SHared automation Operating models for Worldwide adoption

SHOW

Grant Agreement Number: 875 530

D16.2: First version of business and exploitation plans

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Executive Summary

Deliverable D16.2 has the task of detailing the first version of the exploitation and business plans defined within the SHOW Grant Agreement per partner, market segment and test site use case targeting the creation of resilient business models that enable and study all phases of any go-to-market deployment, short-, medium- and long-term.

The document uses the market analysis elaborated in D16.1 and examines the promising paths towards market entry described therein. Due to the complex partner structure in the project and the investments still required in the field of automated driving, another goal is to create bankable business and exploitation plans that might convince potential investors, banks, or other funding institutions.

Consequently, the document starts with a brief general introduction (chapter 1), then explains the methodology used in D16.2 (chapter 2). The first results for the calculations of the TCO, CBA and CEA based on market estimations and data collection with the test sites is found within chapter 3, upon the elaboration of the cost structures in detail compared to the revenues, also considering indirect sources of financing in public transport, i.e., income beyond traditional ticket sales. These estimations are used as a baseline for the calculations of the business cases in chapter 4. As described in D16.1 and stated by all Public Transport Operators involved, a key motivator of Transport Operators in automated driving is the reduction of personnel costs, i.e., the long-term replacement of any safety driver by fully automated tele-supervision (& teleoperation) and the deployment of driverless services in public transport, technically already implemented in subways or airport transfer shuttle trains. In addition, automated driving enables a much better and more flexible passenger demand management while reducing emissions and air pollution through electrification and increased efficiency that comes with the operation of automated shuttle buses.

Deliverable D16.2 studies these aspects in more detail and highlights elements with regards to costs and benefits. In chapter 3, the corresponding costs and revenues using the tools TCO, CBA and CEA derived from chapter 2 are evaluated in terms of content and tables and underpinned with the corresponding figures from relevant SHOW partners whereas chapters 4 and 5 outline new concepts of exploitation covering transport services such as MaaS, Car Sharing (Robo Taxis) or Logistics complemented by Large Scale events where innovation often is linked to branding and innovation. In detail the business models of deliverable 2.2 are mapped and studied in chapter 4 while the new business models and further applications for the SHOW scenarios are evaluated in chapter 5.

At the beginning of the SHOW project, partners were to state their expected exploitation interest which led to a preliminary list of key exploitable results with 18 entrances. This initial list has been updated, now stating **46 key exploitable results** in Chapter 4.2. Results are then further evaluated in this deliverable with an expected final update in D16.3, with the final list of key exploitable results.

Finally, it has to be mentioned that the current deliverable D16.2 reflects discussions and opinions that took place within the consortium during the past 30 months, i.e., after completion of the technical developments and service deployment per pilot regions and use case set-up. The following months will bring operational pilot and service results, which might change and influence many discussions and utilization plans and, therefore, might lead to additional or alternative use case scenarios based on the daily operation and lessons learned for all involved transport operators. This will be documented and described in the final business and exploitation deliverable D16.3.

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List of Abbreviations

Abbreviation	Definition
AV	Automated Vehicle
CapEx	Capital Expenditure
CBA	Cost-Benefit-Analysis
CCAV	Connected and Cooperative Automated Vehicles
CEA	Cost-Effectiveness-Analysis
CLTD	Confidential and Long Term Data
CS	Car Sharing
DRT	Demand Responsive Transportation
EASTD	Easy Access and Short-Term Data
EU	European Union
GHG (emissions)	Greenhous Gas (emissions)
HW	Hardware
IaaS	Information as a Service
IT	Information Technology
KER	Key Exploitation Results
KPI	Key Performance Indicator
LaaS	Logistic-as-a-Service
M3ICA	Multi-impact, Multi-Criteria, Multi-Actor
MaaS	Mobility-as-a-Service
MCK	Modul Construction Kit
ÖBB	Österreichische Bundesbahn
OEM(s)	Original Equipment Manufacturer(s)
OpEx	Operational Expenditure
PT	Public Transport
PTO(s)	Public Transportation Operator(s)
SAE	Society of Automotive Engineers
SAMS (P)	Shared Automated Mobility Service (Person)
SAMS (F)	Shared Automated Mobility Service (Freight)
SME	Small and Medium-sized Enterprises
SW	Software
TCO	Total-Cost-of-Ownership
UC(s)	Use Case(s)
VEC	Vulnerable to Exclusion
VRU	Vulnerable Road Users
WP	Work Package

List of Definitions

This chapter lists and describes certain terms which are used in the course of this document and need to be explained for a better understanding.

Table 1 - List of definitions

Name	Definition
Acquisition costs	All kind of costs regarding hardware, software, vehicle, infrastructure and service implementation (CapEx) for automated mobility services
Baseline	The baseline represents the reference for the assessment of business and economic data collected from the target groups. The build-up of this baseline has been done with the first data collection executed in the pre-demo phase.
Basic scenario	The basic scenarios represent an aggregated version of the SHOW specific shared automated mobility services, separated in person and freight (SAMS(P)) transport (SAMS(F)). These were calculated based on the collected data of the different test sites. This provided the first reliably, anonymised TCO, CBA and CEA results used for the specific business models.
Business and exploitation plan	The main goal of the task is to define business plans and report on exploitation plans. Business plans are defined as the bankable, already on the market established SHOW services. As a baseline, it is assumed that the SHOW services are fully developed from a technological standpoint, need no further “initial” investment. The exploitation plans report on the efforts of the partners to (re-)use the results of the project.
CBA	Cost Benefit Analysis (CBA) is a process that is used by businesses that weights the sum of the benefits of an action against the negatives of that action. Positives would be, for example, financial gain, whereas the negatives would be costs. A CBA is often used to decide a course of action. [1] In SHOW the CBA is especially focused on the costs, revenues and savings to reduce costs and support the deployment of shared automated mobility service into the market.
CEA	Cost Effectiveness Analysis (CEA for short) is an alternative to the cost benefit analysis. It also compares the costs to the outcomes of a course of action, but is particularly useful when CBAs cannot be used due to certain constraints such as the inability to monetize benefits. [2]
CapEx	Capital expenditures (CapEx) are funds used by a company to acquire, upgrade, and maintain physical assets such as property, plants, buildings, technology, or equipment. CapEx is often used to undertake new projects or investments by a company. [3]

Name	Definition
(Business and economic) Impact	Impact within the SHOW Project is defined by analysing the differences between the first and second data collection and are aggregated to the business and exploitation plans.
Leasing	Leasing includes all relevant costs regarding the necessary infrastructure (buildings, space, security…) and HW and SW - equipment's (like charging stations, cleaning station…) for operating the shared automated mobility services of SHOW.
MaaS	Mobility-as-a Service in the context of the SHOW project and this document is defined as a shared automated mobility service
Module(s)	Modules contains all kind of relevant business or economic data of a specific cost category, a revenue or saving.
Modul Construction Kit (MCK)	The MCK is the tool, which has been developed to calculate – where necessary estimate – the TCO and to analyse the CBA for the defined target groups in SHOW.
OpEx	Operating expenditures (OpEx) are expenses a business incurs through its normal business operations. They include rent, equipment, inventory costs, marketing, payroll, insurance, step costs, and funds allocated for research and development. [4]
Target groups	Target groups in SHOW are defined as single partners, test sites and external stakeholders. For test sites also the relevant business environment (partners which are necessary to realize the development results) is included.
Tool Developers	SHOW project partner IESTA and VUB are going to be referred as "tool developers" in the further course of the document.
TCO	Total Cost of Ownership (TCO) is an accounting method to identify all costs incurred in investments in advance and to take a special look at the value of cost drivers and hidden costs. [5]

1 Introduction

1.1 Purpose of the document

Purpose of D16.2 is to report the first results on business and exploitations plans for the mobility services, use cases, test sites and stakeholder groups involved in SHOW.

Ultimately, SHOW strives for a **manageable, traceable way** to determine the corresponding **costs, revenues** and **benefits** of the **SHOW test sites**, **stakeholder groups**, **use cases** and **mobility services,** assess them **with different tools** and aggregates them to **bankable business and exploitation plans** with an special focus on SME, new market entrants and on the OpEx-driven economic aspects.

The main challenges are the **complexity of the assessment** considering the large value chains with its linked business environment, specific boundary conditions and dependencies as well as the **confidentiality of the data** to be collected. These challenges will are resolved by the A16.2 approach by dividing the work in three main areas namely, tool development, data collection and impact assessment, where tool development and data collection can be executed in parallel followed by the assessment and the realization within 2 iterations (baseline, final results) connected by an optimization phase to ensure that there is enough time to collect the data, to optimize the developed tools as well as to assess the results and to provide high-quality and usable business and exploitation plans on partner, test site and stakeholder group-level.

1.2 Intended Audience

The present document addresses on the one hand the project partners of WP16, especially A16.2 project partners, and all the linked WPs (chapter 3-6) for the relevant activities to create the business and exploitation plans and on the other hand all SHOW project partners, test sites and external stakeholder groups for the results of assessment and development regarding the business and exploitation plans (chapter 7-8).

1.3 Interrelations

Analysing the internal and external interrelations from or to other SHOW WPs/Activities the following has been identified and used within this deliverable:

- Internal interrelations
    - WP1 – A1.1: SHOW Ecosystem
      Important information such as the definition of the different stakeholder groups and which consortium partners fall into which stakeholder category as well as their needs, wants and priorities for automated vehicles and mobility services (person and freight) are used to define the relevant boundary conditions and “target markets” for the different calculations.
      Important deliverables: D1.1
    - WP1 – A1.3: SHOW Use cases
      The use cases of the different test sites contain information that is needed for test-site-specific customization of the cost assessment calculation (e.g. stakeholders and related UC(s) or different test sites and related UC(s)).
      Important deliverables: D1.3

- WP2 – A2.3: Business/operating Models application in Pilot sites and their validation
  The results of the business & operating model evaluations (single model or combined ones) and the check of transferability and scalability of the developed models will be used for the CBA calculations. They will give a good overview how single economic and business environments influence the success and therefore will be used to derive impacts for different stakeholder groups. Additionally, the evaluation contains also relevant results about the defined KPI, which also be considered in A16.2 for the different calculations. Furthermore, the results of A16.2 will support the evaluation activities in A2.3 with estimations on revenues and costs, which can be used for the final evaluation of the developed business models aa well as for the transferability and scalability calculations.
  Important deliverables: D2.3, D2.4, D2.5

- WP6 – A6.1: SHOW marketplace
  Information on different categories of relevant data of mobility services and boundary conditions of one specific business environment – the marketplace - will be provided by WP6. The SHOW marketplace is specialized on information and its services (IaaS), to sell them and to support the operations of mobility services.
  Important deliverables: D6.1, D6.2, D6.3

- WP9 – A9.1: Plans for pilot evaluation
  Defines the testing framework including vehicles, infrastructure, use cases to be realized, involved project partners as well as the relevant evaluation and evaluation parameters. All this information will be used for the TCO; CBA and CEA calculations for the use cases as well as the test sites.
  Important deliverables: D9.1 and D9.2

- WP9 – A9.4: Impact assessment framework, tools & KPIs definition
  The KPIs defined in WP9 are the base for the impact assessment in SHOW including the business and economic perspective. Mainly for the CBA, the KPIs will be used to show how a single parameter within the business environment can influence the mobility service and its value chain. Additionally, the list of KPIs will be the base for the CEA tool development and assessment of end user requirements.
  Important deliverables: D9.2

- WP10 – A10.1: Simulation framework for extension of SHOW test sites
  A complete meta-/co-simulation framework is defined which will be used to enhance field tests and experimental results relevant for the calculations. These framework lays the base for the specific simulations in A10.2, A10.3 and A10.4. The boundary conditions for the simulations will be considered for the CEA and the CBA.
  Important deliverables: D10.1, D10.2

- WP10 - A10.2: Vehicle and traffic simulations
  Micro- and macro simulations will be done to represent the proposed shared CCAV services at pilot sites and the assessment of safety, energy and environmental changes for several mixed scenarios. This information will support the CEA regarding traffic safety, energy efficiency and other traffic related calculations.
  Important deliverables: D10.1, D10.2, D10.3, D10.4

- WP10 - A10.3: Person, mobility, freight and environment related simulations
  This activity focuses on conducting simulations related to people, mobility, energy and environment. It also shows the user' behaviour when automated features are present especially the behavioural differences if vehicles of different automation level (Level 0 to Level 4) are presented. The results will be used to calculate the CBA regarding single mobility services and the combination of them.
  Important deliverables: D10.1, D10.2, D10.3, D10.4

- WP10 – A10.4: Combination of simulations
  Combines several types and scales of simulations with the focus on micro/macro level traffic and driving simulations and evaluates the safety level and the economic benefits of highly automated vehicle fleets. The results will be considered for the CEA assessment.
  Important deliverables: D10.3, D10.5

- WP16 – A16.1: SHOW market analysis
  In this task the positioning of SHOW in the CCAV market is conducted. It provides important information for the business impact calculations, such as existing cost structures from the business ecosystem, market shares and specific economic facts like implemented mobility services on the test sites.
  Important deliverables: D16.1

- WP16 – A16.3: Exploitation plans per partner and stakeholder groups
  The results from A16.2 will feed A16.3, which generates business exploitation models and strategies per single partner, stakeholder groups (internal and external) as well as roadmaps for large-scale deployment.

- WP17 – A17.1: Best practices and application guidelines for different stakeholder groups
  This task aims to provide application guidelines in form of an instruction manual for industries, PT authorities, PT operators, cities and regions. These guidelines will be built on the inputs from the SHOW WP2, WP9, WP10 and WP16 especially from the results coming from A16.2, which gives an overview about the relevant business ecosystem, organizational and legal boundary conditions and most promising business factors for the introduction of new CCAV-based mobility services.

- External interrelations
  - External stakeholders working on all kind of mobility: They will provide relevant additional input for the TCO, CBA and CEA calculations in the field of business ecosystem, single economic facts, country-specific information or business calculations as well as external quality assurance of the calculations results (plausibility).

1.4 Structure of the document

The deliverable has the following structure:

Chapter 1: Introduction explaining the basics for the deliverable

Chapter 2: Methodology and Approach containing the basic boundary conditions explaining relevant business environment influences and restrictions for business and economic assessment and the approach describing the general solution for the activity A16.2, the data collection, the tool development as well as the business and economic assessment. The chapter also serves as a support for single partners and their work within A16.2.

Chapter 3: Total Cost of Ownership (TCO) tool and assessment containing the specific conditions for the tool development as well as the assessment and results.

Chapter 3: Cost Benefit Analysis (CBA) and Cost Effectiveness Analysis (CEA) tool and assessment containing the specific conditions for the tool development as well as the assessment and results.

Chapter 3: Business and economic impact assessment describing the results of the assessment according to two general basic scenarios for person (SAMS(P)) and freight (SAMS(F)) transport.

Chapter 4: First business and exploitation plans contains the bankable business and exploitation plans for the different mobility scenarios operated on SHOW test sites, as well as first results for the exploitation plans. Exploitation is sub structured in the specific project results, exploitation of the test sites as well as exploitation for the stakeholders.

Chapter 5: Features discussions on new business plans, meaning scenarios that are outside the initial scope of SHOW, very new to the market but relevant.

Chapter 6: Concludes the deliverable and gives and outlook to D16.3.

Chapter 0 - Annex I: Data collection containing the relevant information (data to be collected, collection process and possible risks) for the tool development and assessment and serves as a support for single partners and their work within A16.2.

Chapter 0 - Annex II: Methodology and base of analysis for exploitations, showing the questionnaire for exploitation as well as the answered.

2 Methodology

The following sub-chapters describe the general approach/methodology for the activity (chapter 2.1), the tool development (chapter 2.2) as base for the business impact and exploitation (chapter 2.3). It has to be mentioned that chapter 2.3 includes the relevant overall methodology for the TCO, CBA and CEA and as an overview the data collection. So, this chapter shows the methods and tools which are used to assess business and exploitation impact and their connection to each other.

2.1 General Approach for A16.2

The general approach for A16.2 is to create the business exploitation plans by analysing the aggregated data collected with two data collections from the pre-demo and demo phase within the SHOW consortium, compare them to identify relevant cost, revenue and saving potentials and to derive then relevant business potentials and exploitation strategies to active the identified advantages. The data and aggregation results of the first data collection are the baseline to which the results of the second and last data collection, which includes all development results, are compared. In Figure 1 the general approach within A16.2 as well as the input side and the output side of the task can be seen.

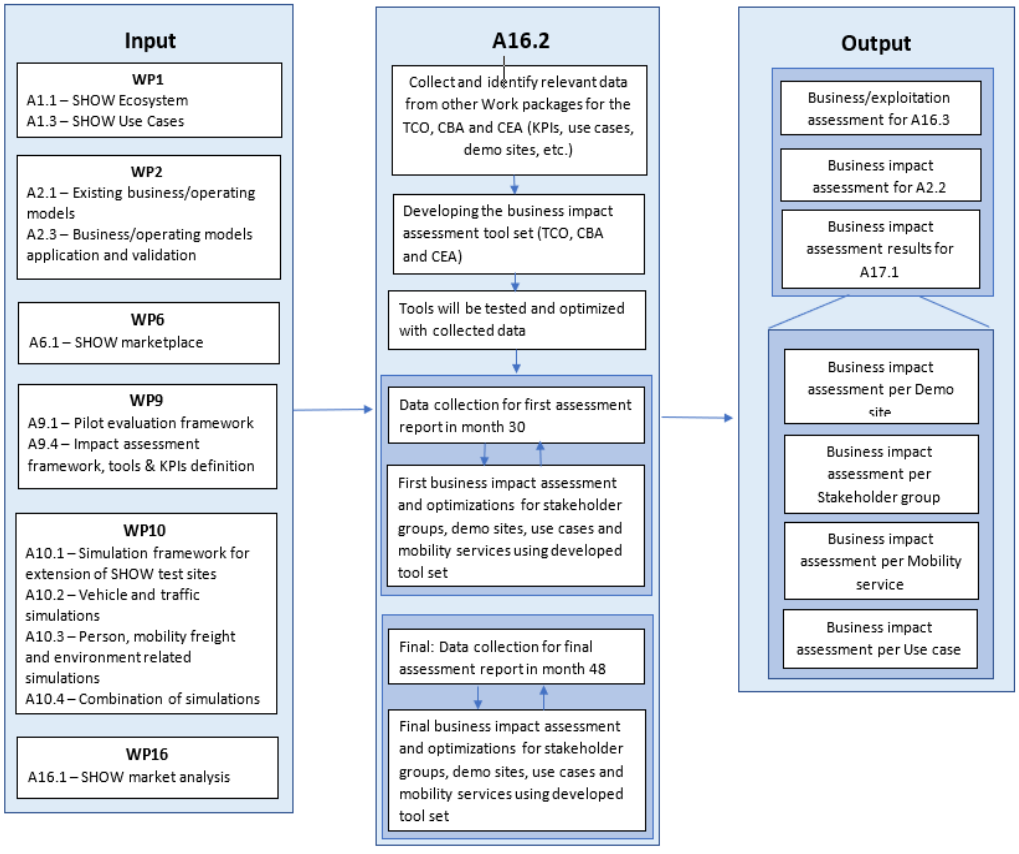

Figure 1: Approach A16.2.

