ULTIMO

Advancing Sustainable User-centric
Mobility with Automated Vehicles

DELIVERABLE

D6.5 – Transformation guidelines towards a future transport ITS/CCAM ecosystem First version

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Acronyms

ADS	Automated Driving Systems
AI	Artificial Intelligence
AM	Automated Mobility
AMB	Automated Minibus
API	Application Protocol Interface
AV	Automated Vehicle
BMM	Business Modelling Manager
CAV	Connected and Automated Vehicles
CB	Consortium Body
CERN	European Organization for Nuclear Research
D7.1	Deliverable 7.1
DC	Demonstration Coordinator
DI	The department of infrastructure (Swiss Canton of Geneva)
DMP	Data Management Plan
DTU test track	Technical University of Denmark test track
EAB	External Advisory Board
EC	European Commission
ECSEL	Electronic Components and Systems for European Leadership
EM	Exploitation Manager
EU	European Union
EUCAD	European Conference on Connected and Automated Driving
F2F	Face to face meeting
FEDRO	(Swiss) Federal Roads Office
FM	Fleet Management
FOT	(Swiss) Federal Office of Transport
GDPR	General Data Protection Regulation
GIMS	Geneva International Motor Show
GNSS	Global Navigation Satellite System
HARA	Hazard Analysis and Risk Assessment
IPR	Intellectual Property Rights
IT	Information Technology
ITU	International Telecommunications Union
LaaS	Logistics as a Service
LIDAR	Light Detection and Ranging
MaaS	Mobility as a Service
MEM	Monitoring and Evaluation Manager
MT	MobileThinking
OCT	General Transport Directorate of the Canton of Geneva
ODD	Operational Domain Design
OEDR	Object and Event Detection and Response
PC	Project Coordinator
PEB	Project Executive Board
PGA	Project General Assembly
PRM	Persons with Reduced Mobility
PTA	Public Transport Authority
PTO	Public Transportation Operator
PTS	Public Transportation Services
QRM	Quality and Risk Manager
QRMB	Quality and Risk Management Board
RN	Risk Number
SA	Scientific Advisor
SAE Level	Society of Automotive Engineers Level (Vehicle Autonomy Level)
SAN	(Swiss) Cantonal Vehicle Service
SDK	Software Development Kit
SLA	Sales Lentz Autocars
SMB	Site Management Board
SoA	State of the Art
SOTIF	Safety Of The Intended Functionality
SWOT	Strengths, Weaknesses, Opportunities, and Threats.
T7.1	Task 7.1
TM	Technical Manager
TPG	Transport Publics Genevois
UITP	Union Internationale des Transports Publics (International Transport Union)
V2I	Vehicle to Infrastructure communication

WP	Work Package
WPL	Work Package Leader

Executive Summary

The ULTIMO project demonstrates the potential of automated vehicles (AVs) to transform public transport and logistics and offers solutions to current challenges such as inefficiency, high costs and environmental impacts. With a holistic approach focusing on user and society needs and cross-sector integration of businesses and public transport, ULTIMO aims to develop and implement large-scale, demand-responsive door-to-door transport services that are both economically viable and accepted by users.

This deliverable therefore outlines the methodology of the entire Work Package 6 (WP6), which serves as a strategic focal point for the development of a vision for future mobility ecosystems. This approach includes an analysis of the current state of mobility, based on the findings of previous projects such as AVENUE, as well as the joint efforts of stakeholders to develop scalable, economically viable models for the integration of AVs into public transport and logistics. However, this overview can also be found in deliverable D6.3 for task T6.2, as these two tasks are very closely related. In T6.2, the vision for a future mobility ecosystem is developed, while in T6.3 the transformation processes that must be undergone before such a vision can be achieved are analysed.

For this reason, Chapters 3 and 4, which are available separately here, first show this transformation process and then the current status quo in the project's test regions:

Chapter 3: Transformation concept and business development

Chapter 3 lays the foundation for ULTIMO's transformation strategy and describes a structured approach to integrating different aspects of strategic planning and implementation within the project. It emphasises the need to understand the interdependencies between the different components of the project and presents a framework for systematic transformation planning. The chapter highlights the importance of standardising transformation work packages to ensure consistent and pragmatic implementation across all pilot sites. The development within ULTIMO is divided into three generic planning phases: Strategic analysis of the ULTIMO status quo (which is already partially present in Chapter 4 but will be further carried out), strategic foresight and design of the ULTIMO future, and planning and elaboration of the ULTIMO transformation. Each phase is carefully outlined and provides a roadmap from the current state to the planned future of integrated AVs in MaaS/LaaS and ITS/CCAM ecosystems. The phases serve as building blocks for business development and focus on analysing the current state, defining future goals and devising strategies to achieve them. Despite a common future scenario and vision, each pilot site starts from a different status quo, resulting in unique project goals and transformation strategies. This differentiation emphasises the tailored approach required for each site and enables cross-site learning and inspiration. At the end of the chapter, a detailed concept design for the ULTIMO transformation is presented, standardising the steps for all pilot sites while taking into account the individual characteristics of the sites. This approach is in line with the "big picture" (see chapter 2) of the project and ensures a coherent and comprehensive strategy for the integration of AVs into a sustainable mobility ecosystem.

Chapter 4: Status quo of the three test sides

Chapter 4 describes the methodology used to assess the current state of AV integration in the three European pilot sites. A structured questionnaire is presented that covers different aspects of current mobility services, social and environmental factors as well as governance and business models. This tool was developed to collect comprehensive data on the existing mobility ecosystem to serve as a basis for transformation planning. It presents the preliminary results of the status quo assessment at each pilot site and provides insights into the site-specific challenges and opportunities that will be further analysed during the course of the project. It highlights the diversity of the current mobility ecosystem at the sites, including differences in public transport services, social acceptance of AV technology, environmental aspects and governance structures. An in-depth analysis of the current mobility offerings at the test sites provides a clearer picture of the operational ecosystem for AVs. This includes an assessment of existing transport services, user demographics and environmental impact assessments. The detailed research that will emerge from these initial findings over the course of the project emphasises the complexity of integrating AVs into the existing transport ecosystem and the need for bespoke solutions tailored to the local context.

To summarise, Chapters 3 and 4 describe the path from the current status quo of mobility services at the three pilot sites to a future integrated AV-based mobility ecosystem. Through strategic planning, detailed analyses and tailored transformation pathways, ULTIMO will provide a blueprint for the realisation of a sustainable, efficient and user- as well as citizen-centric mobility future and underline the crucial role of AV technology in shaping the next generation of transport services.

1 Introduction

During the past few years, many projects and initiatives were undertaken deploying and testing Automated Vehicles (AVs) for public transportation and logistics. However, in spite of their ambition, all of these projects stayed on the level of elaborated experimentation and never reached the level of a large-scale commercial deployment of transport services. The reasons for this are many, the most important being the lack of economically viable and commercially realistic models, the lack of scalability of the business and operating models, and the lack of user oriented services required for large end-user adoption of the solutions.

The ULTIMO project will create the very first economically feasible and sustainable integration of AVs for MaaS public transportation and LaaS urban goods transportation. ULTIMO aims to deploy in three sites in Europe 15 or more multi-vendor SAE L4 AVs per site. A user centric holistic approach, applied throughout the project, will ensure that all elements in a cross-sector business environment are incorporated to deliver large-scale on-demand, door-to-door, well-accepted, shared, seamless-integrated and economically viable CCAM services. We target the operation without safety driver on-board, in a fully automated and mission management mode with the support of innovative user centric passenger services.

ULTIMO's innovative transportation models are designed for a long-term sustainable impact on automated transportation in Europe, around the globe and on society. The composition of the consortium ensures the interoperability between multiple stakeholders by making adoption of new technology at minimum costs and maximum safety. The integration of the ongoing experiments of previous AV-demonstrator projects ensures highest possible technical and societal impacts from the very beginning of the project, as well as during the project lifetime and even long after its completion.

1.1 On-demand Mobility

Public transportation is a key element of a region's economic development and the quality of life of its citizens. Governments around the world are defining strategies for the development of efficient public transport based on different criteria of importance to their regions, such as topography, citizens' needs, social and economic barriers, environmental concerns, and historical development. However, new technologies, modes of transport and services are appearing, which seem very promising to the support of regional strategies for the development of public transport.

On-demand transport is a public transport service that only works when a reservation has been recorded and will be a relevant solution where the demand for transport is diffuse and regular transport is inefficient.

On-demand transport differs from other public transport services in that vehicles do not follow a fixed route and do not use a predefined timetable. Unlike taxis, on-demand public transport is usually also not individual. An operator or an automated system takes care of the booking, planning and organization.

It is recognized that the use and integration of on-demand Automated vehicles has the potential to significantly improve services and provide solutions to many of the problems encountered today in the development of sustainable and efficient public transport.

1.1.1 Fully Automated Vehicles

A self-driving car, referred in the ULTIMO project as a **Fully Automated Vehicle** (**AV**), is a vehicle that can sense its environment and moving safely with no human input.

The terms *automated vehicles* and *autonomous vehicles* are often used together. The Regulation 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles defines "automated vehicle" and "fully automated vehicle" based on their autonomous capacity:

An "automated vehicle" means a motor vehicle designed and constructed to move autonomously for certain periods of time without continuous driver supervision but in respect of which driver intervention is still expected or required

"Fully automated vehicle" means a motor vehicle that has been designed and constructed to move autonomously without any driver supervision

In ULTIMO we operate ***Fully Automated mini and micro shuttles for shared public transportation***. In relation to the SAE levels, the ULTIMO project will operate SAE Level 4 vehicles.

SAE INTERNATIONAL

SAE J3016™ LEVELS OF DRIVING AUTOMATION

	SAE LEVEL 0	SAE LEVEL 1	SAE LEVEL 2	SAE LEVEL 3	SAE LEVEL 4	SAE LEVEL 5
What does the human in the driver's seat have to do?	You <u>are</u> driving whenever these driver support features are engaged – even if your feet are off the pedals and you are not steering			You <u>are not</u> driving when these automated driving features are engaged – even if you are seated in "the driver's seat"		
	You must constantly supervise these support features; you must steer, brake or accelerate as needed to maintain safety			When the feature requests, you must drive	These automated driving features will not require you to take over driving	
	These are driver support features			These are automated driving features		
What do these features do?	These features are limited to providing warnings and momentary assistance	These features provide steering OR brake/ acceleration support to the driver	These features provide steering AND brake/ acceleration support to the driver	These features can drive the vehicle under limited conditions and will not operate unless all required conditions are met		This feature can drive the vehicle under all conditions
Example Features	• automatic emergency braking • blind spot warning • lane departure warning	• lane centering OR • adaptive cruise control	• lane centering AND • adaptive cruise control at the same time	• traffic jam chauffeur	• local driverless taxi • pedals/ steering wheel may or may not be installed	• same as level 4, but feature can drive everywhere in all conditions

Table 1: SAE Driving Automation levels (©2020 SAE International)

1.2 The ULTIMO dream for public transportation

Our city has a population of 700.000, and the local PTO (Public Transport Operator) deploys 3.000 Km of public transportation services' routes, with 4 backbone tram lines, 8 backbone large bus/trolley lines, and 340 fully automated multi-manufacturer mini and micro-shuttles in an on-demand, door-to-door shared public transport service. The fleet of the 340 automated mini-busses is composed of different vehicle generations and models from different manufacturers, as it was purchased in different batches during the last 12 years (it all started with the first 15 bought by a European project in 2023/24). It is today composed of the first 15 twelve-years old vehicles from manufacturer A, 160 eight-years old vehicles from manufacturer B and 160 two-years old vehicles from manufacturer A, which are the new generation of manufacturer's vehicles. These last 160 vehicles re-placed the last 70 old, driver based, thermic busses that reached the end of their life after 18 years in operation. The change from driver large busses to automated mini-buses and from fixed line service to on-demand, door-to-door, for the last area of the city, was decided 6 years ago, and was based to the great success of the already deployed AV-based services in the other parts of the city.

The integration of new vehicles in the PTO fleet was done within just a few days, thanks to the now standardised APIs of the automate vehicles' connection with the AV fleet management and orchestration service, that allows a plug-and-operate functionality, but also enables the combination of AVs with all other means of transport, offering a seamless citizen centric journey to the users. Similarly, the now standardized High Definition (HD) maps between the vehicle manufacturers, allowed us to reuse the maps created in the past for the 3.000 kms of routes of the city, with small adaptations for the new vehicle capabilities. At the same time of the purchase of the last 160 AVs, we also switched to a new AV fleet management and orchestration service, from another provider, which offers more precise trip time estimations, considering also traffic jams in the city and weather conditions (that affect traffic in the city). The replacement was made within just two weeks, thanks to the new standardised interfaces between AV fleet management and PTO MaaS services.

Passengers are now able to reserve, via their mobile phone app, on the fly or with pre-reservation trips from one side of the city to another, using the optimal transport mode available for them, with a combination of different transport modes, and having the automated vehicle arriving next (or almost) to their door entrance and bringing them to their final destination or to a backbone transport connection. All trips are offered with highly reliable and accurate transport and arrival times, based on real time, dynamic route changes of the vehicles, responding to the passenger needs. Many passenger services are available in the AVs via a mobile phone app, adapted to all passengers' needs, from special needs passengers (visually impaired, wheel-chair users, pregnant women, elderly, children), to persons transporting suitcases or a baby-stroller, providing adapted information of their trip (where to get-off, PTO general information, and even infotainment, like city related information and historical facts and anecdotes, related to their current position).

With the full suppression of on-board operators, automated in-vehicle monitoring provides a multitude of passenger services, which were, and are developed with a continuous collaboration and innovation between users and the PTO. An on-board unit identifies locally (that is, in the bus) incidents and events, like aggressions, vandalism, forgot-ten objects, littering, accidents, etc., and raises incident alarms to the PTO back-office. The PTO officer at the back-office evaluates the incident and decides, based on the operator policies, what action to take: dismiss the incident, or stop the vehicle and call one of the intervention teams to go the vehicle and take the required action. The back-office operator, based on the number of incidents and intervention time legal obligations, can deploy any of the 15 intervention teams available in the city, ready to reach within a few minutes any AV. At the back-office, service operators are able, with one set of screens linked to the fleet management, to follow the vehicle status, trip reservations, routes chosen, open and closed road segments (due to works, accidents, etc. thus adapting dynamically the trip routings), while in a second set of screens, the back-office operators can follow the passenger services' incidents and the status and location of the intervention teams. The two systems, although independent, are linked so that the back-office operator can transfer incidents to intervention teams and turn-on, when possible and under the local legal restrictions, video connection to inspect the incident.

The public transport services are operating 24/7 with different active vehicles, de-pending on passenger transport demands. The PTO, being eco-sensible, has defined that the vehicle must have an average occupancy of at least 3 passengers. This of course has implications, especially in off-peak hours, in the transport delays, but it is fully justified for an optimal and eco-responsible operation. Exceptions are made for people with special needs or when the passenger is ready to pay an additional price.

While at peak-hours the full 340 strong fleet of AVs is in service for public transportation, in the off-peak and night hours, due to the reduced transportation needs, part of the fleet is not serving passenger transportation. However, because having a vehicle waiting idly is a waste of resources, the PTO has signed an agreement with Logistics as a Service (LaaS) Service providers. During the off-peak hours the unused vehicles are dynamically chartered by the different LaaS providers to be used for other types of incidental transport of goods or even non-public transportation of passengers. Local shops and enterprises use the service, on demand with dynamic reservation, to offer home delivery of on-line purchases, or B2B delivery of goods from an urban consolidation centre to the distribution centre (hub, many to one or one to many [7], or even transport their VIP customers directly to their offices or exposition centres. This way they can deliver the goods to their customers in the city, with a delay of just 60 minutes with affordable prices, as the last mile is the most inefficient part of the goods delivery chain. The goods send can include books from local bookshops or libraries, supermarket bags or even documents exchanged between companies or waste. The local shops are even using the service in the early hours (5 o'clock in the morning) for re-provisioning their shops for the day. The so chartered AVs are "returned" to the PTO for public transport at the peak-hours automatically, at the end of the chartered time period.

1.3 Preamble – D6.5: Transformation guidelines towards a future transport ITS/CCAM ecosystem – First version

WP6 serves as a central element in shaping the future mobility ecosystem and integrates findings from previous projects such as AVENUE to develop a future-oriented approach to mobility solutions and ecosystems. It combines the information gathered in WP5 with the requirements identified in WP2, taking into account the perspectives of the public and the needs of transport authorities and operators. This leads to the development of a comprehensive strategy that covers technical, social, environmental, socio-economic and governance aspects and enables informed decisions and actions. The vision for the mobility of tomorrow formulated in T6.2 lays the foundation for an intelligent, user- and citizen-centric transport system. T6.3 describes the steps towards this vision, focussing on feasible strategies and specific measures that ensure alignment with the broader objectives of improving mobility, promoting sustainability and effectively involving all stakeholders.

2 Methodology of WP6

The description of the methodology can be found in both deliverables, D6.3 and D6.5, as an introductory chapter, as both deliverables can only be understood in their entirety if the related methodology is explained. D6.1 can function as a stand-alone document, but the two tasks T6.2 and T6.3 are so closely related that this description was used for both tasks.

2.1 Overview WP6 concept (Big Picture)

Work Package 6 (WP6) represents a key transition point in the transformation of the mobility ecosystem and builds on the knowledge generated by initiatives and predecessor projects such as AVENUE. This section explains the multidimensional approach of WP6, which incorporates a wide range of data and other inputs, such as requirements, to formulate a strategic vision for the future of mobility.

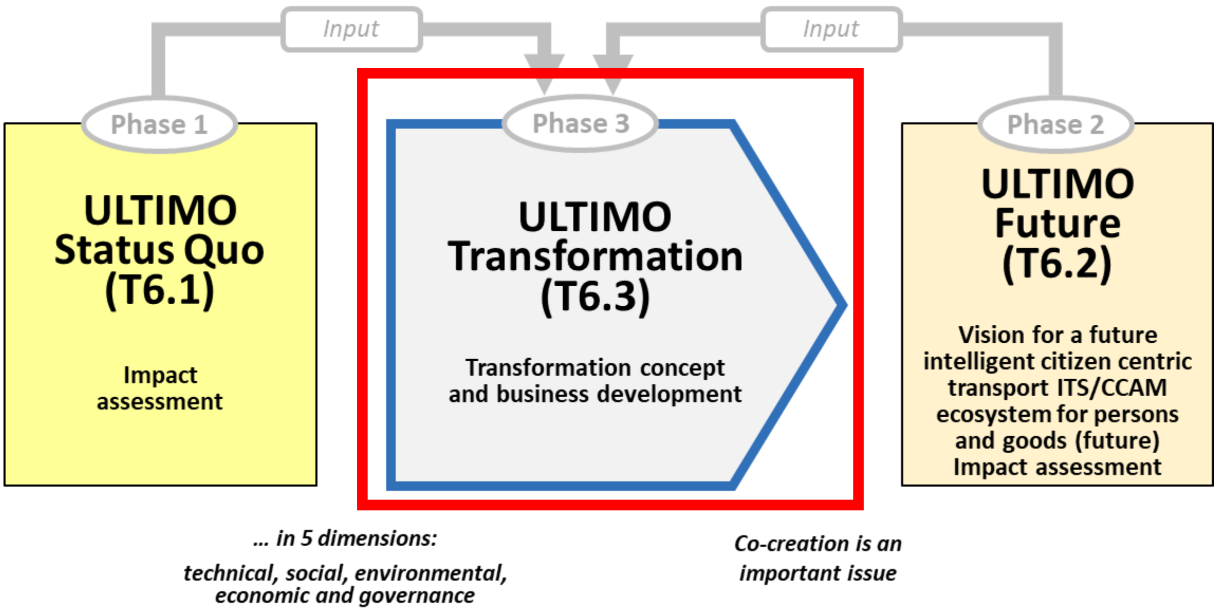


Figure 1: Overview of the three tasks in WP6

Strategic Approach and Projections in WP6

WP6 is characterised by the accurate integration of the data from work package 5 (WP5) and the differentiated needs identified in work package 2 (WP2), taking into account both the citizens' perspective and the requirements of public transport operators (PTOs) and public transport authorities (PTAs). This integrative methodology is essential for the development of a holistic strategy that takes into account the complex dimensions of a modern mobility ecosystem. These dimensions include technical, social, environmental, socio-economic and governance facets, which are considered in detail in the analytical framework of T6.1.

Figure 1 provides a summarised overview of the complex interrelationships in the workpackage, which are briefly described below in order to follow on from the detailed description in the subsequent sub-chapters.

The WP6 strategy is suitable for analysing the status quo of the current mobility ecosystem and for predicting and governing the transition to a more sustainable, integrated future mobility ecosystem. The empirical and methodological rigor in T6.1 lays a solid foundation for subsequent phases, ensuring that transformation efforts in T6.3 are scientifically robust and align with real-world pilot implementations.

Analytical Framework in T6.1

The analytical phase in T6.1 is a stringent process that involves a thorough assessment of the current status quo and its impact on both the proposed pilot sites and the overall mobility ecosystem. This phase will utilise a diverse range of research methods to gain a comprehensive and differentiated understanding of the complex dynamics. The investigation includes technical refinements, social impacts, (positive and negative) environmental impacts, socio-economic interdependencies and governance structures as well as changes. Such a multi-layered approach enables informed decision-making and the formulation of socio-political incentive structures. The integration of empirical data, citizen perspectives as well as needs and PTO/PTA requirements improves the analytical framework and promotes a strategy that goes beyond traditional boundaries.

Visionary Conceptualization in T6.2

T6.2 develops a future-oriented vision for mobility in urban, sub-urban and rural ecosystems. This task systematically outlines the desired future on multiple levels, including the conceptualisation of an overarching mobility vision and the strategic development of key business plans for implementation. T6.2 combines a visionary perspective with practical business planning and demonstrates a high degree of foresight and pragmatism. It serves as a critical intersection on the path to a future mobility ecosystem that integrates intelligent, citizen-centred transport systems for people and goods, while taking into account business plans and partnerships for intelligent CCAM ecosystems.

Transformation Concept in T6.3

T6.3 is tasked with leading a transformation blueprint to realise the vision outlined in T6.2. This concept serves as a blueprint for the development of the mobility ecosystem that is in line with the overarching vision and the previously developed business plans. T6.3 focuses on the implementation strategies, adaptive framework and targeted interventions, providing a comprehensive understanding of the practical aspects associated with the transformation of the mobility ecosystem.

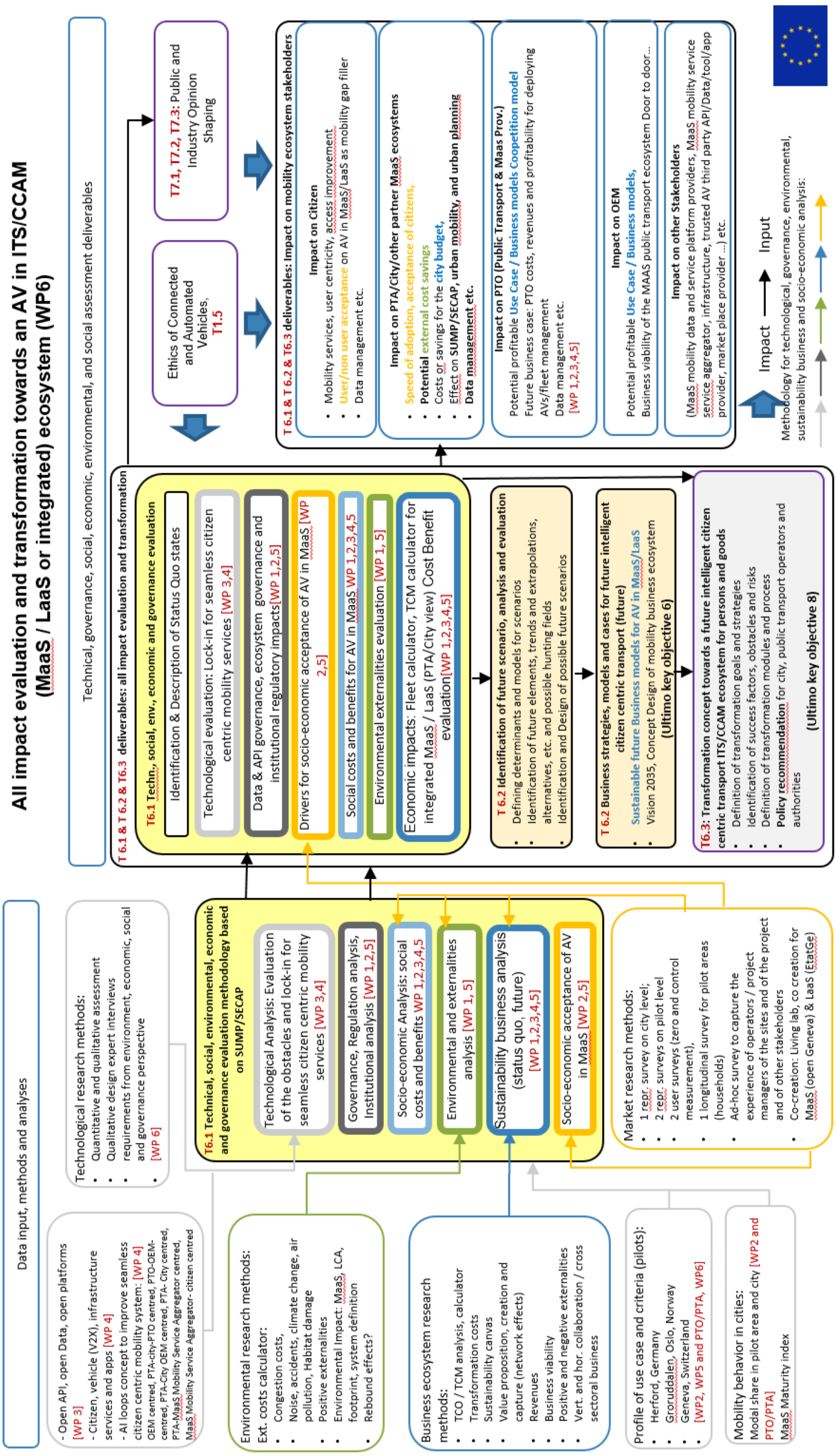


Figure 2: Big picture

2.2 Goals of the Big Picture

Figure 2 above illustrates WP6's comprehensive framework, highlighting its structured interconnections. This visual unfolds the ecosystem's intricate relationships and processes: On the left, it shows incoming data, methodologies, and analytical procedures, representing WP6's scientific foundation.

