (with actions such as legislation, funding, piloting, and public-private cooperation). If not managed well, the applications' contribution to achieving societal goals will be less prominent, and may be even negative (e.g. if the additional transport demand expected to be generated by CCAM [Automated Driving] is not managed well, it may result in additional emissions which may undo any emission reduction at the vehicle level, ending up with higher total emissions levels)." (Schroten et.al 2020:14). So it depends on the actual value in practice for users and society as well as on the level and type of policy packages to manage these impacts. The key business model challenge is to maximize the overall value, not only to companies themselves but also to users and governments, and society to make the business models futureproof and sustainable.

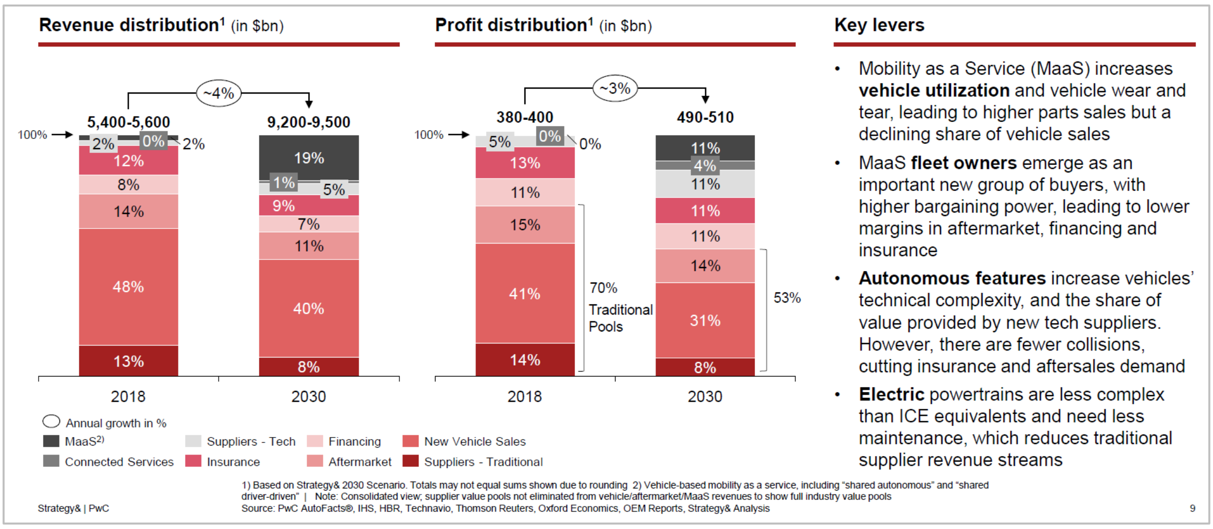

Figure 3.1: Shifts in global automotive value pools (Source: Strategy& 2019)

The sector activities are increasingly influenced by the current economic conditions for the automotive industry. Global trade conflicts, decreasing GDP growth, and decreasing passenger car markets (-5% globally from 2018 to 2019 and -9% in the Chinese Market) (VDA, 2020) have stressed the European automotive industry already in 2019. The current COVID-19 pandemic with its never seen steep decrease in sales for some single months (e.g. car sales in Western Europe have been reduced by 40% during the first half of 2020 compared to 2019) (Automobilwoche, 2020) is a serious and strong additional challenge. Consequently, the automotive industry is intensively assessing its business segments to conserve their necessary financial liquidity and stability. Companies are placing back, reducing, or focusing on their investments. As an example, Daimler announced to focus their automated driving technology stronger on the truck sector, where automation can reduce the cost for the drivers (Kaellenius, 2020). For passenger cars, the activities will be stronger focused on SAE L3 functions. In addition, investments for mobility services have been adapted. Various other automotive companies are currently acting similarly. In opposite to that, there are no announcements of companies like Google, Waymo, or Amazon, related to reductions of their efforts.

However, it all depends on how well and how fast the European automotive market can recover. Sector developments, and with that, the competitive position of the European automotive sector highly differs per sub markets. "Business opportunities are provided to [automotive companies who step into] MaaS operators and transport operators, physical and digital infrastructure and service providers, data providers and data analytics providers." Connected Mobility "deployment may have slight positive impacts on the European industry (GDP, employment). These impacts may vary widely between industries and regions." "The current position of the EU on this [Automated Driving] market is good, but this could change rapidly." (Schroten et. al., 2020: 72, 56, 64)

European policies and government efforts to shape future market

As explained in the previous section, the expected impacts determine if and which policy actions are taken by the European Commission. They aim to safeguard societal goals like reducing greenhouse gas and air pollutant emissions, improving traffic safety, reducing the level of congestion, and boosting the EU economy. The EU strategies focus on making the transport sector in general and the automotive sector specifically, more sustainable, efficient, and safer. Furthermore, the developments in the automotive sector are overall expected to provide attractive economic opportunities for the European automotive industry.

Several policies are focussing on the research priorities of smart mobility applications (e.g. connected mobility and automated driving). The European Commission has worked over the last decade on a legal framework. Furthermore, several public-private partnerships have been initiated by the Commission to support the deployment of these applications (e.g. C-Roads Platform). These initiatives have also provided input on specific issues used by the Commission as input to set the research priorities for the new Horizon Europe Work Programme.' (e.g., European Strategy on C-ITS and the forthcoming strategy for sustainable and smart mobility).

CAD [Connected and Automated Driving] policies are drafted at different levels: national level, EU level, and a worldwide level. Coordination and cooperation between these levels are important to ensure the safety standards (software and hardware), to coordinate different expert working groups so that research and development knowledge, and to align the strategy and ambitions towards the societal goals.

At the EU level, directives are prepared in consultation especially on key areas that are challenges but also enablers of automated driving. For instance, the developments on **cybersecurity and OTA** [over-the-air] updates are monitored closely as those technologies are closely linked to automated driving. There are directives in place for **connectivity and C-ITS (**Directive 2010/40/EU) on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport. Further to address the issues around **privacy and data protection**, the regulation (EU) 2016/679 and repealing Directive 95/46/EC (General Data Protection Regulation) has been passed which allows protection of natural persons concerning the processing of personal data and on the free movement of such data.

Partnerships

CCAM initiative is designed to support EU countries and the European automotive industry in their transition to connected and automated driving while ensuring the best mobility environment for the public. One of the call topics stemming from the Strategic Research and Innovation Agenda (SRIA) developed by the CCAM Partnership will be the continuation and extension of the existing EU-wide knowledge base as the “one-stop-shop” for the exchange of knowledge and experiences on CCAM in Europe and beyond.

The benefits of AD lie in enabling the deployment and adoption of the technology and services for all stakeholders in the value chain including the end-users. CCAM partnership with SRIA identifies the requirements to address the key challenges and prioritizes the focus areas for research and innovation actions such as Horizon Europe through SRIA (Strategic Research and Innovation Agenda) (2).

SRIA’s (3) 10-year vision expects that “CCAM shall foster and support new mobility concepts, shifting design and development from a driver-centred to mobility-user oriented approach, providing viable alternatives for private vehicle ownership while increasing inclusiveness of mobility.” Many challenges have been identified on the path to the deployment of CCAM solutions. One of the key challenges is identified to be **insufficient demand** to accept CCAM enabled mobility solutions. Besides providing CCAM enabled mobility services such as shared, on-demand and personalised transportation to all and contributing to inclusiveness in such future transport systems, new options like automated pods and RoboTaxis will eventually become available. The challenge asks for the development of complementary CCAM solutions and services that are attractive for service providers, operators, and end-users. SRIA clearly highlights the importance of research **business models and business cases** for automated and shared vehicles.

Other key challenges identified include **not yet sufficiently mature CCAM solutions for market uptake** and the need for an **extensive and complex cross-sectorial value chain.** Tackling these challenges requires transparent cooperation among local and regional authorities and the private sector involving a multitude of highly diverse stakeholders. CCAM solutions **involve diverse stakeholders from different technology areas** (e.g. electronic components and systems, processing technologies, data-driven engineering, Internet-of-Things, Artificial Intelligence), where synergies have to be found.

Large-scale research is being performed to tackle challenges in the technical side of CCAM solutions through various programs (as mentioned above). However, the outlook on business models and business cases in the automotive domain for new CCAM services is also an identified challenge that requires research. In the present report *D1.6 - Deployment strategies and business models*, four business models archetypes are identified - In-Car Services, Data+ Platform, Mobility as a Service (MaaS), and RoboTaxi. These business model concepts are seen developing in automotive and other sectors. For example, portable entertainment services are already being offered through smartphones to the users, data platforms are booming in the tech sector, MaaS services are being piloted in many cities across the world, and RoboTaxi concepts are being experimented with in the United States and China.

These business models have relation to the wide-scale cross-sectoral developments (from vehicle technologies to data engineering). The potential business impacts are relatively new in the automotive sector and have to be further researched to understand the opportunities and challenges such innovations offer to the diverse stakeholders in the value chain. Therefore, wide-scale cross-sectoral experts have been consulted to evaluate these business models. Also, in-depth research has been performed into each of these business models to identify the needs of each individual stakeholder involved in each business model. Putting them together in a comprehensive picture allows us to identify new roadblocks and barriers which otherwise would be invisible. Thus, this part of the research is complementary to the SRIA research and coordination action.

3.4 Technology dissemination and market potential

In this section, the market potential for automated driving, shared (automated) mobility services, AI, and data-driven services are discussed.

Automated Driving market potential up to 2030

In D1.5, the expectations of various institutes (McKinsey, IHS Markit, Strategy&) regarding the global market penetration with AV were compared. These were based on reports published between 2016 and 2019. However, recent studies show more cautious estimates for market development. For example, in 2019 Strategy& saw the expected market shares of AV in Europe for 2030 in the order of just under 20% (L3) and around 25% (L4+L5) (Strategy& 2019). In the new edition of the Strategy& Digital Auto Report 2020, this expectation was reduced to 13% (L3) and 7% (L4+L5), (Strategy& 2021). Bain & Company, in a report from 2020, sees the market development in the same order of magnitude and expects about 6% market share for Europe in 2030 (L4+L5), (Stricker et al. 2020). However, this is not an indicator for a general turning away from automated driving, but rather reflects the expectation of a lower dynamic in the development of AD. The COVID-19 crisis was the trigger rather than the reason for reassessments on the part of the OEMs.

Impact of COVID-19 crisis on the market share

The impact of the COVID-19 pandemic affects the autonomous car market. The economic slowdown due to the COVID-19 pandemic in 2020 has led to the global market for autonomous cars shrinking by about 3% - 5.5% (Statista 2021), (Research and Markets 2020). The dip is supposedly due to the COVID-19 measures issued by governments across the world resulting in issues such as raw-material shortage, disruptions in supply-chain, and reduced manufacturing activities. However, this dip is expected to be temporary as the forecasts for the year 2023 are expected to reach around $37bn (see Figure 3.2) and the market share is expected to grow by 14.2% CAGR (compound average growth rate) by 2030 (Research and Markets 2020).

Revenue expectations from new business models play a significant role in the prioritization of development expenditures.

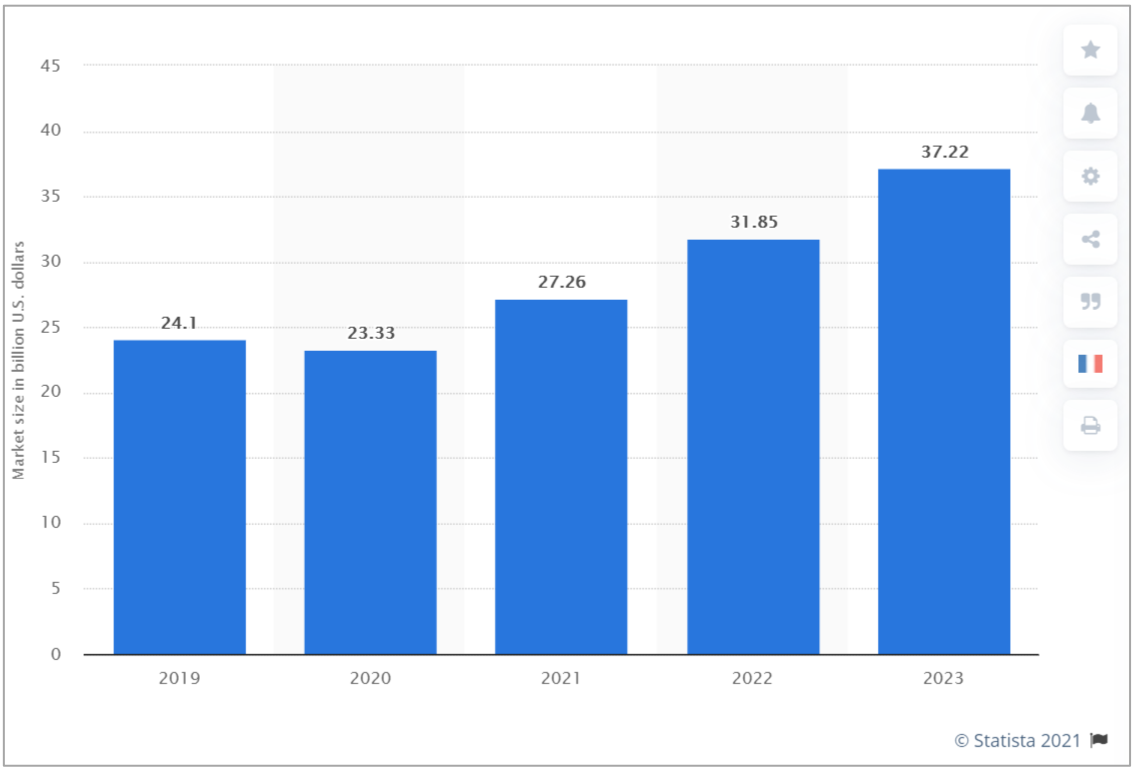

Figure 3.2: Projected size of the global autonomous car market from 2019-2023 (source: Statista 2021)

Revenue potential for AV up to 2030

The current business volume (2020) for SAE Level 1 and Level 2 ADAS components is about $7 billion for Europe and over $20 billion for the Europe, U.S., and China regions. Almost all OEMs now offer ADAS components as optional equipment for their new vehicles, which are also increasingly ordered by their customers. Strategy& expects the ADAS business volume to increase to around USD 44 billion in 2025, USD 18 billion of which will be generated in Europe alone (Figure 3.3, Strategy& 2021).

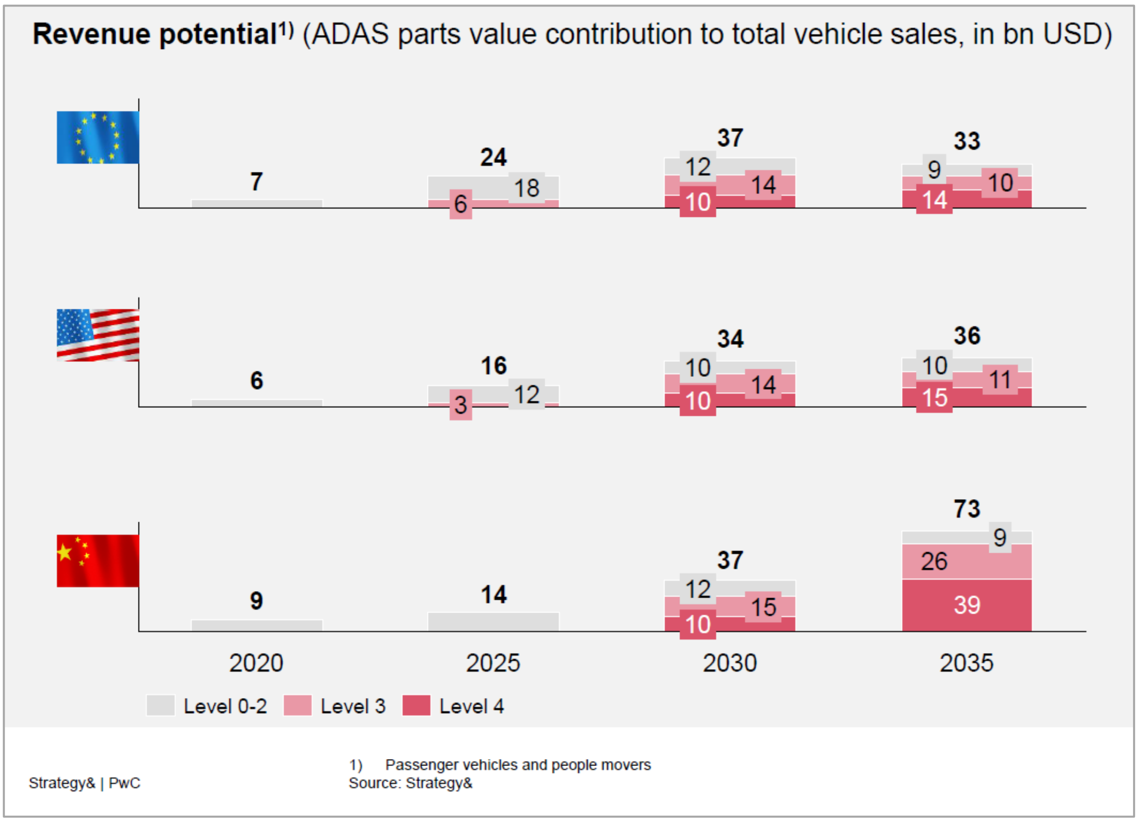

Figure 3.3: Revenue potential of ADAS parts value to total vehicle sales between 2020-2035 (source: Strategy& 2021).

In the further course, Strategy& then expects a decline in the value contributions of Level1+2 systems, but this will be more than offset by the increasing demand for higher-value systems (L3+L4). Strategy& already sees the value contribution of all systems (L1 to L4) for the year 2030 at USD 37 billion for Europe and over USD 100 billion for all three regions. This corresponds to a CAGR of 17%). After 2030, these levels are expected to stabilize for Europe and the U.S., while China is forecasted to continue growing until 2035.

Accenture expects global revenue potential for new business models based on CAV (Connected and Automated Vehicles) for mobility services and smart services in the order of USD 1,300 billion in 2030 vs. USD 140 billion in 2020, corresponding to a CAGR of 25% (Figure 3.4, Seiberth et al. 2018).

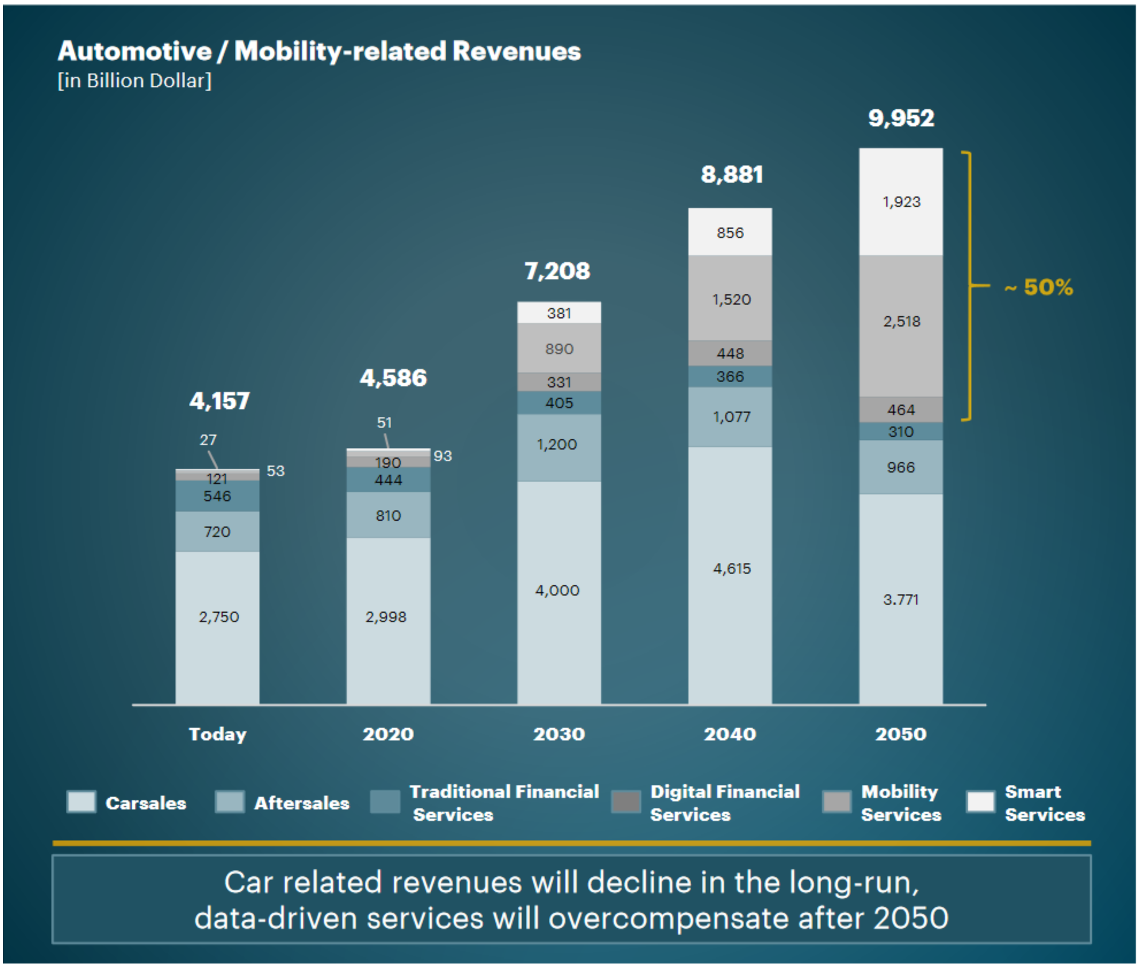

Figure 3.4: Automotive / Mobility related revenues up to 2050 (source: Seiberth et al. 2018)

Shared (automated) mobility services revenue potential up to 2030

Shared-active (e.g. rental, subscription) is expected to grow strongest in the EU (10% of total person kilometres by 2025), while shared-passive (e.g. ride-hailing) is expected to grow significantly more in China (10% vs. 1-3% in the US and EU) (Strategy& 2020).

Impact of COVID-19 crisis

COVID-19 reverses preference for mobility modes – own vehicles regain preference against shared (Strategy& 2020). However, the forecasts of market penetration (related to person-kilometres) of both shared active mobility (example: car sharing, rental) and shared passive mobility (example: ride-hailing, robotaxi) are expected to increase to 20% in Europe by 2035 (Figure 3.5).