The following steps constitute the basic approach in this deliverable including the tool development (for the tools TCO, CBA and CEA), data collection and assessment for the (see middle column in Figure 1).

- **Step 1:** Collect and identify relevant data from other WPs for the TCO, CBA and CEA (KPIs, Use cases, test sites)
- **Step 2:** Developing the business impact assessment tool set
- **Step 3:** Tools are tested and optimized with collected data
- **Step 4:** First business impact assessment
  - Data collection for first assessment report in month 29
  - First business impact assessment and optimizations
- **Step 5:** Final business impact assessment
  - Data collection for final assessment report in month 47
  - Final business impact assessment and optimizations

More detailed approaches for the TCO, CBA and CEA are described in chapter 2.3.2, 2.3.3 and chapter 2.3.4, whereas the corresponding tools and data collection is described in more detail in chapter 0 - Annex I.

2.2 Basic approach TCO and CBA tool – Module Construction Kit (MCK)

The tool for the TCO and CBA has been developed within Excel from Microsoft™, which was selected to ensure flexibility especially regarding specific changes of the input data combined with powerful calculation abilities and statistical graphic illustrations. The basic structure of the MCK considering the relevant (input) data and algorithms for the calculations of the TCO and the analysis of the CBA covering the identified target groups (SHOW internal and external). A general example for the MCK can be seen in Figure 2. Basically the MCK consists of several modules such as “Maintenance”, “Vehicle”, “Personnel”, etc. These modules contain the corresponding data for the TCO and CBA, such as “Vehicles”, “Maintenance” or “Personnel” as well as “Revenues”.

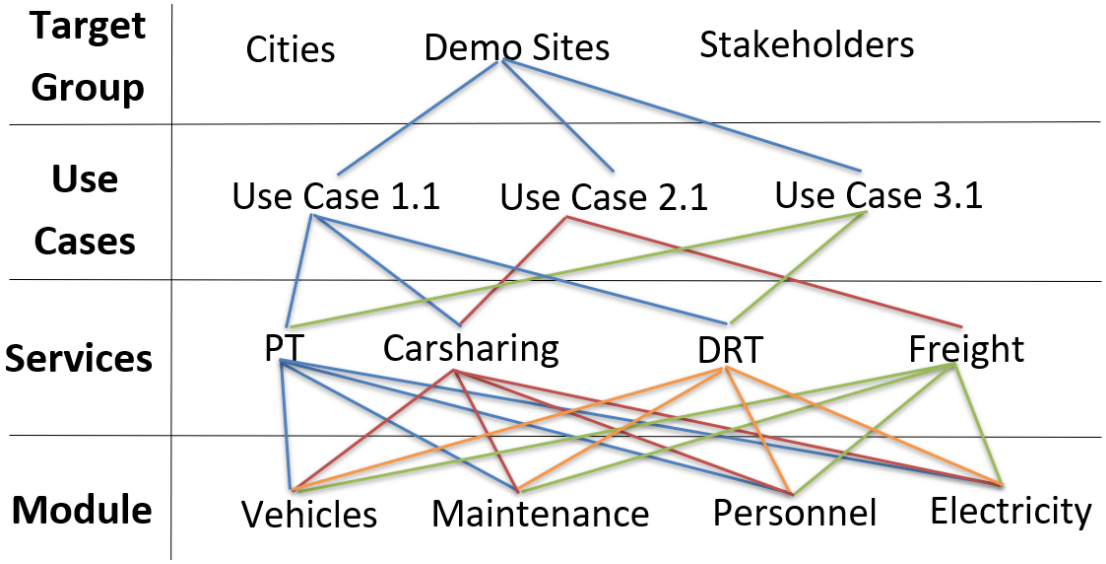

Figure 2: Example of MCK for a SHOW test site

With these modules, the TCO and CBA for the different shared automated mobility services are collected (data) and created/calculated. The SHOW use cases can be

aggregated based on the mobility services by combining them. Finally, as highest level the TCO and CBA for target groups (test sites, different stakeholders, cities or PT/PTO) can derived/calculated by combining the results of the different use cases. Nevertheless, with the created mobility services it is not only possible to build-up use cases, it is also possible link target groups directly to the mobility services to cover the requirements of the external stakeholders without the boundary conditions of the SHOW Use Cases.

2.3 Business Impact Analysis

This chapter gives a solid but summarized overview over the methodologies of the different tools used for business impact analysis.

2.3.1 Methodology Data Collection

In general the data collection is divided in two phases linked to two demo phases of the test sites and finalized by the deliverables (D16.2 and D16.3) within SHOW. The first phase collects the data of the "pre-demo"-phase and focuses on data representing the existing business and ecosystems and laying the base for the assessment and the improvements initiated by the project.

The second and last iteration collects the business and economic data including the progress initiated by the development results of SHOW.

To give a better overview over the data collection process, the data categories as well as the data collection process done for the business impact analysis is described in the two following sub-chapters.

It should be mentioned that due to the confidentiality of the collected data from the different test sites ("CLTD") two basic scenarios were developed based on the collected data and their aggregation which are used for the calculations of the TCO, CBA and CEA (see chapter 3).

Categories of Data

"Easy Access and short term available Data (EASTD)"

EASTD is data that can be collected at any time without additional calculations (sometimes without the help of the relevant partner). These are, for example, annual reports, data from public studies regarding the market development of mobility services, automated driving, legal restrictions or similar.

„Confidential and long term available Data" (CLTD)

CLTD are collected directly at the test site partners including the SHOW use cases and development results. This is done via specific presentations and excel-sheets that are created for the TCO, CBA and CEA. The mobility service related costs, mobility service related revenues, other mobility service related data, the value chain participants and the OpEx costs of the value chain participants are for example part of the dynamic data.

The specific data which is collected during the data collection process, can be seen in detail in chapter 0 - Annex I.

Data collection process

The collection process is executed two times or better in two phases to get information about the existing business and exploitation potential and about the changes and impact of the SHOW development results. The data collection process is fully adapted

to the general approach of A16.2 as well as of A16.3 and A2.3 and are executed and controlled by the Data Collection Administrator (see chapter “Data Collection Administrator” in chapter 0 - Annex I).

In general, the data collection process is defined as follows:

- Step1: Identify relevant EASTD and CLTD
- Step2: Collect EASTD – Phase 1
- Step3: Optimize data collection
- Step4: Collect CLTD and update of EASTD – Phase 2

The following sub chapters describes the single steps of the data collection process.

Step 1: Identify relevant EASTD and CLTD

As a first step, relevant static and dynamic input data (means all kind of costs and revenues) regarding mobility services, use cases, stakeholder groups and customers/end users are identified, documented and quality assured together with SHOW partners of A16.2, A16.3 and A2.3.

The data which is collected can already be found in the chapter “Data to be collected” in chapter 0 - Annex I.

Step 2: Collect EASTD – Phase 1

This first data collection process starts in M17 and ends in M27. During this time the Data Collection Administrator will coordinate the data collection and the A16.2 partners will collect the input data by using stakeholder-adapted presentations and meetings. The tool developers will support the activities by answering specific questions or by training the data collector. Additionally, the partners of Phase 1 will identify missing items (data which should be collected in Phase 2) or optimizations of the organizational issues or data collection presentations.

Step 3: Optimize data collection

Based on the identified missing items and experiences gained during Phase 1, the data collection material like the excel-spreadsheets and/or presentations are optimized for Phase 2. But also the data collection and communication process itself is optimized based on the experiences of step 2 to decrease the amount of time and resources for all affected contributors.

Step 4: Collect CLTD and update of EASTD – Phase 2

This second phase of the data collection follows the same principle as the first collection process. It starts in M31 and ends in M46 using the optimized process and presentations of step3. The results feeding the assessment and D16.3, which is due in M48.

2.3.2 Methodology TCO

Total Cost of Ownership (TCO) is an accounting method designed to help consumers and businesses estimate all the costs incurred by capital goods (such as software and hardware in IT). The idea is to obtain a statement that includes not only the acquisition costs, but all aspects of the subsequent use (energy costs, repair and maintenance) of the components in question. Thus, known cost drivers or even hidden costs can possibly be identified in advance of an investment decision. The most important basis for further understanding of TCO is the distinction between direct and indirect costs.

The basic procedure to determine the TCO of the different SHOW test sites, stakeholder groups, mobility services and use cases is as follows:

- The EASTD and CLTD of the target groups are collected (see chapter 0 - Annex I).
- The data is transferred to the input spreadsheet (modules) of the Module Construction Kit.
- Missing (input) data is added with the help of experts best guesses or literature research.
- From this the TCO of the target groups can be calculated.
- Last, the TCO results of the different target group members like different test sites are compared with each other.

2.3.3 Methodology CBA

Cost–benefit analysis (CBA), sometimes also called benefit–cost analysis, is a systematic approach to estimating the strengths and weaknesses of alternatives. It is used to determine options which provide the best approach to achieving benefits while preserving savings in, for example, transactions, activities, and functional business requirements [6]. A CBA may be used to compare completed or potential courses of action, and to estimate or evaluate the value against the cost of a decision, project, or policy. It is commonly used in commercial transactions, business or policy decisions (particularly public policy), and project investments.

In principle, the methodology (identification of cost and benefits and comparison of them) of a CBA is fixed, but it has to be adapted to the current application or use case. For SHOW this means the relevant boundary conditions, participants and economic parameters have to be identified, classified and matched with the KPIs defined in WP9.

Especially for the adaptation to SHOW, the existing project results of WP2 (D2.1, D2.2) and WP16 (D16.1) are used to ensure consistency and completeness. The basic procedure to determine the CBA of the different SHOW test sites, stakeholder groups, mobility services and use cases is as follows:

1) **Costs** (not covered by the TCO) and **revenues** are collected (see chapter 0 - Annex I).
2) Next, the applying **benefits** are **identified** and **monetized** covering the relevant target groups from the activity description of A16.2 and in line with D2.1 and D16.1 (see chapter 3.3.1).
3) In the last step, the monetized benefit values are **compared** to the corresponding costs.

2.3.4 Methodology CEA

The aim of a cost-effectiveness analysis is to compare the efficiency of a technology, a service, or a policy to different alternatives [7]. For this purpose, two elements are needed: the total cost of each alternative and the outcome on which the alternatives can be compared. These two elements are then computed as a ratio. The most cost-effective alternative is the one that brings one unit of this (positive) outcome at the least possible cost.

For SHOW, these outcomes are measured through the KPIs developed in WP13 and they are compared to the costs collected for the TCO. As with TCO and CBA, the CEA is developed with Microsoft™ Excel. We therefore need the following two inputs:

1. The cost of the services: from TCO calculations
2. The outcomes on which to compare the different services: the pilots KPIs

This analysis is done for both passenger and freight transport. The outcomes have different units, and therefore the KPIs are transformed such that the lower the ratio,

the more cost-effective the service is for this specific outcome. In the current deliverable, the method is explained and shown for the aggregated cost of the service and, since the KPIs are not yet available, results presented in this deliverable are based on the estimated KPIs. These are computed based on the grant agreement targets value or are new estimates for the KPIs that were developed within WP13. In the next deliverable (D16.3), the ratio is calculated for each test site based on KPI measurements, supported by WP10 simulation results and the cost-effectiveness will then be compared across test sites, for passenger transport, on the one hand, and freight transport on the other hand. This allows for the comparison of how these different implementations led to different outcomes.

2.4 Building business scenarios and exploitation roadmaps

Main result of this deliverable D16.2 are the first business and exploitation plans for each SHOW single beneficiary, for the test sites and the different stakeholder groups. The methodology to create this business and exploitation plans is divided into 3 main areas:

- Business and exploitation plans for single beneficiaries, resulting in the updated list of SHOW KERs.
- Business and exploitation plans for test sites, resulting in a report of the technical validation (and for some test sites the pre-demo phase) phase, as well as an outlook until the end of the project.
- Business and exploitation plans for stakeholder groups, resulting on recommendations for an action plan as well as identifying the main enablers and disruptors

All results are based on the reporting period until April 2022, changes between April 2022 and the submission and acceptance of the deliverable are part of the updates and final version of this deliverable in D16.3.

2.4.1 Business and exploitation plans for single beneficiaries

The plans are developed using the methodology and approach developed and specified during the HORIZON RESULT BOOSTER service of the European Commission, which SHOW successfully applied for and conducted during the year 2021/2022.

At the beginning of the SHOW project, partners were to state their expected exploitation interest which led to a preliminary list of key exploitable results with 18 entrances. This initial list has been updated, now stating 46 key exploitable results
The analysis of exploitation and different business possibilities for the SHOW partners is done via a questionnaire survey. The questionnaire can be found in Annex II Business and exploitation plan survey.

The relevant information is reported in chapter 4.3.

2.4.2 Business and exploitation plans for test sites

The basic methodology for the business and exploitation plans of the test sites is the analysis for the business impact assessment. The short summary of the methodology is listed in these bullet points, while the full methodology is described in chapter 4.4.

- Collect the relevant business data (cost, revenues) from the test sites and their business environments including stakeholders evolved

- Calculate the TCO and CBA (revenues) as well as CEA parameters using the developed tools for all single SAMS implemented in SHOW
- Aggregate the results of the single SAMS(P) according to the use cases
- Aggregate the use case results to the specific test site
- Analyze the test site results and develop business and exploitation potential recommendations (mainly basing on the CBA results)

While some business models and therefore business plans are very similar throughout the test sites, the first step for the analysis is a mapping of the business models developed in SHOW (WP2) to scenarios for the uptake of automated driving. These scenarios are groups of business models and listed in the following bullet points.

- Public transportation
- Demand responsive transportation
- Car sharing (Robo Taxis)
- Mobility-as-a-service
- Logistics-as-a-service

The analysis starts off with a mapping of the business models to the test sites and scenarios. Then, the business and exploitation plans are reported on scenario level.

2.4.3 Business and exploitation plans for stakeholder groups

As there is no real business plan for a stakeholder group, the evaluation on stakeholder levels focuses on the business opportunities and different exploitation paths deriving from the results of the test site analysis.

The basic methodology and approach consists of the following steps:

- Use the results of test sites as base of the work
- Analyze the differences and similarities of the single stakeholder groups throughout the a single stakeholder
- Develop business and exploitation potential recommendations (mainly basing on the CBA results)

3 Basic results of Business Impact Assessment

The following chapter describes the relevant results provided by the three assessment tools (TCO, CBA and CEA) for the business and exploitation plans described in chapter 4.

3.1 Basic boundary conditions

The basic boundary conditions for the assessment can be summarized as follows:

- Completeness of collected data
- When applying the TCO, CBA and CEA the specific conditions of the respective target groups must be taken into account and detailed information has to be gathered (Framework conditions).
- In the end, after assessing the economic effects especially on SHOW cities, the results are compared with other European cities, twinning cities and the rest of the world (e.g. C40 cities).
- Basic assumption for the assessment
    - All kind of calculations are not limited to the duration of the SHOW project; they go at least two years beyond.
    - Holding period for vehicles of 96 months and for buses/shuttles 10 years.
    - All other types of costs or benefits are calculated/adapted to the holding period.

3.1.1 Definition of SHOW stakeholders in the mobility business and economic environment

For a better overview, the following table (Table 2) lists all target groups (test sites, external stakeholders, shared automated mobility services, use cases, value chain participants (extracted from D2.1), and relevant cost modules) which were identified for the assessment. Together with the SHOW technical innovations this creates a bundle of services, which are meant to cover long-term objectives instead of a short-term perspective.