Figure 2 provides a visual guide to the big picture of workpackage WP6, illustrating its complex structure and interrelationships. It shows how diverse data and qualitative information are analysed rigorously using specific tools to transform raw data into refined insights for decision making. The right-hand side of the figure shows the envisaged results of WP6, highlighting their development and impact on the wider mobility ecosystem. At the centre of Figure 2 is an illustration of the internal logic of WP6, including methodological details and links to other work packages. It is essential for understanding the structure of WP6 and its three main tasks, which involve numerous ULTIMO partners and four PhD theses, among others.

The core of Figure 2, which is also presented in more detail in Figure 3 below, focuses on six analysis methods for five impact dimensions on automated vehicles (AVs) in intelligent transport systems (ITS) and Mobility-as-a-Service (MaaS) ecosystems. T6.1 covers technical, social, environmental, socio-economic and governance analyses, with each dimension divided into sub-factors. These analyses build on previous results from the AVENUE project and incorporate new data from the ULTIMO pilot sites or new analyses from the ULTIMO partners. The figure also shows the work packages contributing to T6.1 as well as the methods and data input on the left to provide a comprehensive overview of the WP6 research process.

The right-hand side of Figure 3, marked by black arrows, illustrates that the results of these comprehensive analyses, carried out by a team of more than ten scientists in collaboration with various partners, form the basis for all the results of the work package. This important aspect of visualisation underlines the integral role of these detailed studies in shaping the content of the individual work steps within WP6. These results, which are essential to the overall project, embody the concerted efforts and insights gained from this collaborative scientific endeavour.

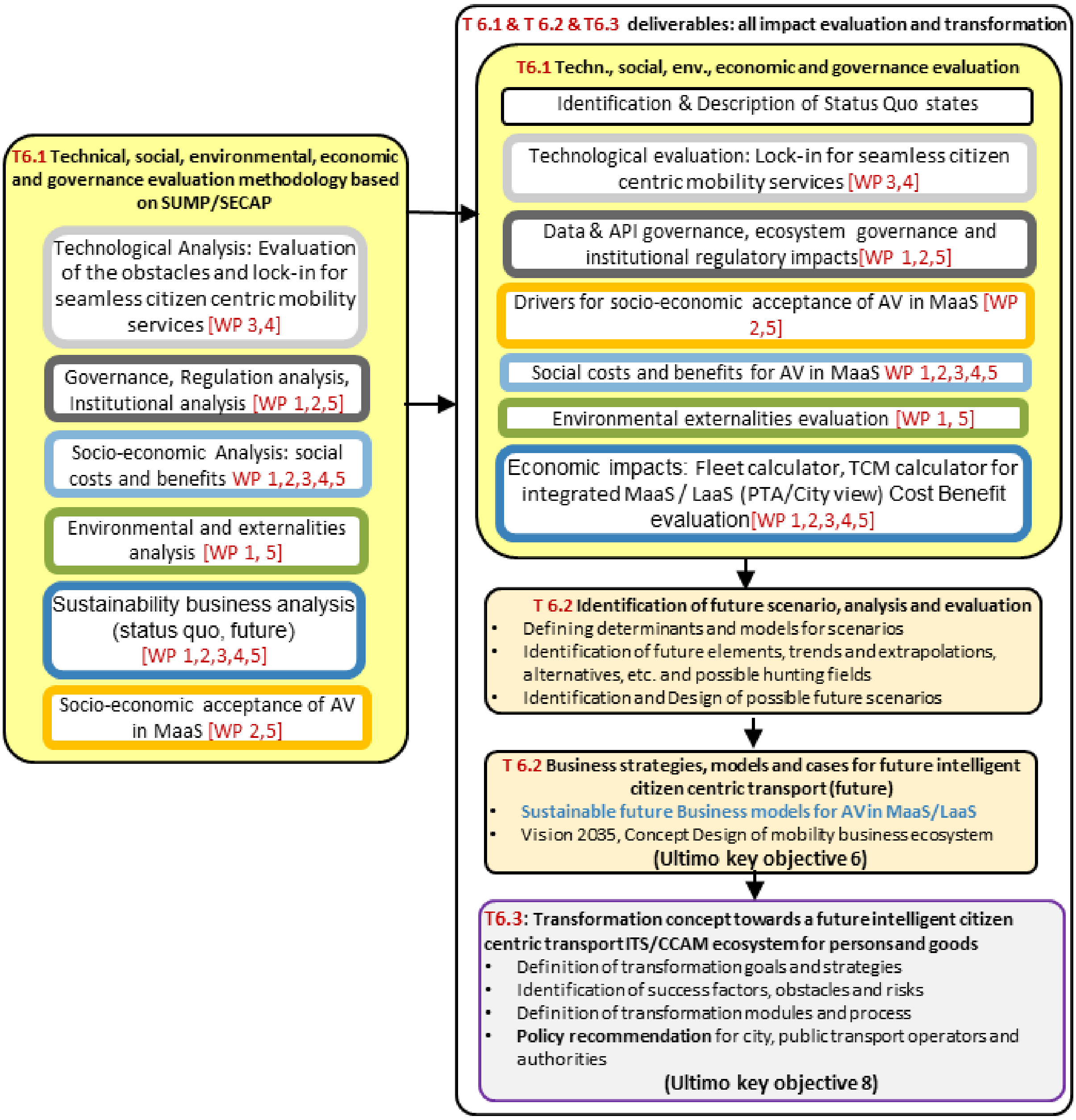


Figure 3: Central pillars of the Big Picture with the transition from the analysis to the deliverables

Each of the resulting six deliverables, the planned content of which is briefly summarised below, represents a specific aspect of the project and reflects the objectives and commitments set out in the grant agreement. The following summary highlights the key elements that were carefully defined and mutually agreed at the outset of the project. These include a range of themes and potential outcomes, all of which have emerged or will emerge from the rigorous analytical processes and collaborative efforts of the scientists and partners involved in WP6. Together they provide a comprehensive picture of the scope of the project and the specific focus areas that will be carefully addressed in the deliverables in accordance with the terms of the grant agreement:

T6.1: Technical, social, economic, environmental, business and governance evaluation of seamless transport of persons and goods

D6.1 & D6.2 – Multivariate evaluation of ULTIMO CCAM ecosystem - First version & Final version

Report on technical, social, economic, environmental and governance evaluation activities. The first version of the deliverable consolidates the knowledge gained from past projects and from the existing project deployments, of the technical, social, economic, environmental and governance impacts, of a seamless transport of persons and goods within an integrated approach. The final version of the deliverable provides a detailed assessment, based on objective measurements from the deployment sites and operations, of the technical, social, economic, environmental and governance impacts, of a seamless transport of persons and goods within an integrated approach.

T6.2: Concept and operating models and business development for a future intelligent citizen centric transport ITS/CCAM ecosystem for persons and goods

D6.3 & D6.4 – Business plans, and partnerships for intelligent CCAM ecosystem – First version & Final version

These deliverables will develop a complete business plan for an efficient, safer, carbon-free, inclusive, and sustainable transport in cities, suburban and rural areas deployment of MaaS and LaaS based on automated vehicles. The first version will consolidate knowledge from past projects and from the project deployments and provide a roadmap, identifying the data that will be needed from the project sites. The final version of the deliverable will provide a detailed and optimal design process that can be applied to any design of a smart transportation eco-system aiming at maximizing a performance vector made of the 5 defined pillars and the acceptability of the users.

T6.3: Strategy for Transformation towards a future intelligent citizen centric transport ITS/CCAM ecosystem for persons and goods

D6.5 & D6.6 – Transformation guidelines towards future transport ITS/CCAM ecosystem – First version & Final version

The target of this deliverable is to elaborate and present description and scenarios for future deployment of MaaS and LaaS service, analysing a stakeholder approach, identifying transition goals and elaborating transition strategies and business models. The first version of the deliverable consolidates existing knowledge from past projects and the project deployment sites and establishes a roadmap and date requirements towards the final deliverable targets (that is, an overall implementation plan and a transition into practice (EU market) measures roadmap towards a sustainable intelligent future citizen centric ecosystem for persons and goods). The final version of the deliverable provides an overall implementation plan and a transition into practice (EU market) measures roadmap towards a sustainable intelligent future citizen centric ecosystem for persons and (small size) goods.

Summary of the deliverable relationships from T6.1 to T6.3

In the deliverables D6.1 & D6.2 for T6.1, the results of the detailed analysis of the evaluation are identified and described as status quo states, e.g. possible lock-in effects for seamless citizen centric mobility services are examined (the rest is explained in more detail below). The results of these comprehensive analyses are then incorporated into Deliverables D6.3 & D6.4 of T6.2, in which not only future scenarios are analysed and evaluated, but above all sustainable future business models for AV in MaaS/LaaS are developed and described in detail in order to achieve a Vision 2035 for a future mobility business ecosystem. This vision of the future corresponds to ULTIMO Key Objective 6 (KO#6: Develop and validate cross-sectoral business models) from the Grant Agreement. These results are then incorporated into deliverables D6.5 & D6.6 for T6.3. In these, a transformation concept towards a future intelligent citizen centric transport ITS/CCAM ecosystem for persons and goods, i.e. this Vision 2035, is defined and success factors are identified. At the end of WP6, D6.6 contains policy recommendations for cities, public transport operators and authorities and thus the ULTIMO Key Objective 8 (KO#8: Realistic, long term transition planning design for the deployment of AVs in MaaS and LaaS).

2.3 Logic of the Big Picture

2.3.1 Data input, methods and analyses

Technical data input and technical research method:

The technical dimension of the integration of AVs into a transport and mobility ecosystem is designed, analysed and evaluated using the results from AVENUE and the work in all the other WPs. By taking into account both the functional and non-functional requirements, the assessment/evaluation focuses on safety (vehicle safety, in-vehicle passenger safety, off-vehicle road-user interaction safety), security (in-vehicle security, cybersecurity, interaction with online supervisors, interaction with other road users), technical performance (reliability and availability), maintainability and serviceability. Previous experiences with deploying AVs in public transport systems resulted in insights into technical barriers and opportunities for technical innovation.

The current need for of an on-board safety operator, mapping & modification of routes, access for disabled and elderly persons without human involvement as well as cyber security challenges are addressed. In addition, this part evaluates system integration and efficiency through the integration of AVs into existing and upcoming innovative mobility platforms as well as the integration of AVs into the infrastructure. This also includes the technical assessment and design of interoperability, intermodality, open data, open software and API, and open protocols to ensure an integrated feasibility of technical components and a user centric approach and single point of contact through combining several modalities towards a seamless transport for users in urban, suburban and rural environments.

For this purpose, the AI loops, which are described in detail in Fournier et al. (2023), are analysed using qualitative expert interviews in addition to input from the other four dimensions and all available quantitative data from the pilot sites.

Socio-economic data input and socio-economic research method:

The aim of the socio-economic analysis is to identify requirements for AVs as a technical system (1) and for AVs in the MaaS system (2) so that they function as a citizen centric approach. The analyses demonstrate under which circumstances high level of acceptance among potential AV users and high level of satisfaction among users can be translated into regular, intensive use and thus a substitution of private cars. In particular, the acceptance of AVs in MaaS is being analysed: Previous studies have shown in AVENUE, for example, that almost half of drivers in Lyon, Copenhagen, Luxembourg and Geneva are "willing" or even "very willing" to give up their own car to use AVs in a MaaS.

However, the resulting potential can only be exploited if the service is user- or/and citizen-centric. The goal is to assess how mobility behaviour changes if AV service is offered, especially focussing on reduce of private car usage. The question why mobility behaviour will change or not will be explored in detail. In order to obtain a comprehensive picture, quantitative and qualitative methods are of course required: several surveys will be carried out, representative at city level in the three participating cities, representative at regional level on the pilot sites, user surveys of actual passengers travelling in the tested vehicles and ad-hoc surveys of stakeholders. In addition, co-creation will be used and a possible incentive system will be developed using living labs, for example.

<u>The following are particularly important contents analysed:</u>

Waiting time: A key factor influencing the acceptance and efficiency of AVs in a MaaS context is the waiting time for services. It is crucial to assess the acceptable waiting times for users and how these expectations influence the willingness to use AVs. A waiting time calculator is being developed to predict and optimise service response times with the aim of minimising user waiting times and increasing the acceptability of services.

Ridesharing willingness: The willingness to rideshare plays a crucial role in the success of AVs within MaaS systems. This analysis examines the willingness of the population to share rides with other passengers, which can significantly contribute to reducing the number of vehicles on the roads, lowering emissions and improving transport conditions.

Willingness to give up private vehicles: It is crucial to understand the conditions under which people are willing to give up their private cars. This includes examining factors such as service reliability, coverage and cost and how these elements influence the attractiveness of AVs as an alternative to private car ownership.

Intermodality and economic demand: A key aspect of this study is to assess people's willingness to travel intermodally, i.e. to use multiple modes of transport for a single trip, and the economic impact of such behaviour. It also analyses how much people are willing to pay for intermodal solutions and how these preferences influence the demand for integrated mobility services.

Furthermore, the socio-economic analysis looks at the changes that will occur in the labour market, not only in general due to automated driving, but especially due to the future scenario of an AV in MaaS ecosystem in Europe, but above all in the three participating regions/countries in which the test sites are located. For this, two macro-level models show, on the one hand, quantitatively which changes can be expected on the labour markets due to automated driving on the basis of existing data, and, on the other hand, qualitatively explain/evaluate not only these in detail, but above all expected changes that cannot yet be quantified due to non-existing data. The available information is used to elaborate predictions about expected changes on the labour market, covering expected job losses, expected job gains, and expected jobs no longer to be filled that were vacant due to a shortage of skilled workers. For the three test regions involved, approximate expected net changes in the labour market are given at the end. In a transition between socio-economic and environmental analyses, the social costs and benefits resulting from the other dimensions, especially the environmental dimension, are also presented.

Environmental data input and environmental research method:

The present environmental impact assessment, undertaken in this study, investigates the external costs connected to automated vehicles (AVs) operating within the framework of Mobility as a Service (MaaS) and Intelligent Transport Systems (ITS), which constitute a part of the mobility ecosystem in the three case studies of the ULTIMO project. The three test sites combined with different future scenarios allow for a more nuanced understanding of the sustainability implications of AV technologies in various contexts. Even potential rebound effects that may result from the implementation of AVs are to be accounted for. In addition to environment-related external costs such as climate-relevant emissions, particulate matter, and noise, the assessment will evaluate social factors that affect various stakeholders, including accidents or discrimination, as well as socio-economic factors like congestion costs. To this end, a Life Cycle Sustainability Assessment approach is adopted, which is based on the triple bottom line sustainability framework encompassing the three aforementioned aspects: environmental, social, and economic. This methodology can function as an indicator to show the impact on the Sustainable Development Goals (SDGs) by covering all three dimensions. Life Cycle Sustainability Assessment is a comprehensive approach to evaluate the impacts of a product or process throughout its entire life cycle. It allows for a holistic understanding of the potential sustainability implications of a product or process, taking into account all stages from raw material extraction, manufacturing, use, and disposal. In the context of automated vehicles together with a new mobility system such as MaaS, a life cycle sustainability assessment can provide valuable insights into the overall sustainability performance of AV technologies compared to the status quo, a traditional mobility system with private vehicles.

In this part of the study, only external economic costs are assessed to avoid interference with the economic impact assessment. The primary objective of this assessment is to bring to light the concealed costs of the mobility ecosystem for society. By employing a holistic life cycle thinking approach, the study evaluates the extent of potential positive and negative externalities associated with the deployment of AVs at various sites and for the overall integrated system. The distinctiveness of this study lies in its exploration of external costs for different governance scenarios, including those focusing on the integrative transport of small-size goods using automated minibuses.

Sustainability business data input and sustainability business research method:

The sustainability business analysis evaluates appropriate innovative models for value creation for citizens, PTOs/PTAs, city governments and other stakeholders. Investigated models for value creation will focus on both, mobility of persons and where applicable, integrated transportation of (small size) goods. Based on these models, this task analyses the horizontal and vertical business models for focused value chains that could be implemented for the deployment of a seamless transport of persons and goods into practice. Special attention is paid to the possibilities of a citizen-centric mobility ecosystem that contributes to the vision of a purpose economy.

Several integrated calculators are provided and enable the calculation of fleet sizes, transformation costs, Total Costs of Ownership (TCO) and Total Costs of Mobility (TCM) and much more. This is important because beyond the TCO methodology, the more comprehensive and relevant approach of TCM[1] combined with revenue estimations is combined to a concept of calculating economic benefit (profitability) to include an integrated on-demand and door-to-door (citizen) journey. Up to a certain point, environmental and social impact assessments can be monetised and taken into account in the business models as much as possible to make them more sustainable. Of course, the results of the environmental and externalities analysis are also incorporated at this point. In this way, an economic valuation of an AV in MaaS ecosystem is achieved for the relevant stakeholders (e.g. users, PTOs/PTAs, OEMs, service providers, city managers) that takes into account all their interests and issues.

[1] TCM is a holistic approach that emphasises the integration of all costs associated with a door-to-door journey, including different modes of transport and mobility services. This perspective, which takes into account the needs and experiences of passengers and citizens, is in line with service-orientated mobility trends. It encompasses traditional modes of transport such as trains and buses as well as modern options such as car/bike sharing, ride sharing and AVs and aims to reflect real mobility needs and facilitate user- and citizen-centric business strategies. In addition, negative and positive external effects can be integrated that are not provided for in traditional forms of calculation.

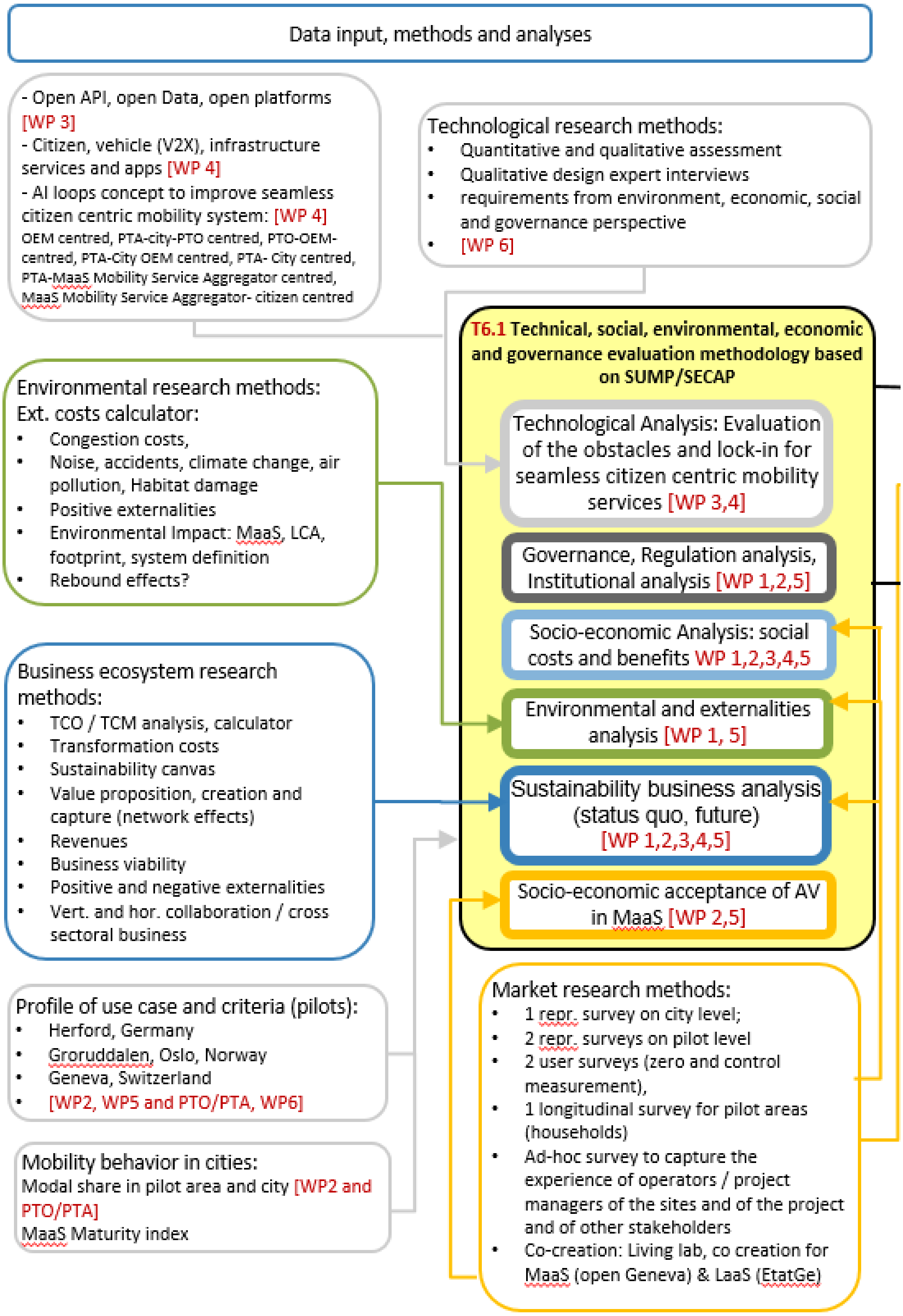


Figure 4: Left part of the Big Picture

These analyses, which are close to the methods of impact finance, make the financial conditions of projects more relevant for the entire mobility ecosystem. Particular interest is being paid to tariffication and cross-sector business models, whereby, for example, possible integration with logistics concepts and results from the ALICE programme such as synchro-modality, hubs and urban logistics or from SHOW for LaaS are being investigated. To this end, suitable business concepts will be developed that integrate the role of users, PTOs/PTAs, OEMs, data and other service providers (e.g. software apps, passengers, vehicles) for AVs into the business and technical ecosystem of MaaS transport. As this is about a vision of a more sustainable mobility ecosystem, the methods of the relatively new Sustainability Business Canvas are used rather than the usual business analysis methods.

It will also be analysed whether the integration of door-to-door and on-demand data from AVs into MaaS can provide more accurate mobility information and transform MaaS into an intelligent, self-learning (possibly AI-based) traffic system to improve the automated decisions of AVs, PTOs/PTAs, cities and, last but not least, the mobility services offered to users. Another focus is the avoidance of dominant market positions of stakeholders (e.g. vehicle fleet providers) and the creation of monopolies. Finally, public authorities play a central and crucial coordinating role in the integration of AVs into a MaaS or ITS ecosystem, which is the last dimension of analysis below.

Governance, regulation, and institutional data input and governance, regulation, and institutional research method:

The governance assessment focuses accordingly on evaluating appropriate governance approaches (such as laissez-faire, governing by enabling or doing, etc.) on the four dimensions mentioned above (technical, social, economic, environmental) to enable and objectify a balance between individual private and general interests as well as between the stakeholders of the ecosystem in general and to maximise the benefits for society to the integrated best for all stakeholders (common interest and the above mentioned purpose economy). A sustainable and inclusive planning process (SUMP/SECAP) is needed to address the complexity and dynamics of the mobility ecosystem. In particular, the analysis identifies the possibilities for a coopetition scenario (integrated and situational cooperation and/or competition) and presents applicable governance concepts, taking into account the applicable regulations within the EU and the European Economic Area and, where necessary, other applicable regulations at national and regional level. In this context, and given the role that regulation can play as both a facilitator and a challenge for innovation in transport systems, particular attention will be paid to regulations such as the General Data Protection Regulation (GDPR), the Network and Information Systems Security Directive (NIS 2) and the Data Management Act. Above all, of course, this analysis is carried out for the three participating cities, regions and nation states.

The final result will be a sustainability radar as presented for AVENUE in Nemoto et al. (2021), Nemoto et al. (2023) or Huber et al. (2022). In this radar, all five aforementioned dimensions are integrated to summarise the performance of AV in MaaS / ITS at the different locations, depending on the available data. These results will not only be described in detail by the participating scientists in the deliverables, but also in qualified scientific publications that will further develop research on AVs in ITS/MaaS.

2.3.2 Evaluation, transformation and stakeholder impact

As described above, the entire WP6 consists of the following three work tasks, each with two deliverables:

T6.1: Technical, social, economic, environmental, business and governance evaluation of seamless transport of persons and goods

D6.1 & D6.2 – Multivariate evaluation of ULTIMO CCAM ecosystem - First version & Final version

T6.2: Concept and operating models and business development for a future intelligent citizen centric transport ITS/CCAM ecosystem for persons and goods

D6.3 & D6.4 – Business plans, and partnerships for intelligent CCAM ecosystem – First version & Final version

T6.3: Strategy for Transformation towards a future intelligent citizen centric transport ITS/CCAM ecosystem for persons and goods

D6.5 & D6.6 – Transformation guidelines towards future transport ITS/CCAM ecosystem – First version & Final version

Based on the extensive research in the previously described section on the left-hand side of the big picture, the results of the comprehensive investigation of the five dimensions merge seamlessly into the two deliverables D6.1 and D6.2, which fall under the task of T6.1. The content of these deliverables, as briefly mentioned above, presents the culmination of careful scientific enquiry and analytical processes that provide a nuanced understanding of the complicated ecosystem of automated mobility.

The first deliverable D6.1, and in particular the final D6.2, acts as a collection of findings, summarising the results of the multiple analyses conducted under the aforementioned dimensions. It serves as evidence of the empirical rigour with which the technical, social, environmental, (socio-)economic and governance dimensions related to automated vehicles in intelligent transport systems and Mobility-as-a-Service ecosystems were investigated. This, of course, goes beyond merely summarising results and provides a strategic narrative that places the findings in the broader context of the ULTIMO project's objectives and the overarching transformation goals for the mobility ecosystem.