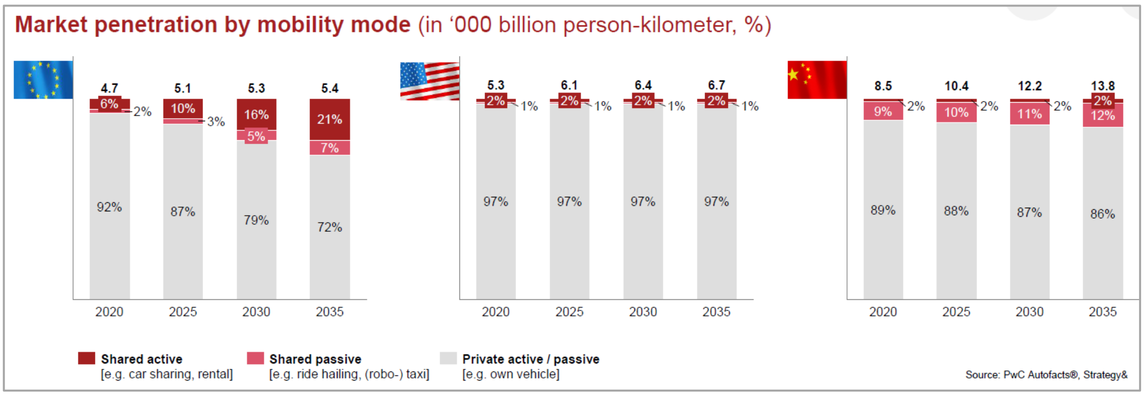

Figure 3.5: Market penetration by mobility mode (source: Strategy& 2020).

AI and Data-driven services market potential up to 2025

Having a look at expectations for future artificial intelligence revenue, the predicted growth rate is rather high. Figure 3.6 shows a prediction by the U.S. market intelligence consultant Tractica, expecting an annual global automotive AI market growth rate of more than 40%. Other predictions show even stronger growth expectations, e.g., Variant Market Research expects annual growth of the total AI market of about 60% from 2015 to 2024 (Market Watch 2020).

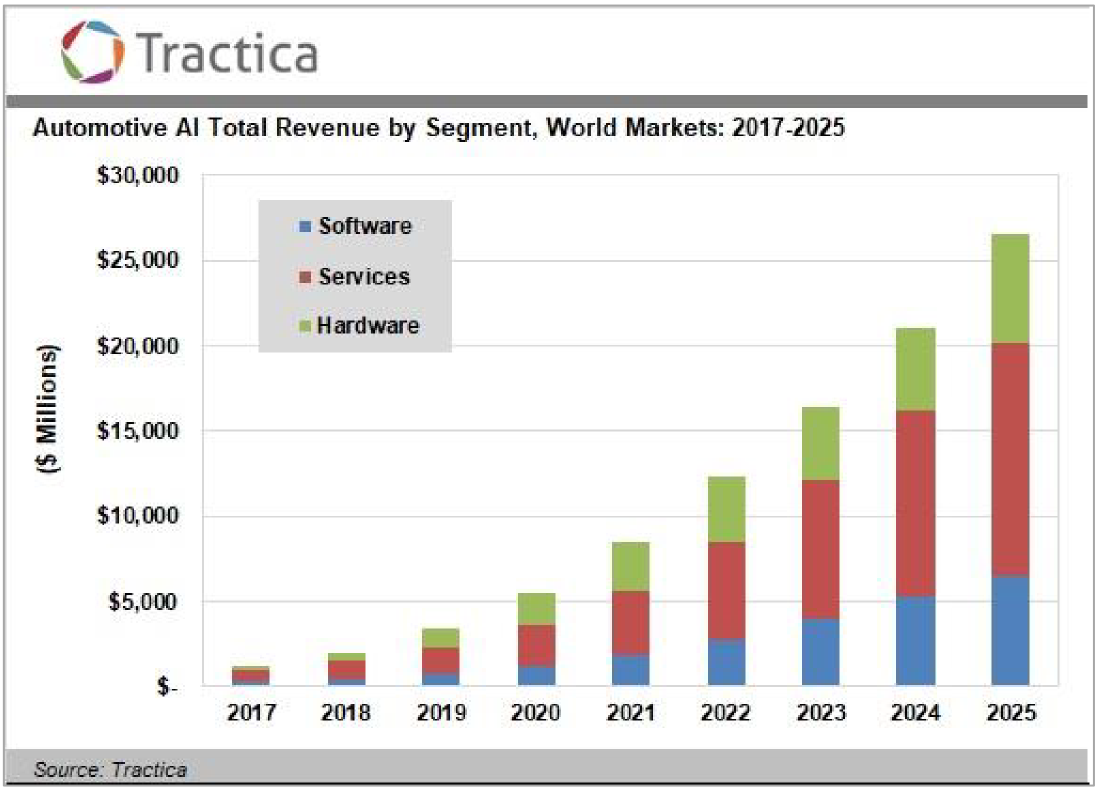

Figure 3.6: Artificial intelligence Global Automotive Revenue Forecast 2017-2025 (source: Tractica 2018).

Robotaxi market potential up to 2030

UBS expects significant global revenue potential for AD-related services such as robotaxis (USD 1,161 billion) or in-car time monetization (USD 472 billion) in 2030, (Figure 3.7). This value far exceeds the revenue potential of AV productions & sales (USD 243 billion) in the view of UBS (UBS 2018).

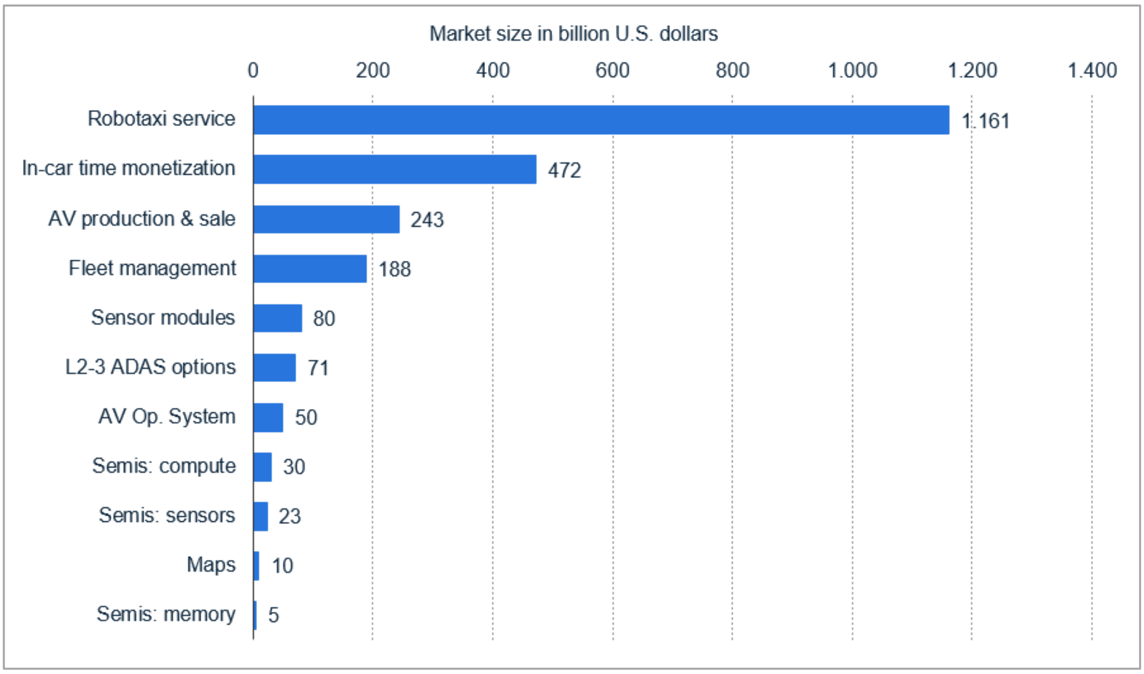

Figure 3.7: Size of the global market for autonomous vehicles in 2030 by segment (in billion U.S. dollars; source: UBS 2018).

However, experts have also become more cautious about revenue expectations from AD-related business models. The lower expected values of the market penetration of AV are also reflected in the expectation of future revenue potential. The Corona crisis has led to a sharp decline in Mobility Services revenue. Reasons for this are reduced mobility as well as health concerns in the use of, for example, sharing vehicles. This has put additional pressure on the already critical profitability of these services. Some OEMs have partly shifted AD development spending towards commercial vehicles, where drivers are a significant cost item.

To summarize: In the recent past, experts have lowered their expectations towards AD market penetration. A moderate development of market penetration and revenue potential of AD-related business models is seen until 2030. However, experts expect ongoing growth in the following decade.

4 Results

4.1 Collaborative business models for automated driving

The following chapter 4 presents and discusses the four different AD- and future-related business models that have been selected to particularly drive the demand for AD, span a broad solution space for AD-related business, and be generic and configurable to many settings. The business models are closely linked to major automotive and mobility trends that have been discussed in Deliverable D1.5, refer to broadly considered business opportunities for the automotive industry players, and are enabled by ADFs like those tested in L3Pilot. The In-Car Services represent a *time-value-dominant offering* to the driver and passengers of an AV. The Data^{+} Platform is a digitisation-driven and *data-dominant offering* as well as the Mobility as a Service (MaaS) business model, which exemplifies *a mobility service-dominant offering.* Finally, the RoboTaxi business model presents a *vehicle-centric offering* to the customers.

The four different but related business models are described and analysed based on the Service-Dominant Business Model Radar (SDBM/R) approach introduced in chapter 3. In the second part of each subchapter the business models are evaluated with regard to 1) their fit to the business environment scenarios, 2) the evaluation criteria desirability, feasibility, and viability, and 3) the stakeholder requirements. In a fourth step, it will be analysed to which extend key stakeholder requirements are addressed by existing roadmaps for automated driving. Finally, major challenges for OEMs are discussed and business model-specific recommendations for OEMs and other stakeholders are derived. These recommendations are to be understood as well-founded options for future actions by the various stakeholders, which were formulated based on the research work carried out including the intensive involvement of internal and external experts.

4.2 In-Car Services

4.2.1 Business model description and analysis

Automated driving technology releases the driver from the driving task. While the vehicle is driving in automated mode (e.g. being enabled by the Traffic Jam Chauffeur, the Motorway Chauffeur, or the Urban Chauffeur), the driver might be able to use the time in the car for other activities. The In-Car Services business model provides particular value to the driver by making this time more useful. He/she will be offered a service experience based on individual interests and preferences concerning the use of his/her time, like on-board entertainment, shopping, healthcare, well-being services, or even *car office* support. The provision of these services is enabled by linking driver- and vehicle-related data with location-based data and navigation information, e.g. personal food preferences, the vehicle batteries state of charge, current position and route information can be combined for planning an attractive break on a ride. To create this value for the driver, different actors – the car manufacturer, the digital interface and service platform provider as well as (location-based) service providers, telco, and payment provider – need to closely cooperate, establish digital interfaces and share data.

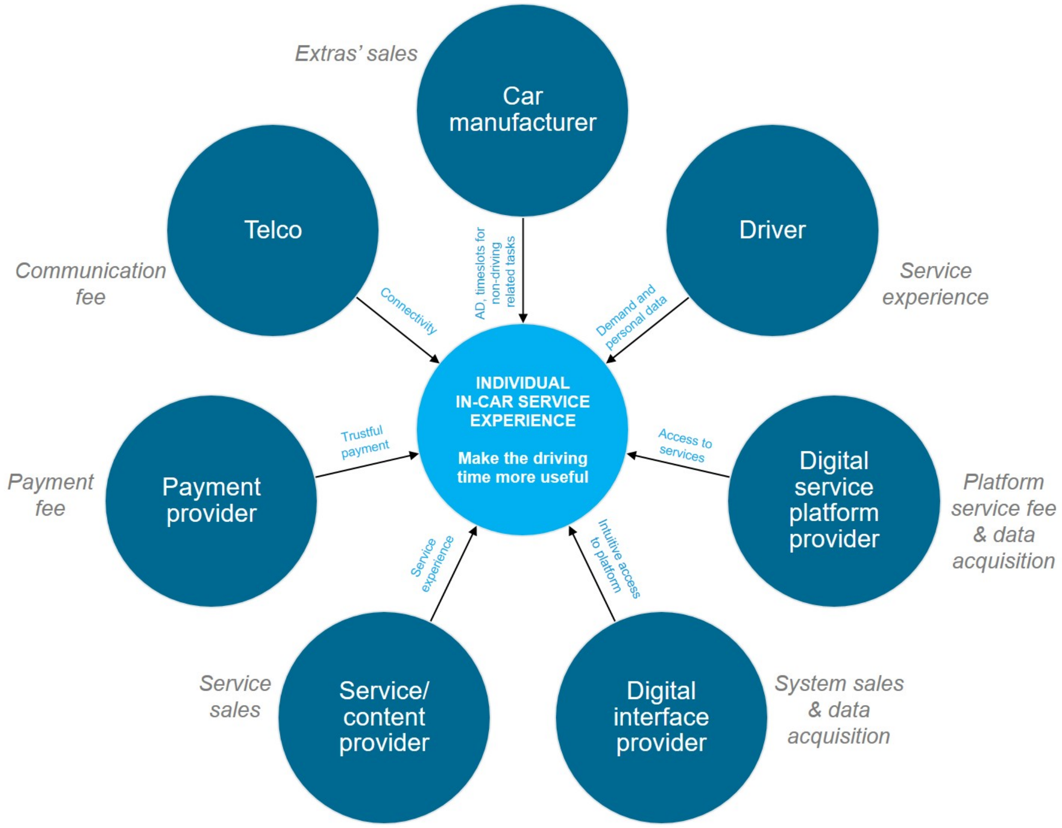

Figure 4.1: L3Pilot In-Car Services business model.

The *driver* (and the passengers), who will benefit from the individual service experience provides his/her particular demand and personal data to co-create the value. There is a wide range of services beyond the above mentioned possible, from location-based offers for eating and drinking (on-site or for taking away) to interactive site-seeing (videos, virtual reality with optional embedded real visits) to on-board education or social networking services or more vehicle-related and route-based offers like fuelling management or road-side assistance. The In-Car Services are orchestrated by the *digital service platform provider* as the focal company in this ecosystem. Big leading tech companies or e-commerce platform providers like those from the U.S. or China have the necessary skills and resources to fulfil this role. The digital service platform provider delivers access to the actual service offers, including a pre-selection of services and a proposal to the driver based on individual preferences and interests. The main benefits for this actor are a platform service fee and the user data that the digital service platform provider acquires. Another key actor in this collaborative business model is the *digital interface provider* who establishes the user's intuitive access to the digital service platform. In return, he gets data from the user with regard to the personal service demand and the current driving situation. In addition, the digital interface provider profits from selling the system to the car manufacturer. There are different types of companies that could act as digital interface providers, like leading tech companies, tech start-ups, or some Tier 1 suppliers.

Service and content providers create and make available the actual customized service experience. They make business by selling their services and getting access to a broad customer base. All service or content providers with online offers or e-shops could present their services via the digital service platform.

The *digital payment provider* ensures the implementation of trustful and reliable transactions between the involved parties and charges a payment fee for his services. The *telco* as the second commodity provider in this ecosystem provides the connectivity for all activities between the involved actors in the In-Car Services business model and charges a communication fee for his services.

Finally, the *car manufacturer* delivers the automated vehicle that enables the driver to engage in non-driving related activities and consume In-Car Services while the car is driving in automated mode. The OEM profits from extra revenues by selling the automated driving systems as extra equipment for the vehicles. Optional the car manufacturer could also generate revenues by charging a usage fee for the AD systems.

In-Car Services are already existing today. Drivers are able to consume low-distraction services via voice control (e.g. music streaming or retrieval of verbal information); passengers - while being driven - can consume entertainment services such as video streaming, interactive video games, shopping, event reservations, and much more. However, the willingness to pay tends to be limited to the services themselves rather than the placement of the services. Moreover, the existing services use the passengers' existing mobile data subscriptions via their mobile phones. This makes it difficult for OEMs to gain a foothold in these services, as consumers simply bring their ecosystem used outside the vehicle (dominated by the big tech players) into the car.

4.2.2 Business model evaluation

4.2.2.1 Fit to business environment scenarios

The penetration of AD technologies in the vehicle population plays a key role in the fit to business environment scenarios. It is lowest in the "Slowly but surely" scenario, highest in "AD Paradise" and in the middle range in the "Tantalus" and "Tech Push" scenarios.

The In-Car Services business model shows potential in all four scenarios, albeit at different intensities. Even in the "Slowly but surely" scenario, in which there is only a rather low penetration of AD technologies in 2030, in-car services show some attractiveness as they do it today (as just described related to the status quo). The potential for OEMs lies primarily in better usability of the services by equipping the vehicle, for example visually (larger screens), acoustically (better sound) or haptically (better operation).

There is great potential in the "AD Paradise" scenario in which market penetration with technologies at SAE level 4 is already high and thus offers not only passengers but also drivers great temporal scope for using in-car services. This scope is also used extensively in this scenario. In addition, there is also a considerably higher willingness to pay for all those functions that significantly simplify the organization of daily life.

The other two scenarios, "Tantalus" and "Tech Push", are in between in terms of business potential. In the "TechPush" scenario, the early adopters are open to and willing to pay for in-car services but might generate only limited business potential due to their limited segment size. In "Tantalus", on the other hand, both drivers and passengers are willing to pay for in-car services, although drivers are severely limited in their use of such services due to the rather low market penetration of advanced AD technologies.

In summary, the following picture emerges for the fit to scenarios of in-car services (see Table 4.1).

Table 4.1: Fit of In-Car Services business model to business environment scenarios.

No fit	Rather low fit	Rather high fit	High fit
o	**+**	**++**	**+++**
	"Slowly but Surely"	"Tantalus" "TechPush"	"AD Paradise"

4.2.2.2 Desirability, feasibility, and viability evaluation

Desirability (Consumer perspective)

First, there is already **strong demand for mobile services.** Many people are using these services via their smartphones or tablets. In the same way, mobile services are used outside cars, they can also be used inside cars. Passengers are already doing that; drivers can only do that under limitations because they have to concentrate on their driving tasks. In general, the usage of a smartphone by the driver is prohibited. This restriction creates a strong attractiveness of ADFs. With automation of level 3+ drivers will be able to hand over driving control to the car and might dedicate themselves to mobile services. Experts stated their expectation, that drivers will also be ready to consume mobile services while being driven by an AV.

From experts' perspectives, **ease of use and seamless integration** are key requirements for attractive in-car services. Accessibility and usability should be as close as possible to consumers' positive smartphone experience. This also refers to the customers' digital ecosystem. Customers are already connected to their ecosystem(s) and will probably not change their ecosystem only for the time they stay in their car. Even adding a further ecosystem for consuming in-car services might have a low attractiveness. Talking about the business model role of the digital service platform provider, the big tech players like Google, Apple, or Amazon are seen to be in a clear pole position with a strong leading edge.

Attractive improvements of an In-Car Service experience would be the **extension of smartphone capabilities inside the car** like the opportunity of having a bigger screen (much bigger than a smartphone, e.g. a head-up display), easier handling and control, and a significantly better sound. As these are vehicle and interior functions, the competitive advantage is here on the side of the car manufacturers.

Experts also discussed the customers' **willingness to pay**. It was seen similar to classical service ecosystems, where customers are ready to pay for analogue services (like cleaning, drinking and eating, or event visits) and for digital services (like video and music streaming, or internet access), but rather not for pure platform usage like a digital service platform. These providers would have to finance themselves via the service content providers.

During the webinar on In-Car Services, experts have been asked to rate the desirability, feasibility, and viability of this business model. The evaluation for "Desirability" on a Likert scale between 1 (strongly disagree) and 5 (strongly agree) shows – compared to the above described rather positive evaluation of the experts - a relatively low value of 3.4 that signifies a "slightly agree". (see Figure 4.2). Some experts' statements during the webinar and the further discussions with experts suggest that the idea of OEMs trying to take on this role may have played a part in it.

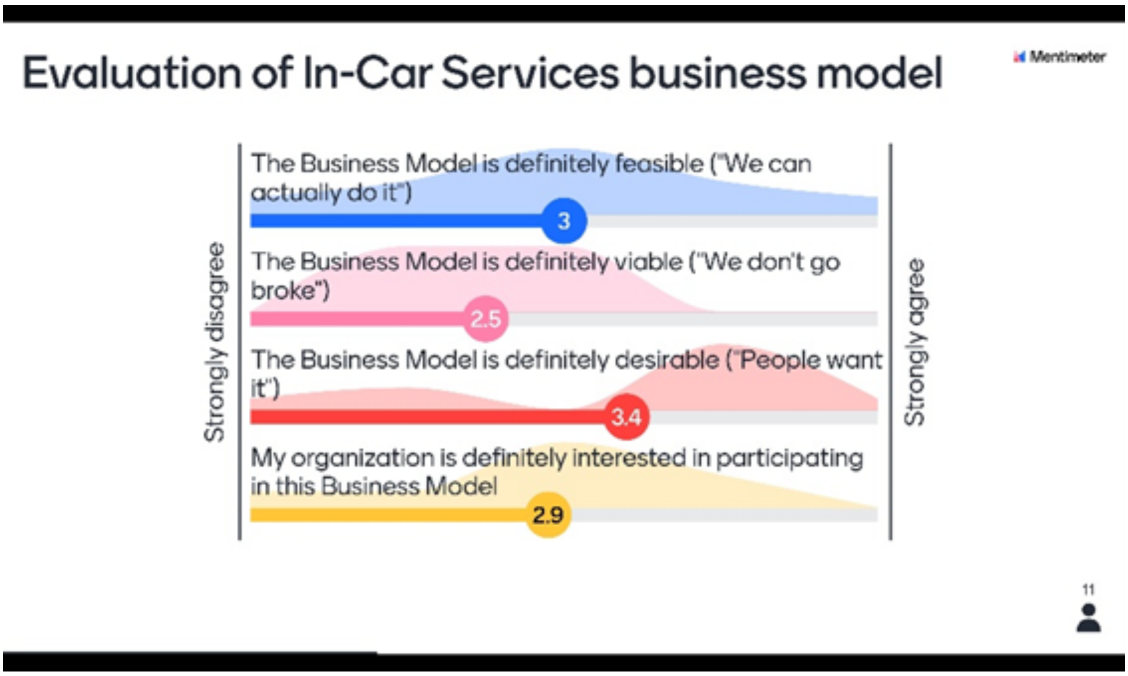

Figure 4.2: Evaluation of the In-Car Services business model during the webinar (own source, using Mentimeter platform).

In addition to the expert evaluation of feasibility, the L3Pilot User Acceptance Survey (carried out in L3Pilot, WP 7.5, Deliverable D7.1.) gives indications to desirability of in-car services from a consumer survey, conducted in 17 European, Asian, American, and African countries. Especially two questions are of specific interest for the In-Car Service business model.

Figure 4.3 shows, that a majority of the consumers would use the time while the conditionally automated car is driving (SAE level 3), for other activities. This majority is stronger in emerging countries and less strong in established industrial countries.