Table 2 - General list of identified test sites, mobility services, use cases, stakeholder groups, Value chain participants and modules

Test sites	External Stakeholders	Mobility services	Use cases	Value chain participants	Cost Modules
Mega Sites	SHOW stakeholder ecosystem clusters: • OEM	MaaS: • Car sharing	UC1: Automated mobility in cities	• Service operator • Municipality • Infrastructure provider • Vehicle provider	• Module Leasing • Module Personnel • Module Maintenance • Module Insurances

Test sites	External Stakeholders	Mobility services	Use cases	Value chain participants	Cost Modules
France: • (Crest Val-de-Drome) • Rouen Germany: • (Frankfurt) • Karlsruhe • Monheim Spain: • Madrid: Carabanchel Villaverde Sweden: • Linköping • Gothenburg Austria: • Graz • Salzburg • Carinthia **Satellite Sites** Netherlands: • Brainport Czech Republic: • Brno Finland: • Tampere Greece:	• Transport/Mobility operator • Tier 1 suppliers/Technology providers • Service companies • Telecom operators • Research and academia • Passengers and other road users encompassing VEC • Umbrella associations/Non-profit organizations • Authorities, policy makers, municipality and road operators Defined M3ICA stakeholder groups: • Vehicle and other road users (passengers, other road users interacting with AVs in traffic, and AV (remote) operator) • Public interest groups and associations • Decision-making authorities or regulators • Operators (e.g. public transport operators, & private fleet operators) • Mobility service providers • Industry (e.g. AV manufacturers) • Delivery senders • Delivery receivers • Delivery service providers	• (Robo)Taxi • Ridesharing (with shuttles) LaaS: • Mail • Food (Take-away) • Grocery deliveries Public Transportation: • Bus • Trolleybus DRT: • Addresses-to-addresses • Addresses-to-hub • Virtual line • Stops-to-stops • Stops-to-hub • End-of-line-to-stops	• UC1.1: Automated passengers/cargo mobility in Cities under normal traffic & environment conditions • UC1.2: Automated passengers/cargo mobility in Cities under complex traffic & environmental conditions • UC1.3: Interfacing non automated vehicles and travellers (including VRUs) • UC1.4: Energy sustainable automated passengers/cargo mobility in Cities • UC1.5: Actual integration to city TMC • UC1.6: Mixed traffic flows • UC1.7: Connection to Operation Centre for tele-operation and remote supervision • UC1.8: Platooning for higher speed connectors in people transport • UC1.9: Cargo platooning for efficiency • UC1.10: Seamless autonomous transport chains of Automated PT, DRT, MaaS, LaaS UC2: Automated mixed mobility in cities • UC2.1: Automated mixed spatial mobility • UC2.2: Automated mixed temporal mobility UC3: Added Value services for Cooperative and Connected Automated mobility in cities • UC3.1: Self-learning Demand Response Passengers/Cargo mobility • UC3.2: Big data/AI based added value services for Passengers/Cargo mobility • UC3.3: Automated parking applications • UC3.4: Automated services at bus stops • UC3.5: Depot management of automated buses • UC3.6: COVID-safe transport	• Maintenance provider • Ticket sale reseller (PT) • Billing system operator • IT provider • Marketing provider • Mobility needs growers • Telecommunication provider • Legal and consulting provider • Safety provider • Technology provider • Umbrella associations • End users and other road users encompassing • Web design provider • Research & academia • Tier supplier	• Module Depreciation • Module Marketing • Module IT • Module Material (for SAMS(F)) • Module Supplies • Module Vehicles • Module Billing

Test sites	External Stakeholders	Mobility services	Use cases	Value chain participants	Cost Modules
• Trikala • (Thessaloniki) Italy: • Turin Belgium (Follower site): • (Brussels) Switzerland (Follower site): • (Geneva)					

Table 2 is the base for the definition of business impact parameters defined in chapters 3.1.2 and of the basic business ecosystem shown in chapter 3.1.3 as well as for the allocation matrix of the shared automated mobility services, use cases and target/stakeholder groups to the respective test sites in chapter 3.1.4.

3.1.2 Definition of business impact parameters

As a basic method, a CBA offers answers to a large number of possible economic questions and must therefore be adapted to the project-specific challenges. Based on the results from chapter 3.1.1 and the basic method, the specific business impact parameters - i.e. the benefits - were derived. The results for SHOW are shown in Table 3.

Table 3 - Definition of business impact parameters of the CBA

Benefit category	Benefit	Question to the Benefit	Definition of the Benefit
Break-even point	Profitability	Is the service rentable at all based on revenues and OpEx/CapEx?	By comparing the revenues with the OpEx and CapEx costs the profitability of the service is calculated. This shows if the service is rentable or not from the financial point of view only.
	Service Acceptance	Is the service accepted at all by the people of the area?	Based on the total inhabitants of the area and the users (also inhabitants of the area) of the service, the service acceptance is evaluated.
	Customer Segments	Who are the main customers and which effect do they have on the revenues?	Each customer segment (Elderly, Students, Regular Users, etc.) has its own value for the mobility service based on the ticket price they are paying for. E.g. Senior cards for 1 year are often cheaper than regular 1 year tickets.
	SAMS integration	What are the costs of SAMS integration?	Some mobility service providers are interested to develop and/or to integrate themselves in an existing SAMS concept. This is coupled with certain

Benefit category	Benefit	Question to the Benefit	Definition of the Benefit
			costs for the mobility service.
	Maintenance	How high are vehicle, depot and station maintenance costs?	Maintenance costs make a considerable amount of the OpEx costs and, therefore, are considered individually as benefit. CapEx costs for key equipment and fleet initial costs are not part here.
Technical	Downtimes caused by technical vehicle issues	How many incidents happened because of technical vehicle issues?	Due to different technical problems (vehicle functions from comfort to safety issues)are not working properly it can happen that the vehicle breaks down or has other technical issues which can lead to the point that the service is not possible to operate as it is expected. The less incidents the better.
	Downtimes caused by technical infrastructure issues	How many incidents happened because of technical infrastructure issues?	Due to different technical problems it can happen that the technical infrastructure breaks down or has other technical issues which can lead to the point that the service is not possible to operate as expected. The less incidents the better.
Environment	Environmental friendliness	How high are the emissions?	Each mobility service produces a certain amount of emissions (CO_2, NO_x, etc.) with its service. The less

Benefit category	Benefit	Question to the Benefit	Definition of the Benefit
			are produced the more environmental friendly is the service.
Economic	Real time information	How is a real time information system influencing the revenues/costs?	Real time information is often a benefit for customers as well as for the service itself, if they know where exactly the next bus is (for the customers) or how many people are standing at the bus stop (for the driver).
	Pricing strategy	How many different tickets are there?	Each mobility service has its own ticketing system (daily tickets, monthly tickets, Subscriptions, etc.) and all this different tickets have a different impact on the revenues.
	Marketing influence	How is the marketing influencing the revenues?	Marketing has a significant influence on the customer's behavior. How this behavior change is influencing the business' revenues is analyzed here.
	Operating times	When/at what times is the service operating and what impact has this on the revenues?	By knowing the operating times of the service and the # of customers for each operating time it can be concluded how much losses are generated for each operating time the service is not operating. E.g. The revenue losses, if a service is only operating on week

Benefit category	Benefit	Question to the Benefit	Definition of the Benefit
			days but not on weekends.
	Realised Use Cases	How many Use Cases of SHOW were realized?	SHOW defined Use Cases for the test sites of the project. By taking the costs and revenues for each use case a value can be defined. The more use cases are realized per test site the better and the higher the total value.
	Funding	How is national funding influencing the CapEx and/or OpEx?	Funding can have a great impact on the OpEx and CapEx costs by reducing them by a significant amount. How much they influence the costs are analyzed here.
Quality of Service	Service information	Where and how is it possible to get information about the new service (Websites, Information stations, Social Media, etc.)?	Information about the service such as prices, how it works, etc. are crucial for a service to generate customers. The more places the information are available the better and easier they are available for customers. This can be an important advantage for the services.
	Calling possibilities of Service	What are the calling possibilities of the service (e.g. App, Regular phone number) and how is this influencing the revenues/costs?	To use a service, it often has to be called (DRT, Taxi, etc.). Nowadays, there are different ways to call one e.g. with Apps or/and a phone number etc. The more of this

Benefit category	Benefit	Question to the Benefit	Definition of the Benefit
			possibilities there are, the better for the customers and the service.
Users & Stakeholders	New actors/businesses	Are there any new actors/businesses in the mobility service value chain after the implementation of the new service? What is their role for the service? What is their value?	After introducing a new service to an already existing service, it is possible that new actors come into view and are part of the Service' value chain. Which role they have, and what value they are contributing are shown here.
	External Know-how	How is external know-how influencing the mobility service regarding costs and revenues?	External knowledge can be a great help for a new upcoming service. This knowledge can come from investors, business partners or other sources.

Table 3 is the base for understanding the different business impact parameters (benefits) used in the CBA calculation in chapter 3.3.

3.1.3 Basic business ecosystem

The business ecosystem defines the boundary conditions for a business or a mobility service. Using the results of other WPs (WP1, WP2 and WP9) which have collected relevant information of the business ecosystem, the relevant conditions like participants of the value chain and where there are involved, were analysed for TCO. Table 4 gives an overview about the partners in the mobility service business environment and their involvement in passenger and freight mobility.

Table 4 - Identified target groups and their main business (adapted table from D9.3)

Defined M3ICA stakeholder groups (as described in D9.3)	SHOW stakeholder ecosystem clusters (as described in D1.1)	Identified stakeholder groups identified for business impact (as described in D2.1)
Vehicle and other road users (passengers, other road users interacting with AVs in traffic, and AV (remote) operator)	Passengers and other road users encompassing Vulnerable to Exclusion (VEC)	End users

Defined M3ICA stakeholder groups (as described in D9.3)	**SHOW stakeholder ecosystem clusters (as described in D1.1)**	**Identified stakeholder groups identified for business impact (as described in D2.1)**
LaaS: Delivery senders/receivers	-	(End users)
Decision-making authorities or regulators	Road operators, Authorities (Cities, Municipalities, Ministries) & policy makers	Public Authorities
Operators (e.g., public transport operators, & private fleet operators)	Original Equipment Manufacturers (OEMs) and transport/mobility operators Tier 1 suppliers, telecom operators, technology providers, Small or Medium Enterprises (SMEs);	Infrastructure and vehicle provider Mobility operator (Logistic) Fleet operator OEMs
Mobility service providers		Service operator
Industry (e.g., AV manufacturers)		IT providers Technology providers Communication providers
Delivery service providers within the LaaS value chain	-	Logistic companies
Others (service providers within the SAMS(P) and SAMS(F) value chain)	Others (service providers within the SAMS(P) and SAMS(F) value chain)	Maintenance operators Ticket sale resellers Billing system operators Marketing providers Support providers Mobility needs growers Investors Safety providers Web design providers

Defined M3ICA stakeholder groups (as described in D9.3)	SHOW stakeholder ecosystem clusters (as described in D1.1)	Identified stakeholder groups identified for business impact (as described in D2.1)
Public interest groups and associations	Umbrella associations; research & academia;	Umbrella associations Research & academia

This table (Table 4) is together with the tables shown in chapter 3.1.1 and 3.1.2 the base for the allocation matrix table (Table 5) in the next sub-chapter 3.1.4.

3.1.4 Allocation matrix of the mobility services, use cases and target groups/stakeholders to the respective test sites

Now that all test sites, mobility services and use cases are known (see Table 2) and the value chain participants are defined (see Table 4), the next step is to link all these results together to create a common understanding and base for the different calculations (TCO, CBA, CEA). Table 5 gives an overview over the different test sites, their mobility services, use cases and business ecosystem which is needed for the following chapters 3.2, 3.3, 3.4 and 4.

Table 5 - Matrix of test sites with their mobility services and use cases

Test site	Mobility services	Use Cases	D9.3 Target groups/ Stakeholders	WP2/16 Target groups/ Stakeholders
France: Crest Val-de-Drome	• Will be updated in D16.3	• Will be updated in D16.3	• Will be updated in D16.3	• Will be updated in D16.3
France: Rouen + Vernon Giverny	• DRT (Shuttles and Robo Taxis), • MaaS (connected to PT, Robo Taxis), • Public transportation (Operator: Transdev)	• UC1.1 • UC1.2 • UC1.3 • UC1.4 • UC1.5 • UC1.6 • UC1.7 • UC1.10 • UC3.1 • UC3.4	• Vehicle users • Decision-making authorities or regulators • Operators • Industry • Other (e.g. insurance provider)	• Public Authorities • Service Operator • Infrastructure and vehicle provider • Maintenance operator • Ticket sale reseller • Billing system operator • IT provider • Communication provider • Marketing provider • Mobility needs growers • End users • Safety provider
Germany: Karlsruhe	• DRT (Shuttles and cars), • LaaS (transporting goods), • MaaS (connected to PT)	• UC1.1 • UC1.2 • UC1.6 • UC1.7 • UC1.9 • UC2.1 • UC2.2	• Vehicle users • Operators	• Public Authorities • Infrastructure and vehicle provider • Maintenance operator • Billing system operator • IT provider • Communication provider • End users • Safety provider • Research & academia

Test site	Mobility services	Use Cases	D9.3 Target groups/ Stakeholders	WP2/16 Target groups/ Stakeholders
				• Technology provider
Germany: Frankfurt	• Will be updated in D16.3	• Will be updated in D16.3	• Will be updated in D16.3	• Will be updated in D16.3
Germany: Monheim	• PT (shuttle connecting old city part and central station) • DRT (connected to PT)	• UC1.2 • UC1.3 • UC1.4 • UC1.5 • UC1.6 • UC1.7 • UC3.4 • UC3.6	• Vehicle users • Decision-making authorities	• Public Authorities • Infrastructure and vehicle provider • IT provider • Communication provider • Mobility needs growers • End users
Spain: Madrid Villaverde	• MaaS (connected to PT), • Public Transportation (Buses/Shuttles involved)	• UC1.1 • UC1.2 • UC1.3 • UC1.6 • UC1.10	• Vehicle users • Decision-making authorities or regulators • Operators • Mobility Service providers • Industry	• Public Authorities • Mobility service operator (EMT) • End users • Mobility needs growers • Research & academia • Communication provider • Ticket sale reseller
Spain: Madrid Carabanchel	• Bus depot	• UC1.7 • UC1.8 • UC3.3 • UC3.5	• Vehicle users • Operators • Mobility service providers • Industry	• Public Authorities • Mobility service operator (EMT) • Infrastructure and vehicle provider • IT provider • Maintenance operator • Marketing provider • Research & academia • Safety provider
Sweden: Linköping	• DRT (Shuttle); • MaaS (connected to PT, rental e-bikes and parking spaces)	• UC1.1 • UC1.3 • UC1.6 • UC1.7 • UC3.1 • UC3.2 • UC3.4	• Vehicle users • Decision-making authorities or regulators • Operators • Mobility service providers	• Public Authorities • End users • OEMs • Research & academia

Test site	Mobility services	Use Cases	D9.3 Target groups/ Stakeholders	WP2/16 Target groups/ Stakeholders
Sweden: Gothenburg	• DRT (Shuttle, Van), • MaaS (connected to PT), • Public Transportation (Operator: Keolis)	• UC1.1 • UC1.2 • UC1.3 • UC1.6 • UC1.7 • UC3.4	• Vehicle users • Decision-making authorities or regulators • Operators • Mobility service providers • Industry	• Public Authorities • End users • Maintenance operator • Marketing provider • Mobility needs growers • OEMs • Research & academia • Technology provider • Ticket sale reseller
Austria: Graz	• DRT (Cars), • MaaS (connected to PT), • LaaS (Transport of goods to shopping mall)	• UC1.2 • UC1.3 • UC3.4	• Vehicle users • Decision-making authorities or regulators • Operators • Industry	• Public Authorities • End users • Infrastructure and vehicle provider • IT provider • Maintenance operator • Mobility needs growers • Research &academia
Austria: Salzburg	Koppl: • DRT (Shuttles), • MaaS (connected to PT) Koppl-Salzburg: • Public Transportation (C-ITS-enabled Buses)	• UC1.2 • UC1.3 • UC1.5 • UC1.6 • UC3.1	• Vehicle users • Decision-making authorities or regulators • Operators	• Public Authorities • End users • Infrastructure provider • IT provider • Maintenance provider • Mobility service operator • OEMs • Research & academia • Safety provider • Ticket sale reseller
Austria: Carinthia	• Public Transportation, • DRT (Shuttles), • MaaS (connected to PT)	• UC1.1 • UC1.2 • UC1.6 • UC2.1	• Vehicle users • Public interest groups and associations • Decision-making authorities or regulators • Operators • Industry	• Public Authorities • Billing system operator • End users • Infrastructure provider • IT provider • Maintenance operator • Marketing provider • Mobility service operator

Test site	Mobility services	Use Cases	D9.3 Target groups/ Stakeholders	WP2/16 Target groups/ Stakeholders
				• OEMs • Research & academia • Safety provider • Communication provider
Netherlands: Brainport	• DRT (Cars and Buses/Shuttles), • MaaS (connected to PT)	• UC1.1 • UC1.3 • UC1.8	• Vehicle users • Decision-making authorities or regulators • Operators • Mobility service providers • Industry	• Public Authorities • Billing system operator • End user • Infrastructure and vehicle provider • IT provider • Maintenance operator • Research & academia • Technology provider • Communication provider • Umbrella associations
Czech Republic: Brno	• DRT (Shuttles and cars), • MaaS (connected to PT, Robo Taxi), LaaS (Transport of goods), • Public Transportation (semi-autonomous transport in city center)	• UC1.1 • UC1.2 • UC1.3 • UC1.6 • UC1.7	• Vehicle users	• Public Authorities • Billing system operator • End user • Infrastructure and vehicle provider • IT provider • Maintenance operator • Research & academia • Technology provider Communication provider
Finland: Tampere (own site as well as replacement for Copenhagen by extending this site)	• DRT (Shuttles), MaaS (connected to PT), • Public Transportation (Part of PT development)	• UC1.1 • UC1.2 • UC1.3 • UC1.4 • UC1.7 • UC3.1	• Vehicle users • Decision-making authorities or regulators • Operators • Mobility service providers • Industry	• Public Authorities • Billing system operator • End users • Infrastructure provider • IT provider • Mobility service operator • OEMs • Research & academia • Technology provider • Communication provider

Test site	Mobility services	Use Cases	D9.3 Target groups/ Stakeholders	WP2/16 Target groups/ Stakeholders
Greece: Trikala	• DRT (Shuttles, Cars), • MaaS (connected to PT), • LaaS (Delivery of freight boxes for businesses, freight vehicle), • Public Transportation (replacing existing PTO line)	• UC1.1 • UC1.2 • UC1.3 • UC1.7 • UC1.10	• Vehicle users • Operators • Other	• Public Authorities • Billing system operator • End user • Infrastructure provider • IT provider • Maintenance operator • Mobility needs growers • Mobility service operator • Research & academia • Safety provider • Technology provider • Communication provider • Umbrella associations
Italy: Turin	• DRT (Shuttle and car), • MaaS (connected to PT)	• UC1.2 • UC1.3 • UC1.5 • UC1.7 • UC1.10	• Vehicle users • Decision-making authorities or regulators • Operators • Industry	• Public Authorities • Billing system operator • End user • Infrastructure and vehicle (Luxof) provider • IT provider • Maintenance operator • OEMs (Navya) • Safety provider • Technology provider • Communication provider • Umbrella associations
Switzerland: Geneva (Belle-Idee) (Follower site)	Will be updated in D16.3	Will be updated in D16.3	Will be updated in D16.3	Will be updated in D16.3
Belgium: Brussels (Follower site)	Will be updated in D16.3	Will be updated in D16.3	Will be updated in D16.3	Will be updated in D16.3
Greek: Thessaloniki	Will be updated in D16.3	Will be updated in D16.3	Will be updated in D16.3	Will be updated in D16.3

3.2 Total-Cost-of-Ownership (TCO)

After using the delivered data collected by the data collection process and implementing them in the TCO tool, the following sub-chapter shows which results can be calculated and the interpretation of them.