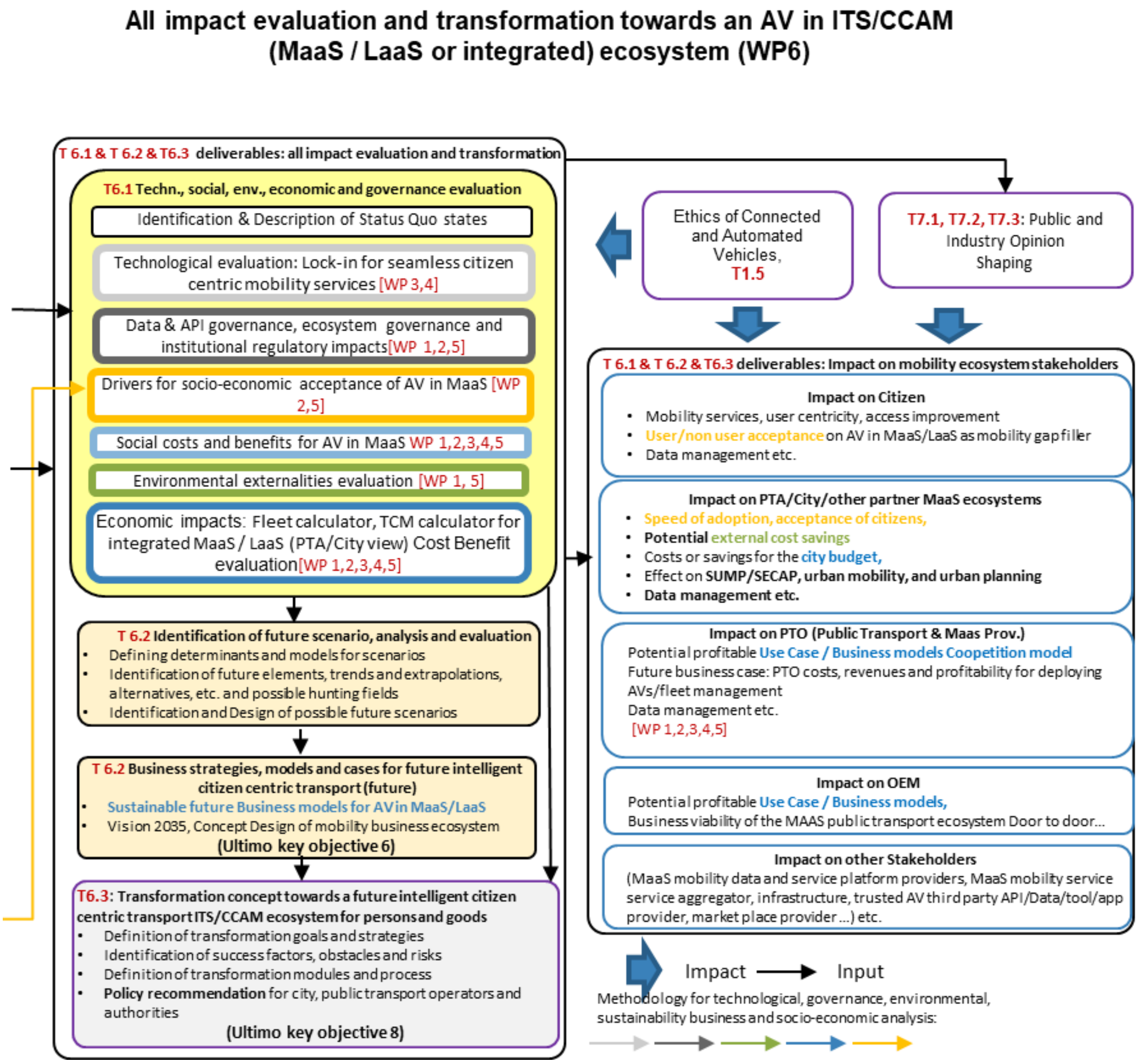


Figure 5: Right part of the Big Picture

The contents of D6.1 and D6.2 are a focused manifestation of the scientific rigour that underpins ULTIMO's efforts, summarising the complexity of automated mobility and its multi-layered implications. The careful integration of data, methods and analyses, as described in Section A, culminates in these findings, which make a significant contribution to the ongoing discourse and understanding of transformative change in the mobility paradigm.

The bottom line is that the final deliverable D6.2, as the project results report for T6.1, presents the detailed analyses of the status quo of the aforementioned five technical, social, ecological, (socio-)economic and governance dimensions.

And this status quo will of course not only be identified and described for the general mobility ecosystem at the European macro level, this analysis and its presentation will of course also be carried out for the meso level of the individual participating countries Germany, Norway and Switzerland and above all for the micro level of the three test areas in Herford, Oslo and Geneva. Ultimately, the various existing status quo states are presented, analysed and interpreted in order to build on them to transform the mobility ecosystem into an integrative, iterative, incremental, citizen-centric future vision of the European mobility ecosystem. It is of course still possible to adjust the objectives and vision throughout the entire project process and this is done depending on the results of the analyses.

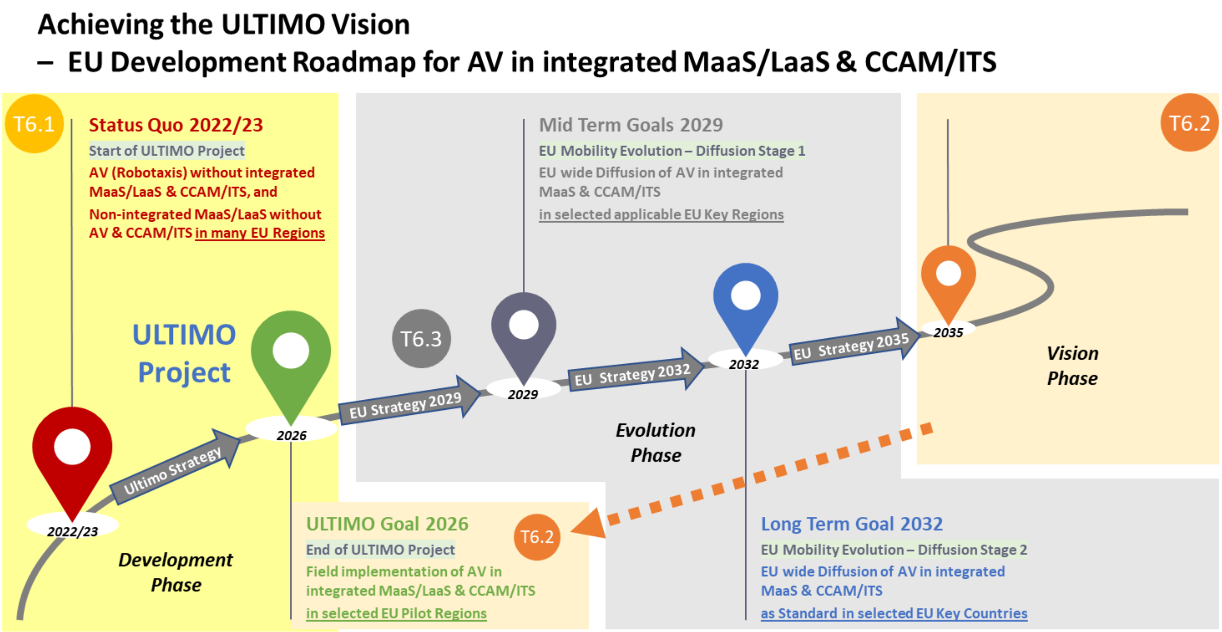


Figure 6: Overview vision for EU mobility ecosystem

In the domain of Task T6.2, and therefore simultaneously within the deliverables D6.3 and D6.4, a conceptual framework, an operational model, and a business development strategy are systematically presented. These components collectively contribute to the formulation of a prospective ITS/CCAM ecosystem that places citizens at its core. This developmental trajectory is complexly rooted in the foundational analyses conducted in T6.1, as shown in Figure 6. The vision for the future ITS/CCAM ecosystem unfolds through a series of discernible stages.

Within this schematic presentation, the project objectives of the ULTIMO strategy traverse from the present day, encompassing the status quo delineated in T6.1, through a development phase, culminating in the realization of the ULTIMO Goal 2026 through on-the-ground implementation. It is noteworthy that the ambit of T6.2 extends beyond the project's temporal confines, projecting its vision into the realm of the EU strategy for automated mobility and envisioning long-term goals leading up to a visionary environment for the mobility ecosystem in 2035.

This forward-looking perspective articulated in T6.2 not only aligns with the overarching project objectives but surpasses them by formulating a distinct vision for the year 2035, concurrent with the EU's strategic trajectory. The formulation of this vision, extending beyond the project's temporal bounds, underscores the proactive stance of ULTIMO in contributing to the broader discourse on the future of mobility. The visionary stance adopted in T6.2 not only complements the project's goals but sets the stage for a sustained and impactful influence on the trajectory of automated mobility beyond the culmination of the ULTIMO project.

Task T6.2 is divided into two different components, each serving a specific purpose: one is visionary, the other pragmatic. The visionary aspect of T6.2 aims to carefully identify, analyse and evaluate a future scenario in the field of mobility and transport. This visionary endeavour is based on analysing likely developments and seeks to provide a comprehensive understanding of the complex ecosystems that await us in the future. The pragmatic aspect of T6.2, on the other hand, is focussed on identifying business strategies, models and exemplary cases that can be used to shape a future intelligent, citizen-centric mobility and transport ecosystem. This pragmatic view takes into account the practical implications and business considerations associated with the envisioned future and aims to derive concrete strategies and models that can guide the realisation of the proposed vision.

As part of the visionary component, T6.2 conducts a multi-faceted analysis that focuses on identifying transformative elements, analysing their impact and evaluating the envisaged future scenario. This endeavour is in line with the overall objectives of ULTIMO and emphasises a future-oriented perspective that goes beyond the immediate project boundaries. At the same time, the pragmatic part of T6.2 includes a careful examination of business dynamics, strategies and practical cases that can be used to implement the proposed smart, citizen-centred mobility ecosystem. This pragmatic view ensures that visionary aspirations are not limited to theoretical constructs, but are underpinned with realisable strategies and models that meet the needs of real-world implementation. Essentially, through its dual focus, T6.2 seeks to bridge vision and practice, creating a comprehensive narrative that not only presents the future of mobility, but also lays the foundations for its strategic and practical realisation. This two-pronged approach adds depth and richness to the scientific enquiry and positions T6.2 as a central phase within the broader ULTIMO research framework. And this is presents the ULTIMO key objective 6.

Task 6.3 will build on the basic work of T6.1, which provides a detailed status quo analysis and future scenarios. It will utilise the future vision outlined in T6.2 to delve into the technical, social, economic, environmental, legal and political dimensions that will determine success or barriers in the mobility ecosystem. This task aims to conduct a thorough stakeholder analysis, define transition goals and develop comprehensive transition strategies along with viable business models. An important outcome will be an overarching implementation plan coupled with a detailed roadmap for EU market access and practical application measures. In addition, a transition plan will be outlined that aims to promote a sustainable, smart and citizen-centred ecosystem for personal and small goods transport. Particular attention will be paid to striking a balance between the different interests of stakeholders to maximise the common good while identifying and overcoming regulatory challenges. To ensure the involvement of all stakeholders in scenario planning, a novel approach is used that combines scenario thinking with the personas method and enables the creation of detailed, personalised narratives.

The comprehensive conceptual frameworks for all impact evaluation and transformation in T6.1, T6.2, and T6.3 aim to facilitate the generation of the deliverables which is also impacted by the results of T1.5: Ethics of Connected and Automated Vehicles. The significance of these initiatives lies in their collective potential to drive the transformation of the entire mobility ecosystem, encompassing all relevant stakeholders from an aggregated and strategic perspective:

- **Citizens**
- **PTA/City/other partner MaaS ecosystems)**
- **PTO (Public Transport & Maas Prov.)**
- **OEM**
- **Other Stakeholders**

(such as MaaS mobility data and service platform providers, MaaS mobility service aggregators, infrastructure, trusted AV third party API/Data/tool/app provider, marketplace provider, etc.)

However, the successful implementation of this strategic transformation concept requires more than just an integrated strategic framework. It requires a differentiated and individualised perspective as well as a strategic approach at stakeholder level within the complex mobility ecosystem. At its core, the concept of strategic transformation embodies a vision for the future of the mobility ecosystem, a plan for change that goes beyond conventional boundaries. However, for this vision to be translated into concrete and impactful outcomes, a dual focus is essential: one that not only includes the macro-level strategic considerations, but also examines the microcosm of individual stakeholder dynamics. The nuances of the mobility ecosystem are multifaceted and involve a multitude of stakeholders with different roles, interests, and responsibilities. To successfully manage this complexity, an individualised approach for each stakeholder group is essential. This includes a thorough understanding of the unique challenges, ambitions and operational intricacies specific to each stakeholder in the mobility ecosystem. In essence, the success of the strategic transformation concept hinges on the amalgamation of the broader strategic vision with the detailed, stakeholder-centric strategies. It is not a one-size-fits-all endeavour but a mosaic of tailored interventions that collectively contribute to the realization of the overarching transformational goals. This dual-tiered approach ensures that the impact of the strategic concept resonates effectively and sustainably throughout the diverse landscape of the mobility ecosystem, fostering a harmonious convergence of macro and micro perspectives. And these is analysed in WP6.

This approach not only provides pragmatic concepts but also serves as a valuable tool in addressing a fundamental question:

'How does the transformation process, at the level of the entire ecosystem, influence the goals, tasks, and operational activities of the key stakeholders?'.

In examining this question, the approach provides a comprehensive framework that goes beyond the theoretical and moves into the practical details of the transformation process. By analysing the impact at the level of the entire ecosystem, it offers insights into the dynamic interplay between the transformation processes and the day-to-day functions of key stakeholders. The holistic perspective afforded by this approach enables a nuanced understanding of how the goals and tasks of stakeholders are both influenced by and contribute to the broader ecosystem transformation.

The transformation of (key) stakeholders towards an AV in ITS/CCAM ecosystem, whether in the context of Mobility as a Service (MaaS), Logistics as a Service (LaaS) or integrated system, essentially follows the same general methodology as analysed in the previous chapters in the holistic strategic transformation process. This methodology, carried out at the ecosystem level, involves a sequential order from the assessment of the status quo to the assessment of the future, resulting in the formulation of a transformation concept. However, when this methodology is applied at the stakeholder level, a more individualised and detailed approach is applied. At the stakeholder level, the transformation pathway is characterised by a detailed examination of how individual and key stakeholders within the ecosystem are adapting to the introduction of automated vehicles. While the general methodology remains consistent, its application becomes more targeted and focussed on the specific dynamics, needs and goals of individual stakeholder groups.

At this level, stakeholders can be broadly characterized using identical categories across each strategic planning phase—Status Quo, Future, and Transformation Concept. These generic characterizations encompass aspects such as roles, characteristics, strategic direction, collaboration, and value contribution, among others. These criteria serve as exemplars for understanding and categorizing stakeholders in the context of the transformative process. In the initial phase of Status Quo evaluation, these generic categories act as foundational elements for assessing the existing state of stakeholders. Roles played by each stakeholder, their inherent characteristics, the strategic directions they currently follow, collaborative efforts they engage in, and the value they contribute to the ecosystem are pivotal factors in comprehending the current landscape. Moving forward to the Future evaluation phase, these same categories become instrumental in envisioning the evolution of stakeholders. Delving into how roles might shift, characteristics adapt, strategic directions transform, collaborations expand or refine, and the evolving value contribution of each stakeholder provides a forward-looking perspective. This anticipatory analysis aids in aligning stakeholders with the envisioned future state of the ecosystem. Finally, in the Transformation Concept phase, these generic characterizations guide the formulation of strategies tailored to each stakeholder group. Understanding the dynamic interplay of roles, characteristics, strategic direction, collaboration, and value contribution is crucial for crafting interventions that seamlessly integrate with the overarching transformation goals. The Transformation Concept, therefore, becomes a bespoke roadmap that accounts for the unique considerations of each stakeholder, fostering a cohesive and effective transition:

1. Role

- What are the stakes (interest profile) of a specific stakeholder towards mobility and the mobility ecosystem?

This question seeks to understand the interests and preferences of a particular stakeholder concerning mobility and the broader ecosystem. It delves into the motivations, goals, and key concerns that drive their engagement and participation within the mobility landscape.

- Which challenges and tasks is a specific stakeholder facing?

This question focuses on identifying the specific obstacles and responsibilities confronting a particular stakeholder. It aims to outline the challenges they encounter in their role within the mobility ecosystem and the tasks they must undertake to navigate and contribute effectively.

- Which tasks is a specific stakeholder responsible for (ownership)?

Here, the emphasis is on delineating the tasks and activities for which a specific stakeholder holds ownership and responsibility. It seeks to define the areas where a stakeholder has a direct impact and control, outlining the scope of their influence and contributions to the mobility ecosystem.

2. Character

- What is the Profile of Attitude and Behaviour (Culture) of the specific stakeholder?

This question explores the prevailing attitudes and behaviours, often encapsulated in the organizational culture, of a specific stakeholder. Understanding the cultural nuances helps in grasping the mindset, values, and approaches that influence their actions within the mobility ecosystem.

- How is the Organization (Structure/Processes) designed or must be designed for fulfilling the tasks?

This question delves into the organizational aspects, including structure and processes, to understand how a stakeholder's entity is configured to meet its responsibilities. It seeks to identify the organizational design necessary for effective task fulfilment within the dynamic context of the mobility ecosystem.

- Which Competencies and Technologies does a specific stakeholder need or which competency profile is required?

Here, the focus is on determining the essential competencies and technologies that a specific stakeholder must possess or develop. This includes identifying the skill sets, knowledge base, and technological capabilities required for the stakeholder to excel in their role within the mobility ecosystem.

- Which Offerings does or shall a specific stakeholder provide?

This question revolves around the products, services, or solutions that a stakeholder offers or intends to offer within the mobility ecosystem. It seeks to define the tangible contributions and value propositions that the stakeholder brings to the table, elucidating their role as a provider within the ecosystem.

- How is the specific stakeholder characterized by SWOT categories?

This question employs the SWOT analysis framework to assess the specific stakeholder's Strengths, Weaknesses, Opportunities, and Threats. It provides a holistic view of their internal capabilities and limitations, as well as the external factors and challenges they face. This analysis aids in strategic planning and decision-making for the stakeholder within the mobility context.

3. Strategic Direction

- Strategic Goals of the Specific Stakeholder

This section is about explaining the strategic objectives of a particular actor within the mobility ecosystem. It is about identifying and analysing the long-term goals and priorities that guide the actor's actions and decisions and shape its role and impact within the broader mobility landscape.

- Designed or Required Strategies of the Specific Stakeholder

The focus here is on presenting the strategies that a particular stakeholder has formulated or needs to develop in order to achieve its strategic goals. This includes examining approaches, plans and initiatives to overcome challenges, capitalise on opportunities and improve their own position in the mobility ecosystem.

- Current or Targeted Value Proposition of the Specific Stakeholder

This question addresses the unique value proposition that the stakeholder offers or intends to offer to the mobility ecosystem. It seeks to define the specific benefits, features and differentiators that make the stakeholder's offering attractive to customers, partners and other ecosystem participants.

- Designed Business Models of the Specific Stakeholder

This section analyses the business models that a particular stakeholder has developed or plans to implement. It includes an analysis of how the stakeholder creates, delivers and captures value, and describes the mechanisms by which it maintains its operations and contributes to the mobility ecosystem.

4. Collaboration

- Ecosystem Partnerships a Specific Stakeholder is Part of

This part examines the networks and partnerships a stakeholder is involved in within the mobility ecosystem. It aims to identify the ecosystems, alliances, and consortia the stakeholder is a member of, highlighting their role and contributions to collaborative initiatives.

- Partners a Specific Stakeholder is Collaborating With

Here, the emphasis is on identifying the key partners with whom a specific stakeholder collaborates. It explores the nature of these partnerships, focusing on strategic alignments, mutual goals, and the collaborative efforts undertaken to enhance the mobility ecosystem.

- Details of Partner Collaboration

This question provides an in-depth look at the specifics of collaborations between the stakeholder and their partners. It covers areas such as joint development projects, innovation initiatives, and sales collaborations, offering insights into how these partnerships function and contribute to the stakeholder's strategic objectives.

5. Value Contribution

- Values or Value Proposition Contributed by the Specific Stakeholder

This section aims to articulate the tangible and intangible values, concrete offerings, and unique selling propositions (USPs) that a specific stakeholder contributes to their partners, the mobility ecosystem, and the mobility topic at large. It seeks to highlight the stakeholder's impact, differentiators, and the benefits they bring to the table.

- Values Provided by the Specific Stakeholder towards AV in ITS/CCAM

Here, the focus is on detailing the specific values and contributions provided by the stakeholder towards Automated Vehicles (AV) in Intelligent Transportation Systems (ITS) and Cooperative, Connected, and Automated Mobility (CCAM). This includes exploring how the stakeholder supports innovation, safety, efficiency, and other key aspects within these specialized domains of the mobility ecosystem.

2.4 Input from the predecessor project AVENUE and from Task T6.1

2.4.1 Input from AVENUE

The AVENUE project, which was funded under the European Union's Horizon 2020 programme from May 2018 to September 2022 (grant agreement No. 769033), focused on the integration of automated minibuses (AMs) into a MaaS/ITS ecosystem to improve cost-attractiveness, efficiency and sustainability in public transport. The project's vision provides a transformative approach for future mobility ecosystems focusing on connected, cooperative and automated mobility (CCAM) and outlines a strategic roadmap from the status quo during the project lifetime (somewhat 2020) to a vision for 2030 that emphasises the integration of AMs into MaaS/ITS ecosystems to achieve economic efficiency, sustainability and improved public transport services.

The roadmap is based on the results of work package WP8, which analysed potential future scenarios and business models for CCAM and identified the integration of AMs into MaaS/ITS as the most viable approach. This integration was analysed using various analytical tools, including the Business Canvas and SWOT analysis. However, there are significant challenges to realising this vision, such as technological barriers, regulatory frameworks and the need for economies of scale and scope. AVENUE finally acknowledged that these obstacles need to be overcome to achieve cost attractiveness, in particular the reduction in the number of safety drivers and their eventual replacement by supervisory functions, a transition that is currently hindered by technological and regulatory constraints.

The recommendations for realising Vision 2030 involve a wide range of stakeholders, including vehicle manufacturers, service providers, public transport operators (PTOs), public transport agencies (PTAs) and the EU itself. Key strategies include standardising vehicle designs, using data and artificial intelligence to improve the capabilities of AVs, clarifying business models, fostering alliances between European manufacturers, integrating AMs into mobility planning and initiating public awareness campaigns to increase the uptake of AM-based mobility solutions. The results of AVENUE emphasise the need for a holistic approach that takes into account social, environmental and economic factors. This includes integrating AM into strategic planning to realise its potential to improve public transport systems, reduce the environmental footprint and provide cost-effective, inclusive mobility solutions. Public and private stakeholders are encouraged to work together to ensure interoperability, regulatory compliance and the creation of a favourable environment for the introduction of innovative mobility services.

To summarise, the AVENUE vision roadmap provides a comprehensive guide for the transition to a sustainable, efficient and citizen-centric mobility ecosystem. By addressing technical, legal and market challenges, it lays the foundation for the widespread deployment of AVs as part of MaaS/ITS and aims to revolutionise urban transport by 2030.

2.4.2 Input from T6.1

The deliverable "D6.1 Multivariate Evaluation of ULTIMO CCAM Ecosystem" provides a first baseline analysis of efforts to integrate AVs into MaaS/LaaS with the aim of a sustainable, commercially viable future for both public and freight transport. Despite previous projects in the EU focussing on AVs, challenges such as non-viable business models, lack of scalability and insufficient user-centric services have hindered the transition from testing to large-scale commercial deployment, or, for example, the AVENUE project described above has identified the need for more detailed analysis.

The deliverable is divided into a number of key dimensions of an impact assessment, four of which are important for the transformation process in Task T6.3:

2.4.2.1 Governance Impact Assessment:

Data governance: Emphasises the need for a robust data governance framework to manage the vast data generated by AVs and advocates for open APIs and data to ensure interoperability and maximise benefits for all stakeholders, especially users and the population at large. The alignment of the ULTIMO project with the European data strategy aims to create a single data market to enable safer and cleaner transport systems through standardised data access and exchange.

Regulatory Analysis: Concentrates on navigating the complex regulatory landscape for the integration of AVs into MaaS. It highlights the challenge of reconciling technological advances with regulatory frameworks and proposes a collaborative governance model to address specific regulatory barriers at national and local levels, emphasising the potential of public transport authorities and operators in fostering innovation within regulatory boundaries.

2.4.2.2 Economic Impact Assessment:

Consists of a cost-benefit analysis and dynamic price modelling. The analysis identifies gaps in empirical data for the design of sustainable business models and the need for comprehensive economic assessments. It explores innovative models for value creation and the implementation of seamless transport services using the Total Cost of Mobility (TCM) approach. Dynamic pricing strategies are explored to support cross-sector business models, with a focus on integrating AI-based algorithms for pricing and improving decision making in the AV in MaaS ecosystem.

2.4.2.3 Social Acceptance:

The aim is to understand and improve user acceptance of AV in MaaS. This includes developing surveys to explore the behaviour and acceptance of potential users, assessing how AV services could change mobility behaviour and focusing on reducing private car use.

2.4.2.4 Environmental Impact Assessment:

Analyses the external costs and environmental impacts of integrating AVs into MaaS. This includes the assessment of potential externalities and the application of a life cycle perspective to provide insights into the hidden mobility/transport costs for society and to promote sustainable mobility solutions.

Overall, the ULTIMO project applies the SUMP methodology to tackle the complexity of integrating AVs into mobility ecosystems. This approach is designed to fulfil people's mobility needs, improve quality of life and foster cooperation between different stakeholders, including public authorities, businesses and citizens. By engaging stakeholders, assessing impact scenarios and developing long-term visions and strategies, the ULTIMO project seeks to create a sustainable, smart and citizen-centred mobility ecosystem that is in line with the European concept of urban transport planning.