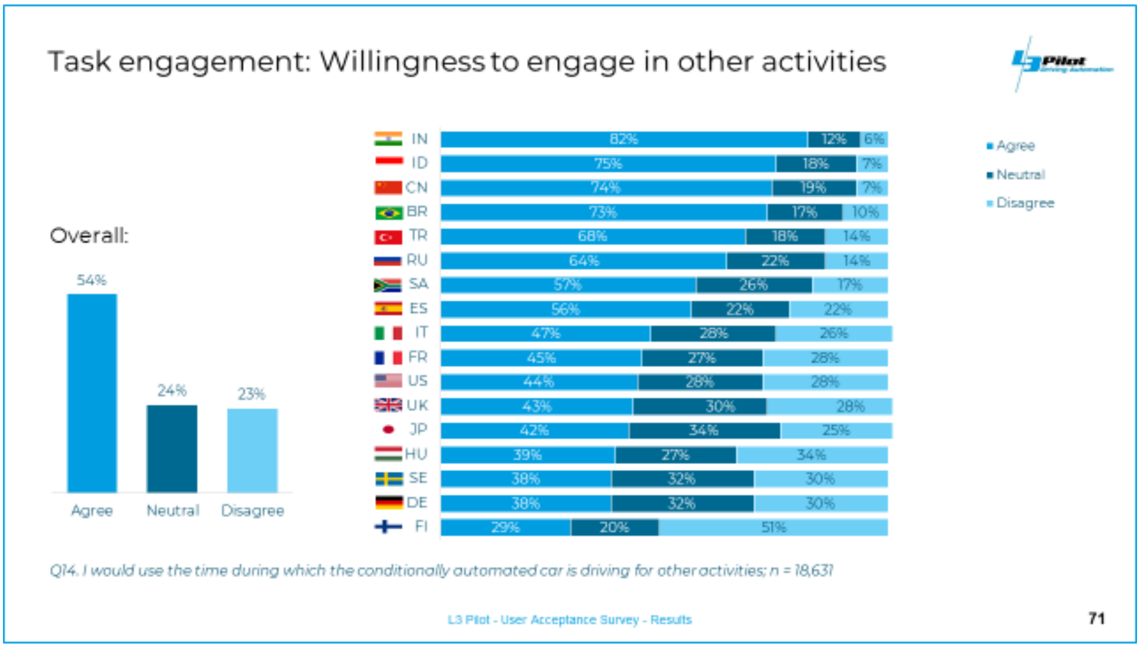

Figure 4.3: Willingness to engage in other activities (Source: L3Pilot User Acceptance Survey, Deliverable D7.1).

Figure 4.4 gives an overview of the attractiveness of different activities, drivers would like to perform in a conditionally automated car. The attractiveness rates up to a maximum of 47%. This might indicate that many consumers are still reluctant with taking their eyes off the road and engage in other activities. However, from the perspective of the business model In-Car Services, a rate of 47% being ready to engage in the internet, videos or TV shows, 35% in relaxing and resting, 28% in eating and drinking or 18% in working, in connection with the expected strong growth of market dissemination of L3 vehicles (see chapter 3.4) is an economically very interesting basis to generate revenue. This confirms the expert feedback to the In-Car Services business model related to desirability.

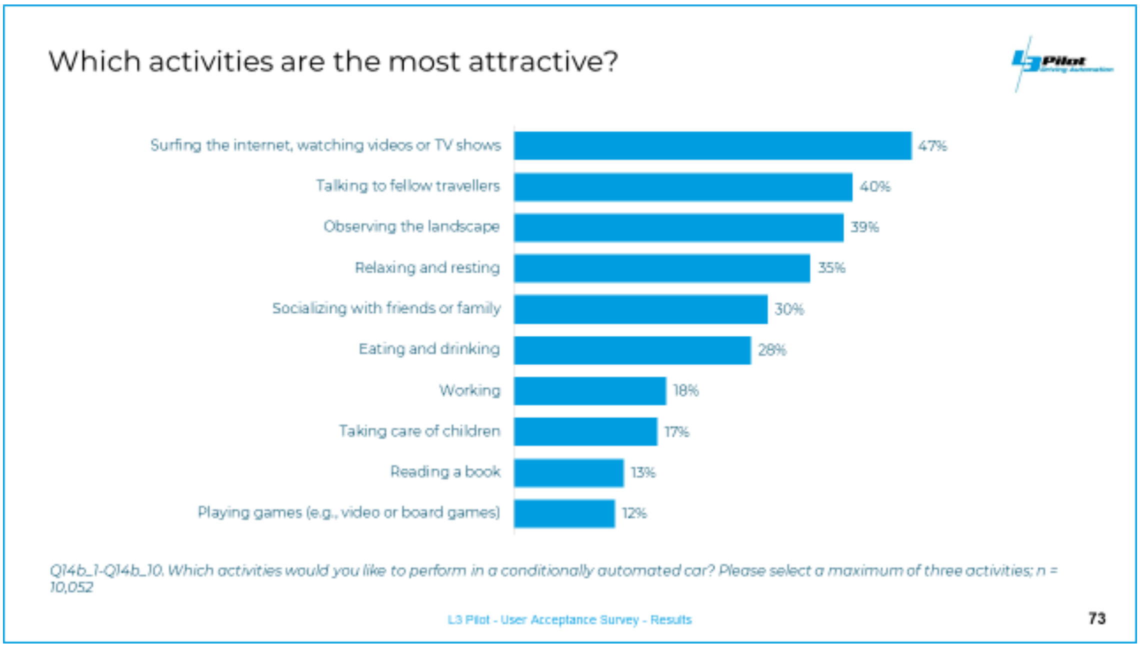

Figure 4.4: Attractiveness of other activities (Source: L3Pilot User Acceptance Survey, Deliverable D7.1).

Feasibility (Technological and legal perspective)

First of all: General feasibility is not seen as a serious problem, although there are still some challenges to overcome.

In principle, in-car services already exist today. All vehicle occupants - except the driver - can already use mobile services in the car while driving. However, automation also enables drivers, who were previously very limited in their use of such services, to use them. Since on the vast majority of journeys a car is occupied by only one person (e.g. the average car occupancy rate in Germany is 1.46) (Deutscher Bundestag 2018), automation could open up a high additional potential for in-car services. As a first step, this could technically be done already at **SAE level 3**, which is a functional precondition for the effective use of in-car services by the driver.

The second technical framework condition is **continuous connectivity**. Streaming services or interactive communication between vehicle occupants, the digital service platform, and the service content providers must be guaranteed. However, this is still not the case even in the European Community. LTE networks and even more 5G/G5 networks still have considerable gaps, especially in rural areas.

Further challenges are seen related to **vehicle technology**. For the integration of mobile services into the automotive IT system, seamless integration of the digital user interface has to be managed under consideration of the much shorter innovation cycles of mobile devices and technology compared to automotive technology.

Also, data protection plays a significant role. **Security and privacy of the collected and transmitted data** as well as the ownership of the data must be given and clarified. Although this is technically feasible, it requires clear standards and transparency in the implementation.

In addition to technological feasibility, **legal feasibility** plays a major role. In Europe, legal regulations that allow automated driving under certain conditions are in the description and coordination phase. Due to the common vehicle licensing requirements and the extensive cross-border traffic, a harmonisation of the legislation is considered to be of great importance for the feasibility of in-car services. While country-specific regulations could accelerate the market penetration of automated vehicles in individual countries, they could be counterproductive in the European context.

The **evaluation of the feasibility during the webinar** by the participants (Figure 4.2) resulted in a neutral average of 3.0. Agreement and disagreement of the participants concerning the statement "The business model is definitely feasible" were balanced. Thus, there is no clear tendency on the part of the experts.

Viability (Business perspective)

First of all: The viability of the In-Car services business model in general, is beyond doubt, as far as the statement refers to the **big tech companies as focal organisations**, their already existing eco-systems and the usage of wide-spread mobile devices (e.g. smartphones and tablets). Big tech companies are already managing ecosystems with huge numbers of participants, car manufacturers will never be able to reach, e.g. globally 2.5 billion android users today (Brandom 2019), about one billion iPhone users (Cybart 2020), and more than 320 million smart speakers in use (Vailshery 2021) vs. up to perhaps 15 million level 3+ vehicles in 2025 (like in the high disruption scenario projections by McKinsey 2016) divided among various car manufacturers. Therefore, the viability of In-Car services provided by car manufacturers is seen as less promising because of their still very small ecosystems and the competition against the existing mobile service world.

However, OEMs can have a strong position in such a business model by:

- Providing the vehicle technology that enables automated driving (product business)
- Providing a user-friendly in-car interface for the drivers as an extension of smartphone capabilities, like bigger screens, augmented or virtual reality, improved handling, better sound (product business)
- Providing vehicle-related and passenger-related data (state of the car and the driving task, state of the passengers detected by in-vehicle sensors, state of the vehicle environment like traffic and infrastructure, detected by vehicle sensors) as a basis for additional (own) services (service and data business).
- An example for OEM proprietary services could be:

- Charge and more: Interactive optimisation of on-trip charging planning including reservation of charging points (using vehicle data for the state of charge and expected range, using customer preferences like on-site access to a playground, a specific type of restaurant or shopping opportunities); re-optimising that plan based on driver fatigue detection.

The **evaluation of the viability during the webinar** by the participants (Figure 4.2) resulted in an average value of 2.5; the viability is seen as rather negative. Some experts' statements during the webinar and in the subsequent expert talks suggest that the idea of OEMs trying to take on this role has played a part in the negative rating.

Conclusions

In-Car services are seen as desirable, feasible, and viable if they are created in a best-of-breed approach. As a consequence, OEM can use the opportunity to benefit from their strengths and concentrate on the vehicle technology (AD technologies and interior technologies for expansion of smartphone capabilities) as well as on the exploitation of their unique knowledge and data about the status of passengers, vehicle, and vehicle environment. In this area, they could provide their own services: In all other areas, cooperation with big tech players and their ecosystems is seen as a strongly promising option

4.2.2.3 Stakeholder requirement evaluation

The various stakeholders in the In-Car Services business model have different service-specific requirements, the fulfilment of which is a necessary framework condition for the successful development and marketing of these services. An overview of these requirements is shown in the following table (Table 4.2):

Table 4.2: Stakeholder requirements for In-Car Services business model

Stakeholder	Requirement	Specification
Driver / Passenger	Usability	Making it easy to use in various ways, e.g. voice, gestures, buttons, etc.
	Reliability	Having it available when it is needed, in a good quality
	Fit to interests	Filtering services to users specific interests, being pro-active
	Fit to situation	Offering services related to the current location, type of trip, traffic situation, etc.
	Seamless integration	Integrating it in the users' usual ecosystem, e.g. connecting to often-used apps, settings, and technologies
	Data privacy	Making the user trust in it, avoiding hacks, leaks, and other privacy issues

Stakeholder	Requirement	Specification
	Discretion / confidentiality	Considering the presence of other passengers when offering user-specific content or services
	Sensual experiences	Making the use of the service to a specific sensual experience (comfort, luxury)
	Connectivity	Being connected everywhere and every time, also in rural areas
Car manufacturer	Potential customer demand	Demand for vehicles with L3/L4 ADFs including the willingness to pay
	Availability of Technology (ADFs L3/4)	Technology has to be ready for L3/L4 and components are available in the market
	Liability	The legal framework that appropriately clarifies the liability has to be in force
	Access to/cooperation with existing platforms/eco-systems	To create a seamless experience inside the car, cooperation with platform providers and their ecosystems are necessary
	Analysis and provision of vehicle-/ environment-/ driver-/ passenger related data	Sensor data from outside and inside the car and additional knowledge about the driver/passenger
Digital interface provider	Access to the driver (bi-directional)	Having interfaces available in the car to communicate with the driver
	Access to digital services/platforms	Basis ability to market the services and contents to the users via the platforms
	Connectivity	Being connected everywhere and every time, also in rural areas
Digital service platform provider	Access to a variety of services/ contents	Having an extensive ecosystem available with manifold content and service providers
	Knowledge about users (incl. situation)	Being able to offer services and content with a high fit to user preferences
	Connectivity	Being connected everywhere and every time, also in rural areas
Service content provider	Access to digital services/platforms	Basis ability to market the services and contents to the users via the platforms
	Presentation of service/content offered to users via digital interfaces	Technical ability to convince the users to consume their services or contents (via screen, ppt, audio, etc.)
Payment provider	No specific requirements concerning the In-Car services business model	
TelCo provider		

The WP1.4 team has assessed the requirements above concerning the criteria necessity (with the options nice-to-have vs. essential) and realizability (easy vs. difficult) to make a selection for further consideration of the requirements and their inclusion in different roadmaps (see the following subsection).

For 16 of the 20 requirements, a rating in the upper right quadrant (Figure 4.5), which means a rather high necessity and rather difficult realizability was the result of the internal evaluation. On the first view, the high number of requirements difficult to realise might be contradicting to the neutral value of the experts' evaluation of feasibility. However, difficult realizability does not indicate necessarily a low feasibility but that there is still some work to do to make it happen as an individual in-car service experience.

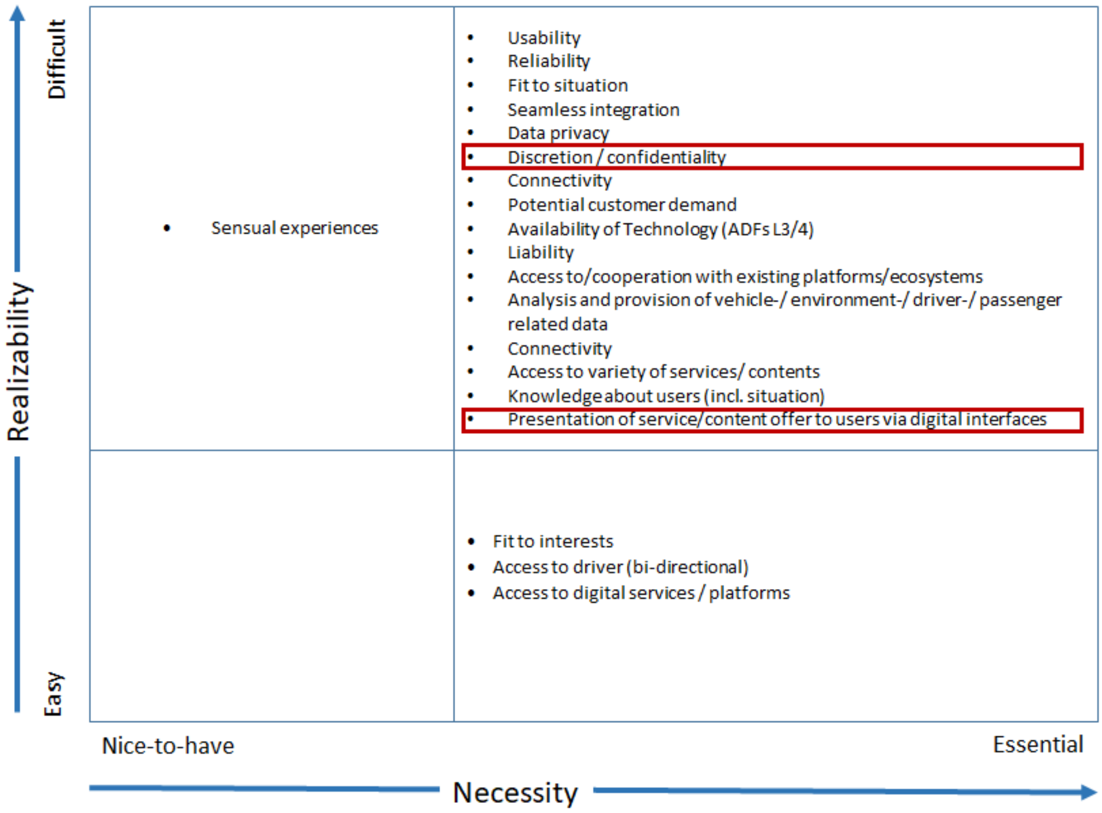

Figure 4.5: Evaluation of the In-Car Services stakeholder requirements related to necessity and realizability (own source).

In the following subsection, these requirements are examined to determine whether they have already been taken into account in selected roadmaps and, if so, whether they have already been located in terms of time. The requirements framed in red do not fulfil both characteristics and are therefore referred to as "new roadmap items". A more detailed explanation is given in the following chapter.

4.2.2.4 Roadmap analysis

Comparing the requirements with the mentioned time lines, challenges, and topics of different roadmaps (as introduced in chapter 3), the following results can be observed:

For some requirements an indication is provided when (years) the fulfilment of the requirements or at least parts of it are expected, e.g. for:

- **Availability of AD technology:** An L3 Highway Chauffeur, that would allow to hand over the driving task on a highway at least temporarily to the AV is expected until 2023 (ERTRAC/ARCADE roadmap). This can be seen as a potential starting point for In-Car Services that allow a limited degree of distraction (like video streaming, simple working tasks, or relaxing). With the expected availability of an L4 Highway Pilot until 2026 (ERTRAC/ARCADE), more complex In-Car Services can be consumed (like shopping, virtual reality applications, or wellness activities).
- **Connectivity:** Highly performing and available connectivity is crucial for In-Car services. Standardisation is expected to happen between 2020 and 2025 (VDA), connectivity-enabled safety is expected until 2028 (Zenzic).
- **Usability:** Common HMI guidance for AD systems is expected between 2022 and 2024, an intuitive HMI design between 2024 and 2027 (Zenzic). However, the roadmaps focus on the usability of the AD system; comparable usability for an integrated In-Car-Services interface is still not on the agenda but could be expected with the same time horizon.
- **Liability:** First progress on the European level for DSSAD (Data Storage System for Automated Driving) and EDR (Event data recorder) is expected as early as 2022 (ACEA), a robust regulatory and legal framework is seen to be in place by the end of 2028 (Zenzic).
- **Data:** A framework for the analysis and provision of vehicle-/ environment-/ driver-/passenger- related data is an item on all roadmaps. Definition of data governance, responsibility, ownership is seen to be realized until 2022 (Zenzic).

Beyond these requirements, the majority of the other requirements are identified as challenges or issues in one or more roadmaps, as the term *services* is predominantly used for mobility services in these roadmaps. In-Car Services in the sense of the described business models are not in the focus there. Unsurprisingly, two of the requirements - very specific for In-car Services - are not yet reflected in the roadmap.

4.2.3 Deployment Strategies: Business model related new roadmap items, challenges, and recommendations

This section concludes new roadmap items, challenges, and recommendations for deployment strategies for the In-Car Services business model, based on the business model description, analysis, and evaluation above.

4.2.3.1 Suggested roadmap items

Based on the analysis performed above two new roadmap items are suggested for realizing important requirements for the deployment of the In-Car Services business model.

Suggested roadmap item 1: Discretion / Confidentiality related to other passengers

When a driver communicates with the digital interface (the artificial intelligence), e.g. via speech, it has to be assured, that possibly very personal and confidential information will not be disclosed. That could refer to persons, visited places, activities, or purchases. This is a crucial function for the acceptance of an In-Car-Services digital interface.

What do the roadmaps say?

Data privacy is a topic on all roadmaps. It refers to the aspect, that clear rules related to the ownership of data and the access rights to data are defined and that mechanisms have to be in place to protect these data against misuse. However, the topic of discretion and confidentiality related to passengers, accompanying a driver during a trip, is not covered by that item. A driver or another person communicating with the digital interface during the trip, might not like, that the digital interface discloses things that are too private to share with other persons in the vehicle. That is, in practice, much more difficult to realise than it seems to be. There are various possibilities to deal with it (e.g. do not disclose any private topics if other persons are inside the car, classify the information, classify the passengers). Anyhow, to finally implement a discrete and convenient way to handle occupant data is an In-Car Service-specific topic, and has to be seen as a specific challenge.

Suggested roadmap item 2: Presentation of service/content offer to the user via digital interface (video, audio, ppt., etc.):

To become a commercial success, there must be a sufficiently high demand for In-Car Services and an appropriate willingness to pay for these services. The better the performance of the technology and hardware devices in terms of enabling inspiring and convincing presentations of services and content inside the car, the bigger the chance to attract customers. The service presentations might get a significant boost when they can appeal to various human senses.

What do the roadmaps say?

Related to technology and devices, all roadmaps focus on two major aspects: AD technologies and the AD interface to the driver. Of course, both are crucial for In-Car services, but they are not covering the described roadmap item. For In-Car Services, additional functionalities are required.

While the elements directly necessary for AD are about rational functions for safe and comfortable automated driving, the marketing of services and content also appeals strongly to the emotional side of the consumer and this requires further interaction and communication possibilities with the driver (visual, acoustic, sensory, haptic, or even olfactory). The required interfaces and devices can but do not have to be independent of the AD-relevant devices. However, these requirements must be included in the interior development at an early stage, also to enable an interior design "from a single mould". In-car services-specific operating concepts can also be considered at this stage.

Overall it can be stated, that the big majority of requirements are already seen as challenges and items in the analysed roadmaps, except the two very specific requirements mentioned for In-Car Services.

4.2.3.2 Deployment challenges for OEMs

The key strategic deployment challenge for OEMs related to the In-Car Services business model will be a well-balanced "*coopetition"* approach, i.e. to find the most beneficial role(s) in this business model and a balance between *coop*eration and comp*etition* with the big tech players and their ecosystems and among OEMs. Experts recommend to OEMs to concentrate on their strengths and integrate them into this business model instead of competing with big tech players for ecosystems.

Beyond that, In-Car Services pose further deployment challenges to OEMs. These can be subdivided into the following four major categories.

- **Technological Challenges**

  AD Technologies: To allow the driver to fully benefit from In-Car Services, AD technologies have to be ready at least at SAE level 3. Readiness at SAE level 4 would allow also services that require stronger attention from the driver.
  In-Car hardware: To create a special service experience for the driver inside the car, specific hardware devices would be needed. This refers to bigger screens for videos and apps, better sound, increased usability of user interfaces, and other attractive gadgets.
  Product cycles: Consumer electronics product cycles are much shorter than in the automotive industry. During the life of a car, various generations of consumer electronic devices appear and disappear. Compatibility related to standards, interfaces, and performance is crucial to play a role in In-Car Services at least as an automotive hardware provider.

  Data security: Highly connected cars could be attractive targets for cyber-attacks. The more gateways exist, the higher the number of partners and suppliers, which deliver these gateways, the bigger the challenge to secure the car.

- **Legal Challenges**

  Access to data: A possible competitive advantage of the OEMs could be the access not only to the immense amount of vehicle sensor data but as well on data about the drivers/passengers, which might have preferences to the OEMs who have trustworthy agreements on user data.

- **Economic Challenges**

  Role in the business model and reasonable profit: In a classical platform economy business model, (as In-Car Services is), the biggest profit is often made by the platform provider. If an OEM would not be the platform provider, but a service content provider (e.g. based on vehicle- and driving-related data), creating profit might be challenging.

- **Challenges related to the customer**

  Relationship to the customer: The service provider has direct contact with the customer. Related to services, the big tech players with their already existing comprehensive ecosystems are at an advantage. As a result, OEMs are threatened with a partial loss of direct access to their customers.
  Service creation: If OEMs have access to comprehensive vehicle data, they still have the challenge to create meaningful and attractive services out of this and customers should be willing to pay for these services. Most likely this will have to be combined with data collected by other parties, which drives the need for collaboration.