Furthermore, all numbers shown in the following tables base on two overall business scenarios representing mobility services for person transport (Table 6 to Table 17) and one for freight transport (Table 18 to Table 29), which are realised within most of the test sites during the pre-demo phase.

Table 6 - SAMS(P) - General Data

Factor	Value	Justification
Holding period	96 months (8 years)	This value was chosen because eight years are the standard warranty period for batteries in electric vehicles.
Vehicle type	Electric Shuttle	Most of the test sites are using electric shuttles for their services.
Mileage	15,000 km/year	Based on the average routes of the test sites the mileage would be 15,000 km/year.

Table 7 - SAMS(P) - Module Vehicle

Factor	Value	Justification
Name	Electric Shuttle I	Neutral name without relation to any OEM.
Year of Manufacture	2020	Average value of the shuttles used at the test sites.
Number of vehicles	2	Average number of vehicles used by the test sites during pre-demo.
Vehicle net price	250,000 €	Average value for automated electric buses/shuttle. [8]
Energy consumption	1.5 kWh/km	Average value for automated electric buses/shuttle. [8]
Energy price	0.222 €/kWh	Price is the midfield in Europe.
Energy price public charging	0.29 €/kWh	Average price in Europe. Used to calculate the Energy Infrastructure costs, which are a part of the operating costs of the vehicle.
Public charging in %	100 %	The shuttles used at the test sites are most likely charged publicly instead of privately. Used to calculate the Energy Infrastructure costs, which are a part of the operating costs of the vehicle.
Fuel origin	EU-mix	The EU-mix is the average energy mix used in European households. Used to calculate the indirect emission costs.

Table 8 - SAMS(P) - Module Leasing

Factor	Value	Justification
Leasing bus garages	1,200 €/month	Average value from test sites.
Leasing other buildings	5,500 €/month	Average value from test sites.
Leasing for grounds	250 €/month	Average value from test sites.
Other leasing	500 €/month	Average value from test sites.
Sum	7,450 €/month	

Table 9 - SAMS(P) - Module Personnel

Factor	Value	Justification
Vehicle driver/Vehicle Safety Observer Salary	4,655 €/month	Average value from test sites.
Customer service Personnel Salary	2,725 €/month	Average value from test sites.
Vehicle workshop Personnel Salary	2,170 €/month	Average value from test sites.
IT Personnel Salary	2,250 €/month	Average value from test sites.
Marketing Personnel Salary	2,000 €/month	Average value from test sites.
Service team Personnel Salary	1,350 €/month	Average value from test sites.
Training costs	700 €/month	Average value from test sites.
Other personnel costs	4,250 €/month	Average value from test sites.
Sum	20,100 €/month	

Table 10 - SAMS(P) - Module Maintenance

Factor	Value	Justification
Maintenance charging stations	45 €/month	Average value from test sites.
Maintenance hardware	100 €/month	Average value from test sites.
Maintenance software	4,420 €/month	Average value from test sites.

Factor	Value	Justification
Maintenance vehicles	550 €/month	Average value from test sites.
Other maintenance costs	3,700 €/month	Average value from test sites.
Sum	8,815 €/month	

Table 11 - SAMS(P) - Module Insurance

Factor	Value	Justification
Accident insurance	2,500 €/month	Average value from test sites.
Theft insurance	100 €/month	Average value from test sites.
Vehicle insurance	4,000 €/month	Average value from test sites.
Other insurance costs	5,750 €/month	Average value from test sites.
Sum	12,350 €/month	

Table 12 - SAMS(P) - Module Depreciation

Factor	Value	Justification
Depreciation charging stations	590 €/month	Average value from test sites.
Depreciation of hardware	2,000 €/month	Based on hardware equipment each test site must have, this number is a rough estimation.
Depreciation of software	600 €/month	Average value from test sites.
Depreciation vehicles	2,328 €/month	Average value from test sites.
Sum	5,518 €/month	

Table 13 - SAMS(P) - Module Marketing

Factor	Value	Justification
Physical advertising	2,000 €/month	Average value from test sites.
Digital advertising	775 €/month	Average value from test sites.
Social media advertisement	490 €/month	Average value from test sites.
TV/radio advertisement	1,500 €/month	Average value from test sites.
Other advertisement	940 €/month	Average value from test sites.
Sum	5,705 €/month	

Table 14 - SAMS(P) - Module IT

Factor	Value	Justification
Landline/Mobile Phone costs	165 €/month	Average value from test sites.
Internet provider costs	125 €/month	Average value from test sites.
Digital security measures costs	450 €/month	Average value from test sites.
Website costs	150 €/month	Average value from test sites.
Cloud service costs	125 €/month	Average value from test sites.
Other IT costs	560 €/month	Average value from test sites.
Sum	1,575 €/month	

Table 15 - SAMS(P) - Module Supplies

Factor	Value	Justification
Electricity costs	169 €/month	Average value from test sites.
Spare parts	50 €/month	Average value from test sites.
Tyres	50 €/month	Average value from test sites.
Cleaning supplies	170 €/month	Average value from test o sites.
Sum	439 €/month	

Table 16 - SAMS(P) - Module Billing

Factor	Value	Justification
Bank: Account costs	50 €/month	Average value from test sites.
Credit institute: Account costs	5 €/month	The costs of a Mastercard credit card is around 60 €/year. [9]
Sum	55 €/month	

Table 17 - SAMS(P) - Module CapEx

Factor	Value	Justification
Buildings	187,000 €/total	Average value from test sites.
Digital equipment	14,375 €/total	Average value from test sites.
Furniture and office equipment	16,000 €/total	Average value from test sites.
Material costs	1,250 €/total	Average value from test sites.
Sum	218,625 €/total	

Freight transport

Table 18 - SAMS(F) - General data

Factor	Value	Justification
Holding period	96 months (8 years)	This value was chosen because eight years are the standard warranty period for batteries in electric vehicles.
Vehicle type	Electric Shuttle	Most of the test sites are using electric shuttles or similar vehicles for their services.
Mileage	10,000 km/year	Smaller tours of post services are around 40 km/day (best expert guess) long. This would be 10,000 km/year.

Table 19 - SAMS(F) - Module vehicle

Factor	Value	Justification
Name	Electric Shuttle II	Neutral name without relation to any OEM.
Year of Manufacture	2020	Average value of the shuttles used at the test sites.
Number of vehicles	2	Average number of vehicles used by the test sites during pre-demo.
Vehicle net price	250,000 €	Average value for autonomous electric buses/shuttles. [8]
Energy consumption	1.5 kWh/km	Average value for autonomous electric shuttles/vehicles. [8]
Energy price	0.222 €/kWh	Price is the midfield in Europe.
Energy price public charging	0.29 €/kWh	Average price in Europe. Used to calculate the Energy Infrastructure costs, which are a part of the operating costs of the vehicle.
Public charging in %	100 %	The shuttles used at the test sites are most likely charged publicly instead of privately. Used to calculate the Energy Infrastructure costs, which are a part of the operating costs of the vehicle.
Fuel origin	EU-mix	The EU-mix is the average energy mix used in European households. Used to calculate the indirect emission costs.

Table 20 - SAMS(F) - Module Leasing

Factor	Value	Justification
Leasing bus garages	1,200 €/month	Average value from test sites.
Leasing warehouses	250 €/month	Average value from test sites.
Leasing other buildings	2,500 €/month	Average value from test sites.
Other leasing	500 €/month	Average value from test sites.
Sum	4,450 €/month	

Table 21 - SAMS(F) - Module Personnel

Factor	Value	Justification
Vehicle driver/Vehicle Safety Observer	5,500 €/month	Average value from test sites.
IT personnel	4,000 €/month	Average value from test sites.
Vehicle workshop personnel	2,000 €/month	Average value from test sites.
Marketing personnel	3,000 €/month	Average value from test sites.
Service team personnel	3,100 €/month	Average value from test sites.
Training costs	550 €/month	Average value from test sites.
Sum	18,150 €/month	

Table 22 - SAMS(F) - Module Maintenance

Factor	Value	Justification
Maintenance charging stations	50 €/month	Average value from test sites.
Maintenance software	2,000 €/month	Average value from test sites.
Maintenance service owned communication measures	500 €/month	Average value from test sites.
Maintenance of owned service infrastructure	100 €/month	Average value from test sites.
Maintenance vehicles	550 €/month	Average value from test sites.
Other maintenance costs	1,750 €/month	Average value from test sites.
Sum	5,000 €/month	

Table 23 - SAMS(F) - Module Insurance

Factor	Value	Justification
Accident insurance	1,230 €/month	Average value from test sites.
Theft insurance	100 €/month	Average value from test sites.
Vehicle insurance	4,000 €/month	Average value from test sites.
Sum	5,330 €/month	

Table 24 - SAMS(F) - Module Depreciation

Factor	Value	Justification
Depreciation charging stations	115 €/month	Average value from test sites.

Depreciation hardware	2,000 €/month	Based on hardware equipment each test site must have, this number is a rough estimation.
Depreciation software	325 €/month	Average value from test sites.
Depreciation vehicles	2,328 €/month	Average value from test sites.
Sum	4,768 €/month	

Table 25 - SAMS(F) - Module Marketing

Factor	Value	Justification
Physical advertising	1,500 €/month	Average value from test sites.
Digital advertising	750 €/month	Average value from test sites.
Social media advertisement	750 €/month	Average value from test sites.
Sum	3,000 €/month	

Table 26 - SAMS(F) - Module IT

Factor	Value	Justification
Landline/Mobile phone costs	78 €/month	Average value from test sites.
Internet provider costs	95 €/month	Average value from test sites.
Digital security measure costs	450 €/month	Average value from test sites.
Website costs	125 €/month	Average value from test sites.
Cloud service costs	125 €/month	Average value from test sites.
Sum	873 €/month	

Table 27 - SAMS(F) - Module Supplies

Factor	Value	Justification
Electricity costs	335 €/month	Average value from test sites.
Spare parts	50 €/month	Average value from test sites.
Tyres	55 €/month	Average value from test sites.
Cleaning supplies	50 €/month	Average value from test sites.
Sum	490 €/month	

Table 28 - SAMS(F) - Module Billing

Factor	Value	Justification
Bank: Account costs	50 €/month	Average value from test sites.
Credit institute: Account costs	5 €/month	The costs of a Mastercard credit card is around 60 €/year. [9]

Sum	55 €/month

Table 29 - SAMS(F) - Module CapEx

Factor	Value	Justification
Buildings	40,000 €/total	Average value from test sites.
Digital equipment (such as computers)	12,500 €/total	Average value from test sites.
Furniture and office equipment	8,750 €/total	Average value from test sites.
Material costs	125 €/total	Average value from test sites.
Sum	61,375 €/total	

3.2.1 First Results provided by the TCO

This chapter shows the results of the TCO for the general person and freight transport scenarios based on the input shown in
Table 6 to Table 29.

Factor	Value	Justification
Holding period	96 months (8 years)	This value was chosen because eight years are the standard warranty period for batteries in electric vehicles.
Vehicle type	Electric Shuttle	Most of the test sites are using electric shuttles for their services.
Mileage	15,000 km/year	Based on the average routes of the test sites the mileage would be 15,000 km/year.

Person Transport

The TCO calculation tool provides the following results:

- OpEx
- CapEx
- Sum of OpEx and CapEx

The following paragraphs will show the results according to the identified overall Person Transport business case.

OpEx

The TCO provides the OpEx costs related to the defined observation period (mainly the holding period of the used vehicles.) structured to the identified cost modules (Figure 3).

OpEx Costs Output (Holding Period)	
Module Leasing	715.200,00 €
Module Personnel	1.929.600,00 €
Module Maintenance	846.240,00 €
Module Insurance	1.185.600,00 €
Module Depreciation	529.728,00 €
Module Marketing	547.680,00 €
Module IT	151.200,00 €
Module Supplies	42.144,00 €
Module Billing	5.280,00 €
Module Vehicles (Operating costs)	100.800,00 €
Sum of the whole Holding Period	6.053.472,00 €

Figure 3: SAMS(P) - Total OpEx costs for the holding period

CapEx

The TCO provides the CapEx costs (see upper part Figure 4 of the table) related to the overall business scenario and the relevant cost modules (vehicles and infrastructure).

CapEx Costs Output	
Sum of CapEx of Business (except vehicles)	218.625,00 €
Sum of CapEx of Vehicles (incl. Incentives)	600.000,00 €
Sum of CapEx total	818.625,00 €
Total costs	
Total OpEx Costs	6.053.472,00 €
Total CapEx costs	818.625,00 €
Total costs (OpEx + CapEx)	6.872.097,00 €

Figure 4: SAMS(P) - Total CapEx costs and Total costs

CapEx and OpEx

Finally, CapEx and related OpEx are summarized and presented (see Figure 4 lower part of the table) in the TCO to give overview about all relevant costs (installation and operation) of a mobility service and therefore also for mobility service provider (e.g. PT/PTO).

Freight Transport

The TCO calculation tool provides the following results:

- OpEx
- CapEx
- Sum of OpEx and CapEx

The following paragraphs will show the results according to the identified overall Freight Transport business case.

OpEx

The TCO provides the OpEx costs related to the defined observation period (mainly the holding period of the used vehicles) structured to the identified cost modules (Figure 5).

OpEx Costs Output (Holding Period)	
Module Leasing	427.200,00 €
Module Personnel	1.742.400,00 €
Module Maintenance	480.000,00 €
Module Insurance	511.680,00 €
Module Depreciation	457.728,00 €
Module Marketing	288.000,00 €
Module IT	83.808,00 €
Module Material costs	- €
Module Supplies	47.040,00 €
Module Billing	5.280,00 €
Module Vehicles (Operating costs)	62.880,00 €
Sum of the whole Holding Period	4.106.016,00 €

Figure 5: SAMS(F) – Total OpEx costs for the holding period

CapEx

The TCO provides the CapEx costs (see upper part Figure 6 of the table) related to the overall business scenario and the relevant cost modules (vehicles and infrastructure).

CapEx Costs Output	
Sum of CapEx of Business (except vehicles)	61.375,00 €
Sum of CapEx of Vehicles (incl. Incentives)	600.000,00 €
Sum of CapEx total	661.375,00 €
Total costs	
Total OpEx Costs	4.106.016,00 €
Total CapEx costs	661.375,00 €
Total costs (OpEx + CapEx)	4.767.391,00 €

Figure 6: SAMS(F) - Total CapEx costs and Total costs

CapEx and OpEx

Finally, CapEx and related OpEx are summarized and presented (see Figure 6 lower part of the table) in the TCO to give overview about all relevant costs (installation and operation) of a shared automated mobility service (SAMS) and therefore also for mobility service provider (e.g. PT/PTO).

3.2.2 Interpretation and usage of the TCO results for business and exploitation plans

Analysing the TCO results the following information and potentials can be identified:

- Overview about operating costs of the mobility service(s)
- Full true cost pricing for implemented mobility service(s)

- Cost optimization potential

The first two bullets clearly describe the operation costs and the investments and “true price” for implementing and running a mobility service. But this perspective is quite important as base for the cost optimization.

After analysing the listed cost modules the following potentials (represented by the questions) could be identified:

- Module Insurances: Can different insurances be bundled to get a better price?
- Module Leasing: Which infrastructure must be owned and which can be outsourced?
- Module Maintenance: Which maintenance can be outsourced?
- Module Personnel: Which personnel must be located at the service provider and which can be externally recruited (including the balancing of these aspects)?

3.3 Cost-Benefit-Analysis (CBA)

For the CBA the collected data as well as the results of the TCO analysis are used to calculate the specific results of the different factors (see Table 42). To give an overview about possible results of the CBA in relation to SHOW, similar to the TCO an example calculation was executed. All numbers shown in the following tables base on two overall business scenarios representing mobility services for person transport (Table 30 to Table 35) and one for freight transport, which is realized by most of the test sites in SHOW. Beside the values a justification is also given to explain how the numbers were created.

Person Transport

Table 30 - SAMS(P) - Standard values, Passengers, Income

Factor	Value	Justification
Holding period	96 months (8 years)	This value was chosen because eight years are the standard warranty period for batteries in electric vehicles.
Days the service is operation per year	250 days/year	Assuming that the service is not operating at weekends but only on work days.
Vehicle type	Electric Shuttle	Most of the test sites are using electric shuttles for their services.
Mileage	15,000 km/year	Based on the average routes of the test sites the mileage would be 15,000 km/year.
Passengers	50 Persons/Day	The test sites are currently in their pre-demo phase. Based on the test site assumptions regarding passenger transport the average number is estimated with 50 passengers/day.
Average number of Trips taken	1 Trip/Day	Based on test site data most regular passengers only use the service once a day.
Average income per trip	2 €	The average single trip price from a PT view after SHOW is 2 € based on the test site collected data.
Average price per monthly subscription	15 €/month	Considering the test site data, current PT Subscriptions and interviews with experts an average price was determined.

Factor	Value	Justification
Average monthly income through other fees	2,977 €/month	Beside the income through the regular tickets, income through other fees such as fare evasion, etc. are also considered based on the following calculation: Fare dodger in Vienna: 2.7 % of all Passengers [10] Fee: 105 € [10] In this case we have in total 1050 passengers per month of which 2.7 % are fare dodgers.
Subsidies/Grants from public hand	200,000 €/year	Considering input of different funding key experts the average amount of subsidies/grants is calculated with 200,000 €/year.
Selling marketing space on/at vehicles/stations	10,000 €/year	Orienting on the prices [11] of the ÖBB (The Austrian Federal Rail Company) this would be for one vehicle per year around 5,000 €.
Income from investors	50,000 €/years	Key experts are most likely ready to invest 50,000 €/year considering the risks.