In the following, we present the transformation concept from the status quo of the current mobility ecosystem to the ULTIMO Vision 2035.

3 Transformation concept and business development

3.1 Introduction to the Transformation Concept

This chapter describes the fundamental aspects of the ULTIMO transformation and aims to provide a structured way to integrate different facets of strategic planning and implementation within the ULTIMO project:

1. Understanding of interdependencies with other chapters of the deliverable representing different views and concepts of ULTIMO planning (e.g. Big Picture)
2. Framework for systemic and systematic transformation planning by definition and assignment of transformation work packages.
3. Preliminary suggestions (templates) for pragmatic deployment of transformation work packages

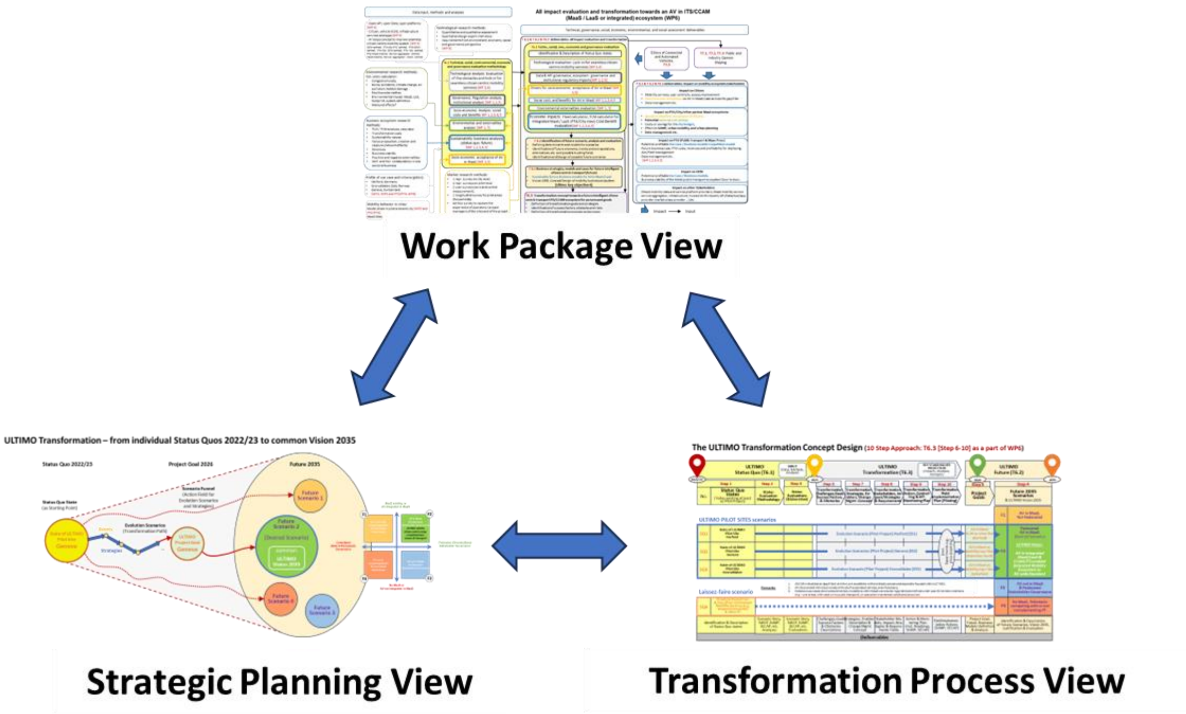


Figure 7: Three different but complementarily integrated Planning Views on ULTIMO Transformation (the individual charts are located at different places in the document in a higher resolution, but for completeness they are also included in the appendix in full page format

In the context of ULTIMO planning, there is a multi-layered perspective that encompasses several different but interconnected views. Among these, the transformation process perspective occupies a central position as it is closely linked to the broader strategic framework of scenario development as expressed in the strategic planning perspective and presented in Deliverable D6.3 for Task T6.2. This alignment is not merely coincidental, but a deliberate integration aimed at ensuring a coherent and consistent approach to planning. Furthermore, the transformation process view is seamlessly integrated with the work package view, which is comprehensively illustrated in the Big Picture above. This Big Picture serves as a visual and conceptual fusion of the various planning elements and symbolises the holistic and interconnected nature of the ULTIMO planning process. Together, these views form a coherent framework, with the transformation process view acting as the centrepiece. This complex alignment emphasises the importance of a unified planning approach, where different perspectives and methodologies come together to create a coherent and strategic roadmap for ULTIMO's development and transformation (see Figure 7).

The development of the ULTIMO Transformation Process, envisioned as a structured roadmap, is fundamentally anchored in the Work Packages' architecture and thematic content, as detailed in the Big Picture. This foundation ensures that the transformation process is both logical and actionable, with each step informed by the strategic objectives and operational insights outlined in the Work Packages. This alignment guarantees a coherent progression towards achieving the project's overarching goals, making the roadmap not only strategic but also practical in its execution (Berryman 2023) (see Figure 8).

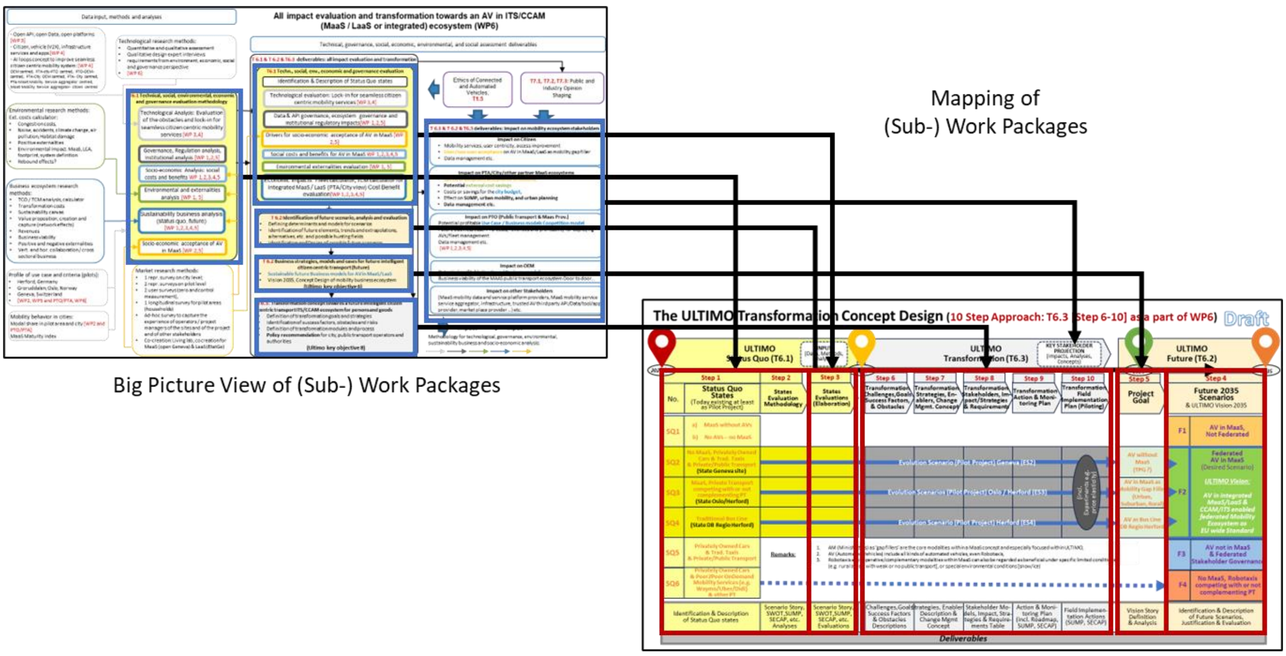


Figure 8: Mapping of Work Packages ('Big Picture' View) (see comment on chart above)

The ULTIMO Transformation occupies a pivotal role as the core component of the Development Phase within the ULTIMO project, spanning from the inception in 2022/23 to its culmination in 2026. Concurrently, it serves as the foundational upstream module for the Evolution Phase, targeting advancements in AVs within MaaS/LaaS and ITS/CCAM. This dual positioning underscores its significance, marking it as both a cornerstone of the current developmental efforts and a critical precursor to the subsequent evolution stages of the project. This constellation is represented in Figure 9.

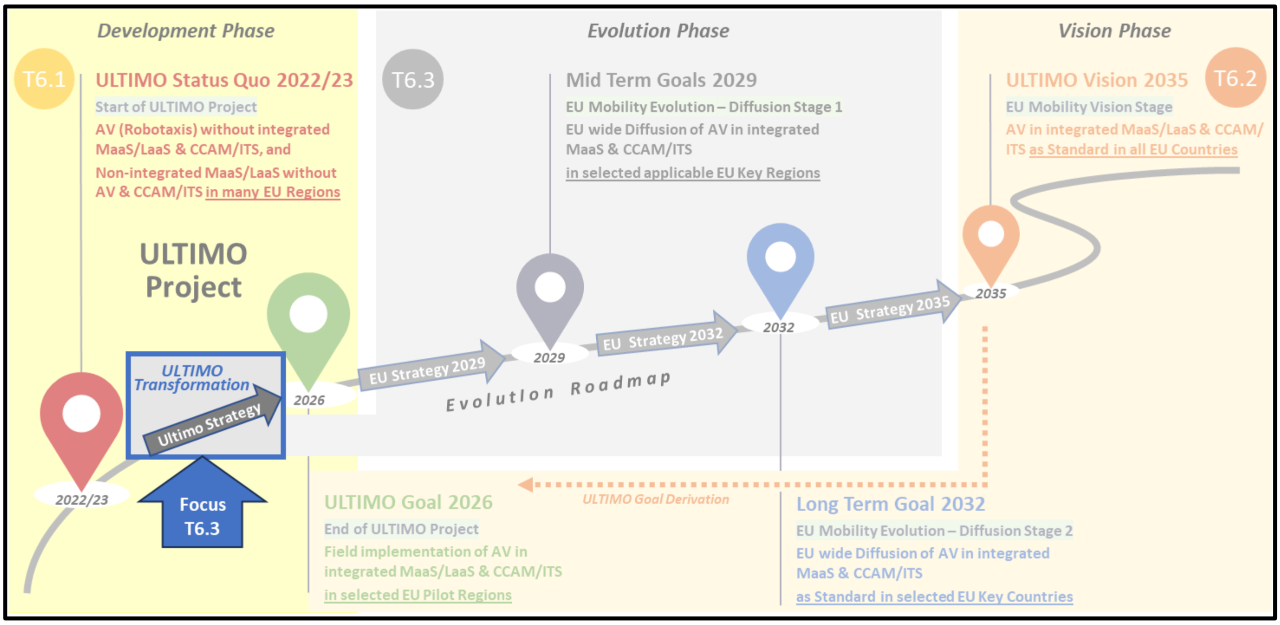


Figure 9: The ULTIMO Transformation Phase within the Roadmap for AV in MaaS/LaaS and ITS/CCAM

While the Transformation has a central subproject character within the ULTIMO project, the Evolution Phase can be characterized as a long-term transition beyond the ULTIMO Status Quo aiming to achieve the ULTIMO Vision 2035 and structured by a sequence intermediate term and long-term goals.

In this sense the ULTIMO Goal 2026 is derived from the Vision 2035 (retropolation) the ULTIMO Transformation plays an ignition role for the evolution (extrapolation) of AV in MaaS/LaaS and ITS/CCAM starting from the ULTIMO Status Quo 2022/23. This understanding leads to a timely rather simultaneous integration or overlaps of AV in MaaS/LaaS and ITS/CCAM development, evolution and visioning supporting the design of incremental iterative development.

3.2 Introduction to the 3 generic design phases

The business development of ULTIMO can be structured into 3 generic design phases (Pillkahn 2007) as shown in Figure 9:

- Phase 1: strategic analysis of the ULTIMO Status Quo, represented by the status quo of the focused pilot projects as project focus (Project Task T6.1),
- Phase 2: strategic foresighting and design of the ULTIMO Future, represented by the desired ULTIMO Scenario the identified ULTIMO vision 2035 within this scenario, and the derived ULTIMO Goal to be achieved in 2026 (Project Task T6.2), and
- Phase 3: planning and elaboration of the ULTIMO Transformation from Status Quo 2022/23 to Future Vision in 2035 (Project Task T6.3).

With this structure the logic of the business development within the ULTIMO project can be described in three steps:

1. Identify and analyse 'Where we stand today',
2. Identify and foresight 'What we want to achieve', and
3. Plan and elaborate 'How we can get successfully from today to our future vision'.

Regarding the ULTIMO Project which is timely limited to 2026 the individual ULTIMO project goal 2026 for a focused pilot site is derived from the desired ULTIMO Future scenario.

For a focused pilot site, the according ULTIMO Transformation from the Status Quo 2022/23 to the ULTIMO Project Goal 2026 is structured into a sequence or path of transformation steps guided by respective transformation strategies.

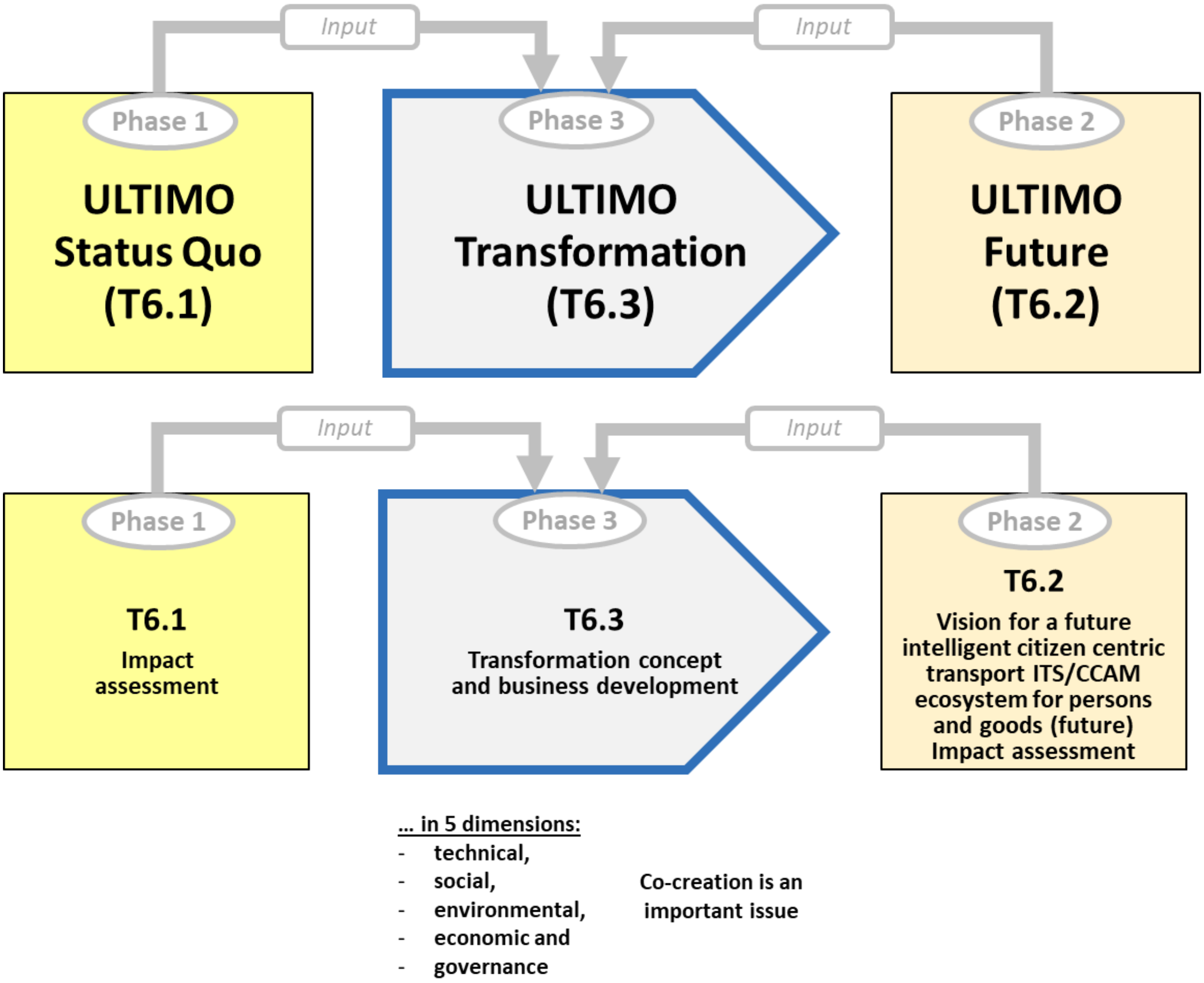


Figure 10: The Generic ULTIMO Design Process Phases as generic and pragmatic building blocks for AV in MaaS/LaaS and ITS/CCAM business development

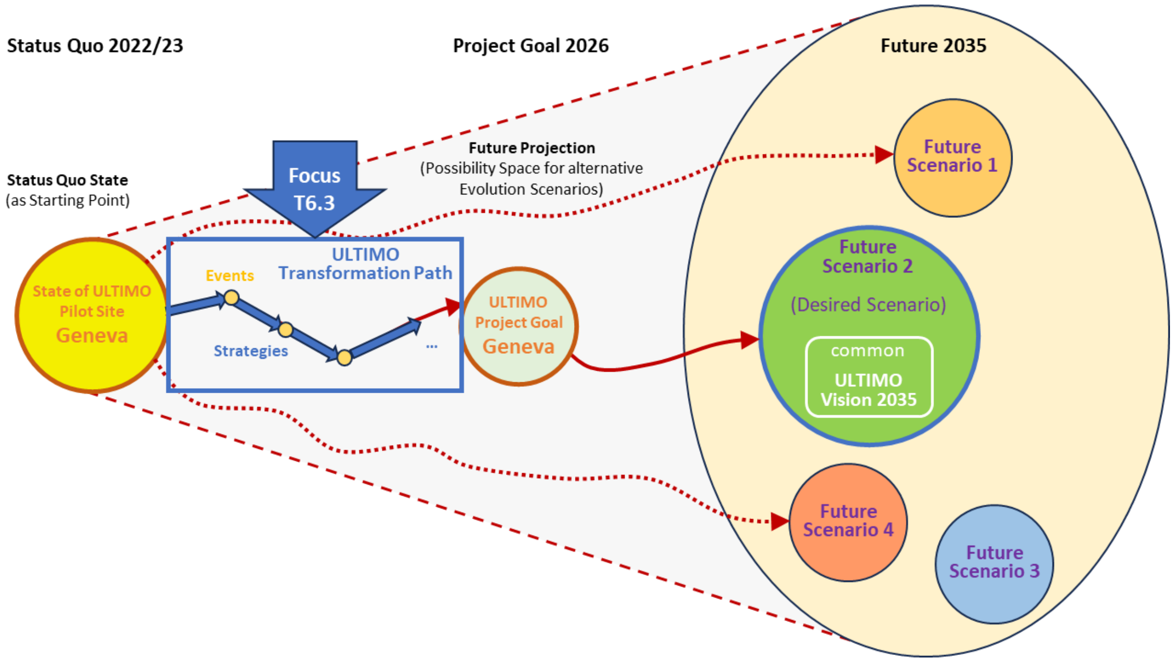


Figure 11: The ULTIMO Transformation Path of a focused pilot site (example: Geneva)

The aggregated overview across all focused ULTIMO pilot sites shows, that the Status Quo state of each pilot site is different and individual. Although the desired Future Scenario and the common vision 2035 of all pilot sites is identical the individual Project Goals 2026 of each pilot site could be different. Therefore, the individual Transformation Paths (steps, strategies) of the pilot sites could also be different and individual [see visualization in figures 11 & 12]. This insight leads to the consequence that the strategic transformation planning aspects (success factors, obstacles, strategies, goals, change concept, etc.) and thus the aggregated transformation plan among the focused pilot sites could be different.

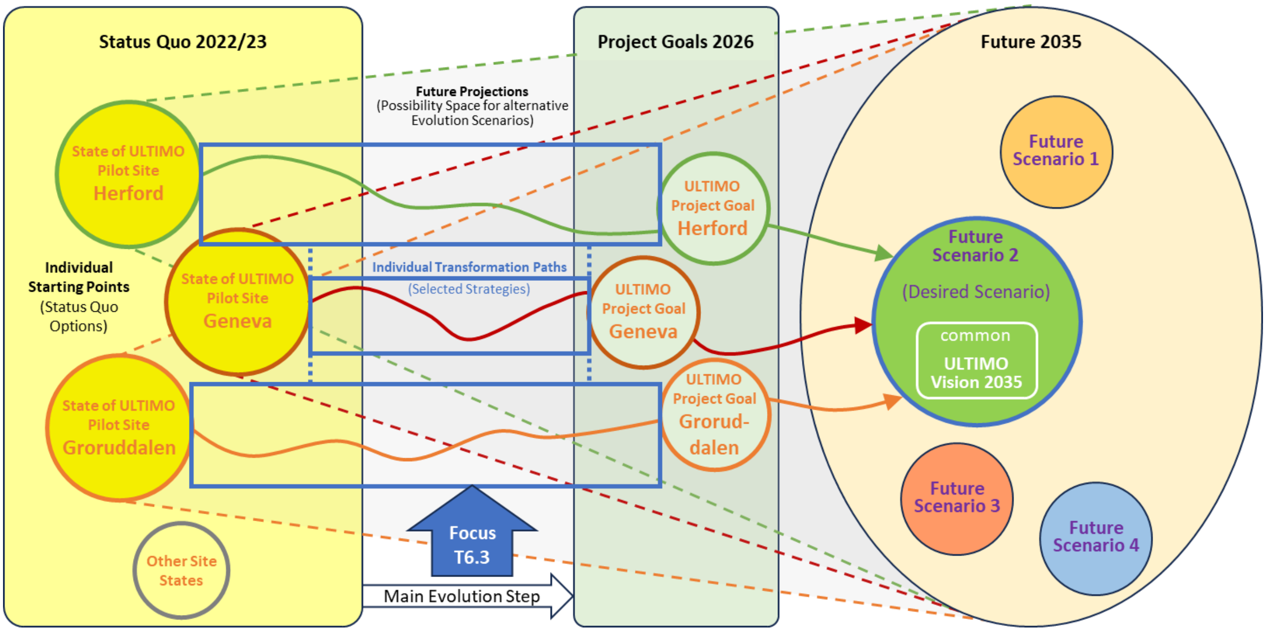


Figure 12: The ULTIMO Transformation Paths of different pilot sites (examples: Geneva, Herford, Groruddalen)

Based on these conceptional preparation it is possible to elaborate a more detailed and comprehensive concept design for the ULTIMO Transformation focusing on the different ULTIMO pilot sites and following the generic design phases shown in Figure 12.

As a main principle of this comprehensive concept design as shown in Figure 13 below, is that for the transformation elaboration in this project:

1. only the focused pilot sites are regarded specifically.
2. each of the focused pilot sites follows the same standardized steps (tasks) as subphases of the three generic phases and provides the same step specific deliverables.
3. with this design the differences between the individual pilot sites and their Status Quo and Transformation Characteristics can be pointed out and compared and cross-site transformation learnings and inspiration can be ensured.
4. The transformation concept is directly aligned by structure and content with the big picture of this project.

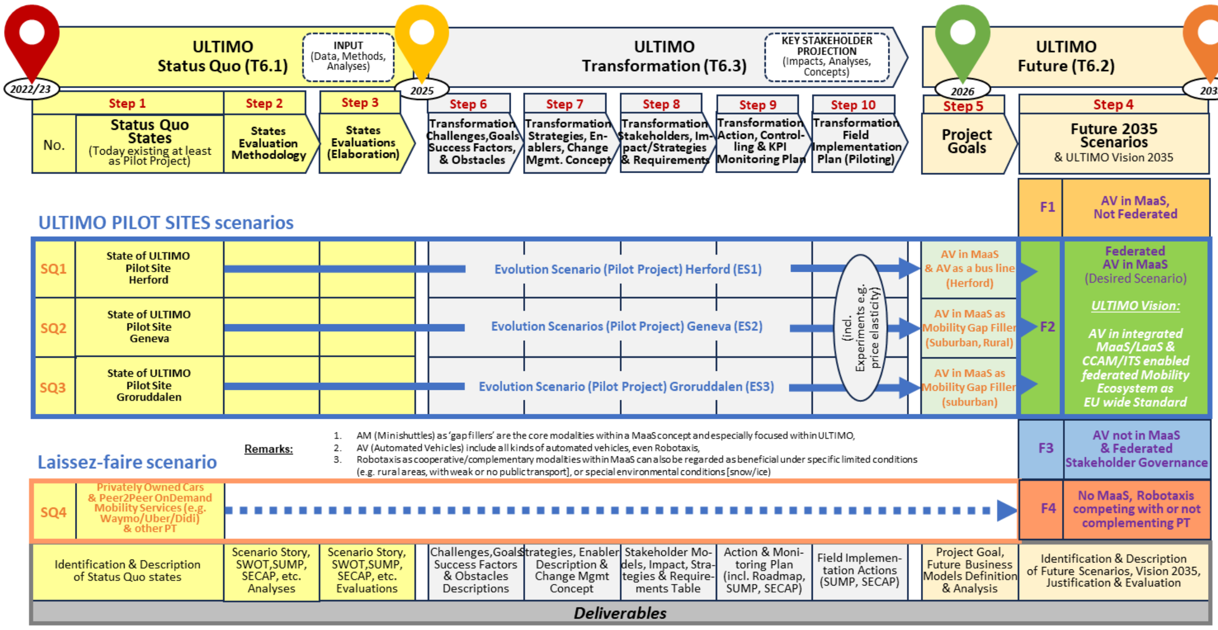


Figure 13: The ULTIMO Transformation Concept Design (Overview)

3.3 Introduction to the Status Quo Identification

A detailed view on the ULTIMO Status Quo elaboration (T6.1) in Figure 14 as basis and starting point of the ULTIMO Transformation shows that after the identification and description of the Status Quo States (Step 1) of each focused pilot site (blue frame) it is an essential task to analyse (Step 2) and evaluate (Step 3) the individual pilot site Status Quo in using dedicated methodologies and models, like: storyline, SWOT, SUMP, SECAP/FAME, etc..