  Discretion / Confidentiality related to other passengers: When a driver communicates with the digital interface (the artificial intelligence) via speech, it has to be assured, that possibly very personal and confidential information will not be disclosed. That could refer to persons, visited places, activities, or purchases. This is in practice, much more difficult to realize than it seems to be.

4.2.3.3 Recommendations to OEMs' deployment strategies

The discussions with the experts in the different phases of the work on business models and their evaluation also considered recommendations to OEMs. These recommendations are not targeted to any specific OEM, but OEMs in general. Some OEMs are already well advanced in some recommended topics; others still have these tasks ahead of them. The following deployment recommendations can be seen as a checklist that every OEM who wants to prepare for the In-Car Services business model can tick off for themselves to see whether they have already addressed these topics.

- **Developing corporate strategies for future roles in new business models.** Beyond being a car manufacturer, OEMs are required to decide about being a platform provider and/or a service content provider in addition. Starting business model pilots with different partners and different roles to gain early experiences can support and validate this strategy.

- **Foster cross stakeholder activities for infrastructure development, standardisation, and realisation** of SAE level 3 and 4 automation as a concerted action from all involved parties, which will allow the implementation of automated driving at a large scale.

- **Develop new concepts of interior design and hardware devices** to create an outstanding service experience for the driver inside the car, e.g. equip the car with augmented reality features to discover the scenery or design a multi-media *car office* for work.

- **Develop an open software and hardware architecture for integration of consumer electronic devices** that will be brought into the car by consumers to get connected (e.g. tablets, laptops, VR devices, game controllers, etc.). The innovation cycle of these consumer devices is much shorter than for vehicle interior technologies. Collaboration with other players will be needed.

- **Develop in-car devices (for visual, optical, or haptic experiences) with a clear competitive advantage against consumer electronic devices.** In addition to the different development speeds of in-car hardware, OEMs are challenged by the cost effect of much lower numbers and stronger safety requirements to devices they provide (e.g. comparing a vehicle integrated screen to a mobile tablet). Therefore, the integration of this hardware into the car architecture, the usability, quality, and performance has to provide a significant additional benefit to the customers.
- **Build-up strong competencies in cyber security** as connected and automated cars will be a potential target for cybercrime. Building strong cyber security skills is seen as an important step in securing some OEMs' plans to develop their own vehicle operating systems. This will be a continuing task.
- **Develop concepts for data usage and monetization.** When data are compared to "the new gold" then strategies are necessary to extract that new gold from the vast amount of raw data, analysing business opportunities and elaborating ways to gather the relevant data.
- **Foster cross stakeholder activities for a common framework on data acquisition, ownership, and usage.** Without a broadly accepted framework, data business will be always at risk of legal conflicts. An active role of OEMs could foster that process.
- **Make strong efforts to stay visible as a company and as a brand, attract the customer with the In-Car experience.** Platform and service providers have direct contact with the customer. Thus, the big tech players with their already existing comprehensive ecosystems are at an advantage. As a result, OEMs are threatened with a partial loss of direct access to their customers. The creation of valuable own paid services based on their knowledge and data about customers and of free services can strengthen OEMs' relationship with their customers.
- **Develop a confidentiality classification for knowledge and teach the AI to consider this classification for the interaction with the customer** to make sure, that no delicate information will be disclosed to other passengers. It is also important to find a customer-friendly and intuitive way of control.

4.3 Data^{+} Platform

4.3.1 Business model description and analysis

Data has become very valuable and is consumed by almost any business to make strategic decisions to provide services to the customers. All ADfs generate huge amounts of data such as the car (sensor) data providing insights on vehicle driving behaviour, user data that provides insights on user needs, preferences, and in-vehicle behaviour. Location data provide insights on trip characteristics, route choice, and preferences. The availability of huge amounts of data opens the opportunity for a Data$^+$ Platform business model.

This business model targets a B2B service where the enriched data (the co-created value) is used for data-driven services (e.g. high-resolution weather reports with temperature, rainfall, ice on streets, range of sight in case of fog, etc., road surface, traffic signs' or traffic lights' status reports for road authorities, counting of pedestrians, bicyclists, free parking spaces, or occupancy rates of passenger cars for traffic planners) and also to design (real-time) services for the users to enjoy a personalized travel experience. To provide smart automated mobility services (like apps to book and pay for a ride or other value-added services that improve the travel experience) to the end-users, it is vital to securely organise, process, and handle the huge amount of data of consumers and enterprises. The Data$^+$ Platform enables the involved actors to create a marketplace for secure data handling, data enrichment, and data sharing, which is completely manageable by its end-users and the involved actors. To create this value, different actors – from car manufacturers to providers of digital interfaces, data aggregators, and service providers – need to closely cooperate, establish digital interfaces and share data (see Figure 4.6).

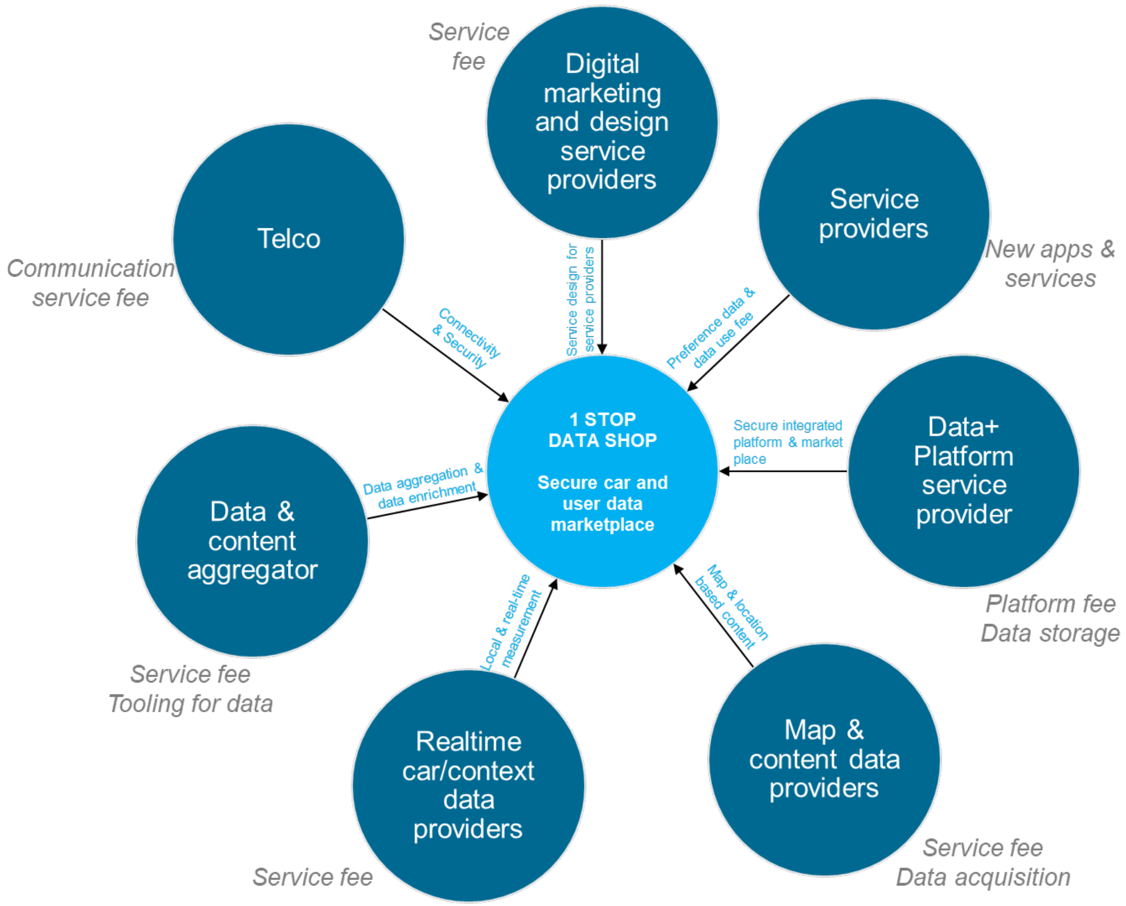

Figure 4.6: L3Pilot Data$^+$ Platform business model. (own source).

The users of the data, the *service providers*, offer new apps and services to the travellers using the enriched data from the marketplace. The *Data$^+$ Platform provider* is the focal company that provides access to a one-stop data shop through a secure integrated platform and marketplace. The *map data*, *real-time car data*, and *telecommunication data* provide content and context on top of the user data. These data are aggregated and enriched via smart algorithms by the *data and content aggregator* to create meaningful information. The enriched data is stored in the one-stop data shop, which can be accessed for a fee by the *digital marketing and design service providers* (and external organisations like the national road agency) to offer the users a personalized service and travel experience. Data can also be meaningful to other parties and organizations (B2B) like road authorities thus generating more business opportunities.

In summary, we can state the following for the Data$^+$ Platform business model:

- There is a **demand for data on travellers needs and behaviour**, reinforced by increasing successful service applications
- There is a **demand for new services** such as comfort, flexibility, carefree, safe, and entertainment. That gives existing service providers a strong competitive advantage to connect with the travellers and drivers through different services, OEMs will not be able to catch up and may lose the link to their customers. Business Potential for OEM has multiple potential streams by taking on the additional role next to manufacturing and selling cars, such as:
  - **Data$^+$ Platform service provider**: Selling cars will remain the predominant business for OEM, expanded with selling enriched data through cooperation with other stakeholders in the data$^+$ platform business model
  - **Service provider**: Selling cars will remain the predominant business for OEM, expanded with providing new services (like parking, charging, car sharing).
  - **Real-time car/context data provider**: Selling cars will remain the predominant business for OEM, expanded with selling real-time car and context data to the data platform.

Today, data platform business models are already running, mainly independent from automotive applications. Tech companies acquire a huge amount of data via the usage of their apps and use them for their own purposes as well as assets. Data privacy and data protection rules are limiting this, therefore data protection concerns should be taken into account from the start when designing the services.

4.3.2 Business model evaluation

4.3.2.1 Fit to business environment scenarios

As data sharing and enriching is crucial in AD, this business model organises data as a service for the ecosystem. It is vital to organise, process, and securely handle the data to harness the intelligence and provide smarter services for society and the consumers. The

Data+ Platform enables actors in the ecosystem to create new opportunities, like enhanced travel experience, by providing a data sharing and enriching environment that is secure and completely manageable by its users and has a marketplace for reusable components (e.g. maps and algorithms).

To create this value, different actors – from data aggregators to providers of digital interface, data platform service providers, and (location-based) services – need to closely cooperate, establish digital interfaces and share data. The level of social acceptance of data collection from users and data sharing, and the level of technology development to turn the collected data into valuable services are key factors that this business model depends on.

The analysis of the fit of the Data+ Platform business model to the four business environment scenarios is provided below (Table 4.3):

Table 4.3: Fit of Data+ Platform business model to business environment scenarios.

No fit	Rather low fit	Rather high fit	High fit
o	**+**	**++**	**+++**
"Slowly but Surely"	"TechPush"	"Tantalus"	"AD Paradise"

The business model has "no potential" in the scenario *"Slowly but Surely"*. Although there are some measures (such as the GDPR) for privacy being put in place, there is a lack of acceptance and a critical view towards data sharing as transparency over the use of shared data is a concern. This would strongly limit the demand for value-added service offerings. Further, the trust in slow-paced technology development that enriches data and provides value-added personalised services is low.

The *"Tech Push"* scenario offers a "low fit" with the business model relative to the *"Slowly but Surely"* scenario. This is because of fast-paced technology developments that can offer a partial advantage, for example with data collection and data sharing, albeit the social acceptance is low. It is expected that the cooperation between different B2B stakeholders still flourishes creating a slightly positive impact on the ecosystems and the business model.

The scenario *"Tantalus"* has a "rather high fit" with the data-driven business model as the societal acceptance towards sharing data, and of value-added personalised services is high. The high demand for services and the potential to collect more data have a positive effect on the business model. However, this is a scenario with missed chances as the technology development is not up with the pace of demand, leading to underutilization of the collected data resulting in offering some mainstream services. In short, gradual growth in business model driven by demand due to high societal acceptance.

The business model has a "high fit" with the *"AD-Paradise"* scenario. The high societal acceptance of users towards AD enhances the opportunities to offer several services to the users. Fast technology development offers innovative data-driven AD services for B2B and

B2C. Strongly induced demand and supply result in a strong and stable reinforcing behaviour.

4.3.2.2 Desirability, feasibility, and viability evaluation

Desirability (Consumer perspective)

There is a demand for data-driven personalised value-added services that improve the travel experience of the end-users. These services aim to make the life of the users easier and convenient to travel. The demand for such services relies on data to produce outcome-based business models (Seiberth et al. 2018).

The actors in this ecosystem need to collaborate to co-create the value, in this case, enriched meaningful data. The Data^{+} Platform is designed to cater to businesses (B2B). The experts agree that there is a strong need for actors to work together in an ecosystem to contribute towards co-creating enriched data. An ecosystem like this requires diverse but relevant actors in the ecosystem to produce meaning out of data. The role of the focal actor can be taken by any stakeholder, not only by the service provider, such as other (governmental) authorities, advertising agencies, who could benefit from the co-created value.

During the webinar on the Data+ Platform business model, experts have been asked to rate the desirability, feasibility, and viability of this business model. The evaluation for “Desirability” on a scale between 1 (strongly disagree) and 5 (strongly agree) shows a low value of 2.6. Thus, the desirability is seen as somewhat negative. (see Figure 4.7). Some experts’ statements during the webinar and the further discussions with experts suggest that inadequate expertise of OEMs to step into a new field of data and to exert control may have led to reduced desirability.

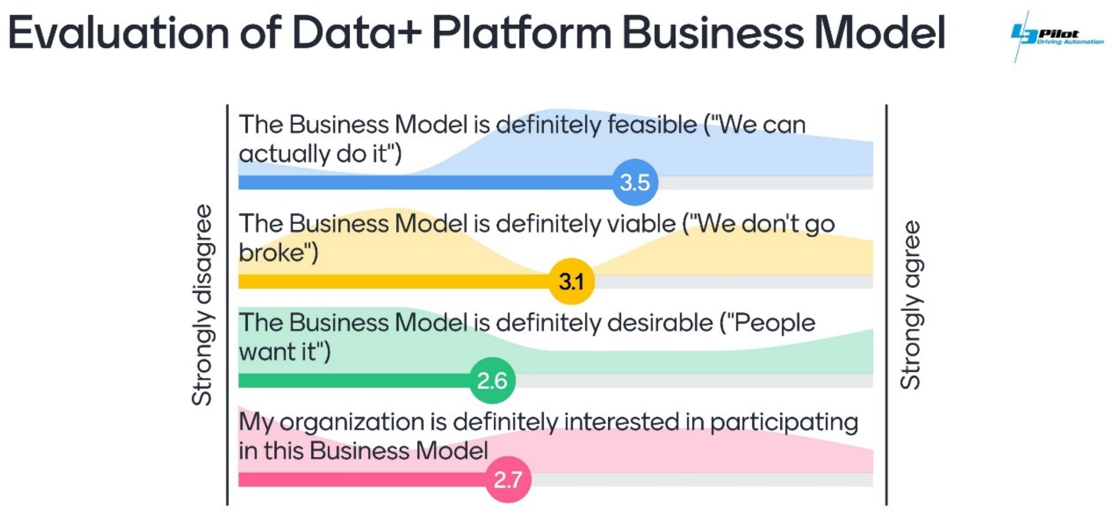

Figure 4.7: Expert evaluation results from the Data^{+} Platform webinar (own source).

Feasibility (Technological and legal perspective)

With the current and upcoming technological advancements, processing such complex data and getting meaning out of it is rather feasible. New technologies like block chain, big-data analysis, and using AI techniques could provide some opportunities to process the vast amounts of data provided from different sources and process them to meaningful insights. The integration and cooperation between actors can be a challenge, but the first moving ecosystem may have a high chance for the 'winner-takes-it-all'-effect. This is recognized by experts from several stakeholders and OEMs (also among L3Pilot OEM stakeholders).

In such an ecosystem, the data changes hands between different actors. Since data is sensitive, and mistakes relating to data can cost dear, proper organisational and legal governance needs to be set up. The first is to have clear agreements on the ownership of data from the moment the data is provided to the data platform. Assigning the ownership of data at every stage in the data analysis and processing sequence provides clarity and makes the responsibilities of every actor transparent.

Ownership of the Data$^+$ Platform is also important as it brings credibility to the Data+ Platform ecosystem. Perhaps having a new role for a neutral data handler such as recognized independent or semi-organisational authority in the ecosystem can reflect the efforts on transparency and raise trust when it comes to handling data.

The transparency of each actor in the ecosystem is identified by experts to be a desired attribute to the ecosystem. Since data is exchanged between multiple actors and the data aggregator relies on the provided data, there is a need to have clear transparent agreements with every actor in the ecosystem to define who does what with the data, which data is shared, and responsibilities for data privacy, data security and data quality.

The availability of relevant data from every actor in the ecosystem is one of the main requirements to extract intelligence out of the vast amounts of data. The quality of enriched data can be affected if the data from different sources do not correspond or correlate.

Reliability of the data is also an important prerequisite in this business model. It is necessary that the enriched data produced is reliable. The customers demand reliable data that can help steer their operations, services, and strategies.

Defining the **level of centralisation of data** is also recognised as a requirement to allow scaling up possibilities of the Data$^+$ Platform ecosystem. Defining levels in data exchange layers can allow the Data$^+$ Platform to produce enriched information on relevant levels. This is because a certain city may be different from another and hence the mobility behaviour collected from one city may not necessarily apply to another. Furthermore, as we move across geographies, every culture is different and that results in the diverse needs of customers. Therefore, defining levels of centralisation allows enriched data to be offered at different levels to different clients, for instance, to cities, provinces, nationally, and internationally. This could be favourable for the Data$^+$ Platform as it offers direction for scalability.

Legal and technical agreements and measures to deal with situations of data mismanagement have to be in place as all actors in the ecosystem face a mandate to perform well and with no flaws while dealing with sensitive data. For instance, it may be decided that the data that is provided by different actors to the Data$^+$ Platform should be anonymized and guarantee the privacy of their specific data. Quick problem mitigation measures have to be already defined and agreed upon by all actors in the unfortunate event of data mismanagement (data leak, security measures against cyber-attacks).

Some improvement areas in the feasibility aspect are data formats and data standards for higher efficiency. Agreements on common data format among OEMs and data providers are crucial.

The **webinar evaluation** of the feasibility of the Data$^+$ Platform business model was rated 3.5 which corresponds to 'slightly agree' (see Figure 4.7). Since the challenges faced in the feasibility area of the Data$^+$ Platform business model are technically solvable by current technological, organisational, and legal measures. However, the number of challenges to overcome is non-negligible and requires considerable effort and change.

Viability (Business perspective)

There is sufficient business interest to form an appropriate ecosystem. The Data$^+$ Platform is of interest to many organizations inside and outside the mobility domain. Data has become the means to strategically support the business direction by getting to know customers' needs better, offering tailor-made services, and devising the pricing of services.

Some experts find that it might be difficult to monetize data. To be able to have a viable business model, many different pieces of the puzzle need to be organised and brought together. Most of which are related to feasibility aspects, such as the type and number of actors in the ecosystem, the availability of relevant data, successful creation of enriched data.

Despite the challenges expressed by experts in monetizing data, there is an increasing number of research and business potential opportunities being explored in monetizing car data (McKinsey 2016a, Tessler 2020).

Sustainability of the Data$^+$ Platform business model may require a thinking out of the box approach and cater to the needs of customers above and beyond just the automotive or mobility sector, for instance, in sustainability, energy, and safety.

Some experts comment on the possibilities to **combine or interlink business models** especially for data exchange between the Data$^+$ Platform business model and other OEM-related business models like MaaS, RoboTaxi, and In-Car Services depending on the ambitions and goals of the actors to contribute to the business model.

The viability of the Data$^+$ Platform business model was rated an average of '3.1' in the webinar evaluation (see Figure 4.7). This corresponds to neutrality between agreement and disagreement. The results of the experts seem to be equally divided.

4.3.2.3 Stakeholder requirement evaluation

The various stakeholders in the Data⁺ Platform business model have different service-specific requirements, the fulfilment of which is a necessary framework condition for the successful development and marketing of these services. An overview of these requirements is shown in the following table (Table 4.4):

Table 4.4: Stakeholder requirements for Data⁺ Platform business model.

Stakeholder	Requirement	Specification
Data⁺ Platform service provider	Demand from service providers	Sufficient demand is necessary for the viability of the business model
	The legality of commercial business on data	Clear data sharing and data ownership rules and policies are to be followed constantly adapting to the changing requirements from regulators in the EU and world-wide
	Safety/Security of the journey and the data	Ensuring the safety and security of the data in the marketplace (for instance against cyber-attacks, data leaks due to ransomware)
Service providers	Ease of accessing and using enriched data	Ease to find and access the enriched data from the marketplace
	Adoption of service by users	Demand and adoption for new value-added services from service providers is necessary for reinforcing the viability of the business model
	Collection of user data	The user data from new services provides new insights and is an input to the data+ platform market place which will be combined with other data sources
	Seamless internet connectivity	Seamless internet connectivity is a technical requirement for seamless and secure transfer of (real-time) data and offering smart value-added services
	Need to provide good/reliable service to the customers	Reliability of the service offerings improve the adoption rate of the service app
Map & content provider	GPS data, connectivity of users, and vehicle	Accurate and seamless GPS connection with users and vehicles provide smart value-added services to the users and collect context data as an input to the data+ platform marketplace
	Updated map and context information	Up-to-date map and context information (example: road works, new shops, finished construction) provide detailed and accurate information
	Real-time positioning data from service apps	Real-time positioning from other service apps (such as route planners) can help improve the accuracy of the location info.

Stakeholder	Requirement	Specification
Real-time car & context data provider	Access to the car (OEM) and sensor data (Tier 1 suppliers)	Access to car data and sensor data is crucial from them OEMs and Tier 1 suppliers for data enrichment
	Connectivity of vehicles (V2V, V2X)	Connectivity between the vehicles and between vehicle and infrastructure is crucial to enable smart AD services and collect vehicle data
	User information	User information is of importance to provide personalised services
	Secure data sharing	It is ultimately important to have a secure environment for data sharing
Data & content aggregator	Quality data	The quality of data collected from various sources has a direct correlation with the enrichment potential of the data
	Data from various data sources (maps, telco, cars, service apps) and collaborations with data providers	Large amounts of data from different data providers are key to this business model and for a content aggregator to produce enriched data.
	Smart algorithms, AI	State-of-the-art data analysis techniques like Big Data and AI help turn raw data into enriched data
	Anonymised data	Data anonymization is a fundamental requirement to conform to the privacy rules
Telco	Data usage statistics in correlation with the location	Location-based data usage statistics can provide insights on user behaviour
	Updated location and context information	Location info based on telco presence and correlated time series can add value to the data
	Network coverage	The quality of coverage of telecom service is necessary to obtain data
Digital marketing and design service providers	Access to data platform	The ease of access to data platform marketplace is required to design services for service providers
	Quality data	Enriched data should yield higher quality data that can be trusted to design business strategies and new services
	Service providers asking for the design of new services	Stakeholders like service providers drive the demand of the business for the Data+ Platform marketplace

The WP1.4 team has assessed the requirements above with respect to the criteria necessity (with the options nice-to-have vs. essential) and realizability (easy vs. difficult) to make a selection for further consideration of the requirements and their inclusion in different roadmaps (see the following subsection).