Table 31 - SAMS(P) - Benefit Break-even-Point

Factor	Value	Justification
Possible customer potential	20,000 People	Average yearly potential that is most realistic when looking at the test sites (demography data of Monheim [12]). This number shows the customer potential (customers that could theoretically use the service) in the area the service is operating.
Customer segments (activated customers)	Children: 1,600 Students: 282 Elderly: 2,938 Physical disabled people: 688 Regular users: 6,992 Ticket price children: 0 € Ticket price students: 1 € Ticket price Elderly: 1.5 € Ticket price physical disabled people: 1 € Ticket price standard: 2 € (see as well factor “Average	Based on the demography data of the test site Monheim [12], the customer segments (people actually using the service) were calculated the following way based on the “Passengers” and “Days the service is operating per year” in Table 30 (250*50 = 12,500) and the “Possible customer potential” (20,000): Children (until 12 years): • 2,561 [12] of 20,000 are 12.8% • 12,500*12.8% = 1,600 children/year Students: • 450 [12] of 20,000 are 2.25% • 12,500*2.25% = 282 students/year Elderly: • 4,705 [12] of 20,000 are 23.5% • 12,500*23.5% = 2,938 elderly/year Physical Disabled people: Around 5,5 % of the people in Germany are physically disabled.[13] This value was taken to calculate the number of disabled people. 20,000*5.5% = 1,100 disabled people 12,500*5.5% = 688 disabled people/year

Factor	Value	Justification
	income per trip")	A lot of PTOs provide reduced ticket prices for certain customer segments, therefore the prices for the students, elderlies and physical disabled people were reduced. Children (until 12 years) are using the service for free, due to the fact that they do not have an income and to encourage them to use the service. This increases their safety on the way to school/home.
SAMS integration	Costs OpEx: 4,200 €/month Revenues coupled with SAMS: 3,000 €/month	SAMS integration is an add-on of a service to an already existing SAMS concept, instead of creating a completely new service. Costs for maintenance, billing, software update and operation. Revenues based on monthly passengers and ticket price.

Table 32 – SAMS(P) - Benefit Technical – Downtime caused by technical vehicle issues

Factor	Value	Justification
Number of Incidents	2	It is assumed that the vehicles of the different test sites will have at least two technical incidents per year caused by the vehicle technology (status of hardware, software and potential updates).
Revenue loss per incident	200 €/incident	It is assumed that the shuttle needs two days per incident to work again. Based on the 50 people per day using the service and a price of 2 € per trip (test site assumption after the SHOW project) that would be a revenue loss of 100 €/day due to the service not operating during vehicle break downs.
Costs per incident (repair, towing, workshop)	10,000 €/incident	This is an assumed value including towing after the vehicle broke down, hours spent in the workshop including personnel costs (for special technical operation team) to get the vehicle ready again.

Table 33 - SAMS(P) - Benefit Economic

Factor	Value	Justification
Pricing strategy – Regular Time Tickets/Subscriptions	Daily ticket price potential users: 16,000 Daily ticket price users: 10,000	20 % of the potential customers (see Table 31 "Possible customer potential" of 20,000) and actual customers using the service (see Table 31 "Customer segments" of 12,500) are using an Subscription, the rest a regular daily ticket.

Factor	Value	Justification
	Subscription ticket price potential users: 4,000 Subscription ticket price users: 2,500	Ticket prices and customer numbers are the same as defined in the factor “Customer segments” in Table 31.
Pricing strategy – Customer Segment Tickets/Subscriptions	Potential Users: • Children: 2,561 • Students: 450 • Elderly: 4,705 • Disabled: 1,100 Users • Children: 1,600 • Students: 282 • Elderly: 2,938 • Disabled: 688	Potential users, users and prices based on the numbers in the factor “Customer segments” in Table 31.
Marketing influence	Revenues before tests: 1,000,000 € Marketing costs before tests: 150,000 €	Based on the ratio of deployed marketing costs and passenger number of existing SAMS(P) services.
Operating times the service is not operating	Night time (20:00 – 5:00): 5 potential users/day Weekends (Sa-Sun): 50 potential users/day	Most of the test sites are not operating during night times and weekends. The night time is generally not a very busy time therefore, only around 5 potential users are not activated. On the weekends the commuters would be replaced by people using the service for leisure activities. Therefore, the number of potential users would most likely be the same as the users during the week.
Realised Use cases	To be calculated in D16.3	Currently all test sites are collecting the costs and income for the service itself (all UCs combined) and not for the single Use Cases. Therefore, no calculations can be done in this aspect yet.

Table 34 - SAMS(P) - Benefit Quality of Service

Factor	Value	Justification
Service information	**Website** • Value of the service in the	Each source of information for the customers means costs for the service provider. These costs

Factor	Value	Justification
	ticket price: 0.02 € • Value what the regular customer is willing to pay: 0 € **App** • Value of the service in the ticket price: 0.02 € • Value what the regular customer is willing to pay: 0.005 € **Information at stations** • Value of the service in the ticket price: 0.02 € • Value what the regular customer is willing to pay: 0 € **Customer center** • Value of the service in the ticket price: 0.002 € • Value what the regular customer is willing to pay: 0 € **Facebook** • Value of the service in the ticket price: 0.02 € • Value what the regular customer is willing to pay: 0.01 € **Instagram** • Value of the service in the	need to be deckled by the income of the service (Ticket prices). The value of the service in the ticket price is based on the ratio of the marketing costs to the revenues. Most of the mentioned services are standard information sources for the customers today. This leads to the effect that the customers are expecting such services naturally and are not willing to pay much money or even nothing at all. In this case this would be mainly digital platforms (Website, Instagram) and the always present information available at stations and the customer service, which mobility services should have from the beginning.

Factor	Value	Justification
	ticket price: 0.02 € • Value what the regular customer is willing to pay: 0 €	
Calling possibilities	**Phone number** • Value of the service in the ticket price: 0,05 € • Customers using the calling method: 3,075 **App** • Value of the service in the ticket price: 0,10 € • Customers using the calling method: 9,425	The calling possibilities are essential for the operation of the service. Therefore, a value in the ticket price needs to be set. The app has a higher value than the phone number due to the fact that more people are using it and has additionally more functions (real time information, other information about the service, etc.). The customers using the phone number are mainly elderly people, which do not use the app. The rest uses the app for booking and calling the service.

Table 35 - SAMS(P) - Benefit Users & Stakeholders

Factor	Value	Justification
New Actors/Businesses	Will be handled in D16.3	At the moment it is not possible to comprehend which new actors or businesses are involved with the test sites and which value they have to them.
External know-how	**Lawyer X & Y:** • Costs/year (best expert guess): 30,000 € • Value/year (best expert guess): 50,000 €	The task of the lawyer for the services is to give advice regarding (national and international) regulations and (technical) standards. This are assumed costs and an assumed value for the basic scenario. Of course, it is possible to differ from service to service, depending on the internal know-how (own legal department) and the demand of the service operator.

Freight Transport

Table 36 - SAMS(F) - Standard values, Passengers, Income

Factor	Value	Justification
Holding period	96 months (8 years)	This value was chosen because eight years are the standard warranty period for batteries in electric vehicles.
Days the service is operation per year	250 days/year	Assuming that the service is not operating at weekends but only on work days.
Vehicle type	Electric Shuttle	Most of the test sites are using electric shuttles for their services.
Mileage	10,000 km/year	Smaller tours of post services are around 40 km/day (best expert guess) long. This would be 10,000 km/year.
Numbers of customers	200 persons/month	Freight transport is a highly competitive area where there are already established services (state postal service, DHL, UPS, Hermes, etc.). For this reason, the market share for this general SAMS(F) scenario is set at 12% for the service. With a customer potential of 20,000 customers/year, this would be 2,400 customers/year and thus 200 customers per month.
Average number of cargo for each customer	2 #/month	It is assumed that there are 24 shipments/year per capita [14], which would be two shipments per month.
Average income per cargo	8.63 €	Sending packages (size M; minimum weight 5 kg) are costing between 1.23 € (Romania) and 19.68 € (Norway). The average price in Europe would be 8.63 €/package. [15]
Subsidies/Grants from public hand	50,000 €/year	Considering input of different funding key experts the average amount of subsidies/grants is calculated with 50,000 €/year.
Selling marketing space on/at vehicles/stations	10,000 €/year	Orienting on the prices [11] of the ÖBB (The Austrian Federal Rail Company) this would be for one vehicle per year around 5,000 €.
Income from investors	20,000 €/year	Key experts are most likely ready to invest 20,000 €/year considering the risks and the novelty of the service concept.

Table 37 - SAMS(F) – Benefit Break-even-Point

Factor	Value	Justification
Possible customer potential	20,000 People	Average yearly potential that is most realistic when looking at the test sites (demography data of Monheim [12]). This number shows the customer potential (customers that could use the service) in the area the service is operating.

Factor	Value	Justification
Customer segments (activated customers)	Students: 54 Elderly: 564 Physical disabled people: 132 Regular users: 1,650 Cargo price for everyone: 8.63 €/cargo	Based on the demography data of the test site Monheim [12], the customer segments (people actually using the service) were calculated the following way based on the "Numbers of customers" and "Days the service is operating per year" in Table 36 (200*12 = 2,400) and the "Possible customer potential" (20,000): Students: • 450 [12] of 20,000 are 2.25% • 2,400*2.25% = 54 students/year Elderly: • 4,705 [12] of 20,000 are 23.5% • 2,400*23.5% = 564 elderly/year Physical Disabled people: Around 5,5 % of the people in Germany are physically disabled. [13] This value was taken to calculate the number of disabled people. 20,000*5.5% = 1,100 disabled people 2,400*5.5% = 132 disabled people/year Children until 12 are not considered here because this group would not send packages and therefore are not using the service.

Table 38 - SAMS(F) - Benefit Technical

Factor	Value	Justification
Number of Incidents	2	It is assumed that the vehicles of the different test sites will have at least two technical incidents per year caused by the vehicle technology (status of hardware, software and potential updates).
Revenue loss per incident	346 €/incident	It is assumed that the shuttle needs two days per incident to work again. Based on the cargo price of 8.63 €/piece and the packages per day that cannot be sent (20 cargo/day), this would be a revenue loss of around 173 €/day.
Costs per incident (repair, towing, workshop)	10,000 €/incident	This is an assumed value including towing after the vehicle broke down, hours spent in the workshop including personnel costs (for special technical operation team) to get the vehicle ready again.

Table 39 - SAMS(F) - Benefit Economic

Factor	Value	Justification
Pricing strategy – Regular Time Tickets/Subscriptions	Potential customers: 20,000 Total customers: 2,400 Price per cargo: 8.63 €	In freight transport there are no timely tickets like in person transport. The price is for every customer the same. Paid is per cargo piece (8.63 €/cargo piece).
Pricing strategy – Customer Segment Tickets/Subscriptions	Potential Users: • Students: 450 • Elderly: 4,705 • Disabled: 1,100 Users • Students: 54 • Elderly: 564 • Physical disabled people: 132	Potential users, users and prices based on the numbers in the factor "Customer segments" in Table 37.
Marketing influence	Revenues before Demo: 800,000 € Marketing costs before Demo: 100,000 €	Based on the ratio of deployed marketing costs and passenger number of existing SAMS(F) services.
Operating times the service is not operating	Night time (20:00 – 5:00): 2 potential users/day Weekends (Sa-Sun): 10 potential customers/day	Most of the test sites are not operating during night times and weekends. The night time is generally not a very busy time (especially regarding freight transport) therefore, maximum two potential users are not activated. For freight there is always a demand, that would only be moved to working days. Therefore, the number of potential users would most likely be the same as the users during the week.
Realised Use cases	To be calculated in D16.3	Currently all test sites are collecting the costs and income for the service itself (all UCs combined) and not for the single Use Cases. Therefore, no calculations can be done in this aspect yet.

Table 40 - SAMS(F) - Benefit Quality of Service

Factor	Value	Justification
Service information	**Website** • Value of the service in the	Each source of information for the customers means costs for the service provider. These costs need to be

Factor	Value	Justification
	cargo price: 0.02 € • Value what the regular customer is willing to pay: 0 € **App** • Value of the service in the cargo price: 0.02 € • Value what the regular customer is willing to pay: 0.01 € **Customer center** • Value of the service in the cargo price: 0.02 € • Value what the regular customer is willing to pay: 0 € **Facebook** • Value of the service in the cargo price: 0.02 € • Value what the regular customer is willing to pay: 0.01 € **Instagram** • Value of the service in the cargo price: 0.02 € • Value what the regular customer is willing to pay: 0 €	deckled by the income of the service (Cargo shipping). Most of the mentioned services are standard information sources for the customers today. This leads to the effect that the customers are expecting such services naturally and are not willing to pay much money or even nothing at all. In this case this would be mainly digital platforms (Website, Instagram) and the always present information available at the customer service, which freight services should have from the beginning.
Calling possibilities	**App** • Value of the service in the ticket price: 0,10 €	The calling possibilities are essential for the operation of the service. Therefore, a value in the cargo price needs to be set. For SAMS(F) there is only the App available to call the

Factor	Value	Justification
	• Customers using the calling method: 2,400	service. Phone numbers are reserved for the customer service.

Table 41 - SAMS(F) - Users & Stakeholders

Factor	Value	Justification
New Actors/Businesses	Will be handled in D16.3	At the moment it is not possible to comprehend which new actors or businesses are involved with the test sites and which value they have to them.
External know-how	**Lawyer X & Y:** • Costs/year (best expert guess): 30,000 € • Value/year (best expert guess): 50,000 €	The task of the lawyer for the services is to give advice regarding (national and international) regulations and (technical) standards. This are assumed costs and an assumed value for the basic scenario. Of course, it is possible to differ from service to service, depending on the internal know-how (own legal department) and the demand of the service operator.

3.3.1 First Results provided by the CBA

This chapter shows the results of the CBA for the general person and freight transport scenarios based on the input shown in Table 30 to Table 41.

Person Transport

Costs

Focus of the cost analysis are the so called “Other cost potentials”. If there are any other costs arising, which were not considered in the TCO, this “Other cost potentials” category is used. The sum of the TCO costs and other cost potentials are the sum of the total costs calculated for the CBA. The sheet shown in Figure 7 serves as input, calculation and output sheet.

TCO costs	
Total OpEx costs	6.053.472,00 €
Total CapEx costs	818.625,00 €
Total costs	6.872.097,00 €

Other Cost Potentials	
Potential 1	
Potential 2	
Potential 3	
Potential 4	
Potential 5	
Sum Other Cost Potentials	- €

Total Costs	
TCO costs	6.872.097,00 €
Other Potential costs	- €
Total sum of costs	6.872.097,00 €

Figure 7: SAMS(P) - Total Costs

Benefits (Revenues)

Benefits analysis bases on the revenues calculations of SAMS(P). Within SHOW not only the direct revenues like ticket prices, funding or marketing are considered, but also missed income or potential losses are identified and included within the CBA calculations. This is done to extended the “pure” economic view of SAMS(P) (like break-even or pricing strategies), with additionally categories from the technology perspective, the user/customer perspective combined with other stakeholder views, the environmental perspective and Quality of Service aspects. The last category is also strongly linked to the technology and the users of the SAMS(P). So the CBA tries to cover the different stakeholders and impact parameters from the business environment of SAMS. All the benefits for the CBA were derived from the KPI of WP9, the KPI and developed results of WP2 and agreed with test sites.

Operational Revenues	
Revenues Person transport	174.400,00 €
Revenues through other fees	285.792,00 €
Revenues Freight transport	- €
Total operational revenues for holding period	460.192,00 €

Revenues through other income	
Subsidies/Grants from public hand	1.600.000,00 €
Selling marketing space on/at vehicles/stations	80.000,00 €
Income from investors	400.000,00 €
Rent/lease from other companies	- €
Other revenues	- €
Total revenues through other income	2.080.000,00 €

Total Revenues	
Operational Revenues	460.192,00 €
Revenues through other income	2.080.000,00 €
Total Revenues	2.540.192,00 €

Figure 8: SAMS(P) - Total revenues

Benefit categories and Benefits

Covering the above mentioned different views and different stakeholders in the business environment, the benefits of the CBA where clustered in so called categories. The identified benefit categories and benefits are the following Table 42.

Table 42 - SAMS(P) - CBA Benefit categories and Benefits

Benefit category	Benefits
Break-even-Point	• Profitability • Service acceptance • Customer segments • SAMS(P) integration • Maintenance • Extra: Needed passengers to reach Break-even-point
Business	• Real time information • Pricing strategy • Marketing influence • Operating times the service is not operating • Realised use cases • Funding
Technology	• Vehicle downtime caused by technical vehicle issues • Vehicle downtime caused by technical infrastructure issues
Quality of Service	• Service information • Calling possibilities of service
User & Stakeholder	• New Actors/Businesses • External know how
Environment & Politics	• Direct and indirect CO_2, PM and NO_x produced from the different vehicles

The monetization is different for each benefit, for example, the monetization value of CO_2 and other emissions are going to be according to official emission prices whereas the monetization of road accidents are measured according to the costs that were caused (people, vehicle and/or infrastructure damage) and revenues that are lost. Benefits that cannot be monetized are handled by the CEA.

As mentioned above the next table (Table 43) show the CBA results of the benefits for the whole holding period.

Table 43 - SAMS(P) - CBA Benefit results based on the overall business scenario

Benefit category	Benefits	Results
Break-even-Point	Profitability	**OPEX** Value: - 3,513,280 € In %: - 58.04 % **CAPEX** Value: 1,701,567 € In %: 210 %
	Service acceptance (only showing	- 79,800,000 €

Benefit category	Benefits	Results
	revenues that are not activated but could, based on the possible available customers)	
	Customer segments	154,888 €
	SAMS(P) integration	- 115,200 €
	Maintenance	- 8,815 €/month - 846,240 €/holding period
	Extra: Needed passengers per day to reach Break-even-point in one year	11,535 passengers/day
Business	Real time information	-
	Pricing strategy	- 2,245,120 €
	Marketing influence	1,142,512 €
	Operating times - the service is not operating	- 112,000 €
	Realised use cases	-
	Funding	1,600,000 €
Technology	Vehicle downtime caused by technical vehicle issues	- 161,600 €
	Vehicle downtime caused by technical infrastructure issues	0 €
Quality of Service	Service information & Calling possibilities of service	8,824.80 €
User & Stakeholder	New Actors/Businesses & External know how	160,000 €
Environment & Politics	Direct and indirect CO_2, PM and NO_x produced from the different vehicles	- 10,985.14 €

Freight Transport

Costs

Focus of the cost analysis are the so called “Other cost potentials”. If there are any other costs arising, which were not considered in the TCO, this “Other cost potentials” category is used. The sum of the TCO costs and other cost potentials are the sum of the total costs calculated for the CBA. The sheet shown Figure 9 serves as input, calculation and output sheet.