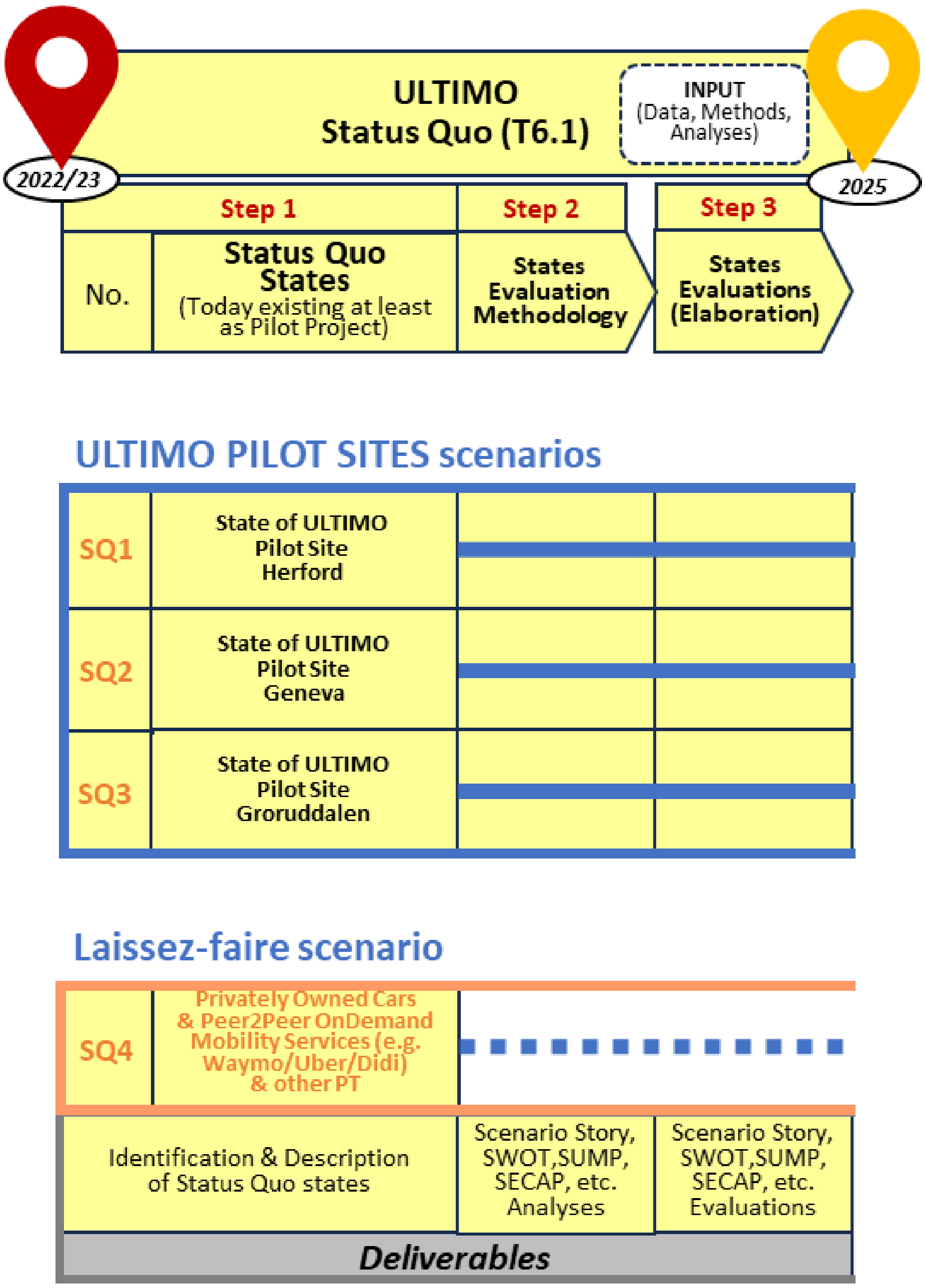
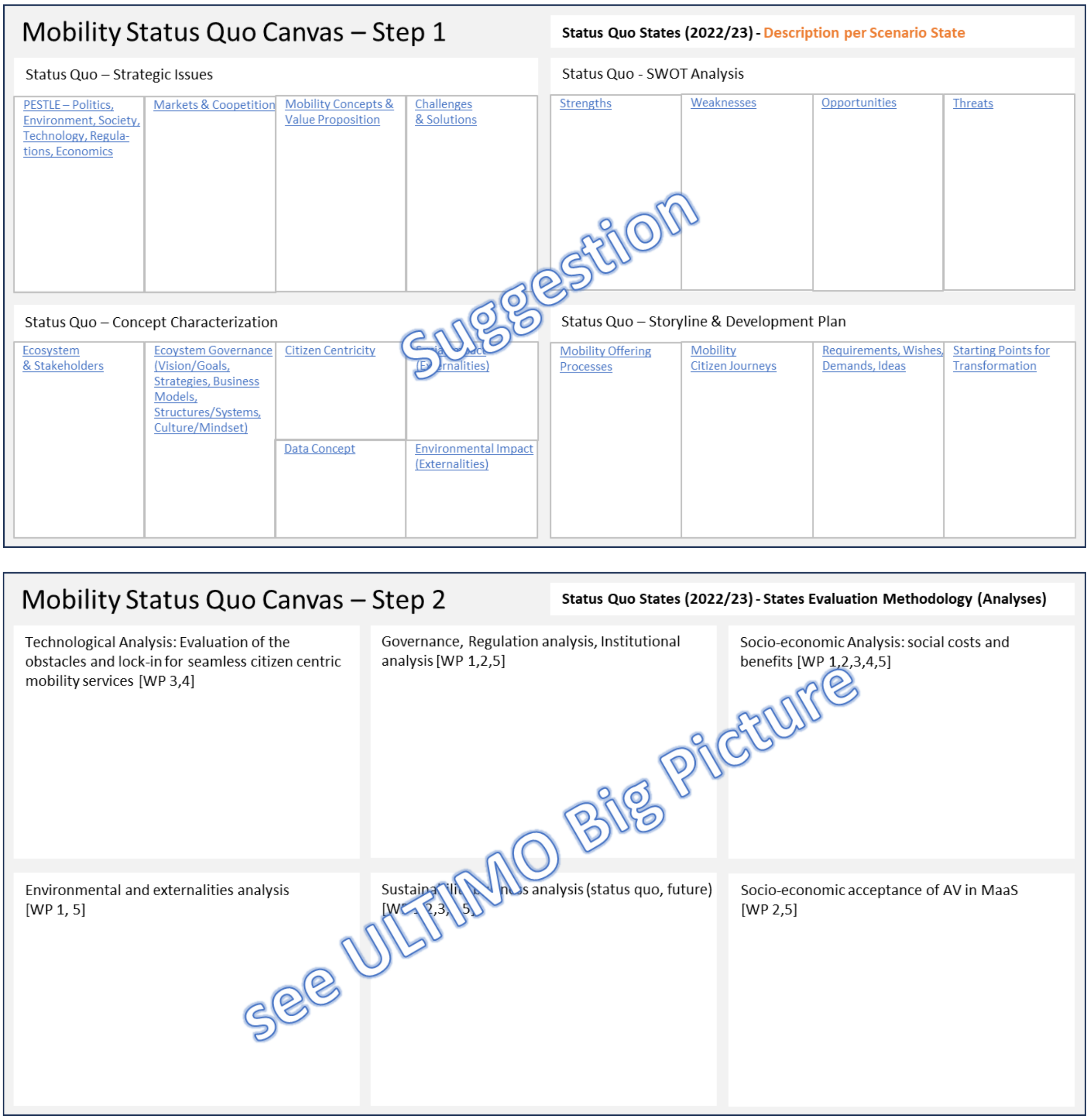


Figure 14: ULTIMO Status Quo Identification and Analysis Phase as preparation for the ULTIMO Transformation

For a common understanding as well as a structured and standardized elaboration of the steps 1-3 of the ULTIMO Status Quo across Status Quo states or for each single one it is necessary to use a set of canvas representations for a quick overview or as an overview guide for more detailed attachments. The following canvases (see Figure 15) for Status Quo steps are suggestions which could define the most important issues necessary as a basis for elaboration of subsequent ULTIMO Future 2035 design steps.



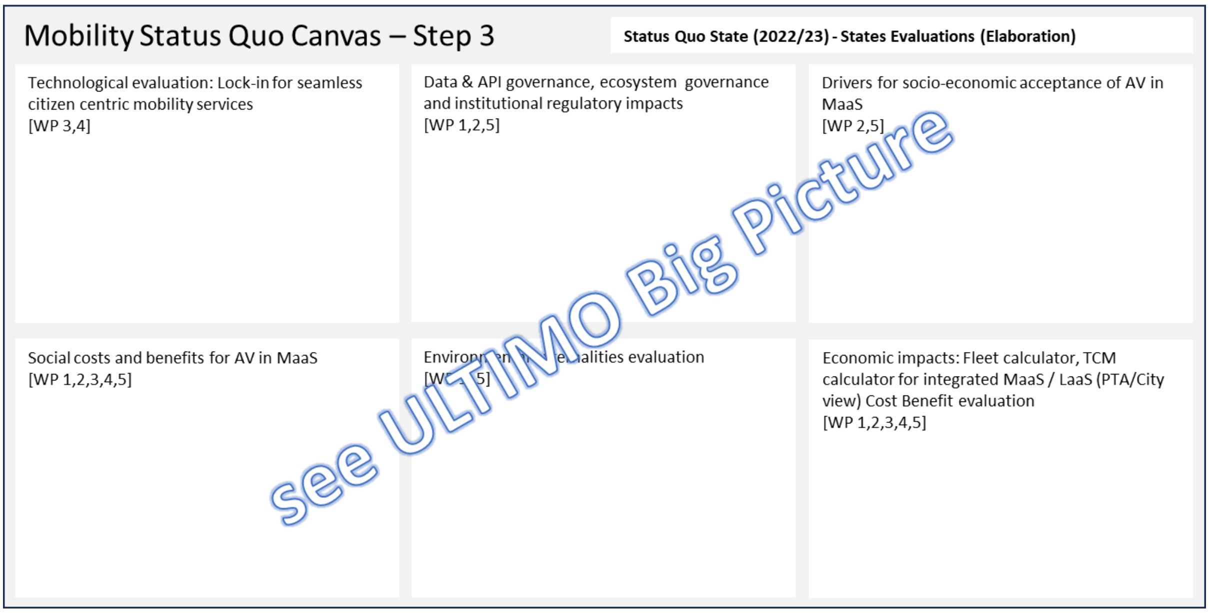


Figure 15: Canvas method representations for Status Quo steps of the ULTIMO Transformation Concept

Another detailed view on the second step of the generic design phases shows the Future 2035 Scenarios and Project Goals 2026 elaborated in Task (T6.2) as target of the ULTIMO Transformation. While the desired scenario and the vision for ULTIMO is identical for all pilot sites and must be described, justified, and evaluated as concrete as possible (Step 4), it is an important task to derive achievable (SMART) Project Goals 2026 and achievable Business Models from this ULTIMO vision individually for each pilot site, and define and analyse them in all relevant details (Step 5).

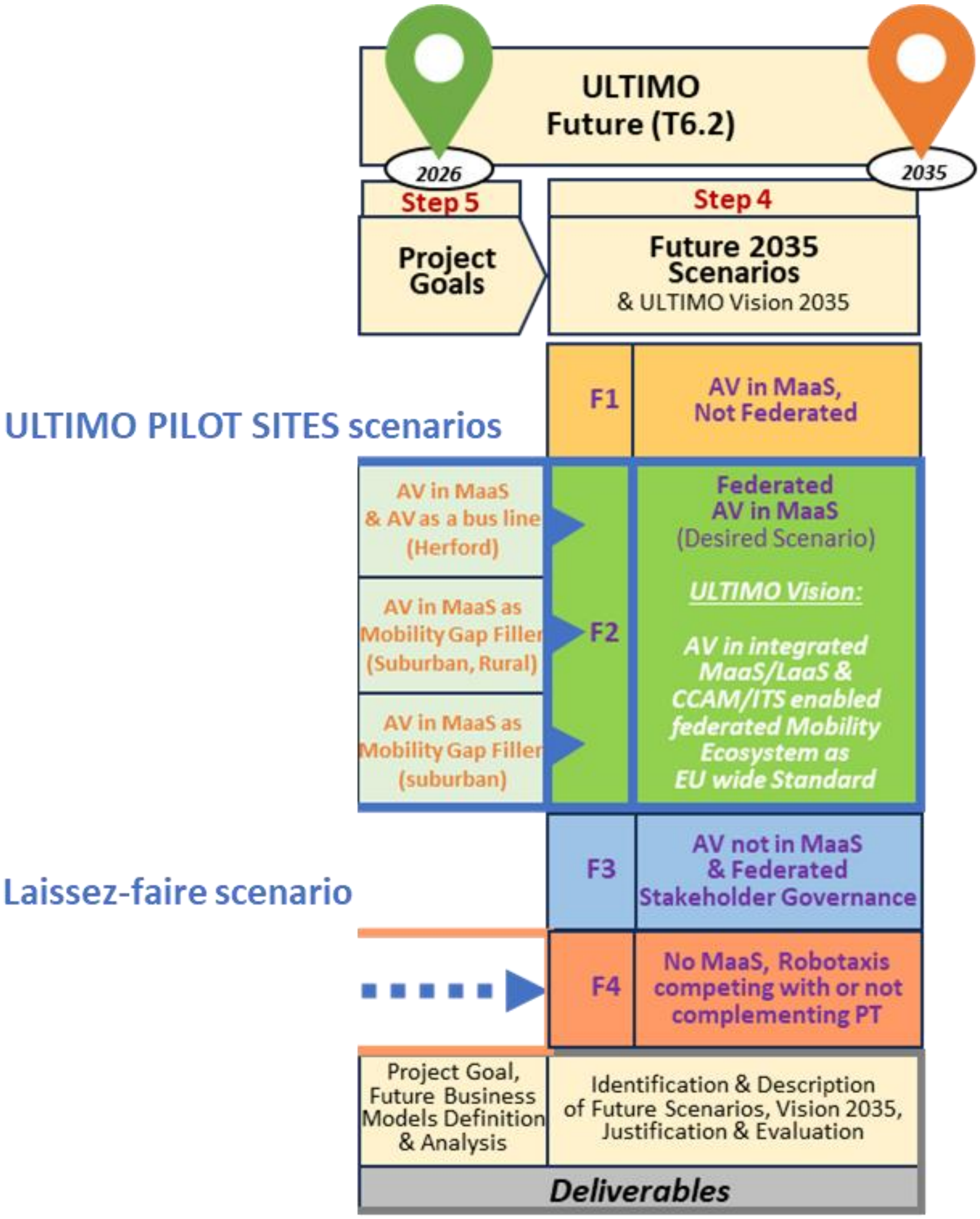


Figure 16: ULTIMO Future 2035 Foresighting and Design Phase as preparation for the ULTIMO Transformation

3.4 Introduction to the future 2035 design steps

The following set of canvases [see Figure 17] for Future 2035 design steps are suggestions which could define the most important issues necessary as a basis for elaboration of the subsequent ULTIMO Transformation design steps.

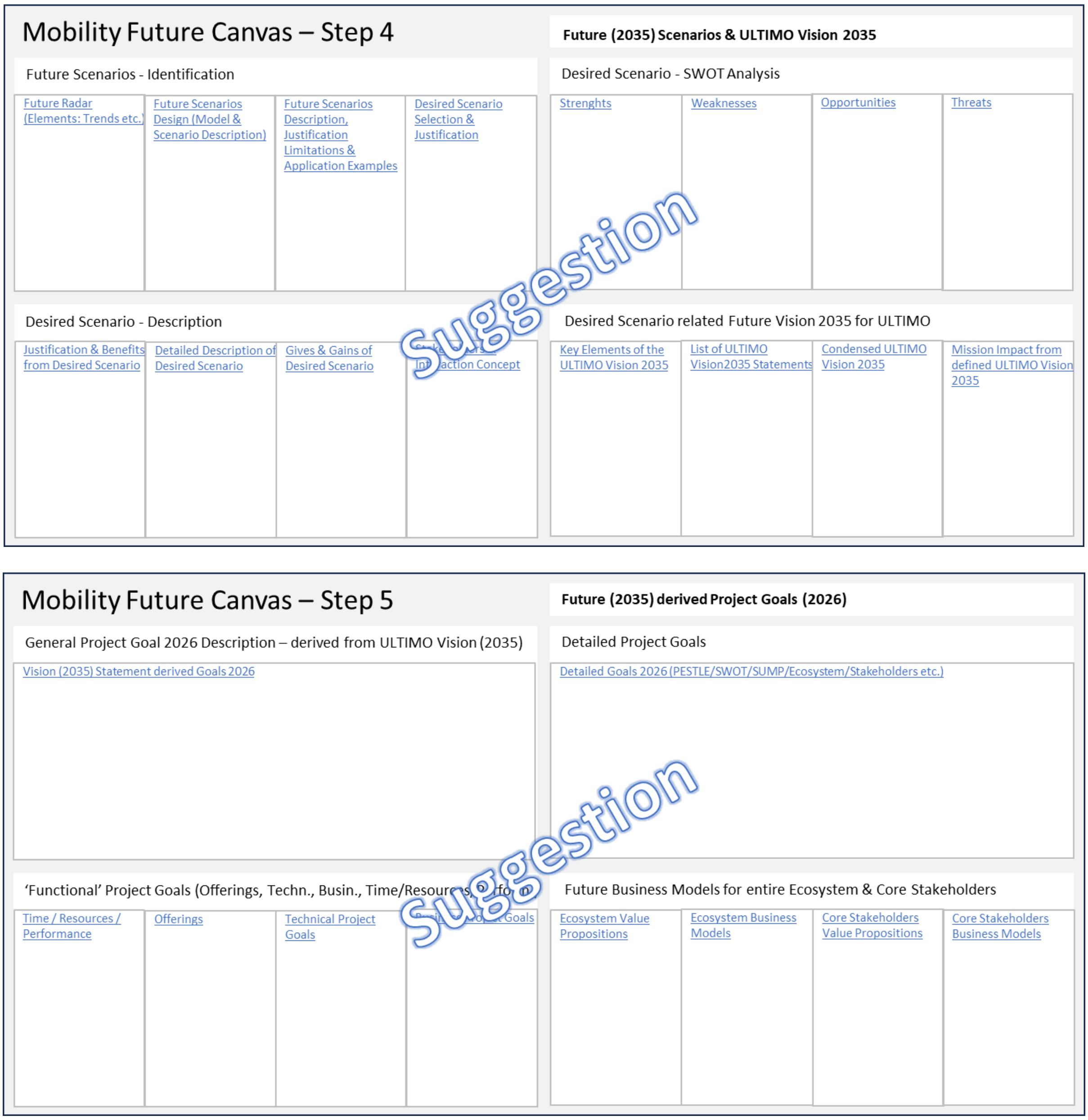


Figure 17: Canvas method representations for Future 2035 steps of the ULTIMO Transformation Concept

Based on the logic of the generic design process the results of the elaborations from the ULTIMO Status Quo phase (T6.1, phase 1) and the ULTIMO Future phase (T6.2, phase 2) are precondition and input for the elaboration of the ULTIMO transformation phase (T6.3, phase 3).

The character of the ULTIMO Transformation process is initially designed as a logical sequence of generic strategic planning steps (steps 6 – 10). For concrete planning of the ULTIMO transformation however these steps and their subprocesses must be processed in an agile way with iterative feedback and feedforward loops to update and adjust the results and the entire planning concept to the new insights and information as well as improvements and learnings emerging during the process.

In the first transformation step (**step 6 – kind of 'strategic coordinates' of the transformation**) it is essential to identify, describe, analyse, evaluate, and prioritize the main challenges (problems, wishes, demand, ideas, tasks, etc.) of the ULTIMO transformation from status quo 2022/23 to the Future vision represented by the achievable project goal in 2016. Opposite to the transformation challenges it is necessary to define general and functional strategic transformation goals that must be achieved. Another important pair of opposite strategic analysis categories is to identify the success factors (positive impact factors) for achieving all these strategic goals, as well as the obstacles that have a negative impact on these achievements.
It is important to mention that for all of these elaborations the whole umbrella of transformation factettes must be addressed (e.g. PESTLE categories, resources, technologies, business, processes, culture & behaviour, change/transformation leadership, etc.).

The next transformation step (**step 7 – 'strategic design' of the transformation**) focuses the identification of transformation strategies for all the facets of the 'strategic coordinates' of step 6. Additionally, it is important to identify the strategic enablers (accelerators, drivers, levers, resources, etc.) to ensure the feasibility of the transformation strategies and the successful achievement of strategic transformation goals. A central and emphasized role in the transformation process plays the 'change management concept' addressing the mental/paradigmatic and cultural/behavioural transformation aspects of stakeholders. It is necessary to pay the greatest attention to this topic, which needs to be analysed and integrated into the transformation concept.

Step 8 (step 8 - 'stakeholder focus' for the transformation) addresses the identification, characterization, analysis, and evaluation of all the stakeholders of the transformation, their ecosystem interdependencies (network of relations) and interaction, their individual transformational 'agenda': strategic resources, challenges, SWOT, goals, strategies, transformation impact and transformation requirements, and last but not least: their individual role and transformation roadmap in the context of the comprehensive ULTIMO transformation.

Step 9 ('operational planning' of the transformation) the strategic elaborations of steps 6-8 must be deployed into a portfolio of operational transformation measures (or actions) which are identified, analysed, validated, structured, assigned, prioritized, and documented in a roadmap. For implementation reasons respective KPIs as strategic metrics for goal achievement must be identified. As a result, an operational 'Action and Monitoring Plan' must be established for the continuous controlling of the transformation.

Step 10 ('concept implementation' or 'piloting') focuses the implementation of all previous strategic and operational planning results (steps 6-9) in the 'field' (or literally: 'on the road') of the pilot sites. In this step a specific 'implementation plan' of the entire transformation concept is required. For this critical phase (especially in the high risk VUCA environments of AM in MaaS/LaaS and ITS/CCAM) an incremental-iterative and agile implementation process (including an 'experimental' deployment approach for max. validated decisions) is highly recommended.

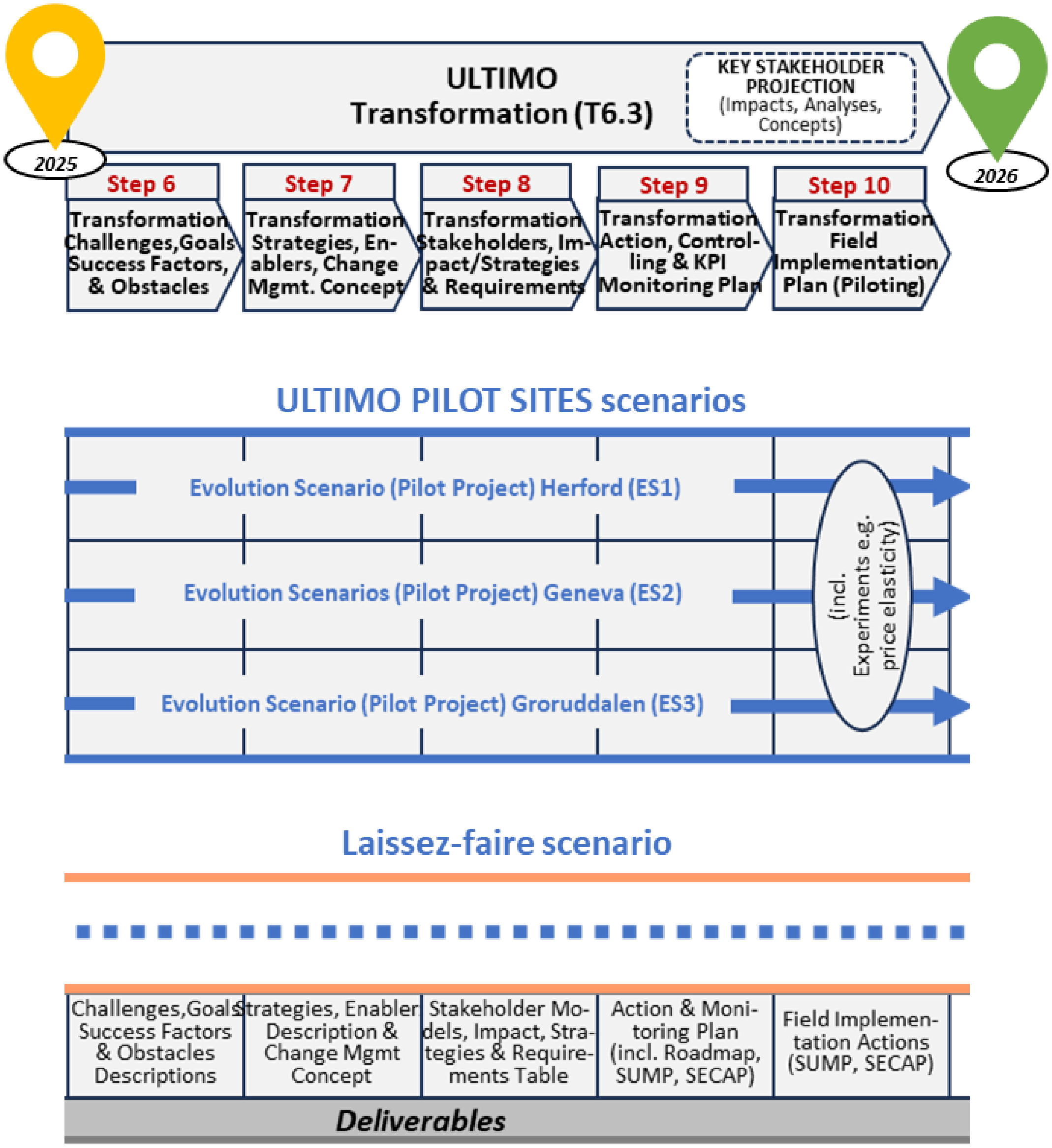


Figure 18: ULTIMO Transformation Planning and Elaboration Phase of the ULTIMO Transformation

The final set of canvases (see Figure 19) for the ULTIMO Transformation design steps are suggestions which could define the most important issues to be elaborated as core tasks of the ULTIMO transformation.