For 9 of the 19 requirements, a rating in the upper right quadrant (Figure 4.8), which means a rather high necessity and rather difficult realizability was the result of the internal evaluation.

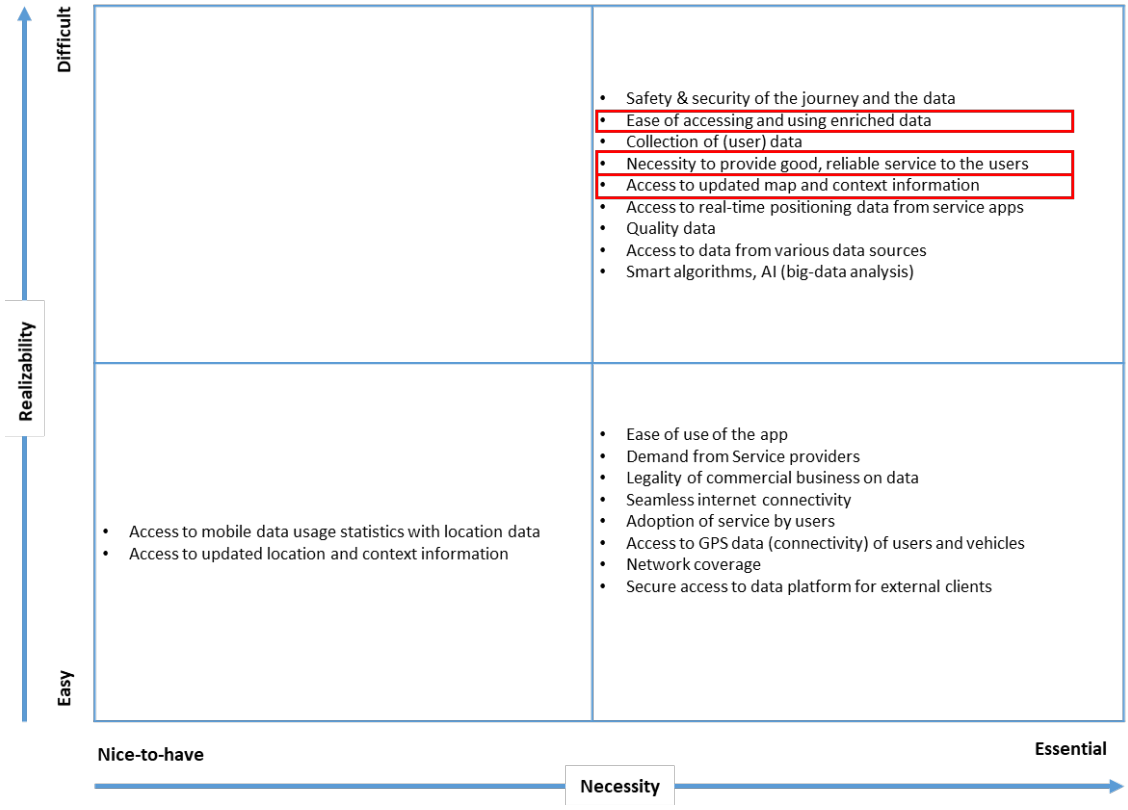

Figure 4.8: Evaluation of Data+ Platform stakeholder requirements related to necessity and realizability (own source).

4.3.2.4 Roadmap analysis

Multiple roadmaps have been analysed for the identified requirements, to check if they are already fully or partly recognized with timelines for an expected period of fulfilment. The majority of the further requirements are recognized in one or more roadmaps as challenges or topics. The requirements framed in red do not fulfil both characteristics and are therefore referred to as "new roadmap items". A more detailed explanation is given below:

- **Safety and security of the data;** Security of data is recognized to be a key focus area in the ACEA roadmap aiming to guarantee safe, secure, and trusted communication between the AD vehicle and the infrastructure. Cyber security and software updates are mentioned in this roadmap (2017-2020) leading to EU implementation or reference to UNECE regulations on safety requirements.
- **Collection of user data:** Public desirability is identified as a roadmap stream involving conducting trials on understanding user acceptance, to a transition phase, and to scaling up and realization of benefits. The focus is on research and sharing of information on how

personal data will be used, which can assure personal safety to the users. (ZENZIC roadmap,2020--2030).

- **Access to real-time positioning data**: Development and deployment of virtual road environments for the operational management of CAM vehicles (digital twinning) are envisioned in the ZENZIC roadmap (2022-2030).
- **Data collection and sharing from various sources:** ACEA recognizes data standardization in its roadmap until 2050 to facilitate data collection, sharing, and enrichment. The implementation of data sharing framework including digital data governance and ownership is highlighted in the ZENZIC roadmap (2022-2023). A national operational data hub is envisioned in the VDA roadmap (2026-2028).

The analysis of the stakeholder perspectives and requirements for the Data$^+$ Platform business model and subsequent analysis of the relevant AD roadmaps on the extent to which the stakeholder perspective has been accounted for has led to the identification of three new roadmap items that are important to address for the realization of Data$^+$ Platform business model.

4.3.3 Deployment Strategies: Business model related new roadmap items, challenges, and recommendations

This section concludes new roadmap items, challenges, and recommendations for deployment strategies for the Data$^+$ Platform business model, based on the business model description, analysis, and evaluation above.

4.3.3.1 Suggested roadmap items

Based on the analysis performed above three new roadmap items are suggested for realizing important requirements for the deployment of the Data$^+$ Platform business model.

New roadmap item 1: Ease of accessing and using enriched data

External customers like national and provincial road agencies, service providers, and consultancies that help service providers to design new services seek for enriched data to offer new services to travellers. These services with enriched data can help provide emission-free, safe, inclusive travel, and improve the convenience of travel.

What do the roadmaps say?

The VDA roadmap briefly touches on the creation of a national operational data hub that can house the data for operations of AD vehicles. The ARCADE roadmap identifies in its key priorities to foster the development of new ecosystems, a new type of partnership, new business models in the field of services. However, the explicit link to a data platform offering a marketplace to new customers, who can redesign or enable new business opportunities is not covered.

New roadmap item 2: Necessity to provide reliable service to the customers

Customers have increasingly many service options to choose from. The service providers face tough competition to attract and grow the customers' market share, which allows the collection of valuable data that in turn improves the service offering, thus having a re-enforcing loop.

What do the roadmaps say?

The roadmaps hardly touch on the requirements from the service provider perspective although acknowledging the necessity and presence of the role of service providers as new businesses in the roadmaps of ZENZIC and ARCADE. The reliability of a service offering drives the demand from the customers and helps businesses grow their market share. The reliability of new service offerings is not covered as a requirement in the roadmaps.

New roadmap item 3: Access to updated map and context information data

Real-time updated map and context information data is expected to serve several important purposes such as providing real-time HD maps for higher levels of automated driving, route planning.

What do the roadmaps say?

VDA roadmap mentions the requirement of highly accurate maps to reliably map the environment of a vehicle. Access to real-time updated map and context information can provide a greater potential for data enrichment. Map providers deal with map data on different levels of detail. This level of information can be beneficial not only for automated driving service providers but also for road agencies to understand traffic scenarios at specific locations. Although collaboration aspects are briefly touched upon in the ARCADE roadmap, identifying relevant stakeholders (in this case map data provider) and forming the ecosystem for the orchestration of a data enrichment marketplace are relevant aspects that are not sufficiently thought about or perhaps underestimated.

4.3.3.2 Deployment challenges for OEMs

The key strategic deployment challenge for OEMs is to define their role in this business model. This does not necessarily mean that OEMs have to explore their role as a focal actor, it could also be other (multiple) roles such as real-time car/context data provider, or service provider.

- **Technological challenges**
  New expertise needed: Acquisition and training of new expertise in the field of data. Encouraging and arranging internal organisational interaction between data scientists and technical engineers would be necessary. It is also important to gain experience by trialling your own apps and services.
  Managing data: The volume of data and storage of data for real-time data collection is a huge challenge for data handling, enrichment, and higher cyber security and connectivity costs, keeping track, storing, and being responsible for safe and secure data

management.
Upscaling: There is an inconsistent level of data availability across Europe.

- **Legal challenges**
  Data ownership: It is understood that the Data+ Platform will host all the data, but the ownership structure of the platform, and its data is to be agreed upon with all relevant ecosystem stakeholders.
  Privacy of data and IPR: Different sensors are used from different suppliers. While sharing data from sensors, the characteristics of the sensor containing the IPR could be shared hence making it vulnerable for the suppliers. This has to be carefully tackled together with the suppliers. Agreements on what level of data can be shared for optimum results (like in the case of raw data) have to be made.
  Data privacy and data sharing business: GDPR is active only in the EU. Other parts of the world do not enforce GDPR. While such rules may enable data sharing business opportunities to other parts of the world, sharing such sensitive information might affect the trust of the users towards their data being collected and thereby also the image of the Data+ Platform.

- **Economic Challenges**
  Reaching a *sustainable business model* requires growth in the ecosystem and consistent demand for enriched data. Attracting more demand may require identifying unique data monetization propositions for the Data+ Platform to stand out in a competitive arena.
  Performance risk: There is a need for every ecosystem partner to perform well without mistakes in their tasks including securely storing and sharing data. Since dealing with (sensitive) data involves risks such as data leaks, cyber-attacks and since it also deals with personal data it can be difficult to correct a mistake and rebuild the trust of users.

- **Challenges related to the end-users**
  Data privacy and trust: while the acceptance of data sharing is beginning to slowly but gradually be accepted among end-users, it may take time for all end-users to feel safe and build trust to share their data.
  Personalisation of service offerings: Too much personalisation of service offerings without sufficient societal acceptance can lead to end users reject a platform that collects or derives too much data from them (such as Google or WhatsApp).

4.3.3.3 Recommendations to OEMs' deployment strategies

The potential to monetize data is undoubted and understood as it is already demonstrated by digital tech giants. Entering and competing in a new field is a recognised challenge for OEMs. However, it is clear that the bigger the data ecosystem, the more insights, and business it can create. It is also understood that such propositions cannot wait too long as start-ups in the digital space are already entering the automotive data sphere. Therefore, there is an opportunity for OEMs already in the short-term.

As a response to the challenges discussed above, the following recommendations to deployment strategies came up out of various discussions with experts:

- Identify suitable and viable stakeholder roles for OEM in the Data⁺ Platform business model.
- Explore collaboration possibilities with other OEMs.
- Identify service offerings that can be directly offered by OEMs and can be driven by the enriched data insights.
- Attract and explore cooperation possibilities with service providers who complement the philosophy, vision, and services of the OEMs and can be a viable contributor to the Data⁺ Platform ecosystem.
- Explore viability and suitability of other data-driven business models (such as personalised (priority) mobility service offerings, in-car entertainment) that can connect with the Data⁺ Platform business model to expand the revenue streams
- Ensure governance and make clear agreements over what data to share, how to share, and how to handle the data between the ecosystem partners.
- Build strong cooperation with European authorities and national organisations dealing with data regulations to stay ahead of the curve and have a proactive stance on dealing with and providing input to the adaptation of data regulations.
- Explore possibilities to expand data collection from geographies outside Europe. Explore possibilities to form cooperation and ecosystems on a geographical basis. Be aware of different data standards that may exist outside Europe.
- Embrace and grow the legal and technical expertise over data at various levels within the company.

4.3.3.4 Recommendations to other stakeholders

National road agencies and city authorities

Collaborate with Data⁺ Platform ecosystems: Access to enriched data at different levels - from street level to city level to national level can help build (real-time) behavioural and traffic insights. This can help to create intervention scenarios through digital twinning. Such interventions can be applied in real-time, for instance, reduced speed at motorways or on city level to ensure efficient and safe traffic flows. At a city level, interventions like, enhancing accessibility and use of public space can be monitored and optimised for smooth functioning of a vehicle with higher AD functionalities.

Public transport service providers

Mobility is being considered more and more as end-to-end solutions travel without ownership, without stress where everything is arranged for the end-user, and where ideally no time has to be wasted by waiting. Collaboration with Data⁺ Platforms can help to provide reliable end-to-end mobility solutions for users such as comfortable first and last-mile connectivity, providing alternative travel options in case of disruptions for end users. Further, this can help to identify competitive and complementary services offerings.

Logistics service providers

Collaborate with Data⁺ Platform ecosystems: Road logistics will still use roads and public spaces that need to be managed optimally and in a complementary manner to ensure operations of logistics and personal AD vehicles. The operation of logistics is largely based on optimisation of routes, cost, and time. Having insights on enriched data can potentially provide an advantage in improving planning and forecasting accuracy. Further, there is an opportunity for new business ideas to combine and merge cargo and passenger transport on certain routes for economic and environmental optimisation.

4.4 Mobility as a Service - MaaS

4.4.1 Business model description and analysis

Mobility-as-a-Service provides the traveller with a seamless and on-demand mobility experience. The service combines and coordinates different modes of transport, such as public transport, micro-modality, privately owned cars as well as a shared AD fleet, to meet the traveller's changing needs. It can be focused on regular as well as more incidental travels. It includes Automated Driving vehicles where available and useful (as an entry-level with SAE level 3 functions Traffic Jam Chauffeur, Motorway Chauffeur, and Urban Chauffeur, later with advanced Level 4 functions like Urban and Suburban Pilot, and Highway Pilot) The interpretations of the Mobility-as-a-Service (MaaS) concept typically vary, but in general, it is presented as a service that organises personal mobility needs, involving multiple modalities, often combined with real-time services for a nearby shared car, public transport, and on-demand taxi services, including planning, booking, payment, and prediction of usage rates and arrival times. These propositions include a strong reliance on data, positioning, and planning. The L3Pilot MaaS business model combines all available modalities, including a growing fleet of AVs, as well as privately owned modalities, in real-time to the user's preferences and taking into account the situation at hand. It would be able to take care of long and short trips, regular and incidental, with or without a group or luggage, in good and bad weather. The service could be covered on a per-ride compensation or using subscriptions. The picture below illustrates the pitch poster used to introduce the MaaS service concept including Automated Driving for the first group evaluation at the General Assembly workshop in November 2019. It promises ultimate configurability and flexibility, as well as the inclusion of AD where available.

Figure 4.9: Pitch Poster for MaaS with AD business model for group evaluation (own source).

To co-create this value, different actors – from fleet operators, public transport operators, and shared AD transport service operators, to a MaaS platform provider, to the city and regulatory authorities – need to closely cooperate to ensure a seamless travel experience while balancing the utilisation of the modalities. The picture below displays the L3Pilot Mobility-as-a-Service business model.

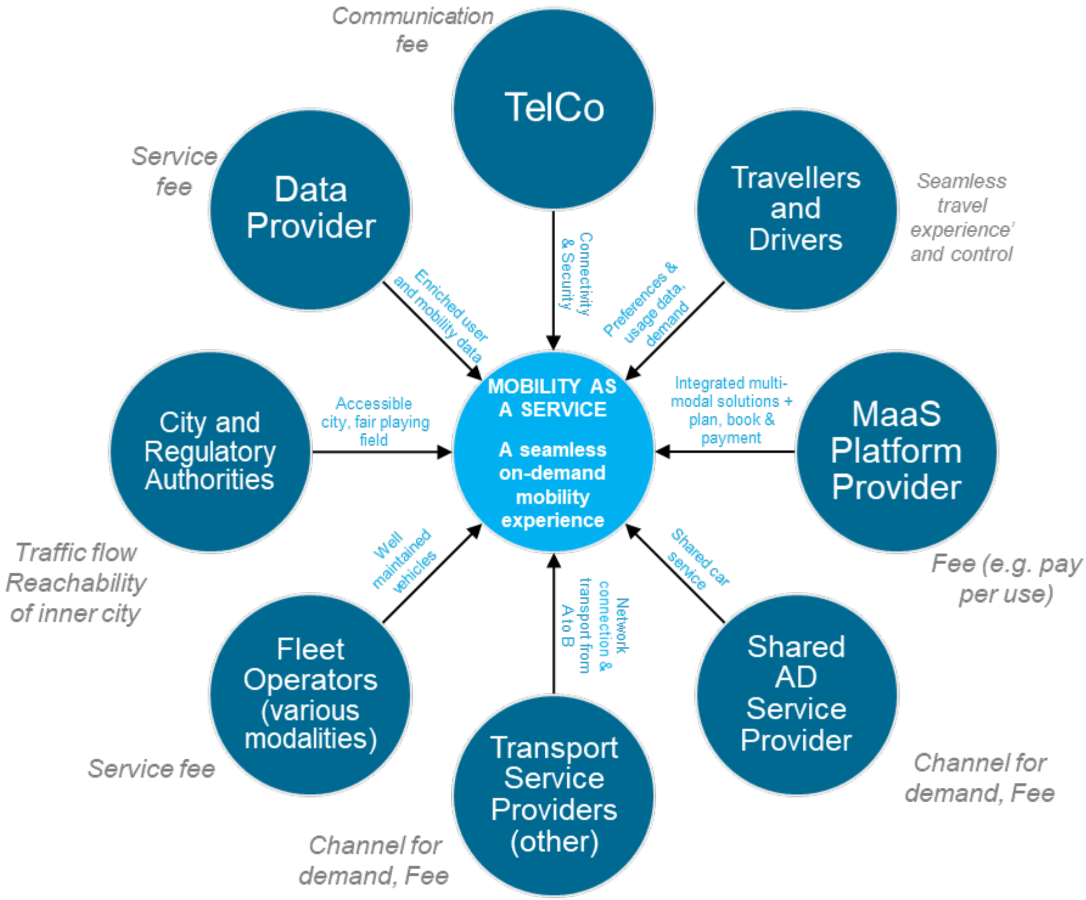

Figure 4.10: L3Pilot MaaS Business Model.

The *traveller* is the end-user who would use the service to get a seamless travel experience and be able to control, or at least real-time monitor, it. Think of urban daily commuters, millennials, business contracts, interregional travellers, disabled, elderly, or holiday travellers. The *MaaS platform provider* is the focal company that integrates the modalities, data, and preferences to make it possible (Think of companies like Moovit, Whim, YourNow, many car-sharing platforms, see e.g. https://www.trustradius.com/mobility-as-a-service). To do so, the MaaS platform provider integrates access to the fleet of a '*shared AD transport service provider*'. This is a managed fleet of AVs that can be booked and used (e.g. Waymo, Hertz, Lev, OEMs' service affiliates, rental car providers, or new entrants providing e.g. pods, car sharing organizations like GreenWheels)[4]. The MaaS service also includes access to other modalities and fleets, including public transport and micro modalities ((e-) bicycles, e-scooters) and regular taxis, under the role of '*various transport service providers*´. All these

[4] A MaaS software system is typically provided by a 'MaaS system provider', as a supplier to the MaaS platform providers in this business model. In the service-dominant business model radar, suppliers are typically not reflected as they do not take part in the primary value creation. This does however not imply that such organizations are unimportant. Clearly, the system settings and limitations will affect the performance of the MaaS service. In this business model we chose to focus on the other actors in the ecosystem that co-create value in this business model.

fleets will have to be operated, including cleaning, maintenance, and relocation. This is done by the *fleet operator*. The *city and regulatory authorities* (here combined, but in practice different actors) are also participating in this business model, by ensuring infrastructure and regulation, such that the different modalities, and thus the MaaS, can be successfully executed in the context of a municipality. Municipalities have strong stakes in their city's liveability, accessibility, and safety. Here, the *data provider* ensures that data of users (demand) and all transport service providers (supply) is being analysed and enriched, such that matches are made and modalities are 'orchestrated' according to the user's preference. Regulatory authority is required for allowing AD, but also potentially, to appoint specific road segments for AD usage, including stop and drive spots.

As modalities are complementary, the business model allows the AD share to gradually increase as its Operational Design Domain (ODD) expands. Answers are given to questions like *What is required for scaling up, e.g. deploying such service in multiple cities and regions? How does the business model relate to existing solutions, like Reach Now, Moovel, Google? How does the business model ensure the desired contributions from cities and regional authorities?*

In summary, the following can be stated on the business model:

- **There is already today a demand for MaaS** based on current travellers' needs, reinforced by increasing ownership restrictions.
- **MaaS already works without AV**, offering car-sharing fleets for individual commutes
- **Travellers will choose a modality mix**, based on preferences and circumstances.
- They like a **seamless experience:** flexibility, reliability, comfort
- That gives **existing service platforms of big tech companies** a strong competitive advantage, OEMs may not be able to catch up, as cars are only one modality in the mix.
- **The business potential** for OEMs has multiple potential streams:
  - **Produce cars to fleet owner**: Traditional linear business model (B2B, like sales to lease companies).
  - Produce and service cars as a fleet owner: Cars will remain in ownership of OEMs.
  - **Produce and service cars as a fleet owner and operate platform**: Cars will remain in ownership of OEMs but are expanded with other modalities.

4.3.4 Business model evaluation

4.3.4.1 Fit to business environment scenarios

In the MaaS business model, as studied here, the MaaS platform provider integrates the services of several modality-as-a-service providers into a seamless offer and execution. This requires in-depth coordination of availability and location of different modalities, served by different modality-service providers, as well as real-time multi-modal planning. The business model thus requires digital capabilities and data-sharing between involved parties. The service will execute (proposed or automated) many micro-decisions, choice of modality, and service-provider routing. AD-as-a-service is part of that modality mix. Because of its high programmability and possibilities for individual support, it can take an increasing and large share-of-modality (~ share-of-wallet).

Below, the fit to the four business environment scenarios, specified in Deliverable D1.5 will be analysed.

Table 4.5: Fit of MaaS business model to business environment scenarios.

No fit	Rather low fit	Rather high fit	High fit
o	+	++	+++
	“Slowly but Surely”	“AD Paradise” “Tantalus”	“TechPush”

The fit of the business model to business scenario “AD-Paradise” is “rather high”. In this scenario, the demand and supply for AD are taking a jump, as AD can cover a large share of the mobility needs, due to its adaptations to individual needs. But it cannot cover all needs. In those cases, the multi-modal service can mix modalities of different providers and include traveller-owned modalities. Individual ownership is however less preferred, which leads to high investment requirements to operate the business models. The competition between ecosystems results in “islands” of cities and regions, so within these cities or regions, the integrated systems are working, but outside there are limitations in interoperability (data) and portability (taking a vehicle to another region). As compared to the “Tech Push” scenario, the added value of the organizing modalities in addition to AD through the MaaS is estimated to be slightly less, since AD would be able to fulfil a substantial set of requirements.