TCO costs	
Total OpEx costs	4.106.016,00 €
Total CapEx costs	661.375,00 €
Total costs	4.767.391,00 €

Other Cost Potentials	
Potential 1	
Potential 2	
Potential 3	
Potential 4	
Potential 5	
Sum Other Cost Potentials	- €

Total Costs	
TCO costs	4.767.391,00 €
Other Potential costs	- €
Total sum of costs	4.767.391,00 €

Figure 9: SAMS(F) - Total costs

Benefits (Revenues)

Benefits analysis bases on the revenues calculations of the SAMS(F). Within SHOW not only the direct revenues (see Figure 10) like ticket prices, funding or marketing are considered, but also missed income or potential losses are identified and included within the CBA calculations. This is done to extended the “pure” economic view of SAMS (like break-even or pricing strategies), with additionally categories from the technology perspective, the user/customer perspective combined with other stakeholder views, the environmental perspective and Quality of Service aspects. The last category is also strongly linked to the technology and the users of the SAMS(F). So the CBA tries to cover the different stakeholders and impact parameters from the business environment of SAMS(F). All the benefits for the CBA were derived from the KPI of WP9, the KPI and developed results of WP2 and agreed with test sites.

Operational Revenues	
Revenues Person transport	- €
Revenues through other fees	- €
Revenues Freight transport	331.392,00 €
Total operational revenues for holding period	331.392,00 €

Revenues through other income	
Subsidies/Grants from public hand	400.000,00 €
Selling marketing space on/at vehicles/stations	80.000,00 €
Income from investors	160.000,00 €
Rent/lease from other companies	- €
Other revenues	- €
Total revenues through other income	640.000,00 €

Total Revenues	
Operational Revenues	331.392,00 €
Revenues through other income	640.000,00 €
Total Revenues	971.392,00 €

Figure 10: SAMS(F) - Total revenues

Benefit categories and Benefits

Covering the above mentioned different views and different stakeholders in the business environment, the benefits of the CBA where clustered in so called categories. The identified benefit categories and benefits are the following Table 40.

Table 44 - CBA Benefit categories and Benefits

Benefit category	Benefits
Break-even-Point	• Profitability • Service acceptance • Customer segments • SAMS(F) integration • Maintenance • Extra: Needed passengers to reach Break-even-point
Business	• Real time information • Pricing strategy • Marketing influence • Operating times the service is not operating • Realised use cases • Funding
Technology	• Vehicle downtime caused by technical vehicle issues • Vehicle downtime caused by technical infrastructure issues
Quality of Service	• Service information • Calling possibilities of service
User & Stakeholder	• New Actors/Businesses • External know how
Environment & Politics	• Direct and indirect CO_2, PM and NO_x produced from the different vehicles

The monetization is different for each benefit, for example, the monetization value of CO_2 and other emissions are going to be according to official emission prices whereas the monetization of road accidents are measured according to the costs that were caused (people, vehicle and/or infrastructure damage) and revenues that are lost. Benefits that cannot be monetized are handled by the CEA.

As mentioned above the next table (Table 45) show the CBA results of the benefits for the whole holding period.

Table 45 - CBA Benefit results based on the overall business scenario

Benefit category	Benefits	Results
Break-even-Point	Profitability	**OPEX** Value: - 3,133,664 € In %: - 76.34 % **CAPEX** Value: 310,017 € In %: 47 %
	Service acceptance (only showing revenues that are not activated but could, based on the possible available customers)	- 32,807,808 €
	Customer segments	165,696 €

Benefit category	Benefits	Results
	SAMS(F) integration	0 €
	Maintenance	- 5,000 €/month - 480,000 €/holding period
	Extra: Needed customers per month to reach Break-even-point in one year	19,824 customers/month
Business	Real time information	-
	Pricing strategy	- 1,215,104 €
	Marketing influence	- 16,608 €
	Operating times - the service is not operating	- 113,916 €
	Realised use cases	-
	Funding	400,000 €
Technology	Vehicle downtime caused by technical vehicle issues	- 165,536 €
	Vehicle downtime caused by technical infrastructure issues	0 €
Quality of Service	Service information & Calling possibilities of service	1,910.33 €
User & Stakeholder	New Actors/Businesses & External know how	160,000 €
Environment & Politics	Direct and indirect CO_2, PM and NO_x produced from the different vehicles	- 7,323.43 €

KPI efficiency

The "KPI efficiency" part is an additional feature in the CBA to measure if and how well some KPIs defined in WP9 have reached the set target or not. This feature is mainly dependent on WP9 results and, therefore, will be further discussed in D16.3.

The KPIs considered here are the following:

- Operational costs
- Person km travelled
- Vehicle utilization rate
- Vehicle utilization efficiency
- Occupancy rate
- Shared mobility rate
- Energy use

Each of this KPIs has its own target (described in WP9) on which the classification is oriented. This classification has seven categories:

- Miserable

- Very bad
- Bad
- Target (Project goal achieved)
- Good
- Very good
- Excellent

An example of classification can be seen in the next figure (Figure 11):

Legend (7 steps)	Miserable	Very bad	Bad	Target (Project Goal achieved)	Good	Very good	Excellent
Operative costs	0% or cost rise	1 % - 10 %	11 % - 20 %	21% before-after pilots	22 % - 30 %	31 % - 40 %	> 40 %

Figure 11: Example of KPI efficiency classification

The numbers in the different classification categories are depending on the value of the target and is therefore not the same for each KPI. Goal of each KPI is to at least reach the yellow “Target” category. Everything in red means the target was not reached everything in green means the target was more than fulfilled.

3.3.2 Interpretation and usage of the CBA results for business and exploitation plans

Table 46 gives an overview of the different CBA benefits, describes them and shows the links to other benefits.

Table 46 - CBA Benefit, Explanation and linkage

Benefit category	Benefits	Description	Link to other benefits
Break-even-Point	Profitability	Gives an answer about the profitability of a mobility including an estimation about "Needed passengers to reach Break-even-point"	
	Service acceptance	Gives an answer about the economic influence of the acceptance to mobility service(s)	Profitability Customer segments Pricing strategy
	Customer segments	Contains the revenues and potentials for mobility service(s)	Pricing Strategy, Profitability
	SAMS integration	Gives an economic overview about the integration of new mobility services to existing ones	Profitability
	Maintenance	Contains the operative maintenance costs for mobility service(s)	Profitability, Operating times
Business	Real time information	Describes the economic impact of real time information to mobility services	Profitability, Quality of Service
	Pricing strategy	Describes the economic impact of the pricing strategy like influence single tickets, weekly, monthly or yearly Subscriptions…	Profitability
	Marketing influence	Describes the economic impact of marketing in the field customer acquisition	Profitability, Customer segments
	Operating times - the service is not operating	Contains the possible losses, if the mobility service is not running	Profitability, Quality of Service, Service Acceptance
	Realised use cases	Contains the economic effects considering the realization of different use cases (for	Profitability

Benefit category	Benefits	Description	Link to other benefits
		shared automated person and freight transport)	
	Funding	Contains the effects of funding (CapEx and OpEx)	Profitability, Pricing strategy
Technology	Vehicle downtime caused by technical vehicle issues	Contains the specific possible losses, if a service is unavailable due to technical vehicle issues	Operating times Profitability
	Vehicle downtime caused by technical infrastructure issues	Contains the specific possible losses, if a service is unavailable due to technical infrastructure issues	Operating times Profitability
Quality of Service	Service information & Calling possibilities of service	Describes the economic effects of an effective, user-specific service information and usability of different user (groups)	Operating times Profitability
User & Stakeholder	New Actors/Businesses & External know how	Describes the economic effects of an effective integration of user and stakeholders within the mobility service	Customer Segment, Profitability
Environment & Politics	CO_2, PM and NO_x produced from the different vehicles	Contains the economic effects of legal and environmental regulations to mobility service(s)	Profitability

To sum up the results of CBA, it has to be mentioned that the defined benefits tries to give answer to most popular questions regarding the introduction/deployment of mobility services (SAMS(P) and SAMS(F)) driven by economic aspects (Break-even & Business), technology (downtimes caused by the vehicle or the infrastructure, or interface to the customer), the user & stakeholder representing the business environment and possible effects and finally by special stakeholders (Environment & Politics).

3.4 Cost-Effectiveness-Analysis (CEA)

3.4.1 First Results provided by the CEA

Person transport

For person transport, 16 KPIs have been selected from the KPIs identified in WP13. The selected ones are all measured at the test site level. The selected ones are all measured at the test site level. In addition, only the ones which can be interpreted in this cost-effectiveness analysis were chosen. Therefore, KPIs related to project success (e.g., number of UC's success) or that are counts of incidents (e.g., illegal overtaking) were not chosen. This resulted of a selection of KPIs linked to four impact areas:

- Road safety,
- Societal, employability and equity,
- Traffic, Energy, and Environment,
- User acceptance

For road safety, the cost-effectiveness ratio allows the comparison of the costs of the different services for a 1% increase in safety. The KPIs used here are computed in A13.1 during a safety assessment of all sites. The next impact category allows comparing the costs of the services on the increase they bring in person km travelled by special groups but also in the increase of shared mobility rates. In this impact category the vehicle utilization rate and the empty vehicle km driven are also included. The latter has been transformed through an inverse scale.

Then, the KPIs related to traffic energy and environment compare the services costs in terms of the number of passengers, the reliability of their service, the total number of km travelled and the energy use. Finally, the last group relates to user acceptance. It consists of six statements measured on a Likert scale from 1 to 9 and one question on the willingness-to-pay.

In this deliverable, as the KPIs were not yet available from test sites, the given KPIs are estimated based on projects targets (if available) or expert opinions. Similarly, the cost are currently available on an aggregated level, although this analysis is aimed at comparing on pilot level which of the services is the most suitable to bring specific outcomes. Nevertheless, we can here already highlight some elements on the aggregated level. With the current estimation of the KPIs, the cost of the person transport service is more than 100 times too high to be covered solely by the willingness-to-pay of its users. Therefore, it still needs to rely on subsidies, grants, and other sources of revenue. With more than 1,000 passengers per month, the service would cost on average 60 € per passenger. However, with a willingness-to-pay of 4 €, more than 16,000 passengers will be needed to cover the costs. Therefore, it is important to assess the cost-effectiveness of this service by looking at the other advantages it can bring. Mainly, this analysis will consist of comparing the services with regards to safety enhancement, service reliability, shared mobility and increased equity and access of marginalized groups (see Table 47).

Table 47 - SAMS(P) - Cost-effectiveness analysis for passenger transport

Impact Category	KPI	KPI estimate	Cost-effectiveness ratio	Ratio description
	monthly cost		64,342.68 €	

Impact Category	KPI	KPI estimate	Cost-effectiveness ratio	Ratio description
Road safety	Safety Enhancement (%)	10	6,434.27	Cost per increase percentage in safety enhancement
Societal, employability and equity	Person km travelled (by special groups)	0.2	321,713.39	Cost per km travelled per special group
Societal, employability and equity	Empty vehicle km	0.8	80,428.35	Cost proportionate to not empty running (inverse scale)
Societal, employability and equity	Shared mobility rate	0.85	75,697.27	Shared service outcome
Societal, employability and equity	Vehicle utilisation rate	0.7	91,918.11	Cost if we used the vehicle fully
Traffic, Energy, Environment	Number of passengers	1041.67	61.77	Cost per passenger
Traffic, Energy, Environment	Service reliability	0.92	69,937.69	Costs compared to a reliable service
Traffic, Energy, Environment	Kilometres travelled	1440	44.68	Cost per kilometre
Traffic, Energy, Environment	Energy use	0.0083	7,721,121.25	Costs proportionate to energy use (inverse scale)
User acceptance	Traveller acceptance	7	9,191.81	Cost for a one unit increase of user acceptance
User acceptance	User reliability perception	7	9,191.81	Cost for a one unit increase of reliability perception
User acceptance	User safety perception	7	9,191.81	Cost for a one unit increase of safety perception
User acceptance	Travel comfort	7	9,191.81	Cost for a one unit increase of travel comfort
User acceptance	Perceived usefulness	7	9,191.81	Cost for a one unit increase of perceived usefulness
User acceptance	Willingness to pay	4.00 €	16,085.67	Number of (monthly) rides to for the WTP to cover the service costs.
User acceptance	Willingness to share a ride	7	9,191.81	Shared service outcome

Freight transport

To assess the freight transport outcomes, ten KPIs specific to logistics have been selected. The current version of the KPI's for logistics developed in WP13 are shown here. More detailed explanations of the KPIs are available in D9.3.

Here again, the aim is to compare the outcome of different services, to see which one is the most cost-effective to reach these outcomes. Nevertheless, the estimated number of cargo transported, unit cost of delivery and willingness-to-pay for it, already show that the number of transported parcels should be higher to recover the costs and that the willingness-to-pay will likely not be high enough (see Table 48).

Table 48 - SAMS(F) - Cost-effectiveness analysis for freight transport

Impact Category	Impact	KPI estimate	Cost-effectiveness ratio
	monthly costs		49,958.66 €
Logistics	Ratio of average load	60%	83,264.43
Logistics	Number of cargo transported	400	124.90
Logistics	Punctuality of deliveries	85%	58,774.89
Logistics	Precision of deliveries	72%	69,387.02
Logistics	Customer satisfaction	75%	66,611.54
Logistics	Unit cost of delivery	8.63 €	5,788.95
Logistics	Load factor patterns	70	713.70
Logistics	Public acceptance	65%	76,859.47
Logistics	Willingness to pay for AV urban deliveries/logistics	5.00 €	9,991.73
Logistics	Fair and equal access in AV UFT facility	90%	55,509.62

3.4.2 Interpretation and usage of the CEA results for business and exploitation plans

The calculated KPIs after the pilot demonstration phase towards the end of the project will allow to draw further conclusions for business and exploitation for the future services.

In the next deliverables, the ratios will be computed for different services, and it will help in the comparison of the different services in terms of their cost to reach these outcomes. This will help in the identification of characteristics in the specific pilots that led to a better outcome at a lower cost. In this way, viable future CCAM services can be identified and scaled up in future scenarios.

4 SHOW business and exploitation plans

The following chapter focuses on the utilization and further development of the project's key results, based on the different kind of mobility services tested within the project, the technological development at the test sites, the specific goals of each Consortium partner as well as the targeted stakeholder groups.

This section will show the evaluation results regarding the mobility services considering the developed business models of SHOW. Every sub-chapter focuses on one mobility service represented by many specific business models implemented in the different test sites of SHOW.

The following table (Table 49) show which test site has implemented which business model and the link to following chapter.

Table 49 - Mapping of WP2 business models to D16.2 scenarios

Business Model from WP2	Existing/ New	Type of user	Mega & Satellite Sites	Scenario for D16.2
Automated PT in combination with additional on-demand services	Existing (new for Tampere and Trikala)	Students, Commuters	Germany Monheim; Tampere/Finland, Trikala/Greece	Demand Responsive Transportation
Automated Bus Depots	New	Public Transport operators and authorities	Spain	n.a.
Advanced MaaS in urban environments	Existing	Inhabitants, Tourists	France Turin/Italy	Mobility-as-a-service
Combined MaaS and LaaS	New	Visitors, In-hospitalized, Commuters, Hospitals	Turin/Italy	Logistics-as-a-service
Peri-urban automated transportation and C-ITS connectivity	Existing (new for Trikala)	Inhabitants of sub-urban areas, Tourists	Austria Trikala/Greece Brainport/ Netherlands	Demand Responsive Transportation
Robo Taxi services for short distance trips	Existing (new for Trikala)	Inhabitants, visitors of malls, commuters	Austria Trikala/Greece	Car Sharing Robo Taxis
Sustainable living areas with automated public transportation	Existing (new for Tampere)	Inhabitants, landlords	Sweden Tampere/Finland, Brno/Czechia, Copenhagen/Denmark	Public Transportation
First/Last mile automated transportation to mobility HUBs	Existing (new for Tampere and Trikala)	Commuters, visitors	Sweden Tampere/Finland, Copenhagen/Denmark, Trikala/Greece	Public Transportation
Integrated automated and electric shuttle buses for large scale events	New	Visitors of the event, event companies, hotels	n.a. Opportunity for France, Olympic Games 2024	Chapter 5
Interoperable IoT platforms for automated mobility	New	Cities, Mobility providers, manufacturers	n.a. Sweden is testing IoT compatibility for automated driving	Chapter 5

4.1 Business plans and exploitation roadmaps of SHOW services and solutions

The following sub-chapters will show the first results of the different mobility services deriving from the SHOW project. As stated in the methodology and mapped in table 45, there are five models. The results are based on the data collected from the test sites. The baseline data is used and adapted for each scenario.

4.1.1 (Automated) Public Transportation

The scenario for automated public transportation features business models, that involve automated vehicles driving on a fixed line within a specific timetable. Apart from the automation (of the vehicle itself) no specific development is needed which makes this scenario the “easiest” to implement and operate. As an example the recent joined partner and public transport operator “Bahnen der Stadt” Monheim” worked as a great example, as they are one of the first cities worldwide to operate shuttles in their city area (old city area) in a live operation.

This chapter features calculations and assumption for the take up of automated public transportation services based on the feedback of the test sites.