Transformation Canvas – Step 6

Transformation Challenges, Goals, Success Factors & Obstacles

Transformation Challenges

Technical Transformation Challenges	Economic/Business Transformation Challenges	Societal & Environmental Transformation Challenges	Political, Regulatory, Governance & Project related Transformation Challenges

Transformation Goals

Transformation Goals for Society, Mobility Culture & Behavior and Environment	Transformation Goals of Strategies, Structures/Concepts, Systems (e.g. IT)	Transformation of Mobility Technologies Offerings/Solutions/Services/etc.	Business Model Transformation for entire Ecosystem & Core Stakeholders

Success Factors of ULTIMO Transformation

Technical Transformation Success Factors	Economic/Business Transformation Success Factors	Societal & Environmental Transformation Success Factors	Political, Regulatory, Governance & Project related Transformation Success Factors

Obstacles of ULTIMO Transformation

Technical Transformation Obstacles	Economic/Business Transformation Obstacles	Societal & Environmental Transformation Obstacles	Political, Regulatory, Governance & Project related Transformation Obstacles

Transformation Canvas – Step 7

Transformation Strategies, Enablers, Change Mgmt. Concept

Transformation Strategies

Technical Transformation Strategies	Economic/Business Transformation Strategies	Societal & Environmental Transformation Strategies	Political, Regulatory, Governance & Project related Transformation Strategies

Transformation Change Mgmt Concept

Transformation Change Mgmt. Topics for Mobility Culture & Behavior Change (Paradigm, Mindset)	Transformation Process & Measures for Mobility Culture & Behavior Change (Paradigm, Mindset)

Transformation Enablers

Technical Transformation Enablers	Economic/Business Transformation Enablers	Societal & Environmental Transformation Enablers	Political, Regulatory, Governance & Project related Transformation Enablers

Transformation Canvas – Step 8

Transformation Stakeholders, Impact/ Strategies & Requirements

Stakeholders of Transformation

Stakeholder Ecosystem Structure (Categories, Network)	Individual Stakeholders Characterization

Impact of Transformation on Stakeholders

Stakeholder Transformation Impact Table

Stakeholder Strategies for Transformation

Transformation Goals of individual Stakeholders	Transformation Strategies of individual Stakeholders

Stakeholder Requirements for Transformation

Transformation Requirements List of individual Stakeholders	Prioritized Transformation Requirements List of individual Stakeholders	Transformation Measures of individual Stakeholders	Transformation Roadmap of individual Stakeholders

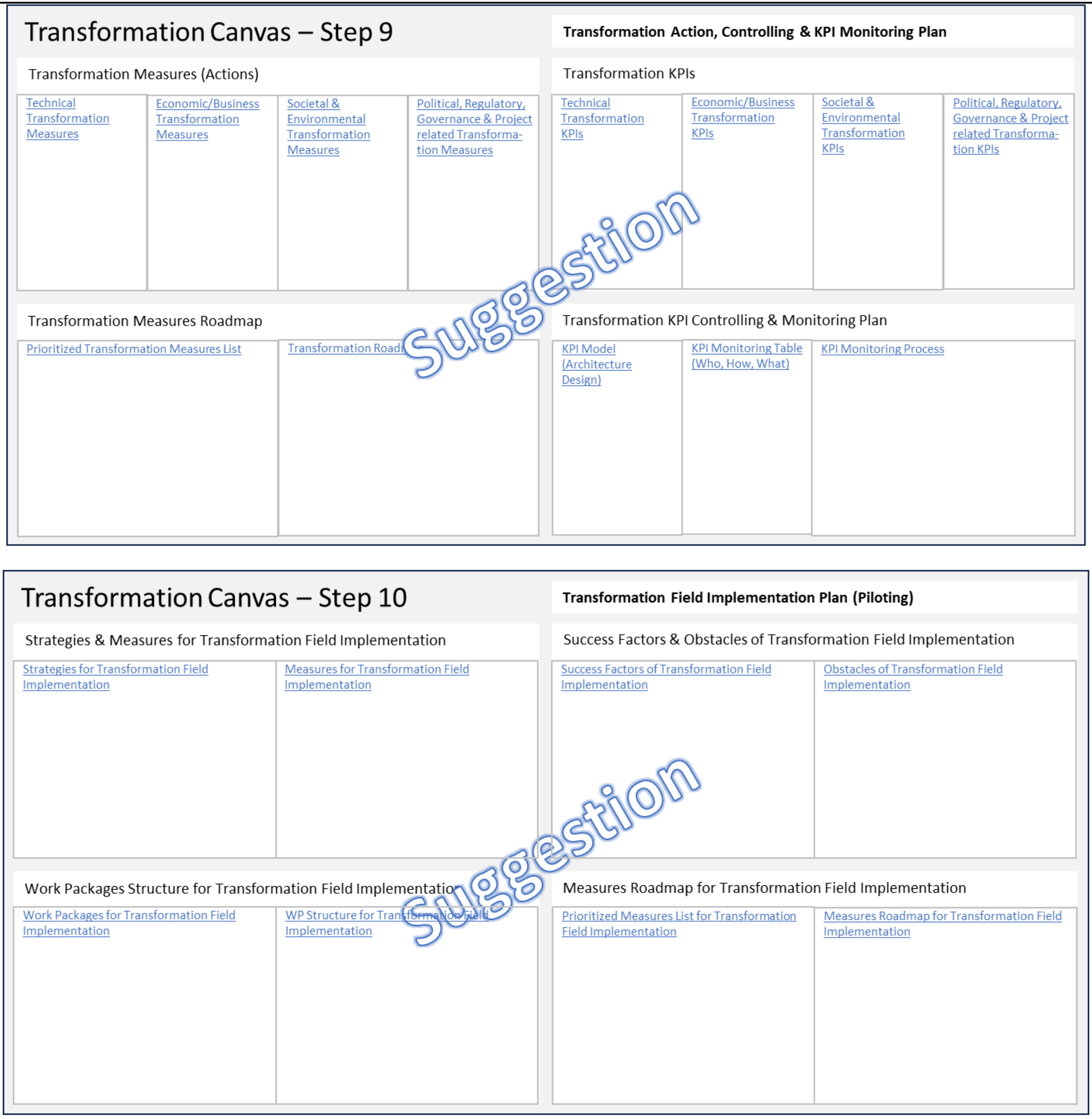


Figure 19: Canvas method representations for the Transformation steps as core of the ULTIMO Transformation Concept

After the design of the ULTIMO Transformation Concept (the 'WHAT') and a more detailed method description of the according design steps by canvas representations (the 'HOW') an assignment of the ownership of these Transformation Concept work packages is required (the 'WHO') to ensure seamless collaboration and the definition of collaboration interfaces among the transformation planning stakeholders. This is also precondition and the basis for a roadmap representation of Transformation Concept Work Packages (e.g. within a GANTT Chart).

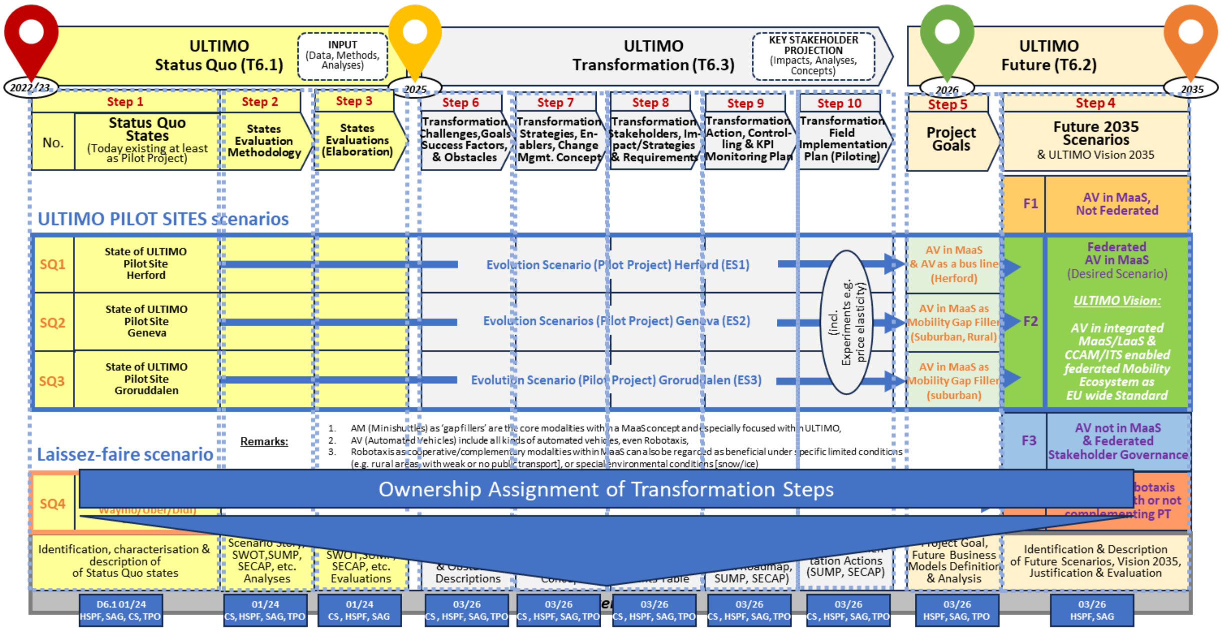


Figure 20: The ULTIMO Transformation Concept Design with Ownership assignment of Transformation Steps

In summary, the transformation concept presented here can form a valid, systematic and systematic basis for successfully developing and implementing AV in MaaS/LaaS with ITS/CCAM.

In the following, we present the first step of the transformation process, the assessment of the status quo of the three test sides.

4 Status Quo of the three test sites

4.1 Introduction

The following chapter provides an initial overview of the status quo of the current state of integration of AVs into MaaS at the three pilot locations in Oslo, Geneva and Herford. Using a structured questionnaire divided into six thematic blocks - site related issues, current mobility services, social aspects, environmental aspects, governance and MaaS, and sustainable business models/business related issues - this provides a detailed snapshot of AV integration efforts. Each block addresses key dimensions of AV adoption, from site specific deployment plans and current mobility service modalities to societal benefits, environmental impacts, governance structures and economic viability. The findings reveal site-specific insights, including deployment strategies, societal and environmental considerations, governance frameworks, and potential pathways to sustainable business models for AVs in MaaS. This summary outlines the collective findings from the interviews and reflects on the unique challenges and opportunities identified at each pilot site, providing a basis for informed decision-making and strategic planning when integrating AVs into MaaS ecosystems.

In examining the governance and structuring of MaaS, a notable parallel emerged between Oslo, Geneva and Herford. Each site emphasised its commitment to adapting to broader regulatory frameworks and stakeholder collaboration within the MaaS ecosystem. This convergence reflects a shared understanding of the importance of a coherent governance structure to facilitate the seamless integration and sustainable development of AVs in MaaS, and illustrates a collective move towards improved regulatory compliance, safety and ethical considerations in AV deployment. This harmonisation of governance approaches between sites is a fundamental step towards creating a consistent and robust framework for the future development of automated mobility services.

4.2 Preliminary status quo questionnaire

4.2.1 Purpose of the Questionnaire

The preliminary status quo questionnaire, which is deliberately divided into different blocks, aims to take a specific look at the integration of automated vehicles (AVs) in Mobility as a Service (MaaS). The questionnaire was created based on findings from a comprehensive interview with a public transport operator and serves the purpose of answering the initial questions regarding the Oslo-Groruddalen pilot sites. It is intended to provide a holistic understanding of the current state of situation and form the basis for informed decision-making and strategic planning.

The overarching purpose of this questionnaire is to gather detailed insights across various dimensions related to AVs in MaaS. Each block of questions is strategically crafted to explore specific aspects, ensuring a comprehensive analysis of site specifics, sustainable business models, current mobility services, social considerations, environmental impacts, and governance dynamics (Figure 21). By addressing these key areas, the questionnaire aims to create a first description of the status quo, thereby setting the stage for subsequent analyses. The structure of the question block 6 (Sustainable business model canvas / Business-related) was aligned with the business model framework of (Bocken et al. 2018).

4.2.2 Question Blocks

Figure 21: Question Blocks for Status Quo Questionnaire

Block 1: Site-related Questions

The initial block sets the stage by delving into the specifics of the Oslo-Groruddalen Pilot Site. Questions focus on site description, deployment plans, and the anticipated timeline for AV integration.

Related Questions:

1. Does a description of the deployment plan for the site exist? If yes, can it be provided?
2. Can you summarize in general how the AV deployment and services are planned?
3. When can the integration of AV in MaaS (Groruddalen and Oslo) be expected?

Block 2: Current Mobility Services

Transitioning to the third block, attention is directed towards the current state of mobility services, examining modal shares, service-specific modal distributions, and potential transformation costs from the present status quo towards future goals.

Related Questions: What is Modal share for different transport modes including private cars?

4. How does the modal share for all modes of transportation differ in the demonstration site? (including private cars)

5. How does the modal share for public transportation services differ in the demonstration site?

Block 3: Social Aspects

The fourth block explores social aspects, shedding light on general mobility habits, mobility needs, and the inherent challenges associated with changing established mobility behaviours.

Related Questions: What are the general mobility habits? Can you elaborate on that?

6. Based on the mobility habits, what are the mobility needs? (Understanding the inertia of the obstacles to overcome)

Block 4: Environmental Aspects

The fifth block investigates the external costs and effects of AV deployment, including potential rebound effects. Existing studies and insights from the Oslo Study are emphasized to provide a holistic understanding.

Related Questions: 22. Different external cost types / external effects

7. Have so-called rebound effects been identified in an existing study?

Block 5: Governance and MaaS

The final block delves into the governance structure surrounding AVs in MaaS, encompassing legal forms, stakeholder relationships, the current status of MaaS modelers, stakeholder collaborations, data governance, and openness within the MaaS ecosystem.

Related Questions:

8. Legal form and annual reports: What is Ruter's legal form, and what insights can be gained from annual reports?
9. Based on the legal form, what is the nature and kind of relationship with all stakeholders (monetary, information exchange, physical data)
10. MaaS Modeler [2]Situation: What are the current functionalities of the MaaS Modeler? Does it provide options for simulation of on-demand services?
11. Stakeholder collaboration & compensation within MaaS: What is the current status?
12. Data Governance and "Open data": How is data governance structured within the MaaS ecosystem, including data categories and openness?
13. Data governance and "Open data": Which data are currently open in the MaaS and for the sites (in particular which data are available from Mobileye,

Data governance and "Open data": Can you provide information on the Data platform, host (EU/other), to understand the ecosystems governance?

[2] MaaS Modeler: Reference to a software internally used by the PTA to model MaaS systems, particularly referred to modal share of different transport modes

Block 6: Sustainable Business Model Canvas / Business-related Questions

The second block shifts the focus to the sustainable business model canvas and associated business-related inquiries, unravelling the intricacies of value propositions, key partnerships, revenue models, and more.

Related Questions: Value Proposition - How is the value proposition being defined? (Superior value)

14. Value Proposition: What is the profile of the use cases and criteria for the pilots involving AVs in MaaS? (Can you provide information on that?)
15. Value Proposition: How is the current value proposition designed to mitigate negative environmental impacts associated with transportation? Are there any existing studies underlining this aspect?
16. Value Proposition: Particularly focusing on end-of-life management, how do you envision this topic and what potential challenges do you see?

Related Questions: Value Creation – Key Partners

17. Can you disclose what key partners are involved in the AVs in MaaS initiative? If yes, who are they?
18. Are there specific incentives in place for key partners to actively contribute to the initiative?

Related Questions: Value Creation – Key Activities

19. What are the key activities involved in creating value for customers, stakeholders, and society through the deployment of AVs?

Related Questions: Value Creation – Key Resources

20. What are the key resources that are necessary to create value for customers, stakeholders, and society through the deployment of AVs?

Related Questions: Value Capture – Cost structure

21. How are costs per km calculated for different modes of transportation (car, walking, bicycle, public transport, etc.)?
22. How are costs influenced by demand peaks and valleys? Are there specific strategies to manage costs during peak and off-peak?

Related Questions: Value Capture – Revenue Streams:

23. What is the current revenue model, including revenues per passenger and per km for various transportation modes?
24. How is the pricing done? (Normal tariffing / Tariffing depending on external costs)

Related Questions: Value Delivery – Customer Relationships

25. How does the AV business plan to build a strong customer base for the AV services?

Related Questions: Value Delivery – Customer Segments

26. How are passenger categories defined?
27. What is the current volume of passengers (site) and can you provide insights into the age distribution?

Related Questions: Value Delivery – Channels

28. How does the AV business plan to make AV services accessible to its target customers?

4.3 Preliminary Results of Status Quo in Oslo-Groruddalen Pilot Site

4.3.1 Block 1: Site-related Questions

A comprehensive deployment plan, informed by a range of studies, is already in place. Looking ahead, the overarching goal is to initiate the introduction of automated vehicles (AVs) on either the westbound or southbound of Oslo, covering the entire city eventually. The vision extends to the future, where the aim is to have 500 AVs operating within Oslo's urban landscape, marking a substantial leap forward in widespread adoption. Moreover, the Public Transport Authority (PTA) is deeply committed to understanding the potential systemic impacts of AVs on Oslo, emphasizing the necessity of conducting a thorough and comprehensive evaluation. This evaluation will be instrumental in informing decision-making processes at all levels, ensuring that the integration of AVs aligns with the city's broader transportation goals and enhances overall urban mobility.

4.3.2 Block 2: Current Mobility Services

A preliminary summary of modal shares, detailing the distribution of travel distances across various transport modes, has been provided. Additionally, the Public Transport Authority (PTA) has underscored the importance of comprehending the social benefits of automated vehicles (AVs). They seek to convince policymakers that the societal advantages of AVs outweigh any potential cost differences in ticketing and subsidies. For the pilot project in Groruddalen, priority will be given to specific types of trips. Primary trips include errands and leisure activities, and internal first/last-mile journeys. These internal first/last-mile trips cater to different travel needs, such as connecting to public transport or avoiding parking and driving in adverse weather conditions. Secondary trips encompass pick-up/drop-off travel and commuting within the pilot area.

4.3.3 Block 3: Social Aspects

Elaborating on social aspects, a representative from the Public Transport Authority (PTA) related to various particular mobility needs respectively types of trips:

- Homeward journey (traveling back to one's own residence)
- Commuting (traveling to and from work)
- School travel
- Business trips (travel for work-related purposes, meetings, etc.)
- Shopping, errands, and service-related travel

Furthermore, attention is given to:

- Care and pick-up/drop-off travel
- Visits
- Leisure activities

4.3.4 Block 4: Environmental Aspects

The Public Transport Authority (PTA) has highlighted a particular study for Oslo, centred on the topic of rebound effects. Further clarification on this study will be provided later.

4.3.5 Block 5: Governance and MaaS

The Public Transport Authority (PTA) is identified as a publicly owned shareholder company. Regarding the data platform, they expressed their commitment to align with EU open data regulations. In terms of stakeholder compensation within Mobility as a Service (MaaS), further clarification is needed. The PTA highlighted the significance of revenue distribution to operators, especially given the discrepancy in pricing references; while the PTA bases pricing on public transport zones, operators base it on travelled distance. As for other aspects regarding data governance, responses are pending at present.

4.3.6 Block 6: Sustainable Business Model Canvas / Business-related Questions

Value proposition:

Regarding the value proposition, specific details on the profile of use cases and criteria for the pilots involving automated vehicles (AVs) in Mobility as a Service (MaaS) need further clarification and will be addressed at a later stage. In terms of mitigating negative environmental impacts associated with transportation, the current value proposition emphasizes the importance of circularity, as highlighted by the Public Transport Authority (PTA). However, challenges may arise when AVs are deployed on a large scale, particularly regarding circularity. Additionally, a key goal is the replacement of private vehicles to generate positive societal value. With a focus on end-of-life management, similar considerations are reiterated, along with the acknowledgment that the self-driving system may not last as long as the vehicle itself. Notably, there is currently no recycling plan in place, posing potential challenges in this aspect of the value proposition.

Value creation

In terms of value creation, the PTA mentioned that the Public Transport Operator (PTO) is considered the most important key partner. Regarding incentives for key partners to actively contribute to the initiative, this aspect is yet to be verified. As for key activities involved in creating value for customers, stakeholders, and society through AV deployment, further information is required. Similarly, for key resources necessary to create value through AV deployment, the relationship with the operator providing services needs to be explored further to understand its significance in value creation for customers, stakeholders, and society.

Value capture:

For value capture, additional details regarding the cost structure have been fine-tuned through collaboration with the Public Transport Authority (PTA). In terms of revenue streams, the current approach entails initiating AV services with a fixed pricing model, while remaining open to adjustments based on customer feedback and responses.

Value Delivery:

In advancing value delivery, the PTA is actively seeking to understand customer segments. Their approach involves gaining insights into shifts in modal split, aiming to acquire a deeper understanding of how travel patterns evolve before and after the implementation of AV services. Leveraging historical passenger data could provide valuable support in this matter.

4.4 Preliminary Results of Status Quo in Geneva

4.4.1 Block 1: Site-related Questions

In response to inquiries about site-related aspects, Transport Publique Genevois (TPG) confirms the existence of a deployment plan, although access to detailed information is restricted. The plan outlines a systematic approach to AV deployment, commencing with the identification of suitable vehicles and proceeding through authorization for site exploitation at Belle-idee, vehicle homologation, testing phases on Champagne, and eventual accommodation of first passengers.

4.4.2 Block 2: Current Mobility Services

The current mobility services within the demonstration sites are characterized by the inclusion of Demand-Responsive Transport (DRT) services, offering a distinctive mode of public transportation within the ULTIMO project framework.

4.4.3 Block 3: Social Aspects

Social considerations shed light on prevalent mobility habits, primarily revolving around individual or family car usage. Additionally, there is a noted desire for on-demand services, particularly in rural areas, contingent upon the availability of automated vehicles to ensure affordability.

4.4.4 Block 4: Environmental Aspects

Environmental considerations focus on identifying external costs and effects associated with AV operations, prioritizing prompt technical issue resolution to ensure the viability of the project. Despite challenges in dissemination, an existing study highlights improved usage of DRT services over time.

4.4.5 Block 5: Governance and MaaS

Governance dynamics within the ULTIMO project are multifaceted, with insights gleaned from annual reports informing organizational changes. A Stakeholder relationships encompass various forms of engagement, including monetary transactions, information exchange, and physical data sharing. Collaboration and compensation aspects are works in progress, alongside ongoing efforts to refine data governance structures. Notably, DRT data remains separate from the normal TPG fleet, indicating ongoing integration efforts.

4.4.6 Block 6: Sustainable Business Model Canvas / Business-related Questions

While the Public Transport Operator provided responses to the preceding blocks, the sustainable business model canvas and associated business-related questions remained unanswered, signifying areas for further exploration and collaboration within the ULTIMO project framework.

4.5 Preliminary Results of Status Quo in Herford

4.5.1 Block 1: Site-related Questions

The respondent confirms that a deployment plan exists for the Herford pilot site, albeit with some restrictions on access to the plan. According to the provided information, the deployment plan outlines a phased approach to introducing automated vehicles (AVs) into the area. The initial phase of the deployment plan focuses on a small pilot area situated in the north-east of Herford. The primary objective of this phase is to introduce the local population to the concept of automated driving through an initial test operation. During this initial phase, AVs are expected to operate at level 2/3 autonomy, indicating a significant level of automation but with some human intervention required. These vehicles will initially be deployed for regular services, such as fixed-route transportation or scheduled shuttle services. The deployment of AVs at this stage aims to familiarize the community with AV technology and assess its feasibility in real-world conditions. Following the initial phase, the deployment plan outlines further development work to expand the test area. This expansion involves defining larger service areas within Herford to facilitate on-demand transport services using level 4 automated vehicles.

4.5.2 Block 2: Current Mobility Services

The latest survey data reveals the modal split in Herford, with walking accounting for 16.7% of trips, bicycle usage at 12%, public transport usage at 5.5%, and private car usage dominating at 65.9% (Figure 22). This data suggests that public transport has not yet played a significant role in Herford's transportation landscape. However, efforts to enhance public transport usage are underway as part of the Ultimo project, which aims to improve mobility through various measures.

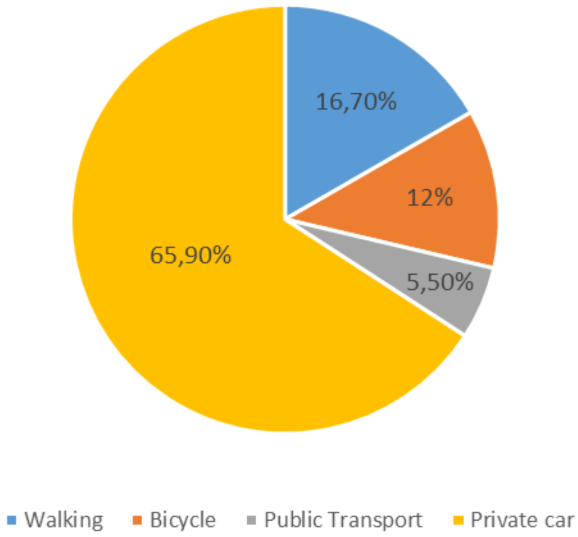


Figure 22: Modal Share in Herford

Regarding the modal split specifically for public transportation services in the demonstration site, the respondent indicates a lack of sufficient data to provide an answer. Currently, only a standard bus service is available on-site, with no on-demand or other specialized services offered. This highlights the limited scope of public transportation options available in Herford at present.