The fit of the business model to the scenario “Tantalus” is also “rather high”, mostly due to high user demand and consequent high willingness to pay for digital content and services. The user demand also allows service providers to gradually introduce AD into the modality mix, by providing “surrogates” (e.g. by covering parts of the travel by chauffeured rides where AD is not available). So, in combination with different modalities, the service can as much as possible cover the travellers’ needs. In this scenario, however, data-sharing and -technologies are not optimal, so mostly feasible only for seasoned tech companies with ‘deep pockets’ (investment power).

The fit of the business model to the scenario “Slowly but surely” is rated as ”low”. The rationale for this is that although the service covers fragmentation, by integrating modalities, there is still limited willingness to pay for such service. Integration itself is still cumbersome, as different ecosystems use different standards and systems, which is typically for data players taking advantage to acquire user data.

The fit of the business model to the scenario “Tech Push” is “high”. In this scenario the business model can be driven by OEMs, being in control of the technology and services development. Beneficial for this strategy is that in the MaaS business model, the share of AD can gradually increase, much like Uber’s announcement to replace drivers with AD. Also, the increased willingness to share modality may increase adoption.

Across the board, the fit of the MaaS business model is relatively robust. This is due to its strong potential to adapt to travellers’ needs by coordinating the modality mix provided. It is also flexible in the share of AD in that modality mix. However, depending on the actual availability and expected use of AD in that mix, the role of OEMs can be more or less prominent and thus more or less risk-bearing.

4.3.4.2 Desirability, feasibility, and viability evaluation

Desirability (Consumer perspective)

In the separate evaluations, the desirability of the MaaS proposition, as presented, is clearly confirmed (see also Figure 4.11). Specifically, the value of automating the gathering of insights into alternative modalities and planning options and taking away complex traveller decisions was touted. A 3rd party could integrate this, but potentially at the expense of the visibility of the transport service providers. It was mentioned that the service should be perceived to be competitive in comfort and cost to owning a car and the pleasure, image, and perceived freedom of driving a car. Focusing on a particular user segment, e.g. business travellers, or urban populations, the proposition was considered more promising. Worries about rural availability were expressed.

Figure 4.11 illustrates the responses for the business model evaluation obtained in the webinar.

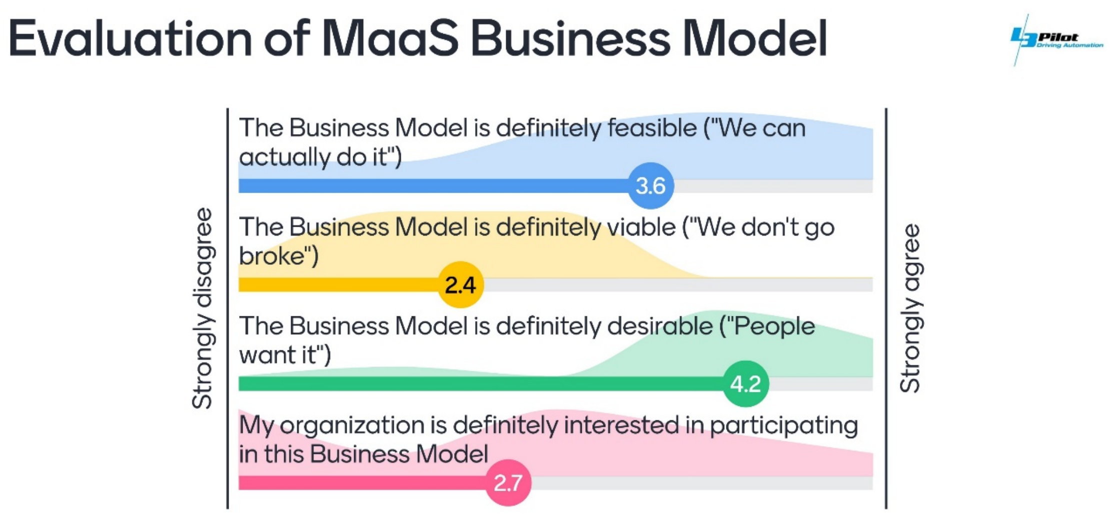

Figure 4.11: Evaluation of the MaaS business model during the webinar (own source, using Mentimeter platform).

Feasibility (Technological and legal perspective)

Also, the feasibility, in general, is not challenged, specifically since we are looking at the future (2030) and potential shortcomings of L4 technology can be complemented by the other modalities. It was noted that there are different MaaS types, with different levels of completeness and integration (Sochor et al., 2018), and that the higher level is currently not feasible. It was claimed by some experts that Google is already providing services overarching multiple modalities and acquiring user data. However, standards and ticketing automation are examples of features that are blocking a full integration. Furthermore, the aggressive strategies of Uber, Waymo, and Tesla, specifically on the AD modality were highlighted. It was reported that there are currently many different user interfaces depending on the provider and region. Therefore, there is a challenge in interoperability and cross-city scaling. It is a business model that requires substantial alignment with many actors, at least at a full-blown scale, e.g. across cities and each modality-service provider has to be negotiated for.

Viability (Business perspective)

The strongest reservations were expressed concerning the viability of the business model. Currently, even car-sharing itself is considered problematic, as issues were reported with regard to availability, utilisation rate as well as cleanliness. Consequently, services for cleaning, maintenance, and relocation have to participate in the model. Companies that do AD vehicle inspections in a ‘drive-thru’ set-up were also reported. Micro modality-shared services (e-scooters, bicycles), often focused on collecting user data, are flooding many urban areas. Furthermore, the experts have also observed the global advancements in integrating mobility services by the YourNow joint venture of Daimler and BMW and similar initiatives. It was also observed that different initiatives cover different cities. As currently, these companies are focusing on urban markets and largely depend on publicly available information, it was questioned whether the MaaS model would also include rural areas. It was perceived unclear to what extent the MaaS would replace or complement public transport and if it could support traffic control. The enormous stake of municipalities in the business model became clear: reachability and openness to traffic management, inclusiveness, safety, and ecological improvements. As this business model is focused on the AD contribution to MaaS, the amount of AD in the modality mix might be controlled by authorities to be able to stay in line with overall policy objectives (e.g. emission reduction). Currently, cities and municipalities are learning and sharing experiences on working with AD.

Additionally, it was emphasized that the pandemic taught us that there is a huge societal value in mobility. To varying degrees, modalities are competing, and experts are worried about the lack of visibility and transparency for allocation of demand to competing transport service providers contributing certain modalities. For a full MaaS model, the OEM has many capabilities, but not all, so collaboration would be necessary.

4.3.4.3 Stakeholder requirement evaluation

In this section, the specific requirements, taking into account the insights from the participative evaluations, of the different stakeholders involved in the MaaS business model are specified.

Table 4.6: Stakeholder requirements for the MaaS business model.

Stakeholder	Requirement	Specification
Traveller	Seamless	The primary value-in-use of the MaaS business model is the seamless travel experience. This implies that not only the process of planning and booking is easy and integrates information from all modalities, but also that the realization of travels, using multiple modalities, and specifically when interrupts occur, will be updated reliably. Furthermore, after the travel, the administration, payments, and support need to be in line.
	Comfort	The traveller must be able to receive mobility offers that meet his or her level of required comfort.
	Price	The value for money for MaaS must be competitive to public transport and privately owned vehicles.
	Flexible and reliable	Travellers require services to be flexible to changing circumstances and preferences and be reliable in the execution from planning to realization to billing.
	Incorporation of privately owned modalities	Travellers want to use their own modalities as part of the travel.
MaaS Platform Provider	Complete offering	The MaaS PP wants to integrate all available modalities as well as planning and payment resources.
	Not having to say no	MaaS PP cannot afford to not be able to service a certain request. This is related to the reliability from traveller's perspective.
	Predict and influence demand:	For the profitability of the business model, the MaaS PP must be able to accurately predict and even influence demand for modalities, such that no unnecessary commitments are made.
	No assets (flexibility):	The MaaS PP should not have assets in order to be in a better position to allocate the best value to the travellers, rather than focusing on utilization of the owned assets.
	Real-time asset control	The MaaS PP must be able at any time to observe available transportation services and be able to book these to manage mobility services.
	High utilization rate	Transport providers require high utilization rates to offer competing prices and stay profitable.

Stakeholder	Requirement	Specification
Shared AD Service Provider	Limited wear	Maintenance, reparation, and replacement are strong cost drivers, so maintenance-free operation is strongly preferred.
Transport Service Provider (other)	High utilization rate	Transport providers require high utilization rates to offer competing prices and stay profitable.
	Limited wear	Maintenance, reparation, and replacement are strong cost drivers, so maintenance-free operation is strongly preferred.
Fleet Operator	Simple operations	Complex maintenance and cleaning operations are labour intensive and drive costs upward.
	Continuous work	Idle personnel is costly. The utilization affects the cost level.
City Regulatory Authority	Reachability	For a municipality's liveability, access to locations (e.g. city center) is essential. It was observed that this problem already plays in many cities.
	Traffic safety and security	Mobility solutions have to be safe for use and also for other stakeholders. It must be secure from any misuse.
	Emissions	Future mobility solutions must be emission-free.
	Influence on traffic flow	The traffic management of a city must be able to control the traffic flow.
	Rural Connection	Mobility services must also connect more distant and hard-to-reach areas.
Data Provider	Access to data	The data provider must have access to data to process it.
	Learn Performance	The data provider must be able to learn about the performance of services in order to support coordination and continuous improvement of the ecosystem.
	Predict demand and availability	The data provider must be able to predict demand and availability to support matchmaking.
TelCo	Subscribers	A telco needs subscriptions as a revenue stream.
	Coverage and capacity	The network must have sufficient coverage and capacity to have mobility services available.
	All modalities must be traced	To allocate the right modalities to the demand, the whereabouts of modalities have to be traced.

The WP1.4 team has assessed the requirements above with respect to the criteria necessity (with the options nice-to-have vs. essential) and realizability (easy vs. difficult) in order to make a selection for further consideration of the requirements and their inclusion in different roadmaps (see the following subsection).

For 6 of the 25 requirements, a rating in the upper right quadrant (Figure 4.12) resulted, which means a rather high necessity and rather difficult realizability was the result of the internal evaluation.

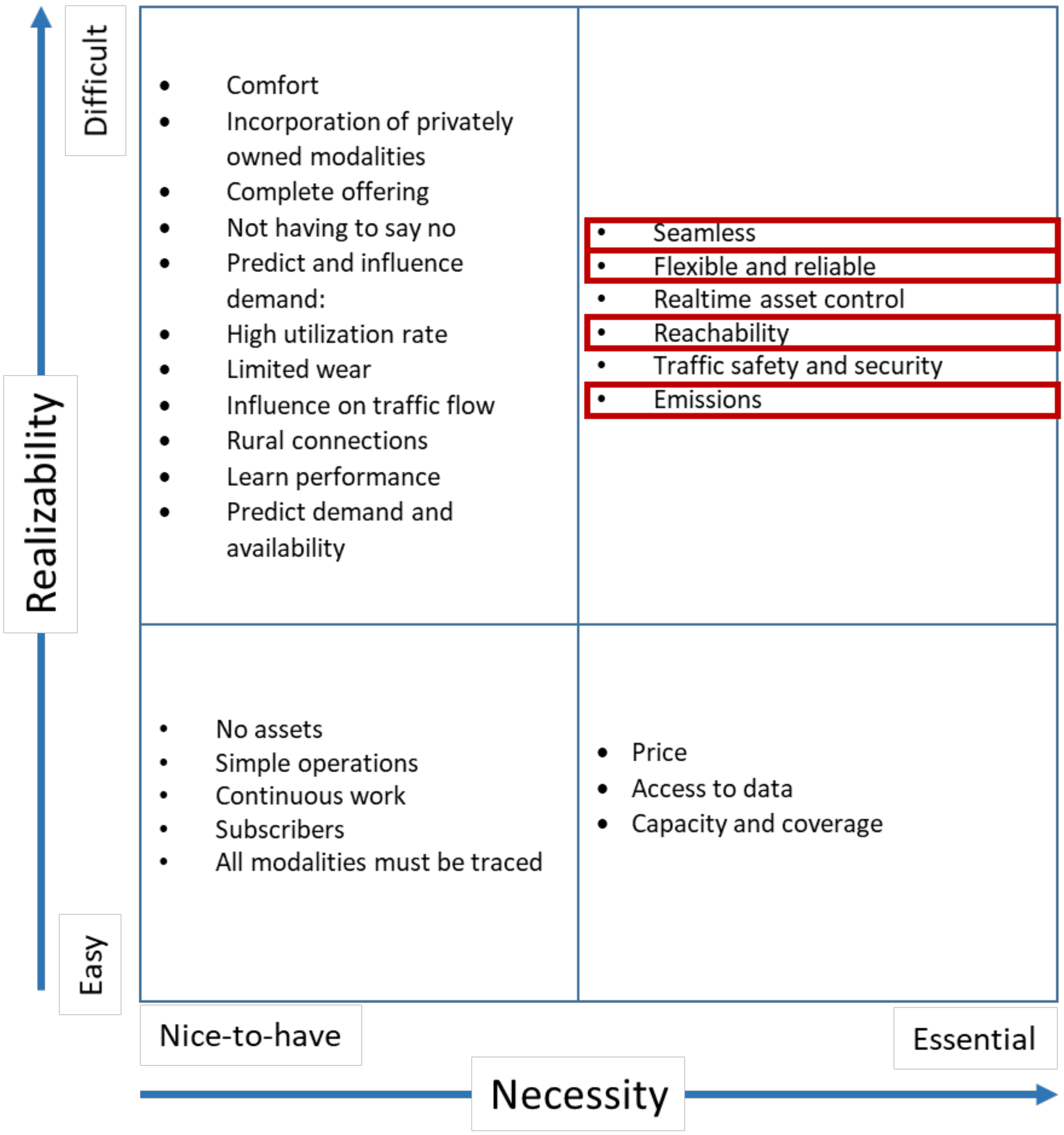

Figure 4.12: Evaluation of the MaaS stakeholder requirements related to necessity and realizability (own source).

4.3.4.4 Roadmap analysis

Analysis of the stakeholder perspectives and requirements for the MaaS business model and subsequent analysis of the relevant AD roadmaps on the extent to which the stakeholder perspective has been accounted for has confirmed most of the essential and easy to moderately difficult to realize requirements. It also has led to the identification of three requirements that are suggested as new roadmap items. These requirements are not or barely covered in the roadmap documents (2.4.3.3 Roadmap analysis) but are important to address for the realization of the MaaS business model.

Traffic safety and security was identified as a critical requirement. Both safety and security concerns have been widely recognized in the roadmap documents, albeit for different system elements. E.g., requirements for the vehicle itself, or the software system. Nevertheless also for the traffic itself these requirements have been clearly recognized and voiced: This is witnessed by "**Recommended Action 01** (VDA): Requirements must be provided concerning infrastructure facilities (road markings, traffic signs, etc.) that are necessary for the introduction and safe and reliable operation of automated driving functions.", or "**GOLDEN THREAD 02** (ZENZIC): Safety - Legislation for clearing road space for automated vehicles (HW17 (Highways related milestone)), Revised highway safety and design standards (HW11), Harmonised vehicle approval scheme established (LR57 (Law and regulation related milestone)), Evidence of safety record begins to show (PA55 (public acceptance related milestone)), Validation process highly automated (SN15 (sensors related milestone))". The ARCADE roadmap even identifies two related **key priorities**: Interaction with external road users (human factors) and safety validation and roadworthiness testing. The ZENZIC roadmap emphasizes its importance in the "**Roadmap vision statement**: By 2030, the UK is benefitting from proven connected and automated mobility, with an increasingly safe and secure road network, improved productivity, and greater access to transport for all. CCAV Priority Safety & Security".

4.3.5 Deployment Strategies: Business model related new roadmap items, challenges, and recommendations

This section concludes new roadmap items, challenges, and recommendations for deployment strategies for the MaaS business model, based on the business model description, analysis, and evaluation above.

4.3.5.1 Suggested roadmap items

Based on the above-performed analysis three new roadmap items are suggested for realizing important requirements for the deployment of the MaaS business model.

Suggested roadmap item 1: Emissions

City Authorities have a strong incentive to get and keep cities liveable. This includes traffic safety, but also substantially decreases the emissions of vehicles. New modalities, such as L4 vehicles, should contribute to this objective. Typically, authorities set out regulations that control which type of vehicles can enter a city (e.g. older diesel vehicles cannot be allowed).

It is generally expected that many new AD vehicles will be electric, and therefore implicitly will contribute to the reduction of emissions. However, this expectation is explicitly confirmed. Still, there are choices to be made that influence the emissions and sustainability impact of AD vehicles. Choices in the construction of AD vehicles (e.g. materials used) as well as in the configuration of their behaviour (e.g. acceleration, traffic flow management).

What do the roadmaps say?

The ARCADE roadmap identifies that ‘Socio-economic assessment and sustainability’ is a key priority. This implies that estimating and measuring the ecological, economical, and sociological effects of automated driving is considered a crucial capability. This is essential to be able to inform decision-makers, including city authorities, on the expected impacts of deploying automated driving. The ERTRAC roadmap states under "5.10. Deployment” that ‘the overall ambition is “to make Europe a world leader for the deployment of connected and automated mobility making a step-change in Europe in reducing road fatalities reducing harmful emissions from transport and reducing congestion”.’

This clearly points to ambition, or rather expectation, in which automated driving is expected to contribute to reduced emissions, yet this ambition seems not to be operationalized in any specific milestone and therefore it must become a milestone.

Suggested roadmap milestone 2: Seamlessness, flexibility and reliability and real-time asset control (clustering)

The primary value-in-use of the MaaS business model is the seamless travel experience. This implies that not only the process of planning and booking is easy and integrates information from all modalities, but also that the realization of travels, using multiple modalities, and specifically when interrupts occur, will be updated reliably. Furthermore, after the travel, the administration, payments, and support need to be in line.

What do the roadmaps say?

The ACEA and ERTRAC/ARCADE roadmaps acknowledge that ‘Integrated mobility will help deliver important societal goals’ and expect smart integration of traditional public transport services. Furthermore, the requirement is expressed ‘to increase the safety of future automated vehicles and their integration in the overall transport system’. The ZENZIC roadmap is more explicit and mentions literally “integrated and seamless journeys”. Their **milestone IM31** is that CAM is integrated into travel demand management by 2030. The PWC roadmap describes some architectural requirements for the underlying platforms and the ACEA document endorses the service interoperability efforts of C-ROADS and states that involvement of public authorities is necessary for border-crossing services. Flexibility appears in the documents only in the context of linking modalities and services to a platform, rather than the interpretation of responsiveness of mobility services to unexpected deviations. Furthermore, real-time insights and controls are barely identified, except for vehicle interfaces needed for dynamic traffic management and law enforcement, and the VDA roadmap recognizes that ‘requirements concerning the operational management of automated vehicles and vehicle fleets […] affects the operation of vehicle fleets for passenger and freight transport including availability management, parking, service, refuelling, access authorization, and fault management.’(p13).

So, in general integration and seamlessness are to some level acknowledged and somehow expected to happen. This is mostly approached from an information systems capability perspective and less so from an ecosystem and user-facing services perspective. This leaves the conditions under which the various transport service providers are willing to cooperate and be governed to share data, costs, risks, and revenues, across different locations, open. Consequently, the realization of truly integrated and seamless mobility systems, in which AD is "part of the equation" is at risk and deserves stronger attention.

Suggested roadmap milestone 3: Reachability

City authorities have a strong incentive to get and keep cities liveable. The reachability of inner-city as well as rural locations is considered important value for that.

What do the roadmaps say?

Several roadmaps mention the need for rural connections and the importance of flowing traffic. The ACEA roadmap expects that 'automated vehicles will increase the availability of passenger transport services while reducing their cost' when professional drivers are being substituted. The ZENZIC roadmap states that "ensuring safety, equality, accessibility and environmental conservation remain at the heart of CAM's future is paramount.", yet little directions in this, or any of the other roadmaps are given on how to implement that, other than that "public authorities should also be involved in early stages of the deployment of these services to ensure the balance between economic interests (e.g. jobs creation, profit of operators) and social needs (e.g. accessibility, public health, etc.)".

So, general societal values are acknowledged in the roadmaps studied, yet concrete contributions to solutions or directions on how to establish such societal values in an increasingly complex mobility mix are not identified. This leaves the city and regulatory authority, as the main holder of these requirements in the MaaS business model somewhat vulnerable. Consequently, adverse effects may arise, putting the mobility mix, including AD, at risk.

4.3.5.2 Deployment Challenges for OEMs

Based on the analysis of the business models, and the responses obtained from general stakeholders and OEM experts specifically, several deployment challenges for OEMs related to the MaaS business model as a driver for automated driving are presented below.

The clearest link of OEMs to the MaaS business model is as 'shared AD Service Provider'. In this role, AD vehicles are 'contributed' as a shared modality in the mobility mix. A logical next role is that of the fleet operator that ensures that the fleet is operational. Many OEMs are already offering similar services through service and leasing subsidiaries. In general, it is expected and observed that OEMs are exploring several related roles under the hypothesis that these are adding to the position and profitability. The role of the main integrator, the MaaS Service Platform Provider, is considered with caution.

Technological Challenges

- *The MaaS business model* requires the management of geolocations at a very granular level, e.g. dealing with bus stops, parking, regulations, etc. spaces, places, digital maps, and continuous communication with the vehicle should be handled.

- The operation of the MaaS service is coordinated by data. This requires reliable data sharing between multiple organizations. This is currently not in place.
- |t is expected that adaptations in the built environment and infrastructure are needed to optimally accommodate AD vehicles, e.g. stop-and-go spots, fewer parking spaces, specific lanes et cetera.

Economic Challenges

The coordination in the modality mix is not only based on data - but it is also a *local* configuration of services, and thus organizations, that is different in every city. Consequently, integration in the metropolitan areas is seen as another challenge for MaaS business models from the perspective of OEMs.

- This characteristic also affects the scalability across cities and regions.
- The MaaS service already sees head-on competition between OEMs and big techs in several cities, that do not have to own the assets (vehicles). Moreover, these companies do not have capital fixed in production equipment.
- The above actually implies a formidable transformation from producer to a profitable and digitally mature service provider. Such identity change, despite the position and efforts of service-providing subsidiaries, is unprecedented.

Challenges related to the customer

One of the key strategic challenges for OEMs in the MaaS business model is the indirect relationship with the traveller. The strong desirability of this service is based on overcoming weaknesses by combining different modalities of transport, in which the AV is only one. It will be very challenging to reflect the OEM's image and value through a broader modality mix

Social challenges

The contributions of AD and MaaS to emission reduction as well as reachability and traffic flow and safety are as yet unclear, although some preliminary evidence from practice (e.g. (Henscher et al., 2021)) and simulation (e.g. (Muller et al., 2021)) is surfacing.