TCO results

The TCO results are based on the baseline costs from chapter 3. Assuming the scenario for public transportation is the most simplistic and least cost intense in the case of uptake. The baseline costs change as follows and also can be seen in Table 50:

- Module Leasing: Organizations (mostly PTOs) are less likely to leas in this scenario, as they will own most of the needed products and build and maintain assets on their own (e.g. vehicles & garages)
- Module Personnel: Costs stay the same as in the basic scenario
- Module Maintenance: Costs stay the same as in the basic scenario but changes due to the additional vehicles (four instead of two) nevertheless
- Module Insurance: Costs stay the same as in the basic scenario as no additional insurances are needed but changes due to the additional vehicles (four instead of two) nevertheless
- Module Depreciation: The module remains the same as there are no additional depreciations but changes due to the additional vehicles (four instead of two) nevertheless
- Module Marketing: The service that is offered with public transportation is very familiar with the inhabitants who will use the service. Marketing therefore isn’t as high of a priority, as it would be with more advanced and complicated services or services in the field of new business models
- Module IT: Costs stay the same as in the basic scenario as no additional IT is needed
- Module Supplies: Costs stay the same as in the basic scenario as there are no additional supplies needed
- Module Billing: Costs stay the same as in the basic scenario as no additional billing system is needed
- (CapEx): As the organization is more likely to own assets in this scenario, CapEx is higher

Table 50 - (Automated) Public Transportation - Cost Modules change compared to SAMS(P) Basic Scenario

Cost modules	Baseline	Deviation	Result
Module Leasing	7,450 €/month	- 20%	5,960 €/month
Module Personnel	20,100 €/month	Same as basic scenario	20,100 €/month
Module Maintenance	8,815 €/month	Change due to the additional 2 vehicles	9,365 €/month
Module Insurance	12,350 €/month	Change due to the additional 2 vehicles	16,350 €/month
Module Depreciation	5,518 €/month	Change due to the additional 2 vehicles	7,846 €/month
Module Marketing	5,705 €/month	- 20%	4,564 €/month
Module IT	1,575 €/month	Same basic scenario	1,575 €/month
Module Supplies	439 €/month	Same as basic scenario	439 €/month
Module Billing	55 €/month	Same as basic scenario	55 €/month
(CapEx without vehicles)	218,625 €/total	+ 20%	262,350 €/total
(CapEx vehicles)	2 vehicles	+ 2 vehicles	1,200,000 €/total
(CapEx sum)			1,462,350 €/total

CBA results

Revenues, benefits, and potential savings of automated public transportation services are shown in Table 51 to Table 53:

Table 51 - (Automated) Public Transportation - Revenue Input change compared to SAMS(P) Basic Scenario

Factor	Baseline	Deviation	Result
Operation days per year	250 days/year	Service is established and able to run the whole year, considering some downtime for repairs and other outside factors	320
Mileage	15,000 km/year	Same as basic scenario	15,000 km/year
Passengers	50 Persons/Day	With the go-live of the service we expect more passengers to use the service. Increase factor 50%	75 Persons/Day
Average number of Trips taken	1 Trip/Day	Increase of 100% as most passengers are	2 Trip/ Day

Factor	Baseline	Deviation	Result
		likely to take a trip to and from their destination	
Average income per trip	2 €	Same as basic scenario	2 €
Average price per Subscription	15 €/month	Same as basic scenario	15 €/month
Average monthly income through other fees	2,977 €/month	Same as basic scenario	2,977 €/month
Subsidies/Grants from public hand	200,000 €/year	Same as basic scenario	200,000 €/year
Selling marketing space on/at vehicles/stations	10,000 €/year	4 instead of 2 vehicles	20,000 €/year
Income from investors	50,000 €/years	Same as basic scenario	50,000 €/years

Table 52 - (Automated) Public Transportation - Revenue Output

Revenues	Result	Explanation of Results
Revenues Person Transport	636,000 €/holding period	Based on the number of customers, trips taken per day and the ticket price(s) these are the total revenues generated through the holding period.
Revenues through other fees	285,792 €/holding period	Based on the category “Monthly income through other fees” which is income through fare dodgers through the holding period.
Income through subsidies/grants from public hand	1,600,000 €/holding period	Calculated income through subsidies and grants throughout the whole holding period.
Income through selling marketing space on/at vehicles/stations	160,000 €/holding period	Calculated income through selling marketing places throughout the whole holding period.
Income through investors	400,000 €/holding period	Calculated income through investors throughout the whole holding period.

Table 53 - (Automated) Public Transportation - Benefits Output

Benefits	Result	Explanation of Results
Break-even Point	- 207,783,544 €/holding period (- 204,032,000 € are revenues not activated)	A negative value means that the costs of the service are in total more than the revenues. But most of this value are revenues not activated (in the brackets) based on the inhabitants of the area and the users of the service. As long as there are more inhabitants in the area than users, this value is negative.
Technical	- 161,600 €/holding period	Due to assumed technical break downs of the vehicles per year and the corresponding costs, this value is negative. The best value available in this category would be 0 € which would mean that there are no technical breakdowns at all though the whole holding period.
Environmental	- 10,985.14 €/holding period	This value is based on the indirect and direct emission produced by the vehicles based on the energy consumption, mileage, energy origin, and emission prices.
Economic	1,525,072 €/holding period	This category shows a positive economic value based on pricing strategy, marketing influence, operating times and funding. A negative value would mean that all the mentioned categories have in total a negative economic impact.
Quality-of-Service	8,824.04 €/holding period	This value shows a positive result regarding service information and calling

Benefits	Result	Explanation of Results
		possibilities. A negative value would mean that these services cost more than they bring.
Users & Stakeholders	160,000 €/holding period	This value means that the assumed stakeholders bring more value to our service than they costs. A negative value would mean they cost more than they bring.

Due to the changes of the input parameters for the (automated) public transportation compared to the ones of the basic scenarios described in chapter 3 the following conclusions can be made:

- Costs can be saved in the field of marketing and rent and outsourcing to SMEs
- More customers are activated due to the prominence of the service in the area and the fact that the service operates almost around the year
- Funding is most likely given to PTOs compared to other mobility services
- Higher CapEx costs due to having more vehicles compared to other mobility services

4.1.2 Demand Responsive Transportation

The scenario for demand responsive transportation gathers business models that evolve around automated vehicles which not only drive on a fixed line. The main factor of a service being demand responsive, is that it has no fixed time schedule. Passengers can call a vehicle to their position (or on the line) when needed. Demand responsive transportation is the transition between classic public transportation and (robo) taxis.

From a technical point of view the scenario is close to normal public transportation, as long as the vehicle drives on a specific route. If the route is flexible, the service would need a higher level of automation, which cannot be evaluated with the use cases developed and tested within the SHOW project.

Additional costs for the demand responsive transportation therefore lie in the module IT and personnel, as there's a need for a type of application to be able to call the vehicle on the line, as well as additional service personnel to maintain the application and respond to problems.

Additional cost modules for automated demand responsive transportation are stated as follows (see Table 54):

TCO results

- Module Leasing: Remains the same as with (automated) public transportation
- Module Personnel: Slight increase as more personnel is needed to support with the application and respond to problems of passengers
- Module Maintenance: Remains the same as basic scenario

- Module Insurance: Remains the same as basic scenario
- Module Depreciation: Remains the same as basic scenario
- Module Marketing: Remains the same as basic scenario
- Module IT: Slight increase of costs, as an application is needed to call the vehicle
- Module Supplies: Remains the same as basic scenario
- Module Billing: Remains the same as basic scenario
- (CapEx): Increase of costs for multiple vehicles and equipment

Table 54 - Demand Responsive Transportation - Cost Modules change compared to SAMS(P) Basic Scenario

Cost modules	Baseline	Deviation	Result
Module Leasing	7,450 €/month	- 20%	5,960 €/month
Module Personnel	20,100 €/month	+ 5%	21,105 €/month
Module Maintenance	8,815 €/month	Change due to the additional 2 vehicles	9,365 €/month
Module Insurance	12,350 €/month	Change due to the additional 2 vehicles	16,350 €/month
Module Depreciation	5,518 €/month	Change due to the additional 2 vehicles	7,846 €/month
Module Marketing	5,705 €/month	Same as basic scenario	5,705 €/month
Module IT	1,575 €/month	+ 10%	1,732.5 €/month
Module Supplies	439 €/month	Same as basic scenario	439 €/month
Module Billing	55 €/month	Same as basic scenario	55 €/month
(CapEx without vehicles)	218,625 €/total	+ 20%	262,350 €/total
(CapEx vehicles)	2 vehicles	+ 2 vehicles	1,200,000 €/total
(CapEx sum)			1,462,350 €/total

CBA results

The benefits of this scenario remain close to the public transportation scenario. Possible additional revenue could arrive from higher ticket prices. But to make this scenario more comparable we will keep the ticket prices at 2€/ trip.

Revenues, benefits, and potential savings of automated demand responsive transportation services can be seen in Table 55 to Table 57:

Table 55 - Demand Responsive Transportation - Revenue Input change compared to SAMS(P) Basic Scenario

Factor	Baseline	Deviation	Result
Days the service is in operation per year	250 days/year	Service is established and able to run the whole year, considering some downtime for repairs and other outside factors	320
Mileage	15,000 km/year	Same as basic scenario	15,000 km/year
Passengers	50 Persons/Day	With the go-live of the service we expect more passengers to use the service. Increase factor 50%	75 Persons/Day
Average number of Trips taken	1 Trip/Day	Increase of 100% as most passengers are likely to take a trip to and from their destination	2 Trip/ Day
Average income per trip	2 €	Same as basic scenario	2 €
Average price per Subscription	15 €/month	Same as basic scenario	15 €/month
Average monthly income through other fees	2,977 €/month	Same as basic scenario	2,977 €/month
Subsidies/Grants from public hand	200,000 €/year	Same as basic scenario	200,000 €/year
Selling marketing space on/at vehicles/stations	10,000 €/year	4 instead of 2 vehicles	20,000 €/year
Income from investors	50,000 €/years	Same as basic scenario	50,000 €/years

Table 56 - Demand Responsive Transportation - Revenue Output

Revenues	Result	Explanation of Results
Revenues Person Transport	636,000 €/holding period	Based on the number of customers, trips taken per day and the ticket price(s) these are the total revenues generated through the holding period.
Revenues through other fees	285,792 €/holding period	Based on the category “Monthly income through other fees” which is income through fare dodgers through the holding period.

Revenues	Result	Explanation of Results
Income through subsidies/grants from public hand	1,600,000 €/holding period	Calculated income through subsidies and grants throughout the whole holding period.
Income through selling marketing space on/at vehicles/stations	160,000 €/holding period	Calculated income through selling marketing places throughout the whole holding period.
Income through investors	400,000 €/holding period	Calculated income through investors throughout the whole holding period.

Table 57 - Demand Responsive Transportation - Benefits Output

Benefits	Result	Explanation of Results
Break-even Point	- 208,004,680 €/holding period (- 204,032,000 € are revenues not activated)	A negative value means that the costs of the service are in total more than the revenues. But most of this value are revenues not activated (in the brackets) based on the inhabitants of the area and the users of the service. As long as there are more inhabitants in the area than users, this value is negative.
Technical	- 161,600 €/holding period	Due to assumed technical break downs of the vehicles per year and the corresponding costs, this value is negative. The best value available in this category would be 0 € which would mean that there are no technical breakdowns at all though the whole holding period.
Environmental	- 10,985.14 €/holding period	This value is based on the indirect and direct emission produced by the vehicles based on the energy

Benefits	Result	Explanation of Results
		consumption, mileage, energy origin, and emission prices.
Economic	1,525,072 €/holding period	This category shows a positive economic value based on pricing strategy, marketing influence, operating times and funding. A negative value would mean that all the mentioned categories have in total a negative impact.
Quality-of-Service	8,824.04 €/holding period	This value shows a positive result regarding service information and calling possibilities. A negative value would mean that these services cost more than they bring.
Users & Stakeholders	160,000 €/holding period	This value means that the assumed stakeholders bring more value to our service than they costs. A negative value would mean they cost more than they bring.

Due to the changes of the input parameters for the demand responsive transportation service compared to the ones of the basic scenarios described in chapter 3 the following conclusions can be made:

- Costs can be saved in the field of rent and outsourcing to SMEs
- More customers are activated due to the prominence of the service in the area and the fact that the service operates almost around the year
- Higher CapEx costs due to having more vehicles compared to other mobility services
- Higher personnel and IT costs due to the additional personnel for customer support and technical equipment needed for the service

4.1.3 Car Sharing (Robo Taxi)

Although most public transportation is done via buses/shuttles and other vehicles which hold bigger groups of people, there are scenarios where normal passenger vehicles are used for shared mobility. A very futuristic but often tested use case is the ones of Robo Taxis. A vehicle that takes you from point A to B at any time, by any route. Also SHOW test sites like Graz and Trikala develop and test use cases with Robo Taxis, although this is tested on fixed itineraries. The evaluation in this chapter is based on the SHOW state of art.

To date there are no commercially shared automated fleets which can be used for car sharing, but many pilots, e.g. a Volkswagen fleet in the city of Hamburg (planned for 2025) as well as an automated SIXT (car sharing operator) fleet in the city of Munich (pilot planned for 2022).

TCO results

Additional cost modules for automated car sharing (changes are shown in Table 58):

- Module Leasing: Same as basic scenario
- Module Personnel: Increased costs due to higher educated and more personnel needed
- Module Maintenance: Increased costs due to newer high tech equipment which needs to be maintained more often than usual. Due to change from shuttle to normal car decrease of the basic scenario
- Module Insurance: Same as basic scenario but due to change from shuttle to normal car decrease of the baseline results
- Module Depreciation: Same as basic scenario but due to change from shuttle to normal car rise of the baseline results
- Module Marketing: Increased costs due to unsure acceptance of passengers as the service of this scenario is quite unknown in the general public
- Module IT: Increased costs due to high tech equipment and needed software
- Module Supplies: Same as basic scenario
- Module Billing: Same as basic scenario
- Module Vehicle: Change to the baseline from electric shuttles to electric cars (Kia Soul)
- (CapEx): Increased due to high tech equipment for the vehicle

Table 58 - Car Sharing - Cost Modules change compared to SAMS(P) Baseline Scenario

Cost modules	Baseline	Deviation	Result
Module Leasing	7,450 €/month	Same as basic scenario	7,450 €/month
Module Personnel	20,100 €/month	+ 10%	22,110 €/month
Module Maintenance	8,637 €/month	+ 10%	9,500.7 €/month
Module Insurance	8,490 €/month	Same as basic scenario	8,490 €/month
Module Depreciation	5,690 €/month	Same as basic scenario	5,690 €/month
Module Marketing	5,690 €/month	+ 10%	6,275,5 €/month
Module IT	1,575 €/month	+ 10%	1,732.5 €/month
Module Supplies	439 €/month	+ 10%	482.9 €/month
Module Billing	55 €/month	Same as basic scenario	55 €/month
(CapEx without vehicles)	218,625 €/total	+ 5%	229,556.25 €/total
(CapEx vehicles)	2 shuttles	- 2 shuttles + 2 electric cars	180,000 €/total
(CapEx sum)			409,556.25 €/total

CBA results

The revenues of the robo taxi scenario remain rather unclear, as the potential is high but the technology has to be finalized first. The benefits themselves are that better car sharing solutions have the potential to subside the individual car traffic.

Revenues, benefits, and potential savings of automated Robo Taxi services as can be seen in Table 59 to Table 61:

Table 59 - Car Sharing - Revenue Input change compared to SAMS(P) Basic Scenario

Factor	Baseline	Deviation	Result
Days the service is in operation per year	250 days/year	Service is established and able to run the whole year	365
Mileage	15,000 km/year	Higher milage as people will take longer trips	~75.000 km/year
Passengers	50 Persons/Day	Same as basic scenario	50 Persons/Day
Average number of Trips taken	1 Trip/Day	Same as basic scenario	1 Trip/ Day
Average income per trip	2 €	Activation fee plus fee per km is a normal business model for car sharing. A day/ trip with a shared car can be estimated around 30-50€	40€
Average price per Subscription	15 €/month	n/a	n/a
Average monthly income through other fees	2,977 €/month	Same as basic scenario	2,977 €/month
Subsidies/Grants from public hand	200,000 €/year	Private companies most likely to not get as many grants from public hand	20.000 €/year
Selling marketing space on/at vehicles/stations	10,000 €/year	Marketing and partnerships with the private car sharing companies will result in higher revenues	200,000 €/year
Income from investors	50,000 €/years	Investors are more likely to invest in growing private business	200,000 €/year

Table 60 - Car sharing - Revenue Output

Revenues	Result	Explanation of Results
Revenues Person Transport	5,840,000 €/holding period	Based on the number of customers, trips taken per day and the ticket price(s) these are the total revenues

Revenues	Result	Explanation of Results
		generated through the holding period.
Revenues through other fees	285,792 €/holding period	Based on the category "Monthly income through other fees" which is income through fare dodgers through the holding period.
Income through subsidies/grants from public hand	160,000 €/holding period	Calculated income through subsidies and grants throughout the whole holding period.
Income through selling marketing space on/at vehicles/stations	1,600,000 €/holding period	Calculated income through selling marketing places throughout the whole holding period.
Income through investors	1,600,000 €/holding period	Calculated income through investors throughout the whole holding period.

Table 61 - Car sharing - Benefits Output

Benefits	Result	Explanation of Results
Break-even Point	-2,323,393,425.6 €/holding period (- 2,330,160,000 € are revenues not activated)	A negative value means that the costs of the service are in total more than the revenues. But most of this value are revenues not activated (in the brackets) based on the inhabitants of the area and the users of the service. As long as there are more inhabitants in the area than users, this value is negative.
Technical	- 161,600 €/holding period	Due to assumed technical break downs of the vehicles per year and the corresponding costs, this value is negative. The best value available in this category would be 0 € which would mean that

Benefits	Result	Explanation of Results
		there are no technical breakdowns at all though the whole holding period.
Environmental	-16,734.03 €/holding period	This value is based on the indirect and direct emission produced by the vehicles based on the energy consumption, mileage, energy origin, and emission prices.
Economic	5,966,672 €/holding period	This category shows a positive economic value based on pricing strategy, marketing influence, operating times and funding. A negative value would mean that all the mentioned categories have in total a negative economic impact.
Quality-of-Service	8,824.04 €/holding period	This value shows a positive result regarding service information and calling possibilities. A negative value would mean that these services cost more than they bring.
Users & Stakeholders	160,000 €/holding period	This value means that the assumed stakeholders bring more value to our service than they costs. A negative value would mean they cost more than they bring.

Due to the changes of the input parameters for the car sharing (Robo Taxi) service compared to the ones of the basic scenarios described in chapter 3 the following conclusions can be made:

- Costs can be saved in the field of vehicles. Instead of shuttles regular cars are taken in this case
- But higher OpEx costs in the fields of: Personnel, Maintenance, Marketing, IT and Supplies
- Most car sharing operators are private enterprises, which need investors to cover the start-up costs

4.1.4 Mobility-as-a-Service

Mobility-as-a-service is not one use case on its own and rather the combination of different actors, offering a variety of mobility solutions and services. The point of view of the evaluation for MaaS differs from the other scenarios, as not the mobility operator is in focus and rather the platform provider who combines multiple different mobility operators. Concerning the costs this makes of a very different outcome compared to the basic scenario. The organization operating the MaaS platform will have less assets as they are not providing the vehicles themselves. The main business lies in connecting different partners, the partner acquisition and billing systems. For the TCO that brings us to the following assumptions.