4.5.3 Block 3: Social Aspects

The respondent's insights into social aspects of mobility reveal gender disparities in travel behaviour. Women are observed to engage in walking more frequently and also rely on cars more often as passengers. Conversely, men are more inclined to drive themselves. However, both genders exhibit similar usage patterns for bus, train, and bicycle transportation modes. In terms of the dominant purpose of travel, the respondent identifies "shopping/strolling" and "errands" as the primary motivations, collectively accounting for 34% of travel. Leisure and visiting travel activities also command a significant share, comprising 21.5% of trips. Interestingly, work-related travel emerges as the third most common purpose, constituting 21% of journeys. Moreover, the respondent emphasises the need for improved public transportation services, advocating for increased availability and diversification of service offerings. This suggests a desire for more frequent and varied public transport options to better meet the diverse travel needs of the communities.

4.5.4 Block 4: Environmental Aspects

The respondent indicates that there are currently no specific external cost types targeted for determination in Herford. Instead, the focus lies on enhancing the local mobility situation and providing improved services for residents and visitors. This suggests a prioritization of immediate mobility challenges and service enhancements over the analysis of external costs. Regarding the identification of rebound effects in existing studies, the respondent states that such effects have not yet been identified. This implies that there is limited insight or research available on potential rebound effects associated with mobility interventions or changes in Herford. Further investigation may be needed to explore this aspect comprehensively.

4.5.5 Block 5: Governance and MaaS

Regarding the legal form and annual reports, the respondent identifies BVO Busverkehr Ostwestfalen GmbH (BVO) as the local service provider. BVO, a subsidiary of DB Regio AG, operates as a bus company, with annual reports published by DB Regio AG providing information on financial developments and key figures. In terms of stakeholder relationships, the respondent highlights their role as a service provider for the Public Transportation Authority (PTA). They mention that the PTA commissions and compensates for transport services, with limited information exchange currently regulated by contracts between the service provider and the city/PTA. Regarding MaaS collaboration, the respondent notes the absence of a comprehensive MaaS solution on-site, with the OWL mobile app being the only available option. Developed by Hacon, this app provides ticketing and line information for existing bus lines. Concerning data governance and openness, the respondent indicates ongoing efforts to develop their MaaS platform and coordinate with key stakeholders. While current information includes international timetable data and ticketing options, the extent of open data usage remains unclear, with limited availability observed thus far. Furthermore, specific details regarding open data within the MaaS ecosystem and the data platform/host are yet to be provided. The respondent expresses intent to furnish this information once all necessary details are gathered.

4.5.6 Block 6: Sustainable Business Model Canvas / Business-related Questions

<u>Value proposition:</u>

The respondent outlines the value proposition by stating their intention to offer additional services to the residents of Herford. This initiative aims to improve access to public transportation, particularly benefiting people in rural areas who may not have access to private vehicles. However, further elaboration is needed regarding how these additional services will enhance the overall value proposition compared to existing transportation options.

Value creation

In terms of key partners, the respondent mentions engagement with the city administration of Herford and their BVO branch. These entities serve as primary contacts for initial project steps and subsequent integration efforts. However, specific incentives for these partners to contribute actively to the AVs in MaaS initiative are not disclosed. Further exploration is required to identify key activities involved in creating value for customers, stakeholders, and society through AV deployment, as well as key resources necessary for value creation.

Value capture:

The respondent indicates a lack of insights into calculating costs per kilometre for AVs, suggesting that further research and analysis are needed in this area. Additionally, while the respondent acknowledges the variation in revenue streams based on demand peaks and valleys, no specific strategies for managing costs during these periods are outlined. Further clarification is required regarding the revenue model, including pricing mechanisms for various transportation modes.

Value Delivery:

In terms of customer relationships, the respondent highlights strategies such as pilot programs, customized service offerings, transparent pricing, feedback mechanisms, and targeted marketing and education to build a strong customer base for AV services. However, the absence of passenger counts limits insights into customer segments and age distribution. Furthermore, while the respondent emphasizes the aim of making AV services accessible to all passengers, additional details on specific channels for service delivery are needed to ensure effective implementation.

4.6 Status Quo: current mobility offers at the test sites

In order to comprehensively evaluate the current state of mobility at our three test sites, we conducted extensive research on the pilot site's transportation options. We compiled a detailed map of all available mobility offers on Google Maps, including train and metro lines, various bus routes with their corresponding stops, and even highways and bike-sharing systems. However, these have not yet been fully finalised for all three test tracks and may need to be reported in full in the final deliverable.

4.6.1 Oslo: Grorud Valley test site

The comprehensive overview of the mobility options available at the Grorud Valley test site and the public transportation that connects Grorud Valley residents with Oslo is illustrated in Figure 23. The area marked in black represents the specific pilot site where the automated vehicles will be tested. Three metro lines originate from Oslo centre and travel towards Grorud Valley, stopping at the designated locations marked with the "M" symbol. Additionally, a train (represented by a green train symbol) traverses Grorud Valley. A ring bus (indicated by a light blue bus symbol) has also been included, which is anticipated to be replaced by an automated vehicle during the project. Lastly, the three highways that traverse Grorud Valley are depicted in yellow and orange in Figure 23.

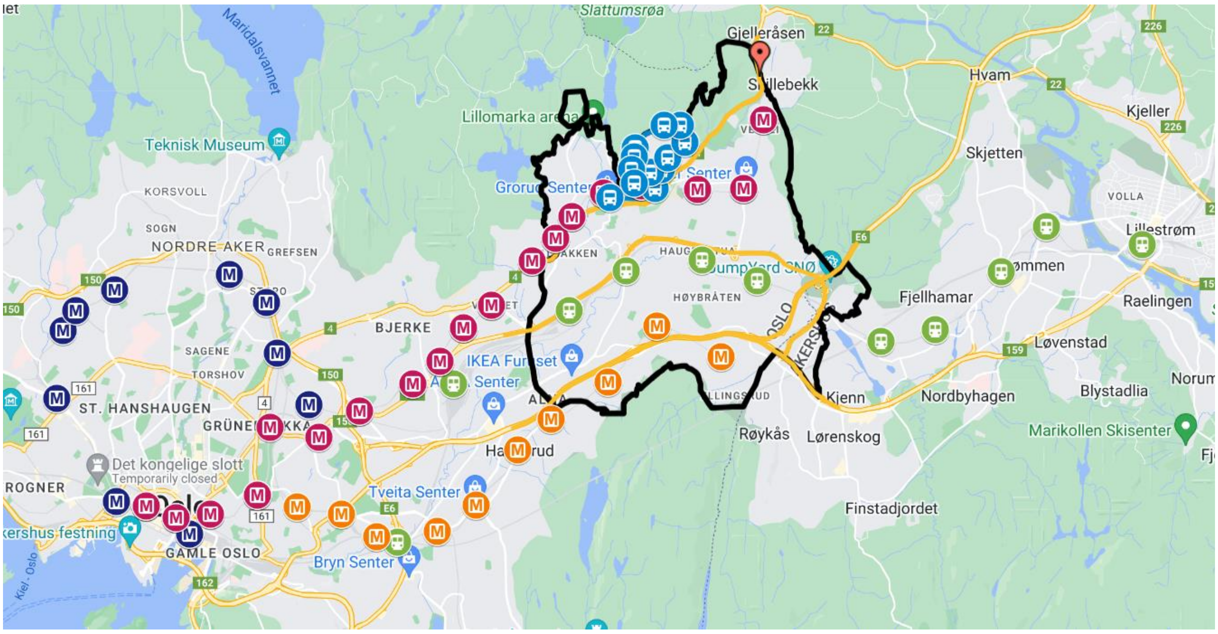


Figure 23: Complete overview of mobility offer in Grorud Valley with connection to Oslo

The purpose of Figure 23 is to depict the transportation connections between Oslo centre and the Grorud Valley. Conversely, Figure 24 focuses on the test site to showcase the available transportation options within the designated pilot area. A comprehensive explanation of each mobility option is provided below.

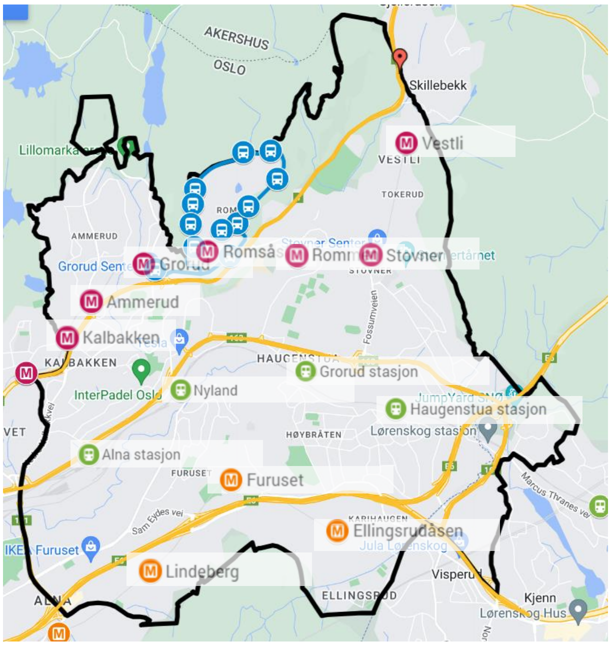


Figure 24: Pilot Site overview

Train

There is a single railway line that runs through the Oslo centre and the Grorud Valley pilot site, extending up to Lillestrøm, starting from either Asker or Spikkestad. This line is referred to as the local train L1 and is represented by a green train symbol, displaying all stations from Oslo centre to Lillestrøm, as illustrated in Figure 25 below.

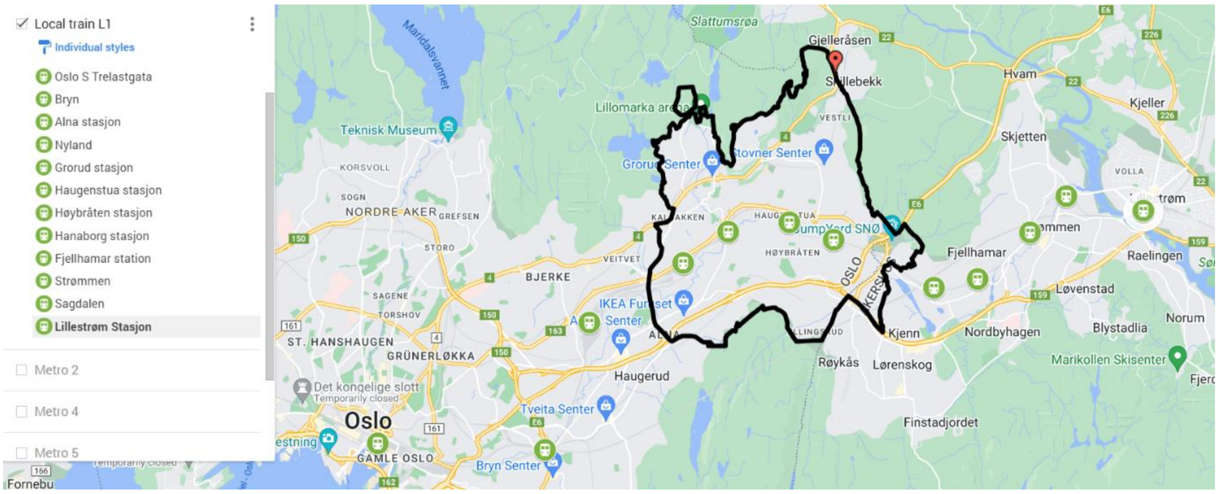


Figure 25: Local Train L1 (Spikkestad/Asker - Lillestrøm) from Oslo centre to Lillestrøm Stasjon

The most important stations to consider for the ULTIMO project are Oslo centre, Alna stasjon, Nyland, Grorud stasjon, Haugenstua stasjon and Høybråten stasjon. Oslo S Trelastgata, the main train station in Oslo, is included because of the connection of this train between Oslo and the pilot site. The other four stations are within the test site area outlined in black and explicitly shown in Figure 26.

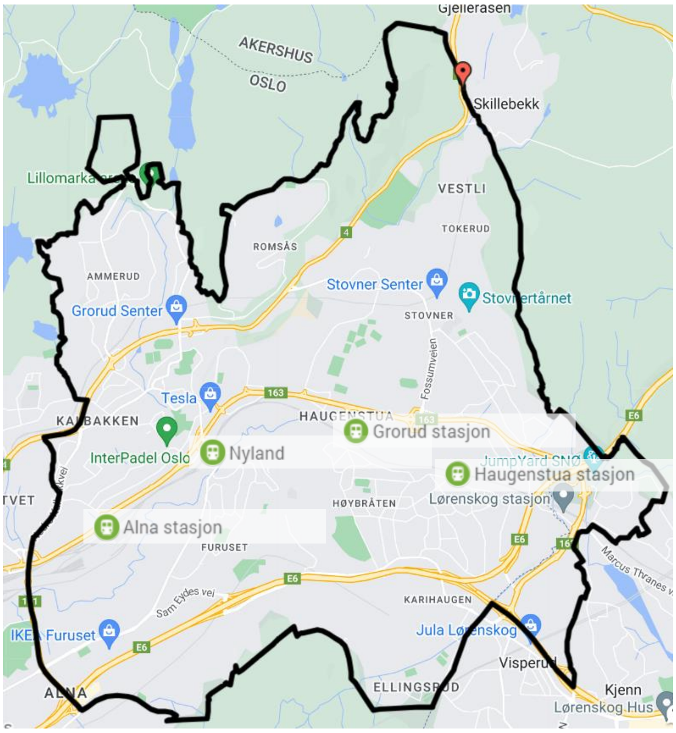


Figure 26: Local train L1 stations in pilot sites

Metro

There are three metro lines that are important to the Grorud Valley test site, detailed in Figure 27 below. Metro 2 (orange symbols) includes 14 stops, with start and end points in Stortinget (Oslo) and Ellingsrudåsen (Grorud Valley pilot site). Metro 4 (dark blue symbols) and Metro 5 (pink symbols) share the same stations towards Grorud Valley, starting from Økern. While Metro 4 commences at Bergkrystallen, Metro 5 begins at Sognsvann, both passing through Oslo's primary train station, Oslo S Trelastgata, and terminating in Vestli.

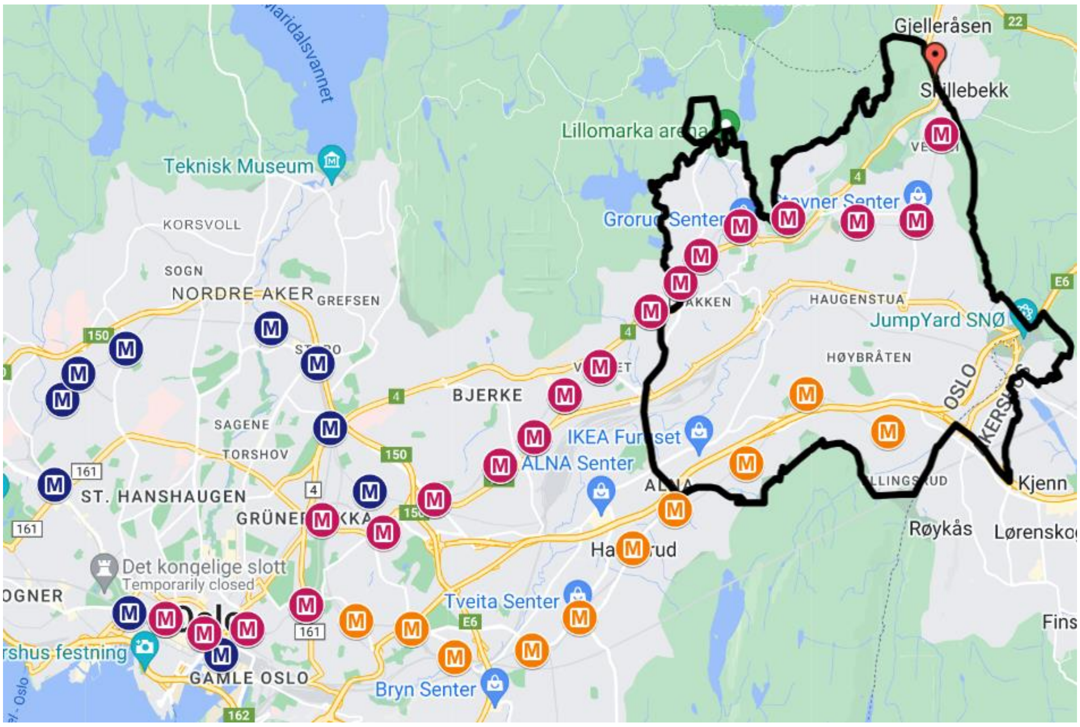


Figure 27: Metro lines in Grorud Valley

The next Figure 28 below details the specific metro stations in the pilot site. The left map shows metro 2 (orange) and metro 5 (pink), the right map shows metro 2 (orange) and metro 4 (dark blue) to show that the stations in the pilot site are the same.

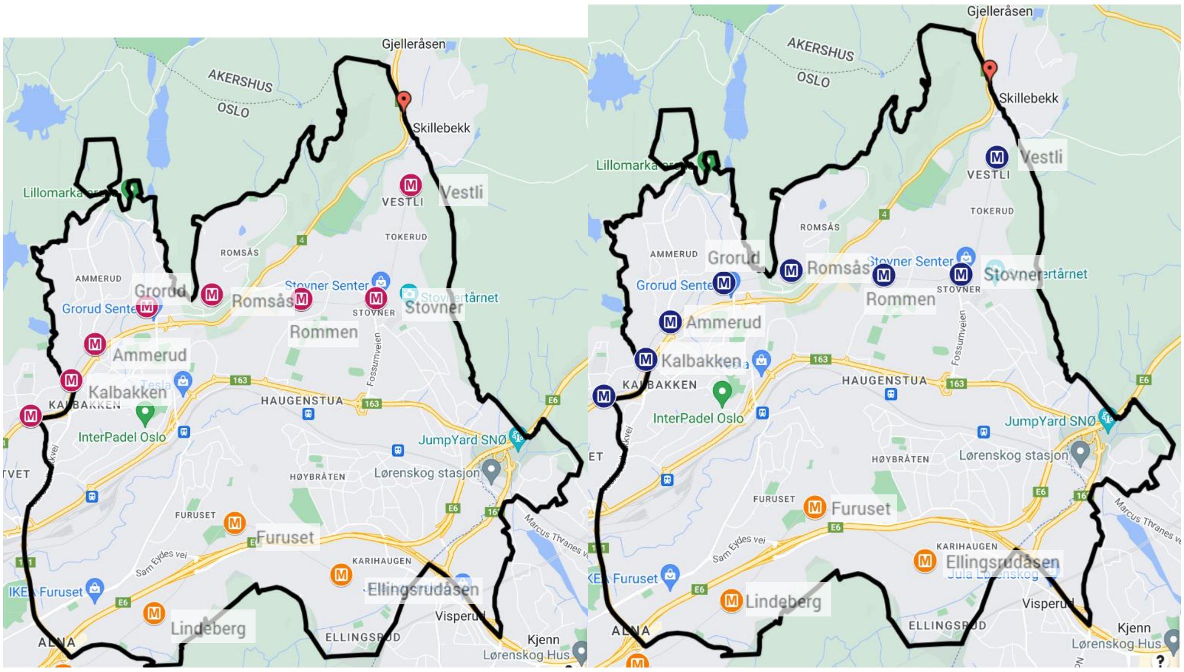


Figure 28: Metro Lines Pilot Site

The stations that are important to consider in this area extend beyond those in the Grorud Valley, encompassing several locations in the urban center of Oslo that connect the suburb to the central region. These stations include Kalbakken, Ammerud, Grorud, Romsås, Rommen, Stovner, Vestli, Lindeberg, Furuset, and Ellingsrudåsen.

Ring bus line 63

The Grorud Valley test site is serviced by multiple bus routes, one of which, the ring bus line 63, has garnered particular attention as a potential candidate for automated vehicle replacement. Starting and ending at the Grorud Metro Station, which links it to Metro lines 4 and 5, this bus travels a distance of approximately 5 kilometres and makes 12 stops, as illustrated in Figure 29 below. It is located at the periphery of the pilot site.

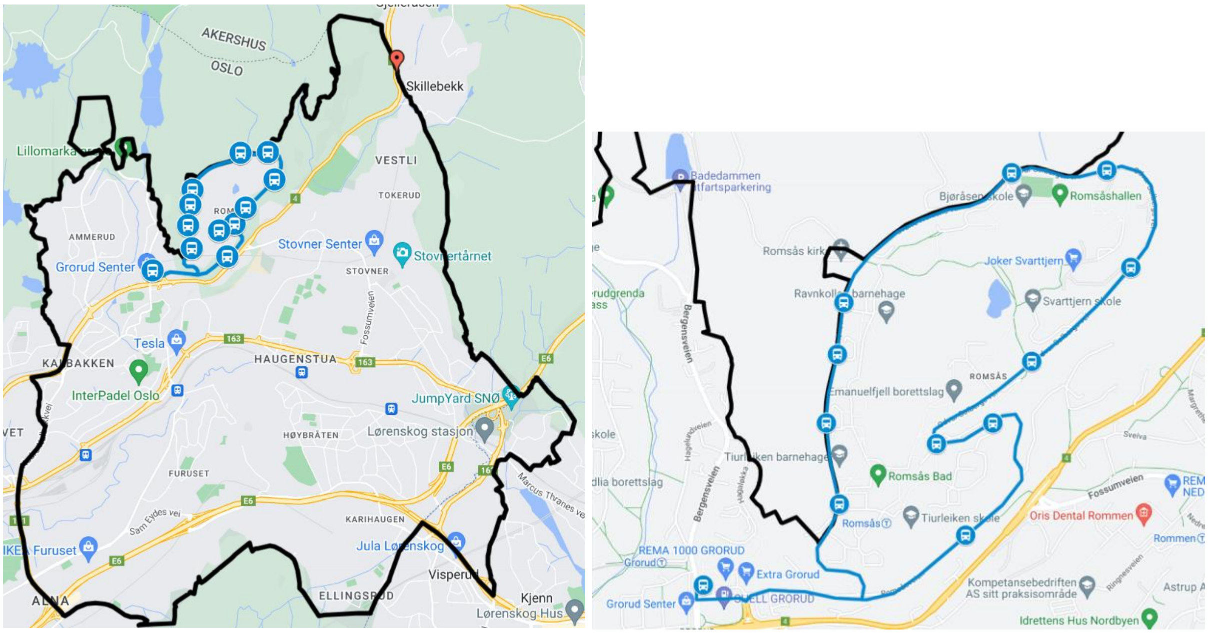


Figure 29: Ring bus route

Highways

Apart from public transport, there are several highways that traverse Grorud Valley and therefore need to be considered. The three highways depicted in Figure 30 below are (from top to bottom) the National Road 4, the National Road 163 and the European Highway E6, which splits into E6 (above) and National Road 153. These highways are important to consider because one the one hand, the tested automated vehicles must be capable of operating on them, requiring faster speeds. On the other hand, these highways pose challenges of crossing them for slower AVs, as well as pedestrians and cyclists, thereby fragmenting the pilot site into distinct sections.

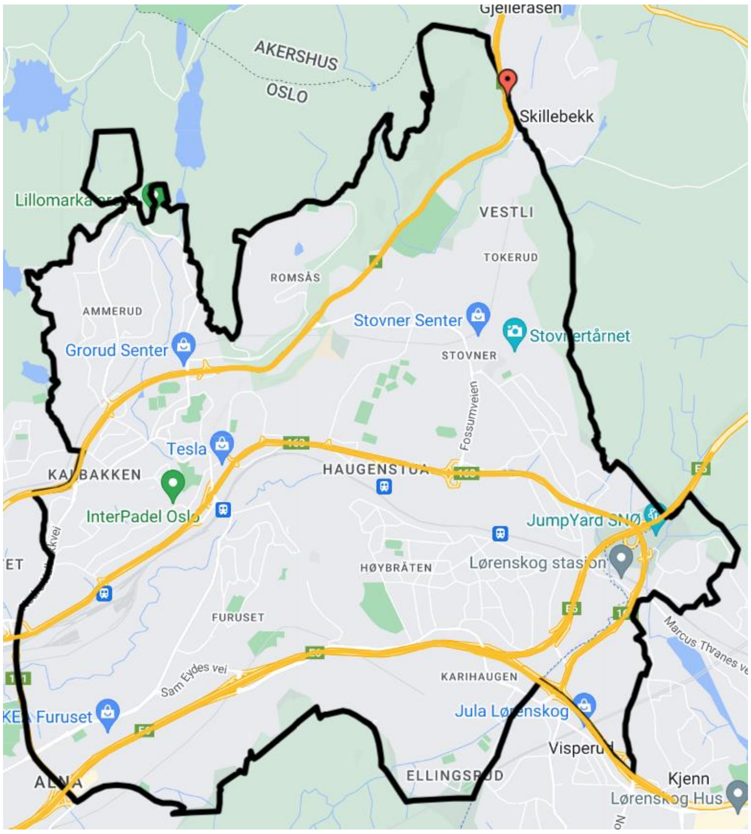


Figure 30: Highways in Grorud Valley

4.6.2 Herford test site

At this test site, the responsible PTO (Deutsche Bahn) is currently deciding upon the pilot area where the automated vehicle should operate later in the project. They designed various test tracks, and overview is shown in Figure 32. There are two areas that are taken into considerations with various route suggestions (Figure 31). We are currently working on including all existing bus routes into the map to have a similar overview as for Grorud Valley. However, it is possible that this extension will not be introduced until the next deliverable.