4.3.5.3 Recommendations to OEMs' deployment strategies

Overall, the MaaS business model is seen as very desirable, and it can be enhanced by adding a flexible, growing share of AD to the mobility mix. In order to secure the OEM's position in this system, and as a response to the challenges discussed above, the following deployment recommendations came up out of various discussions with experts.

- **Digital mobility-service interface:** For an AD vehicle to be part of the MaaS, the AD vehicle, and the fleet should be considered to be made "MaaS"-capable, i.e. be digitally accessible for booking and planning.

- **Enhance collaboration capabilities:** As in each city and region, the set of organisations delivering the MaaS and AD plays a part in it, managing the different alliances, consortia, etc. becomes vital in gaining ground in the MaaS market.
- **Data management:** In each city or region where MaaS is implemented, management of geolocations, e.g. bus stops, parking, regulations, spaces, places, digital maps, etc. is vital to the operation of the MaaS. It may be attractive for OEMs to promote the realization of this market precondition.
- **Collaborate horizontally with OEMs:** Given the enhancing value of AD in the mobility mix, OEMs could consider collaborating to define and standardize the AD role in this market. City and regional authorities require a reliable partner that helps them solve mobility challenges.
- **Prove the social and environmental value of MaaS and AD:** Local authorities have a strong role in the MaaS business model, and it must thus also deliver on their stakes of reachability and emission reduction. The potential of MaaS, including AD to realize such societal values is insufficiently clear but can be expected to become important for establishing the MaaS with the AD market and becoming the reliable partner, city and regional authorities are looking for.
- **Continue exploring roles:** The MaaS offers many different positions that are relevant to OEMs. Currently, different OEMs are already exploring different roles and business models and this is expected to be necessary also in the near future.

4.3.5.4 Recommendations to other stakeholders

As the MaaS business model can only be established by cooperation, many of the recommendations expressed above, apply also to other actors. City and regulatory authorities, fleet operators, (other) transport service providers, and shared AD service providers also benefit from enhancing collaboration capabilities, data management, and exploring roles. However, some specific recommendations can be highlighted for specific actors.

City and regulatory authorities

- Collaborate horizontally with other cities and regions: Although the MaaS business model is largely a local configuration, many of the challenges that transport service providers, including shared AD, are facing are in nature general. In order to gain the desired control in the MaaS business model (safety, emission reduction, reachability), horizontal cooperation does not only aggregate ‘bargaining power’, but it also can help in realizing infrastructure better, share experiences, and moreover it can lower entry barriers in an otherwise highly fragmented market.

Transport Service Provider

- Identify complementarity with AD: The modality mix is changing when AD is added. The functionalities and reach (ODD) of AD is increasing over time and may complement or even replace other modalities, e.g. modes of public transport with low demand. To establish a valuable and clear role in the new modality mix, transport service providers are recommended to understand the potential overlap and complementarity of their services in scenarios of AD availability. This could even result in the adoption of or participation in the shared AD service provider role.

MaaS Platform Provider

- Prove the social value of MaaS (and AD): Local authorities have a strong role in the MaaS business model, and it must thus also deliver on their stakes of reachability and emission reduction. The potential of MaaS, including AD to realize such social values is insufficiently clear but can be expected to be important for establishing the MaaS with the AD market. As the overarching integrator of services, the MaaS Platform Provider has the obligation to prove the efficacy of the modality mix in economic and societal dimensions.

4.4 RoboTaxi

4.4.1 Business model description and analysis

RoboTaxi is the provision of taxi services using automated vehicles. The SAE level 4 functions Urban and Suburban Pilot, and Highway Pilot are preconditions for offering RoboTaxis. The concept of RoboTaxis offers, next to the direct users, also possible benefits to society and the environment, such as lower emissions, less congestion, and improved road safety. For potential providers of such a service, the possibility to optimize vehicle allocation, lower personnel costs, and serving new mobility patterns offer attractive business avenues.

Under the assumption that remote monitoring and operation of large numbers of vehicles will not be viable, offering a RoboTaxi service will only be possible through the development of vehicles that do not require the constant attention of a human. Defined by SAE as Level 4-automation, such vehicles would be able to drive without human intervention in a given set of conditions (referred to as the Operational Design Domain (ODD)). To facilitate the discussion on the RoboTaxi business model, the authors followed the assumption that the underlying technology is capable of safely operating in a (geo-fenced) urban environment, under any given road conditions, weather, time of day, and traffic flow.

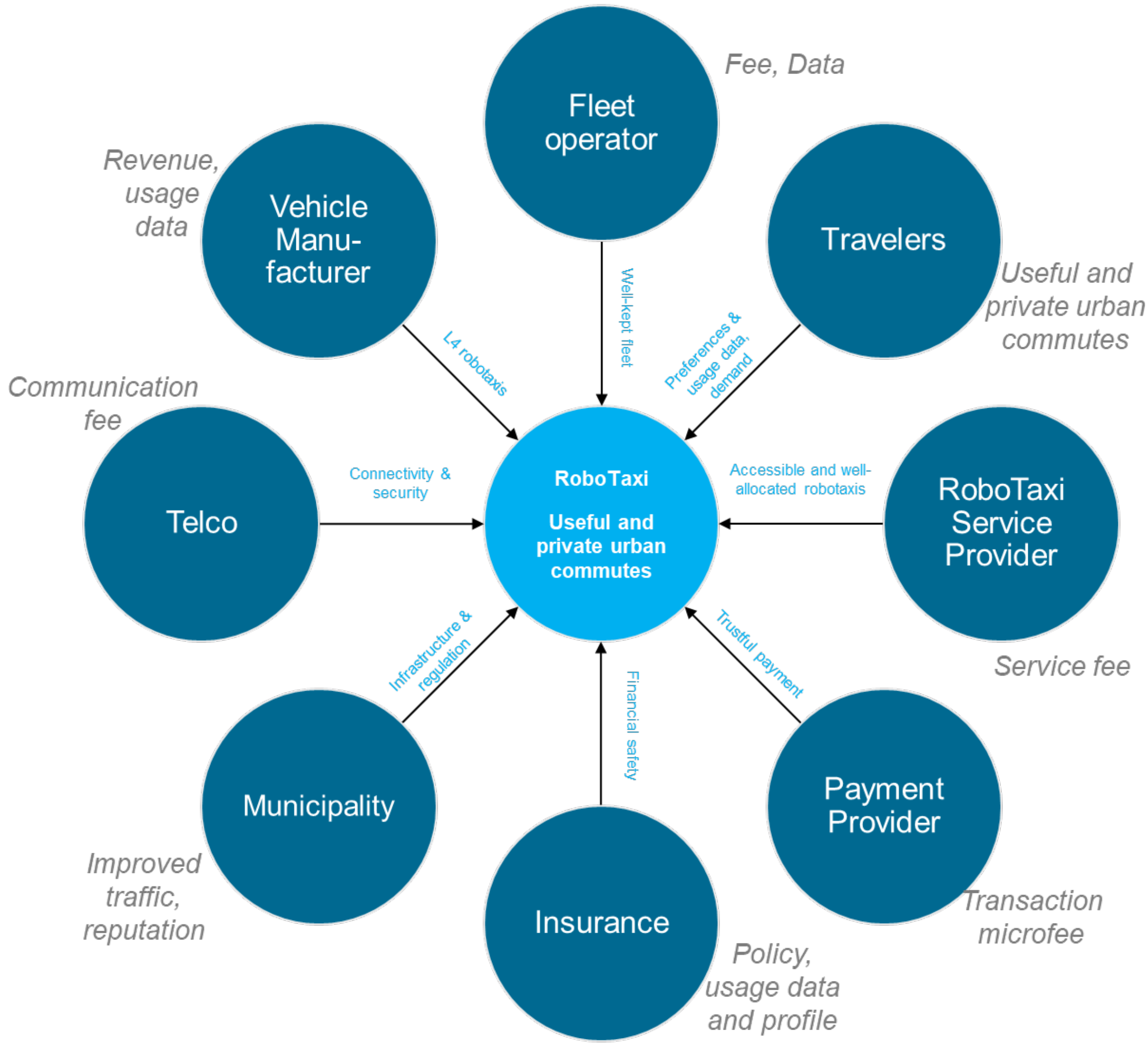

Figure 4.13: L3Pilot RoboTaxi business model (own source).

Following the Service-Dominant Business Model Radar (SDBM/R) approach, the co-created value of this business model offered to the travellers is *useful and private urban commutes*, allowing them to use their travel time productively in a private environment. In turn, the *travellers* provide their preferences and usage data needed to optimize the service. The *RoboTaxi service provider* acts as front-end to the customer collecting trip requests, providing information, and optimizing vehicle allocation to match the demand. A *payment provider* ensures easy and accessible payment processing, offered via the platform of the RoboTaxi provider. To assess and diversify the risks involved for both the traveller and service provider, *insurance* is needed to lower barriers to investment and consumer reluctance. The *municipality* plays a central role in providing the infrastructure and regulation needed. A *telecommunication provider* ensures that the automated driving functions receive information from Cooperative Intelligent Transport Systems (C-ITS) services and that the contributing actors can exchange all information necessary to cooperate. The *vehicle manufacturer* produces the L4 vehicles employed in the service. In the analysis, the availability of dedicated vehicles for the RoboTaxi service is assumed. Lastly, the *fleet operator* makes sure that the vehicles are well maintained, including repair, cleaning, and charging. The fleet operator also supports the allocation of vehicles, where an automated allocation is not feasible.

The willingness to pay for a RoboTaxi service is closely related to possible safety benefits and convenience (McKinsey 2020). Taking into account that the analysed business model is based on SAE L4 technology, it can be expected that consumers place sufficient value on the service. However, the business model will compete with other modes of transport such as traditional taxis in this regard, making competitive pricing a key variable in consumer uptake.

4.4.2 Business model evaluation

4.4.2.1 Fit to business environment scenarios

As mentioned above, both the progress in AD technology and its societal acceptance are key to the success of any AD business model. This is especially true for the RoboTaxi business model, seeing that automated driving is the defining element of the offered service. The business model, therefore, shows a greater dependence on the business environment scenarios, resulting in a direct correlation between the level of societal acceptance and the technological development with the potential of the business model.

The “Slowly but Surely” scenario offers no potential for the business model, as the limited evolution of automated driving technology prohibits a sufficiently large ODD to make such a service viable. More importantly, the low societal acceptance of automated driving is likely to act as a limiting factor on the willingness of regulators to push for favourable legislation and related infrastructure investments. Low demand for AD technology further lowers the potential for the business model and leads to a low saturation of automated vehicles.

In the “Tech Push” scenario, the societal acceptance is equal to the “Slowly but Surely” scenario, leading to similarly low demand and supporting infrastructure.
However, the disruptive development of AD technology allows for a significant expansion of the ODD, therefore raising the feasibility and customer reach of the business model.

In contrast, the “Tantalus” scenario foresees an evolutionary technological development, with a limited ODD and feasibility.
Although this limited ODD might lower the attractiveness of the offering to the user, the significant increase in societal acceptance and generally high demand for AD technology in this scenario counteracts this effect, thus improving the viability of the business model. The high societal acceptance furthermore pushes regulators to push for favourable legislation for AD.

The “AD-Paradise” unites both significantly raised societal acceptance and disruptive development of the technology. This is expected to result in a high fit of the business model to the scenario, based on a large ODD and good availability of supporting infrastructure, as well as high demand, leading to favourable legislation and saturation.

Table 4.7: Fit of RoboTaxi business model to business environment scenarios.

No fit	Rather low fit	Rather high fit	High fit
o	+	++	+++
"Slowly but Surely"	"TechPush"	"Tantalus"	"AD Paradise"

4.4.2.2 Desirability, feasibility, and viability evaluation

Desirability (Consumer perspective)

The interviewed experts rated the RoboTaxi business model as highly desirable. As the RoboTaxi business model represents a new mode of transport, all discussions related this business model's advantages and disadvantages to existing modes of transport. The main points of comparison can be summarised as the overall impact of robotaxis on urban mobility, and the advantages and disadvantages to the consumer.

Impact of the RoboTaxi business model on urban mobility:

The experts anticipated three major impacts on mobility stemming from the large-scale deployment of the RoboTaxi business model:

- **Improved traffic flow:** Connectivity and coordinated route planning allow for improvements of the overall traffic flow in cities.
- **Improved road safety:** The safety features of the deployed automated vehicles, as well as integration with C-ITS, has the potential to improve overall road safety in urban areas.
- **Improved environmental footprint:** Coordinated route-planning, as well as optimised allocation of the RoboTaxis, could improve overall vehicular emissions in cities. Multiple experts were critical of this assumption, stressing that RoboTaxis will be competing with environmentally friendly modes of transport, such as public transport and cycling.

Advantages and disadvantages to the consumer:

The advantages offered to the consumer were discussed in the light of the modes of transport competing with the RoboTaxi offering, such as public transport and traditional taxis. Consequently, the comfort and privacy while riding in a robotaxi are expected to be higher than traveling by public transport. Although traditional taxis offer a similar level of privacy, the comfort level will depend on the driving of the taxi driver, while robotaxis are expected to drive more reliably, thus offering more comfort.

As mentioned below, the pricing of the service will be a decisive factor in its success. Considering recent pricing estimates (Steitz 2021), the service could be offered at around 7€

per hour, which would place it slightly above public transport and well below the price of travelling by a traditional taxi. This estimate correlates with the expert assessment during the conducted workshop, where participants foresaw a competitive advantage in comparison to traditional taxis, with clear difficulties to compete with the pricing of public transport. The pricing would thus need to be accompanied by strong additional advantages, such as the privacy stated above.

Besides the potential higher costs for the consumer, the experts highlighted the limited area of operation of the service as a clear disadvantage. Depending on multiple factors such as the technical advancements, the legal environment, road infrastructure, and support by local authorities, the ODD of the vehicles will define, among other variables, the radius of operation of the service. Experts stressed that this radius would need to be sufficiently large to allow door-to-door transportation for users, in order to compete successfully. In addition, experts underlined the need for a seamless travel experience in the robotaxi, which will require a well-working integration into existing MaaS offerings, thus adding to the need for successful cooperation with other stakeholders.

Lastly, the experts highlighted potential user concerns over legal issues, such as liability in case of an accident, and data privacy.

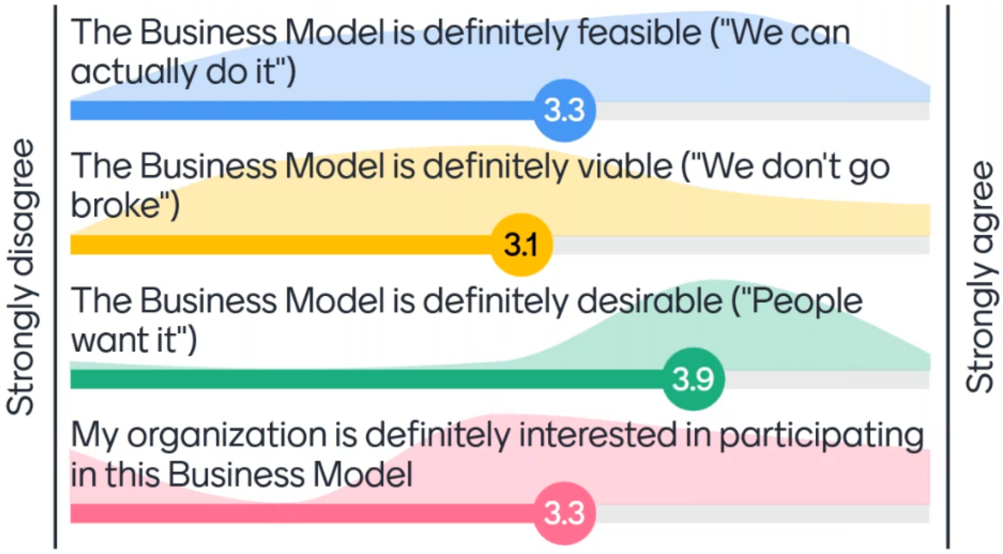

Figure 4.14: Evaluation of the RoboTaxi business model during the webinar (own source).

Feasibility (Technological and legal perspective)

While the experts acknowledged that the testing of the underlying technology is well-progressed, a majority saw clear challenges in its realization. The year 2030, the target year for our analysis, was seen as a very ambitious goal for the deployment of L4 vehicles with a sufficiently large ODD to offer the above-mentioned seamless service.

Another limiting factor will be the need to adapt existing infrastructure to the needs of AVs and to provide regulation ensuring legal certainty.

Viability (Business perspective)

Similar to the feasibility of the service, participants rated the viability cautiously optimistic. The manufacturing costs, as well as the operating costs of the service of L4-vehicles provided, will need to be sufficiently low to allow for competitive pricing compared to public transport. In addition, scalability is key, requiring not only a sufficiently large ODD allowing the service to reach a critical mass of travellers but also a seamless integration into existing modes, to capitalize on market gaps.

4.4.2.3 Stakeholder requirement evaluation

The specific requirements of each stakeholder for the successful contribution to the business model are listed in the table below.

Table 4.8: Stakeholder requirements for RoboTaxi business model.

Stakeholder	Requirement	Specification
Traveller	Usability	The service should be easy to use for a broad range of user types.
	Reliability	The service needs to be reliable for all user types.
	Affordability	The service needs to be affordable in comparison with competing modes of transport.
RoboTaxi Service Provider	Sufficient demand	Sufficient demand is necessary for the viability of the service.
	Political support	Political support is needed to provide a suitable environment (e.g. road real estate).
	Regulation (e.g. liability)	Fitting regulation is needed to mitigate the risks and uncertainties for all parties involved.
	Usage data	Usage data is needed to improve the service.
Payment Provider	Regulation & licensing	Any payment provider needs an appropriate legal framework and a license to operate in all countries of the service.
	Integration w/ other services (e.g. banks)	To implement transactions, integration with other services is needed.
	Interoperability (scaling-up)	The payment service needs to function in all target countries of the service.
	Telco tech	Reliable communications infrastructure is necessary to implement the transactions.

Stakeholder	Requirement	Specification
Insurance	Information to calculate risks	Sufficient information from the relevant participants and operating environment provides the basis for the calculation of risks.
	Reinsurance	Reinsurance lowers the risk for the insurance provider.
	Regulation	A clear and reliable regulatory framework is needed to appropriately calculate risks and to operate the policy.
Municipality	Regulation (national & EU)	National and international regulation provides a framework for municipal regulation.
	Integration (MaaS)	Integration in existing MaaS offerings needs to be ensured to provide added value for urban mobility.
	Infrastructure & funding	Infrastructure needs and appropriate funding need to be balanced.
Telco	Infrastructure / CapEx	Capital expenditure is needed for both, maintenance of existing infrastructure and acquisition of new infrastructure needed for C-ITS.
	Regulation (5G / G5)	Clear, coordinated regulation for C-ITS communication technology is needed to lower the investment risk and ensure supra-regional scalability.
	Compatible vehicle tech	The employed vehicle technology needs to be capable of using the offered C-ITS infrastructure.
	Data for optimisation & profit	Data is needed to improve the service and, possibly, to be monetised.
Vehicle Manufacturer	Infrastructure	The vehicles will depend on supporting infrastructure, such as C-ITS, or charging facilities.
	Regulation	Appropriate regulation is necessary to operate the robotaxis on public roads and mitigate potential legal issues, such as liability and data ownership.
	Cybersecurity	Sufficient cybersecurity is indispensable for the reliable operation of vehicles.
Fleet operator	Charging infra & strategies	Appropriate charging infrastructure and optimised charging strategies are needed to provide a feasible and financially viable service.
	Integration w/ supporting services	Supporting services such as licensing support, insurance, and accident management are crucial for the fleet operator.

Stakeholder	Requirement	Specification
	Regulation (plannability)	Clear and reliable regulation is needed for planning (e.g. licensing, safety requirements).
	Technology for fleet optimisation	Technology to collect and exploit usage data is needed for fleet optimisation.

As with the above business models, WP1.4 rated the identified requirements for each stakeholder by necessity and realizability. The requirements deemed essential and difficult to achieve should be treated as priorities to achieve the needed environment for the RoboTaxi business model.

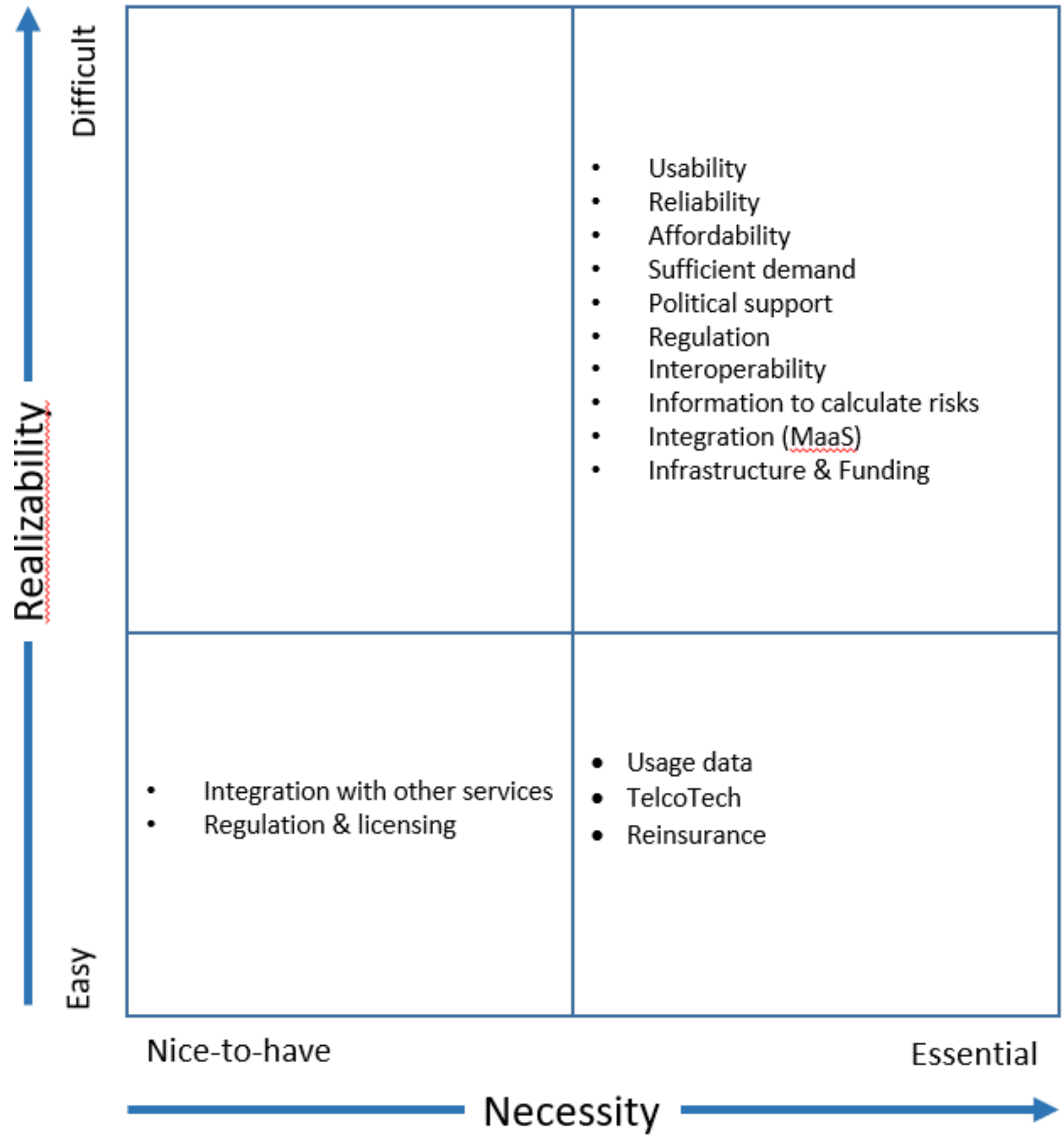

Figure 4.15: Evaluation of RoboTaxi stakeholder requirements related to necessity and realizability (own source).