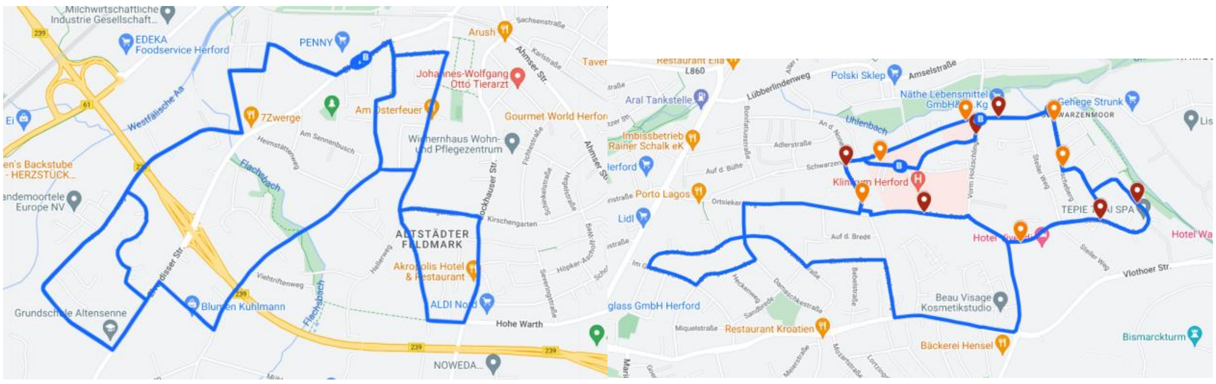


Figure 31: Herford suggested test areas

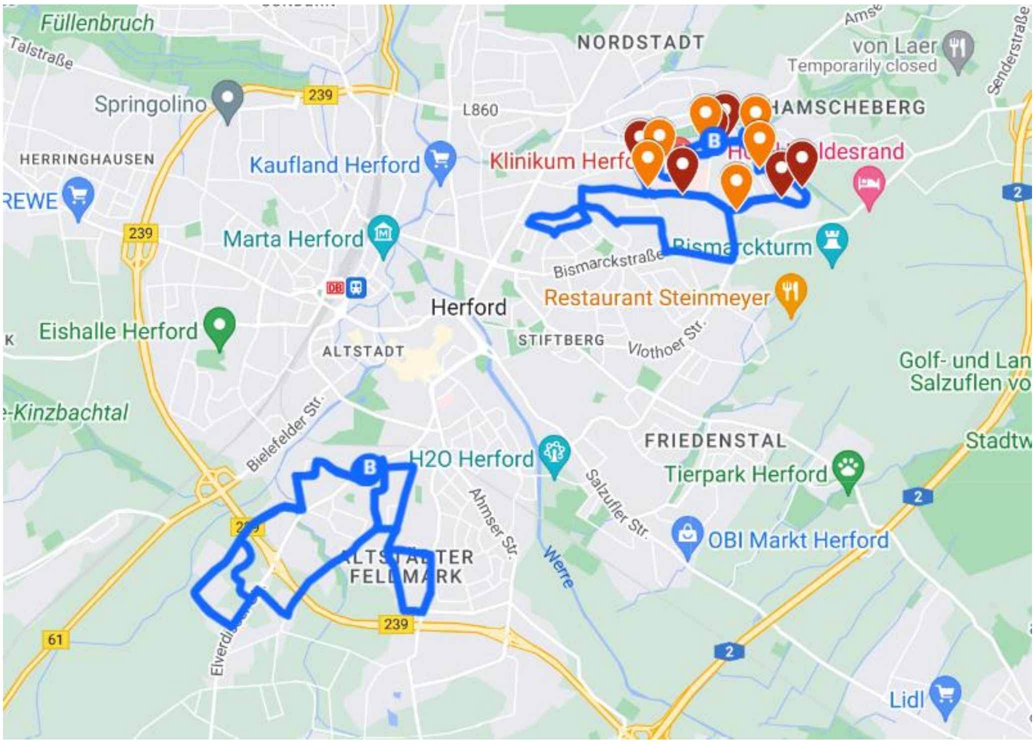


Figure 32: Herford Overview

Geneva: Test Sites

The two designated test sites for Geneva include Belle-Idée and the Champagne area. Belle-Idée stands out as an optimal location for testing various automated vehicles, particularly well-suited for the current Gama vehicles.

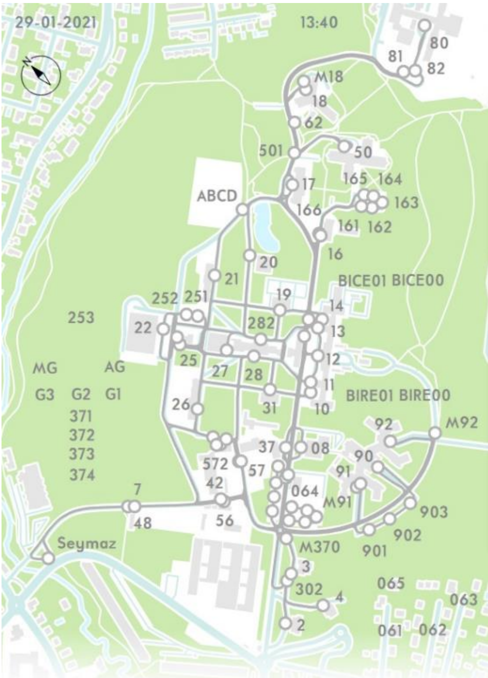


Figure 33: Belle-Idée area test site

On the other hand, the Champagne area is more demanding, necessitating higher speeds and superior vehicle performance.

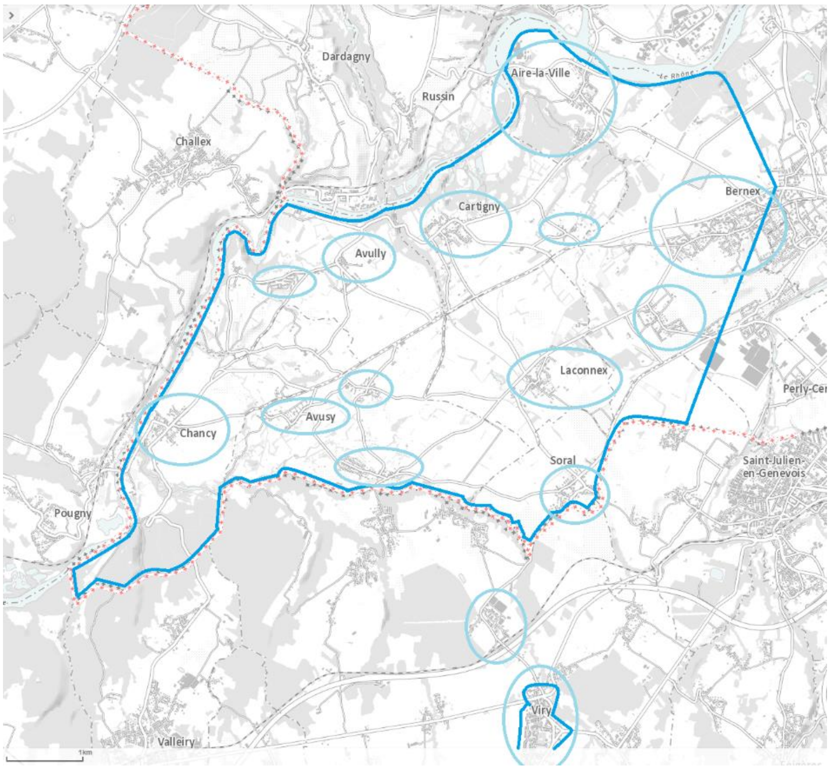


Figure 34: Champagne area test site

5 Summary & Conclusion – Key Objective 8

This deliverable is a fundamental step towards developing a comprehensive guide for the design and transformation of future ITS/CCAM ecosystems in public and goods transport across Europe. It directly supports the ULTIMO project's commitment to integrate AVs into MaaS/LaaS and to promote a sustainable, citizen-centric approach. Central to this endeavour Key Objective 8 of the grant agreement, which is central to the success of the development.

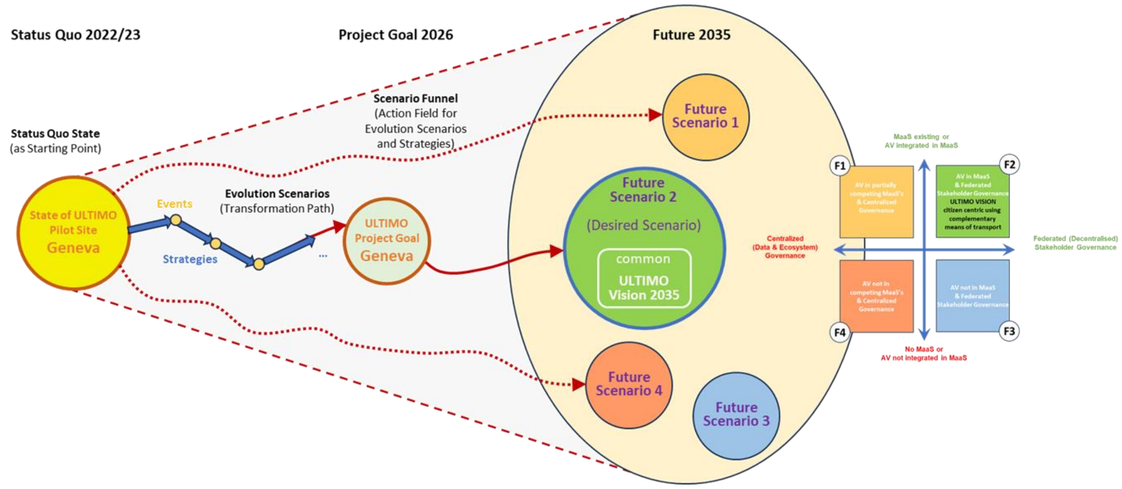
Key Objective 8 (KO#8) outlines the need for realistic, long-term transition planning for the deployment of AVs in MaaS and LaaS contexts. It includes a comprehensive assessment of the technical, social, economic, environmental and governance implications with the aim of shaping the future of AVs in ITS/CCAM ecosystems. The aim is to create a transition plan in collaboration with (potential) users and stakeholders, aiming for a smart, citizen-centric, inclusive, efficient, safe, environmentally friendly, resilient and sustainable transport system. This system should optimally serve societal goals in synergy with flagship initiatives in Europe and beyond and in line with the guidelines of the CCAM partnership. The first steps towards this have been outlined and started in the transformation plan presented here, and the entire process will be described in detailed in the final deliverable.

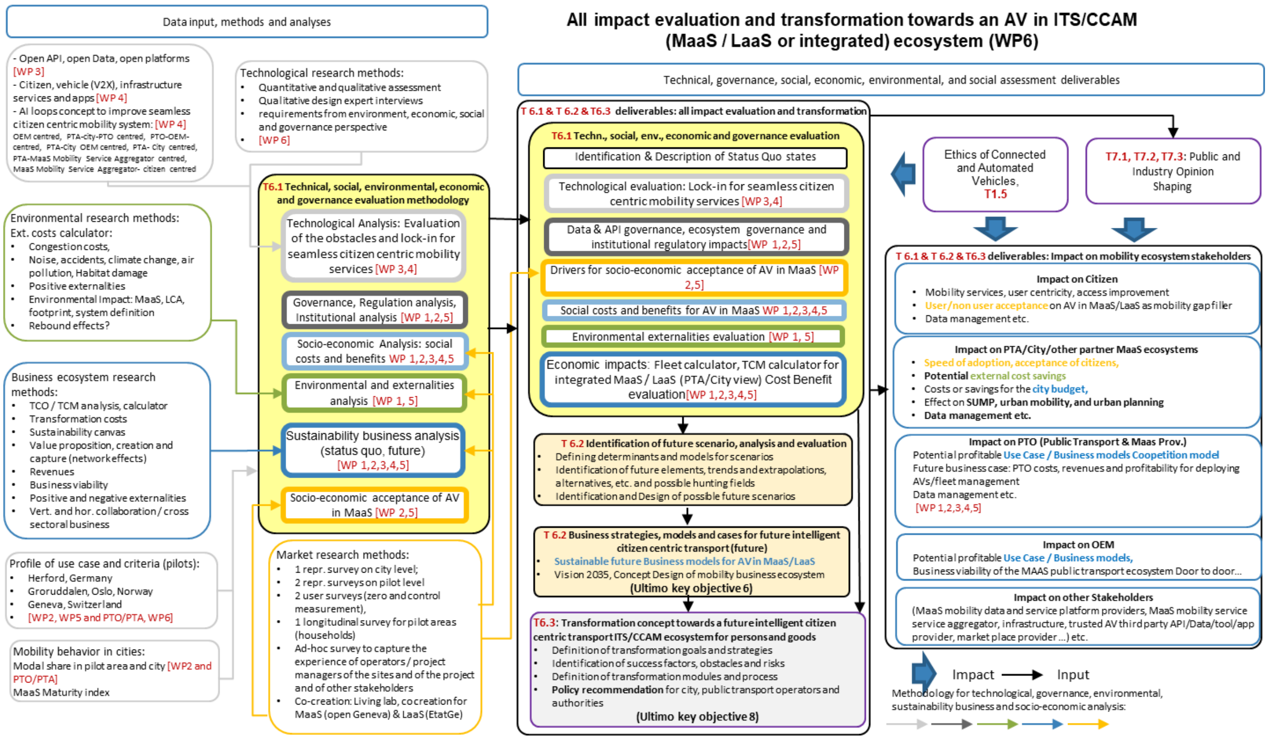
By incorporating these key objectives, a strategic framework is created that not only addresses interoperability and safety aspects, but also emphasises the economic viability of CCAM services. The document outlines a holistic strategy that utilises previous project experience, such as that of AVENUE, and aims to improve mobility, sustainability and stakeholder engagement through a detailed transformation plan. The success of this transition depends on the effective implementation of the strategies outlined, fostering collaboration between stakeholders and overcoming regulatory, technological and scalability challenges.

The prognosis points to a successful transition to an integrated, intelligent and citizen-centric transport system, provided that the strategies outlined are effectively implemented, stakeholder collaboration is encouraged and regulatory, technological and scalability challenges are overcome. This transformation could have a significant impact on automated transport in Europe, with sustainability, efficiency and inclusivity at the forefront. This will be explored in more depth over the next two years and presented in much greater detail in the final deliverable.

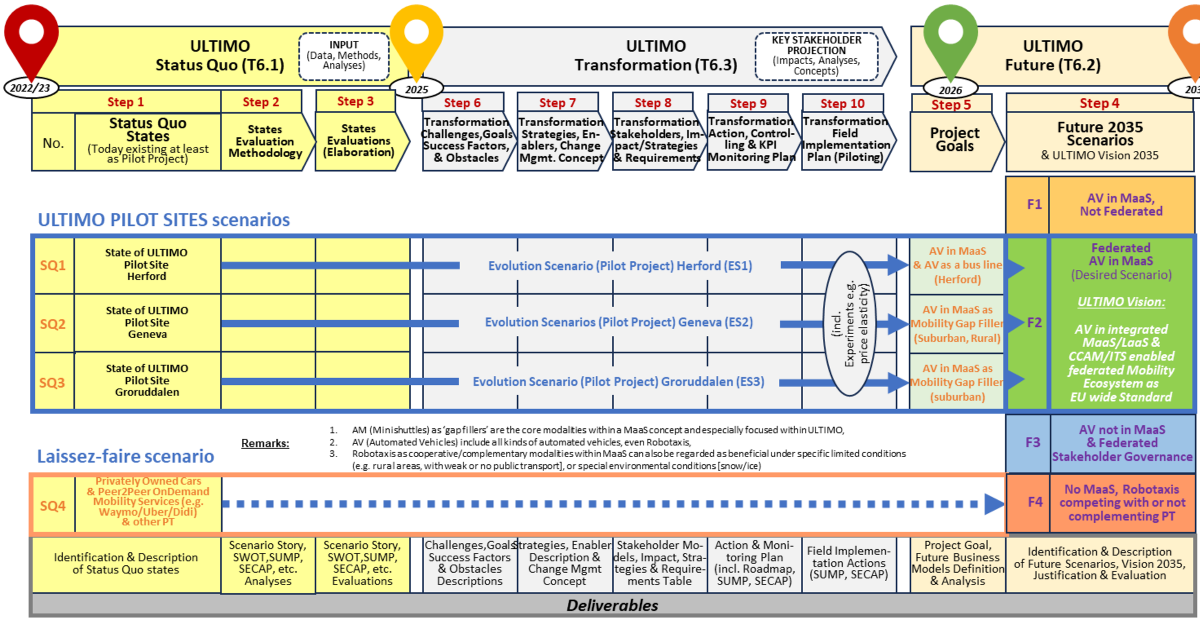
Annex 1: Figures from chapter 4

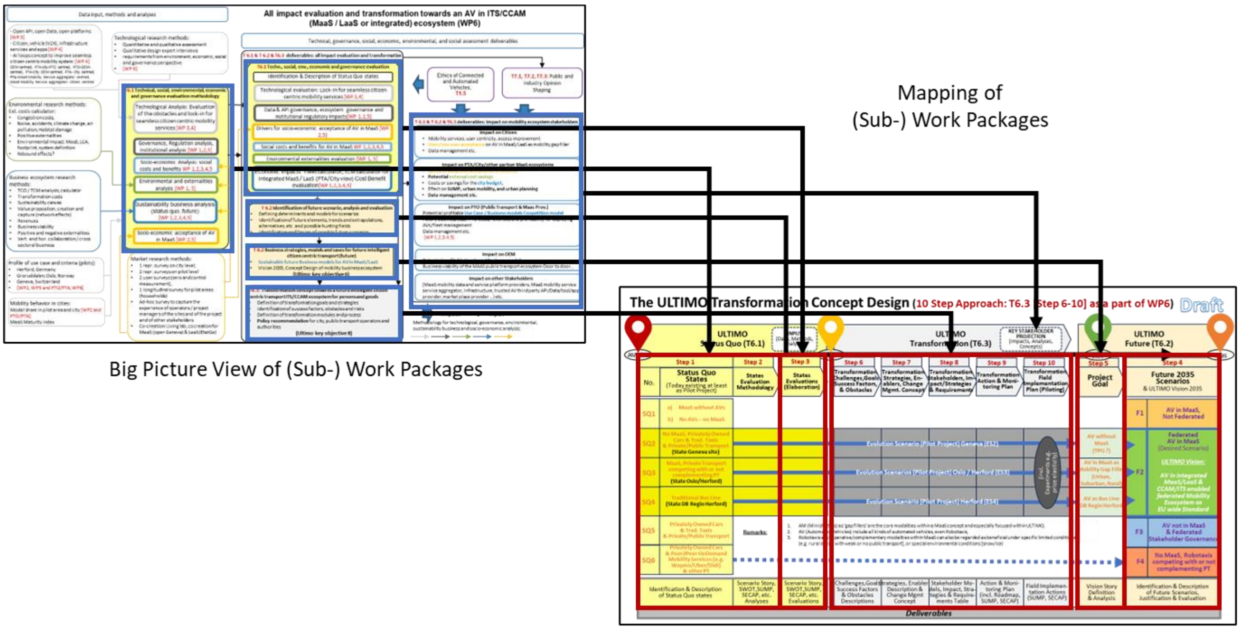
ULTIMO Transformation – from individual Status Quos 2022/23 to common Vision 2035





The ULTIMO Transformation Concept Design (10 Step Approach: T6.3 [Step 6-10] as a part of WP6)





Big Picture View of (Sub-) Work Packages

Transformation Process View of (Sub-) Work-Packages

Annex 2: Roadmap Proposal

	Q4/22	Q1/23	Q2/23	Q3/23	Q4/23	Q1/24	Q2/24	Q3/24	Q4/24	Q1/25	Q2/25	Q3/25	Q4/25	Q1/26	Q2/26	Q3/26
Step 1 (T 6.1) - Status Quo Demo Sites																
Development of Questionnaire & Testing					X	X										
Online Questionnaire						X										
Evaluation and Assessment of Status Quo							X									
State of Pilot Site Herford									X							
State of Pilot Site Geneva									X							
State of Pilot Site Oslo - Groruddalen									X							
Step 2 (T 6.1) - States Evaluation Methodology																
Scenario Development	X	X	X	X	X											
SWOT	X	X	X	X	X											
SUMP	X	X	X	X	X											
SECAP	X	X	X	X	X											
Analyses	X	X	X	X	X											
Step 3 (T 6.1) - States Evaluation Elaboration																
Scenarios Development			X	X	X	X										
SWOT							X	X								
SUMP					X	X	X	X								
SECAP					X	X	X	X								
Analyses							X	X								
Step 4 (T 6.2) - Future 2035 Scenarios																
Defining determinants and models for scenarios					X	X	X	X	X							
Identification of future elements, trends and extrapolations, alternatives, etc. and possible hunting fields						X	X	X	X							
Identification and Design of possible future scenarios						X	X	X								
Development of F1, F2, F3, F4						X	X	X								
Final Version of F1, F2, F3, F4									X							
Justification of Scenarios									X	X						
Evaluation of Scenarios									X	X						
Development of Ultimo Vision 2035									X	X						
Justification of Ultimo Vision 2035											X					
Evaluation of Ultimo Vision 2035															X	X

Step 5 (T 6.2) - Project Goals																
Development of Project Goals	X	X	X	X	X	X	X									
Justification of Project Goals										X						
Evaluation of Project Goals											X	X	X	X	X	X
Business Analysis				X	X	X	X	X	X							
Future Business Models Development							X	X	X	X						
Future Business Models Definition											X	X	X			
Future Business Models Evaluation														X	X	X
Step 6 (T6.3) Transformatio Challenges, Goals Success Factors & Obstacles																
Definition of transformation goals and strategies - Herford							X	X	X							
Identification of success factors, obstacles and risks - Herford							X	X	X							
Definition of transformation modules and process - Herford										X						
Policy recommendation for city, public transport operators and authorities - Herford											X	X				
Definition of transformation goals and strategies - Geneva							X	X	X							
Identification of success factors, obstacles and risks - Geneva							X	X	X							
Definition of transformation modules and process - Geneva										X						
Policy recommendation for city, public transport operators and authorities - Geneva											X	X				
Definition of transformation goals and strategies - Oslo / Groruddalen							X	X	X							
Identification of success factors, obstacles and risks - Oslo / Groruddalen							X	X	X							
Definition of transformation modules and process - Oslo / Groruddalen										X						
Policy recommendation for city, public transport operators and authorities - Oslo / Groruddalen											X	X				
Step 7 (T6.3): Transformation Strategies, Enablers, Change Mgmt. Concept																
Strategies, Enablers Description & Change Mgmt Concept - Herford													X			
Strategies, Enablers Description & Change Mgmt Concept - Geneva													X			
Strategies, Enablers Description & Change Mgmt Concept - Oslo / Groruddalen													X			

Step 8 (T6.3): Transformation Stakeholders, Impact/ Strategies & Requirements																
Stakeholder Models, Impact, Strategies & Requirements Table - Herford														X		
Stakeholder Models, Impact, Strategies & Requirements Table - Geneva														X		
Stakeholder Models, Impact, Strategies & Requirements Table - Oslo / Groruddalen														X		
Step 9 (T6.3): Transformation Action, Controlling & KPI Monitoring Plan																
Action & Monitoring Plan (incl. Roadmap, SUMP, SECAP) - Herford													X	X		
Action & Monitoring Plan (incl. Roadmap, SUMP, SECAP) - Geneva													X	X		
Action & Monitoring Plan (incl. Roadmap, SUMP, SECAP) - Oslo / Groruddalen													X	X		
Step 10 (T6.3): Transformation Field, Implementation Plan (Piloting)																
Herford														X		
Field Implementation Actions (SUMP, SECAP) -														X		
Field Implementation Actions (SUMP, SECAP) - Oslo / Groruddalen														X		
Evaluation of Impact on Citizens - Herford															X	
Evaluation of Impact on Citizens - Geneva															X	
Evaluation of Impact on Citizens - Oslo / Groruddalen															X	
Evaluation of Impact on PTA/City/other partner MaaS ecosystems - Herford															X	
Evaluation of Impact on PTA/City/other partner MaaS ecosystems - Geneva															X	
Evaluation of Impact on PTA/City/other partner MaaS ecosystems - Oslo / Groruddalen															X	
Evaluation of Impact on PTO (Public Transport & Maas Prov.) - Herford															X	
Evaluation of Impact on PTO (Public Transport & Maas Prov.) - Geneva															X	
Evaluation of Impact on PTO (Public Transport & Maas Prov.) - Oslo / Groruddalen															X	
Evaluation of Impact on OEM																X
Evaluation of Impact on other Stakeholders																X
Milestones																
No. 10: Holistic impact assessment of the project results															30/09/2026	
No. 11: Formulated guidelines for transformation of ITS/CCAM ecosystem															30/09/2026	

References

Berryman, Will (2023): Using the As-Is To-Be Methodology in Business Transformation. In *Will Berryman Consulting*, 3/31/2023. Available online at https://willberryman.com/?p=74, checked on 3/6/2024.

Bocken, N.M.P.; Schuit, C.S.C.; Kraaijenhagen, C. (2018): Experimenting with a circular business model: Lessons from eight cases. In *Environmental Innovation and Societal Transitions* 28, pp. 79–95. DOI: 10.1016/j.eist.2018.02.001.

Huber, Dominik; Viere, Tobias; Horschutz Nemoto, Eliane; Jaroudi, Ines; Korbee, Dorien; Fournier, Guy (2022): Climate and environmental impacts of automated minibuses in future public transportation. In *Transportation Research Part D: Transport and Environment* 102, p. 103160. DOI: 10.1016/j.trd.2021.103160.

Nemoto, Eliane Horschutz; Jaroudi, Ines; Fournier, Guy (2021): Introducing Automated Shuttles in the Public Transport of European Cities: The Case of the AVENUE Project. Nathanail E.G., Adamos G., Karakikes I. In: Nathanail E.G., Adamos G., Karakikes I. (eds) Advances in Mobility-as-a-Service Systems. CSUM 2020. Advances in Intelligent Systems and Computing: Springer, Cham (1278).

Nemoto, Eliane Horschutz; Korbee, Dorien; Jaroudi, Ines; Viere, Tobias; Naderer, Gabriele; Fournier, Guy (2023): Sustainability assessment of the deployment of automated minibuses in urban mobility of European cities. In *Transportation Research Procedia* 72, pp. 1364–1371. DOI: 10.1016/j.trpro.2023.11.599.

Pillkahn, Ulf (2007): Trends und Szenarien als Werkzeuge zur Strategieentwicklung. Wie Sie die unternehmerische und gesellschaftliche Zukunft planen und gestalten. Erlangen: Publicis Kommunikationsagentur. Available online at http://swb.eblib.com/patron/FullRecord.aspx?p=482230.