4.4.2.4 Roadmap analysis

After the identification and rating of the stakeholder requirements listed in the above table, relevant roadmaps (ERTRAC, ARCADE & ACEA roadmap) were analysed to understand how these roadmaps account for those issues. A challenge in this analysis was the differing perspective between the present deliverable and those roadmaps: while the WP1.4 team undertook deep dives into each of the business models and pertaining stakeholders, existing roadmaps take a high-level perspective, which cannot cover the requirements for each stakeholder in such detail. In addition, some of the analysed requirements take stakeholder perspectives that are not typically covered in the present CCAM roadmaps, such as insurance and payment providers.

The most commonly covered challenge in high-level roadmaps is regulation. In the analysed roadmaps, the need for adaptation of EU regulation is highlighted for multiple areas, including, among others, vehicle regulations (including type approval), traffic regulations, regulation of physical-digital infrastructure, and regulation of connected and automated driving in general.

The roadmaps furthermore stress the need for regulatory harmonisation, a crucial requirement for the scalability of the business model.

The authors of the present deliverable assume that *connected* includes regulation of data protection and the telecommunications needed for the RoboTaxi service. While multiple requirements such as *information to calculate risk* for insurance providers, *data for optimisation & profit* for telco providers, or the *usage data* for providers of robotaxi services are not explicitly mentioned, it appears reasonable to conclude that existing roadmaps expect such requirements to be covered by provisions on *connected* driving and data protection. However, the application of the analysed roadmaps to the RoboTaxi business model highlights two critical points:

Firstly, the **significant inter-dependencies between a wide-ranging network of stakeholders need a comprehensive approach to regulation that overcomes sectorial blinkers** to achieve the successful deployment of AD-based business models.

And secondly, **juxtaposing high-level roadmaps with concrete business models can be a valuable exercise in identifying priorities for future deployment enablers**, that should be repeated regularly.

4.4.3 Deployment strategies: Business model related new roadmap items, challenges, and recommendations

4.4.3.1 Deployment challenges for OEMs

The key strategic deployment challenges for OEMs will be to identify which roles in the business model will be viable and to tackle the numerous remaining technical challenges in developing vehicles fit for such a service. These include the ability to operate in a complex urban environment involving mixed traffic, choosing the key technologies to employ, such as 5G and G5, and ensuring cybersecurity.

Technological Challenges

AD Technologies: The RoboTaxi business model analysed in L3Pilot not only requires SAE Level 4 vehicle technology, but a sufficiently large Operational Design Domain (ODD) to offer an attractive service. The ODD includes many variables, such as time of day, road conditions, traffic flow, and weather. As the underlying analysis supposes a roll-out from 2030, this poses a significant challenge. An insufficient ODD risks fragmentation of the serviceable area, as well as consumer trust and comfort, stemming from frequent interruptions of the service. Supporting infrastructure, as well as key supporting technologies such as artificial intelligence and satellite positioning will play a crucial role in mitigating these risks.

Legal Challenges

Data ownership: The ownership of the data produced by the vehicle is a heavily debated topic at the EU level[5]. As vehicle data play a crucial role in the co-created RoboTaxi service, European legislation on this topic plays a crucial role in its success.

Access to data: Third parties offering RoboTaxi services need low-cost access to vehicle data to optimise the service and provide cost-efficient upkeep of the fleet.

Economic Challenges

Pricing: To reach sufficient uptake, a RoboTaxi service will need to offer competitive pricing compared to other modes of transport. This challenge is aggravated by the high production costs of automated vehicles. Dedicated vehicles produced for the service and sold B2B might help mitigate this problem.

Challenges related to the customer

Consumer trust: Being novel technology, consumer trust will be central to wide-scale deployment. This requires clear information, reliability, and service quality.

Data privacy: The provision of the service will require the use of consumer data. This raises concerns about data ownership and data privacy. The challenge will be to make use of this data where necessary while ensuring data ownership for the user.

Liability: As passengers of RoboTaxi vehicles, concerns over liability for the consumers will emerge. A clear liability regime is needed to mitigate these concerns.

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[5] See, for example, https://www.acea.auto/files/ACEA_Position_Paper_Access_to_vehicle_data_for_third-party_services.pdf and https://www.beuc.eu/publications/beuc-x-2021-062_beuc_and_fia_joint_letter_on_urgent_need_for_a_legislative_proposal_on_access_to_in-vehicle_data_and_functions.pdf

4.4.3.2 Recommendations to OEMs' deployment strategies

The majority of OEMs in L3Pilot have plans for a future robotaxi service. While these plans differ in their goals and ambitions, it is clear that RoboTaxi business models are seen as a profitable endeavour.

Based on the multi-stakeholder perspective used in the present analysis, a set of deployment recommendations can be given to tackle the abovementioned challenges:

- Take a comprehensive perspective in the business model assessment, anticipating other stakeholders' requirements.
- Take into account the interests of municipal transport policy.
- Identify viable roles in the RoboTaxi business models, including those that are not part of traditional OEM business models.
- Resist overpromising to the consumer in the light of competition and clearly communicate functionalities in order to strengthen consumer trust.
- Ensure reliable and affordable data access for all stakeholders to allow for innovation through a low threshold for market entry.

4.4.3.3 Recommendations to other stakeholders

RoboTaxi Provider

- **Tailor the offering to the needs of individual cities.** Municipalities play a crucial role in facilitating the RoboTaxi business model. That being said, robotaxis will have to compete with the other modes of transport for the support of the municipalities (e.g. road real estate, regulation, C-ITS infrastructure). Here, the fit to the political priorities of the individual municipality will be key, including issues such as emission reduction, urban planning, and inclusive mobility.

Municipality

- **Research citizens' needs and preferences.** Further research on user needs on a regional level will ensure that the RoboTaxi service improves inclusive mobility depending on the specific situation per municipality. Research of user preferences will give insights into the change of mobility behaviour upon introduction of a RoboTaxi service, thus helping to avoid perverse incentives (the "cobra effect"), leading to unintended changes of mobility patterns.

Fleet Operators

- **Think about scaling up from the start.** The pre-conditions for the management of the RoboTaxi fleet will differ greatly between cities, regions, and countries. To reduce scale-up costs, differences in critical factors such as charging infrastructure, regulation, access to maintenance facilities, and demand should be considered from the start. Scenario testing and simulation should be employed to support the analysis.

4.5 Recommendations in a comparative perspective

In the following, a comparative and aggregated overview of recommendations for deployment strategies is given.
As L3Pilot has strong participation of OEMs this research report focuses on the derivation of AD-related business models on deployment recommendations to OEMs. In addition, some major recommendations to further stakeholders are also highlighted.

Highlighted cross-business model recommendations to OEMs' deployment strategies

- **Role of OEMs**
  Playing a crucial role as car manufacturers in all business models, relevant roles beyond that have been discussed intensively by the experts. For *In-Car-Services* and *Data⁺ Platform* experts recommend collaborating with big tech players and their existing large ecosystems as a data and service provider, but not to take over the platform provider role themselves. For *RoboTaxis* and *MaaS*, experts rather recommend the role of RoboTaxi Service Provider or Shared AD Service Provider (MaaS) to stay in direct contact with the customer.
- **Data**
  Skills with regard to cybersecurity, data privacy, data analysis, and data monetization are crucial for all business models. OEMs are recommended to build up strong competencies in this field and to demonstrate them to build trust with customers.
- **Level 3 / Level 4 readiness**
  All business models require AD readiness, RoboTaxis on SAE level 4, the others at least on level 3. That requires not only advanced vehicle technology but also appropriate legal and infrastructure standards. Experts recommend fostering related cross stakeholder activities and initiatives.

Highlighted business model specific recommendations to OEMs' deployment strategies

- For **In-Car Services,** experts propose to OEMs to develop new interior concepts with attractive devices for an inspiring In-Car Service experience as well as the creation of their own viable services based on the accessible data about the customers and from the vehicle sensors.
- For the **Data⁺ Platform**, the creation of own data-based viable services not only to vehicle users but also to third parties (public authorities, private companies) has been recommended.
- For **MaaS** and **RoboTaxi**, the enhancement of cooperation capabilities with other stakeholders plays an important role, especially the cooperation with municipalities to support them in reaching their sustainability and transport policy goals.

Highlighted recommendations to other stakeholders

- **Municipalities** are expected to prepare concepts and regulations for integrating AD-related services **(RoboTaxi, MaaS)** in their transportation system to increase the overall societal (customer-related transportation system quality) and ecological benefit (congestion, emissions, needed space). Horizontal cooperation of municipalities can enhance the scalability and hence the viability of these business models.
- **Transport Service Provider and MaaS Platform Provider** have to develop a clear understanding of how automated services **(RoboTaxi, MaaS)** will influence the transportation system. They have to recalibrate the roles of the different means of transport to optimise the benefit under the conditions set by the local authorities.
- **National road agencies and city authorities** should consider cooperating with **Data⁺ Platform** ecosystems to detect and exploit the benefits of comprehensive data availability, from real-time traffic and road status data to long-term analyses.

4.6 Fit to scenarios in a comparative perspective

Based on the evaluations of the fit to business scenarios for each business model, the following overview can be shown.

Table 4.9: Fit of the different business models to the business environment scenarios.

	In-Car Services	Data+ Platform	MaaS	RoboTaxi
AD Paradise	+++	+++	++	+++
Tantalus	++	++	++	++
Slowly but Surely	+	o	+	o
TechPush	++	+	+++	+

(+++ High fit; ++ Rather high fit; + Low fit; o No fit) (own source)

It is obvious that the scenario “AD Paradise” offers outstanding conditions for the four business models, followed by the scenarios “Tantalus” and “TechPush”. The scenario “Slowly but surely” would be the most critical business environment for AD-related business models. This result confirms the approach followed in the previous project report D1.5, that “AD Paradise” was seen as the most desired scenario. Comprehensive recommendations to shape the future in the way that the occurrence of “AD Paradise” will become more likely are derived and discussed in D1.5.

Looking at the robustness of the business models concerning the different scenarios, In-Car Services and Maas are showing advantages because they are not completely dependent on

AD. In-Car Services do already work with passengers as customers and MaaS runs currently with non-automated sharing vehicles, too. In the “Slowly but Surely” scenario the “Data$^+$ Platform” and “RoboTaxis” show no fit because of missing customer trust in data privacy and missing technological readiness.

As a consequence of the strong effect of the future scenarios on the desirability, feasibility, and viability of the different business models, two key directives have to be highlighted:

- *Shaping the future*: Stakeholders should cooperate strongly to create the most desired future.
- *Observing the future*: Beyond trying to shape it, stakeholders should observe the future development to early understand and anticipate, to which scenario the future goes and which consequences this will have for future business models.

5 Conclusions, business impact, and outlook

5.1 Conclusions

The final chapter provides the aggregated conclusions of the development, analysis, and evaluation of the different business models and gauges the value these business models add to the dissemination of automated driving. This is followed by an assessment of the impact, this report has related to the different impact categories of the overall L3Pilot project (knowledge impact, societal impact, and business impact). Finally, an outlook is given with respect to the further and more detailed analyses related to the business models that will be carried out in the follow-up project Hi-Drive.

In this deliverable four selected and coherent AD-related service-dominant business models have been evaluated, described as In-Car Services, Data$^+$ Platform, Mobility-as-a-Service, and RoboTaxi, to understand the viability of the business models that drive the demand for new service-, and data-driven mobility solutions, to understand the collaborations these require from the different actors across the AD ecosystems, and to identify key challenges for OEMs' deployment strategies.

The methodology builds forward on desk research on academic, project, and popular literature to identification and selection of the prominent business models. Next, these business models were detailed using a specific service-dominant logic-based method for collaborative business models. In the second stage, the business models were iteratively evaluated and improved based on the criteria desirability, feasibility, and viability, consulting different groups of experts and stakeholders. In parallel, the WP1.4 team specified and prioritized the requirements for each of the actors participating in the business models and checked to what extent these requirements are already addressed in prominent roadmaps.

Considering the findings presented in the previous chapter, in all business models the AV plays an important, but differing role. Consequently, the business models provide clear but differing opportunities for OEMs to create and capture value. In the In-Car Services business model, the AV is the prerequisite providing the traveler with free time that can be valuably used by consuming services in that same AV. In the Data$^+$ Platform business model, the AVs are both a source (in between many others) and an endpoint of data-driven services. In the MaaS business model, the AV is a complementing and potentially growing modality in a wider mix. Finally, in the RoboTaxi business model, a fleet of AD vehicles forms the main asset, the key 'carrier' of value. If these business models are taking off, they increase the use of and demand for AD and vice versa.

These business models emphasize servitization (a combination of product offer and related services), instead of a focus on product sales. In-car Services provide ways to valuably use the time spent in an AV. The Data$^+$ Platform serves access to data to empower data-driven services. MaaS serves mobility, using different modalities. And a RoboTaxi serves trips. This is confirming the trend of servitisation and underlying digitalisation and datafication. Another implication is that these business models require data sharing and consequently data platforms and service platforms that support the orchestrating of servicing multiple partners in the ecosystem.

Servitisation and digitisation are powerful and demanding transitions. They change the way how value is created and captured. It breaks with the conventional transaction and ownership-based paradigm with which the traditional automotive supply hierarchies have been functioning and optimized for many decades. Sensors and actuators, traditional 1st tier components interact with the driver, the car, and the environment, while generating and consuming tons of data. Ownership of assets, like vehicles, is not transferred (the traditional role of the franchising dealers), but access to use the assets is provided as-a-service.

The need for collaborations with many different organizations in different constellations, the focus on services rather than ownership, the role of data, and platformisation, all point to a transition in the automotive industry. So far it was a product-oriented ecosystem and OEMs have developed excellence in being the successful physical integrator of hundreds of suppliers. The change to a service-dominated ecosystem needs new capabilities to organize and a new understanding of their former focal role, shifting from a controlling physical integrator in the pre-usage phase to a peer partner in the usage phase. OEMs are currently not in the leading position to manage these ecosystems and they still need to find their role in future mobility ecosystems. Such transitions cannot be achieved overnight and come with great unclarity and uncertainty. Exploring different business models from a multi-stakeholder perspective is a way of dealing with this future.

In the design and evaluation of these business models, the strong need for different collaborations among different actors, which can be realized in different configurations, is strongly emphasized. In practice, we already see big tech companies as well as scale-ups working with OEMs and vice versa, and we see different service provisions in different cities and regions. Many of the key challenges for the deployment strategies of OEMs are closely related to dependencies between actors and collaboration within local, national, and international ecosystems:

The In-Car Services business model is merely a “platform” and context in which services provided by third parties are delivered and consumed in the AV. Although various delivery services are currently already being provided in other contexts, this, again, points to the OEM’s challenge to offer third-party access to the vehicles as a ‘platform’ where services are delivered and consumed. The OEM has a unique position to design features and interfaces that attract such services. This can be in collaboration with companies like Amazon or Apple that could as well be the overall platform provider for In-Car Services or Uber who could be the RoboTaxi company.

The Data$^+$ Platform illustrates the need for secure data sharing and enrichment, e.g. in collaboration with road authorities, creating the necessary basis for data-driven services. This is prominent in all business models and in fact, secure data sharing can be seen as a necessary and collective provision. It does not necessarily have to depend on one organization, but it can be implemented in a distributed and federating manner. This is e.g. recently demonstrated in the Mobility Data Space (Pretzsch et al, 2020).

In the MaaS business model, the AV complements or competes with other modalities. The MaaS provider, if not the OEM, is controlling the customer's interface and thus the customer relationship, potentially diminishing the visibility of the OEM. Moreover, the MaaS business model requires intensive local configurations, dealing with city-specific conditions. This potentially hampers the scaling up of this business model. Yet uniting the interests of cities, focusing on societal value creation, and those of OEMs might create the organizational leverage needed to create scale and societal value combining a more prominent role for OEMs. These are the strongest recommendations that follow from the evaluation of this business model.

Finally, in the RoboTaxi business model, it was identified that the deployment of a suitable connectivity infrastructure is beyond the control of OEMs. Cooperation of cities and OEMs on a large scale might however create mutual benefits to break that catch 22.

The consumers' willingness to pay for the different business models will depend on the type of values offered. For hardware-oriented offers like an attractive and functional interior with specific devices (In-Car Services) consumers are expected to be willing to pay as they already do it today for ADAS systems. For pure platform services, especially for platforms consumers already are using outside cars like music streaming or navigation services (In-Car Services Platform, MaaS platform), no willingness to pay is expected. Services, which offer a real benefit like increased comfort or time-saving (In-Car Services, RoboTaxi, MaaS) are expected to see consumers' willingness to pay. As a B2B offer, the Data^{+} Platform is only indirectly connected to consumers. Their willingness to pay will depend on the value created with the data acquired by the B2B customers.

The current dominant co-created roadmaps take a more high-level perspective on predominantly technical and regulatory aspects, while the WP1.4 team undertook deep dives into each of the business models and pertaining stakeholders. This approach has uncovered some requirements that may be overlooked from the higher-level perspective. This does, however, not disqualify these, if business models of some kind cannot be realized, then creating value using AD technologies will be challenging.

The additional requirements, identified by this business model analysis emphasize the interoperability, or integrability, of the AD in a wider context, be it In-Car Services, MaaS, or RoboTaxi. All implying a stronger collaboration and data sharing between OEMs and other ecosystem members including cities and regulators, which could be facilitated by Data+ business models.

Thus, based on the analysis of these four coherent business models, AD has a strong promise to create additional values in the mobility system, yet it depends on the collaborative, servitised, and digitalised transition the automotive sector is going through.

5.2 Business impact of business model analysis

Three major impact areas have been defined for L3Pilot: knowledge impact, societal impact, and business impact. *Knowledge impact* is based on enhanced methodological and technical knowledge generated by the project partners. Especially, detailed knowledge of user behaviour, acceptance, and vehicle interactions will help to create realistic and user-centric deployment plans. The s*ocietal impact* of the project results refers to the L3Pilot contributions to reach the major societal objectives of automated driving in the long run, i.e. increase of road safety and traffic efficiency by reducing accident rates and CO_2 emissions. The *business impact* is particularly addressed by work package *1.4 Exploitation and Innovation*. With Deliverable *D1.5 – the business environment scenarios for AD* – a detailed and structured knowledge base concerning possible future developments for AD-related business and recommendations for decision-makers from industry, politics, and academia have been provided to shape the desired future and jointly design innovative and sustainable future mobility systems. The business models and deployment perspectives analysed and developed in Deliverable D1.6 enhance this knowledge base. The collaborative business model approach applied in L3Pilot captures a multi-stakeholder perspective for the AD-related business models and shows the different actors involved and their partly diverging interests. The challenges that may result from the specific actor constellations with regard to the implementation have been detailed for every business model and recommendations for action for the various stakeholders with a particular focus on the OEMs' deployment strategies have been derived. Further, based on a business model-centric analysis of existing roadmaps for AD new requirements for the implementations – which have not been on the agenda yet – have been defined. The work of WP 1.4 and the results of the business model analysis fed into an ongoing dialogue with project internal and external partners from industry, policy, and academia as well as with the interested public to contribute to the discussion and joint efforts to pave the future deployment path of the European automotive industry (see Table 5.1 for an overview of exploitable results and measures taken by WP1.4 to maximize the business impact of L3Pilot).

Table 5.1: Business impact of business model analysis and deployment perspectives.

Exploitable results	Measures to maximize the impact
• Generating four different business models for AD	• Applying a collaborative business model approach to integrate the multi-stakeholder perspective for the business models • Conducting an expert evaluation of the business models to increase the viability of the business models
• Developing deployment perspectives for AD	• Defining major challenges for OEMs to implement the business models and deriving deployment recommendations for action for OEMs and other stakeholders

Exploitable results	Measures to maximize the impact
• Providing input for deployment roadmaps for AD	• Analysing existing roadmaps for AD and defining new roadmap items for the implementation of AD-related business models
• Establishing a dialogue platform with industry, policy, academia, and the interested public	• Conducting live webinars (and provide videos), stakeholder workshops, and publishing conference papers to present and discuss the AD-related business models

5.3 Outlook

The different business models have been qualitatively analysed comprehensively and in detail in this report. With the Hi-Drive project, which builds upon the work and findings of L3Pilot, is planned to further detail and concretize the analyses of business models that promote the market dissemination of AD technologies and vehicles.

What does this mean in detail?

For **In-Car Services**, a clear expert recommendation has emerged to the effect that OEMs on the one hand use their expertise as a vehicle and interior provider. On the other hand, they might develop their own services on the basis that vehicle-, driver- and vehicle environment-related data are available to them and cooperate with existing ecosystems of established platform operators.

Possible data-based business models themselves are to be described and analyzed in more detail in the Hi-Drive project. They can make use of the **Data^{+} Platform**, which itself is seen by the experts in the hands of already established platform operators.

The business model of **RoboTaxis** poses technological requirements that go beyond SAE level 3. Nevertheless, it was already considered as one of four archetypal business models in the L3Pilot project because of intensive discussion among experts, but also among the public. In Hi-Drive, which includes the necessary technologies for level 4, this business model will be examined even more in detail. The focus will be on the conflicts that may arise between the economic operation of RoboTaxis and the societal and ecological requirements and needs of cities and their inhabitants. A **multi-stakeholder dialogue** should create new insights and solutions to those conflicting interests.

This will also have a significant impact on the **MaaS** business model because level 4-based **RoboTaxi** fleets must find their place in urban transport systems and need to be integrated.

Beyond that, the follow-up project **Hi-Drive** is planned to provide **quantifications** in form of **monetary estimates** to the so-far qualitatively analysed business models as well as **modelling and simulation of effects on urban transport systems.**

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