As a side note, for a transport operator the cost assumptions would stay close to the baseline with the difference, that billing and marketing costs will go down significantly, as these are part of the service scenario of the MaaS operator.

TCO results

Additional cost modules for mobility-as-a-service (as shown in Table 62):

- Module Leasing: The organization doesn't have a direct need to rent assets to be able to operate the platform of services if they only act as a "connector". Nevertheless, the operator/ connector can also operate different kind of mobility services, but he will resort to those, which are more profitable (e.g. small automated services instead of multiple public transport shuttles)
- Module Personnel: Slightly increased costs as the platform operation (software & maintenance) needs more personnel
- Module Maintenance: Decreased, as there are not as many assets
- Module Insurance: Decreased, as there are not as many assets
- Module Depreciation: Decreased, as there are not as many assets
- Module Marketing: Increased costs as the main business is focused on partner and customer acquisition
- Module IT: Increased costs as this is the main business and asset for a MaaS operator
- Module Supplies: Decreased, as there are not as many assets
- Module Billing: Increased, as the billing system is a core asset and unique selling point for the MaaS operator
- Module Vehicle: No vehicles because MaaS is only viewed as interface between mobility services
- (CapEx): Decreased, as there are not as many assets

Table 62 - MaaS - Cost Modules change compared to SAMS(P) Basic Scenario

Cost modules	Baseline	Deviation	Result
Module Leasing	7,450 €/month	- 80%	1,490 €/month
Module Personnel	20,100 €/month	+ 20%	24,120 €/month
Module Maintenance	8,815 €/month	- 80%	1,763 €/month
Module Insurance	12,350 €/month	- 80%	2,470 €/month
Module Depreciation	5,518 €/month	- 80%	1,103.6 €/month
Module Marketing	5,705 €/month	+ 100%	11,410 €/month
Module IT	1,575 €/month	+ 100%	3,150 €/month
Module Supplies	439 €/month	- 80%	87.8 €/month
Module Billing	55 €/month	+ 100%	110 €/month

Cost modules	Baseline	Deviation	Result
(CapEx without vehicles)	218,625 €/total	- 50%	109,312.5 €/total
(CapEx vehicles)	2 vehicles	- 2 vehicles	0 €/total
(CapEx sum)			109,312.5 €/total

CBA results

The revenues of the mobility-as-a-service scenario come mainly from arranging the transactions between the passengers and operators. Each transaction will have a small percentage of transaction fee for the operator:

Revenues, benefits, and potential savings of automated car sharing services (see Table 63 to Table 65):

Table 63 - MaaS - Revenue Input change compared to SAMS(P) Basic Scenario

Factor	Baseline	Deviation	Result
Days the service is in operation per year	250 days/year	Service is established and able to run the whole year	365
Mileage	15,000 km/year	Higher milage from all modes of travel	500.000 km/year
Passengers	50 Persons/Day	Many more customers from connecting different mobility services	250 Persons/Day
Average number of Trips taken	1 Trip/Day	The customers will most likely do multiple (multi modular) trips with the different MaaS partners	5 Trip/ Day
Average income per trip	2 €	Smaller transaction fee	0,30 €
Average price per Subscription	15 €/month	An Subscription to use the whole MaaS fleet	90 €/month
Average monthly income through other fees	2,977 €/month	Same as basic scenario	2,977 €/month
Subsidies/Grants from public hand	200,000 €/year	Private companies most likely to not get as many grants from public hand	20,000 €/year
Selling marketing space on/at vehicles/stations	10,000 €/year	Marketing and partnerships with the private car sharing companies will result in higher revenues	200,000 €/year
Income from investors	50,000 €/years	Investors are more likely to invest in growing private business	200,000 €/year

Table 64 - MaaS - Revenue Output

Revenues	Result	Explanation of Results
Revenues Person Transport	1,308,000 €/holding period	Based on the number of customers, trips taken per day and the ticket price(s) these are the total revenues generated through the holding period.
Revenues through other fees	285,792 €/holding period	Based on the category "Monthly income through other fees" which is income through fare dodgers through the holding period.
Income through subsidies/grants from public hand	160,000 €/holding period	Calculated income through subsidies and grants throughout the whole holding period.
Income through selling marketing space on/at vehicles/stations	1,600,000 €/holding period	Calculated income through selling marketing places throughout the whole holding period.
Income through investors	1,600,000 €/holding period	Calculated income through investors throughout the whole holding period.

Table 65 - MaaS - Benefits Output

Benefits	Result	Explanation of Results
Break-even Point	- 84,929,233.60 €/holding period (- 81,505,000 € are revenues not activated)	A negative value means that the costs of the service are in total more than the revenues. But most of this value are revenues not activated (in the brackets) based on the inhabitants of the area and the users of the service. As long as there are more inhabitants in the area than users, this value is negative.
Technical	- 161,600 €/holding period	Due to assumed technical break downs of the vehicles per year and the corresponding costs, this value is

Benefits	Result	Explanation of Results
		negative. The best value available in this category would be 0 € which would mean that there are no technical breakdowns at all though the whole holding period.
Environmental	0 €/holding period	This value is based on the indirect and direct emission produced by the vehicles based on the energy consumption, mileage, energy origin, and emission prices.
Economic	2,014,292 €/holding period	This category shows a positive economic value based on pricing strategy, marketing influence, operating times and funding. A negative value would mean that all the mentioned categories have in total a negative economic impact.
Quality-of-Service	8,824.04 €/holding period	This value shows a positive result regarding service information and calling possibilities. A negative value would mean that these services cost more than they bring.
Users & Stakeholders	160,000 €/holding period	This value means that the assumed stakeholders bring more value to our service than they costs. A negative value would mean they cost more than they bring.

Due to the changes of the input parameters for the shared mobility service operator compared to the ones of the basic scenarios described in chapter 3 the following conclusions can be made:

- Costs can be saved in the following fields: Rent, Maintenance, Insurance, Depreciation, Supplies and CapEx. This is due to the fact that a MaaS operator has no own vehicle fleet.

- But higher OpEx costs in the fields of: Personnel, Marketing, IT and Billing
- Most shared mobility service operators are private enterprises, which need investors to cover the start-up costs
- Higher revenues can be generated by using the marketing potential of the mobility providers involved in the shared mobility service

4.1.5 Logistics-as-a-Service

The use of the word logistics-as-a-service usually describes, similar to mobility-as-a-service, the integration of a logistics chain with different logistic actor into one platform. For the SHOW project this is not the case. The SHOW scenario “logistics-as-a-service” describes the integration of logistic into the mobility use cases/ scenarios mentioned in the above chapters. In details this could mean using the vehicle in off-peak hours as a logistics vehicles. Or using the vehicle simultaneously for passenger and logistic transportation on a campus area.

The baseline costs for the logistics-as-a-service scenario are reported to be lower than the mobility-as-a-service scenario.

This chapter features calculations and assumption for the take up/ go-to-market of automated logistics-as-a-service solution.

TCO results

Additional cost modules for automated LaaS (shown in Table 66):

- Module Leasing: More operation results in higher costs for rentals
- Module Personnel: More operation requires more/ more skilled personnel
- Module Maintenance: Same as basic scenario
- Module Insurance: Same as basic scenario
- Module Depreciation: Same as basic scenario
- Module Marketing: Same as basic scenario
- Module IT: Integration and booking of the services will play a bigger role, which makes costs for IT go up
- Module Supplies: More trips require more supplies
- Module Billing: Same as basic scenario
- (CapEx): Same as basic scenario

Table 66 - LaaS - Cost Modules change compared to SAMS(F) Basic Scenario

Cost modules	Baseline	Deviation	Result
Module Leasing	4,450 €/month	+ 10%	4,895 €/month
Module Personnel	18,150 €/month	+ 10%	19,965 €/month
Module Maintenance	5,000 €/month	Same as basic scenario	5,000 €/month
Module Insurance	5,330 €/month	Same as basic scenario	5,330 €/month
Module Depreciation	4,768 €/month	Same as basic scenario	4,768 €/month
Module Marketing	3,000 €/month	Same as basic scenario	3,000 €/month
Module IT	873 €/month	+ 50%	1,309.5 €/month
Module Supplies	490 €/month	+ 10%	539 €/month
Module Billing	55 €/month	+ 10%	60.5 €/month

Cost modules	Baseline	Deviation	Result
(CapEx without vehicles)	61,375 €/total	Same as basic scenario	61,375 €/total
(CapEx vehicles)	2 vehicles	Same as basic scenario	600,000 €/total
(CapEx sum)			661,375 €/total

CBA results

Revenues, benefits, and potential savings of logistics-as-a-service scenario (see Table 67 to Table 69):

Table 67 - LaaS – Revenue input change compared to SAMS(F) Basic Scenario

Benefits	Baseline	Deviation	Result
Numbers of customers	200 persons/month	Established service will result in more customers	500 person/month
Average number of cargo for each customer	2 #/month	A weekly shipment per customer is assumed	4 #/month
Average income per cargo	8.63 €	Price is expected to go down to attract customers and choose this service over others	5 €
Subsidies/Grants from public hand	50,000 €/year	Considering input of different funding key experts the average amount of subsidies/grants is calculated with 50,000 €/year.	50,000 €/year
Selling marketing space on/at vehicles/stations	10,000 €/year	Orienting on the prices [10] of the ÖBB (The Austrian Federal Rail Company) this would be for one vehicle per year around 5,000 €.	10,000 €/year
Income from investors	20,000 €/year	Key experts are most likely ready to invest 20,000 €/year considering the risks and the novelty of the service concept.	20,000 €/year

Table 68 - LaaS - Revenue Output

Revenues	Result	Explanation of Results
Revenues Freight Transport	960,000 €/holding period	Based on the number of customers, number of cargo shipped and the cargo shipping price(s) these are the total revenues generated through the holding period.

Revenues	Result	Explanation of Results
Income through subsidies/grants from public hand	400,000 €/holding period	Calculated income through subsidies and grants throughout the whole holding period.
Income through selling marketing space on/at vehicles/stations	80,000 €/holding period	Calculated income through selling marketing places throughout the whole holding period.
Income through investors	160,000 €/holding period	Calculated income through investors throughout the whole holding period.

Table 69 - LaaS - Benefits Output

Benefits	Result	Explanation of Results
Break-even Point	- 41,119,387.68 €/holding period (- 37,440,000 € are revenues not activated)	A negative value means that the costs of the service are in total more than the revenues. But most of this value are revenues not activated (in the brackets) based on the inhabitants of the area and the users of the service. As long as there are more inhabitants in the area than users, this value is negative.
Technical	- 165,536 €/holding period	Due to assumed technical break downs of the vehicles per year and the corresponding costs, this value is negative. The best value available in this category would be 0 € which would mean that there are no technical breakdowns at all though the whole holding period.
Environmental	- 7,323.43 €/holding period	This value is based on the indirect and direct emission produced by the vehicles based on the energy consumption, mileage,

Benefits	Result	Explanation of Results
		energy origin, and emission prices.
Economic	- 816,784 €/holding period	This category shows a negative economic value based on pricing strategy, marketing influence, operating times and funding. A negative value means that all the mentioned categories have in total a negative economic impact.
Quality-of-Service	15,999.33 €/holding period	This value shows a positive result regarding service information and calling possibilities. A negative value would mean that these services cost more than they bring.
Users & Stakeholders	160,000 €/holding period	This value means that the assumed stakeholders bring more value to our service than they costs. A negative value would mean they cost more than they bring.

Due to the changes of the input parameters for the LaaS service operator compared to the ones of the SAMS(F) basic scenarios described in chapter 3 the following conclusions can be made:

- Higher OpEx costs in the fields of: Rent, Personnel, IT, Supplies and Billing
- Most LaaS service operators are private enterprises, which need investors to cover the start-up costs

4.2 Overview of exploitable key results

At the beginning of the project all partners stated the results which are to be expected from them as an organization to the SHOW project to succeed. This list can be found in the Grant Agreement of the SHOW project which acts as the contract for the partners throughout the project runtime. The activity for exploitation (A16.3) dedicated half a day of the exploitation seminar to update and map the initial list of key exploitable results, which leads to the updated list in this chapter.

A16.3 Exploitation will further analyze this list and present a final update in D16.3, focused on and evaluated in detail. Updating and analyzing the key exploitable results of a project is of incredibly high relevance, as these are the topics, the organizations are actively working on, finally resulting into real business. The entirety of the exploitable results are therefore part of the future business plans.

Table 70 - First updated list of SHOW KERs

Category	Exploitable result	Owner	Provisional strategy – Months (M) to market after project end
Safety	Increased vehicle safety	VALEO	Integration to vehicles, direct sales – 12M
	Increased interaction and communication with VRUs	LINKS	Further research, collaboration, papers – just after
	Vehicle position improvement	KEOLIS, CEA	Module for TMC -24 M
Integrationn	Piloting automated transport services in real traffic networks and in challenging conditions.	SITOWISE, TRE, Sensible 4	Implementation, direct sales – 24M
	Integreation of automated transport services into TMCs, TM2.0	TNO	Consulting, further research and licensing to TMC and traffic controllers and other stakeholders – 12M
	C-ITS solutions for interaction of automated vehicles with VRUs	CERTH/HIT	Consulting, Licensing – 12M
	Influences of automatic traffic on the overall traffic system performance and road users	DLR, TRE	Evaluation of real life demonstrations and decision guidance for authorities – 12M

Category	Exploitable result	Owner	Provisional strategy – Months (M) to market after project end
	Collaborative TMC module	Swarco	Kit for integrating AV fleet operation and remote control to city TMC - 18 M
Technical Development	Improve the capacity for vehicle modules for the perception of the environment, e.g. bad weather conditions, communication between the vehicle and infrastructure, interaction with VRUs	SRFG	Execution of pilots with automated vehicles to answer research questions – 36M
	Roadside warning systems for monitoring occluded or otherwise dangerous pedestrian crossings, and to inform a vehicle about the status of the crossing	VTT	Licensing, direct sales – 24M
	Increase in average-speed, ride comfort, communication with smart infrastructure	FZI	Consulting of service providers, TMCs, PTO's – 24M
	Development and connection of SHOW marketplace + Services for the marketplace	CERTH/HIT	Licensing and integration – 12M
	Validation of automated shuttles on open road with mixed traffic with a high automated mode rate and gradually prepare for automated vehicle experimentation without safety driver on board	Bahnen der Stadt Monheim, KEOLIS	Demonstration from PTO's to authorities – just after

Category	Exploitable result	Owner	Provisional strategy – Months (M) to market after project end
	AV buses/shuttles parking assistance	IRIZAR	Own fleet use and royalties - 30 months
	AV SAE level upgrade from 2 to 5	Objective, Technalia	Services to the industry & research platforms, AVDRIC architecture licensing exploitation – 24M
Architecture and Standardization	Architecture Specification for complex CCAM systems integrating public transport services, HMI and handover strategies	ICCS	Standardization, Licensing – 36M
	Development new C-ITS standard messages (e.g. SSREM and SSEM)	Swarco	Standardization, Licensing – 36M
	C-ITS communication in combination with smart camera systems	LINKS	Future research projects and knowledge transfer – 24M
	SHOW Data Management Platform (DMP)	CERTH/ITI	Integration to various stakeholder systems, licensing, integration to spin offs (12M)
	SPY tool for social media analytics	ITML	Direct sales and licensing – just after
	SHOW Dashboard	Combitech & RISE	Direct sales to AV fleet operators -12 M
	Control Tower AV teleoperation solution	ERICSSON	Open platform with sales of license and data subscription - 12 M
Services	Big data-AI based services (at least seven)	CERTH, DTU, SITOWISE, ITML, CTLup	Services to all fleet operators, TMC and traffic controllers and other stakeholders - 0-12 M (depending on the service)
	DRT & Inductive charging solution for automated vehicles	CERTH/ITI	Service to PTO and service providers – 12M

Category	Exploitable result	Owner	Provisional strategy – Months (M) to market after project end
	Big data collection platform, big data AI toolboxes	CERTH (+spin offs)	Services to the industry as well to an ecosystem of connected SMEs, developing VASes - Just after
	SHOW marketplace + personalized service	CERTH (+spin offs)	Services to the industry as well to an ecosystem of connected SMEs, developing VASes - Just after
	Energy management services for AV fleets	AVL	Services for optimal planning, scheduling, routing of AV fleets for fleet range maximization - 12 M
	Simulation platform/ services	Siimulation providers	Sales of services to the Industry & Authorities -6 M
	Fleet management AI services	CERTH/HIT	Services to the industry as well to an ecosystem of connected SMEs - 12M
	Digital twin technology and simulation for automated transport services	SITOWISE	Direct sales, consulting & further projects – 12M
	Long range remote station developed solution for teleoperated driving	ARTIN	Sales to AV fleet operators are expected to be multiplied 30 times in the next 5 years; thus resulting in a revenue of 16 M€ - 12 M
	All around multi sensor fusion for high speed AV shuttle kit	Valeo	Direct sales to OEMs -30 M
Vehicle	Enhanced functionality shuttles	NAVYA, EASYMILE	Direct sales. NAVYA alone estimates potential future sales enhancement between 65 and 135 shuttles; with estimated revenue 26-55M€ - 6 M
	Furbot automated cargo vehicle	UNIGENOVA	Patent and sale to OEM - 24 months
	Modules for AVs	Bosch	Direct sales to OEMs - 24 M
Knowledge transfer	Knowledge for organising and	EASYMILE, GTT	Direct sales to OEMs, PTOs - 24 M

Category	Exploitable result	Owner	Provisional strategy – Months (M) to market after project end
	managing CCAM deployments		
	M3ICA impact assessment framework for CCAM solutions	VUB, NTUA	Consulting – just after
	Analysis and consulting of different stakeholders on business models for CCAM in public transportation	T-Systems, IESTA, VUB, BAX	Consulting – just after
	Development and coordination of (online) training (platform) on Automated Mobility for PTA/PTO	UITP	Service for stakeholders, Direct platform sales – 12-24M
	Development and enhancement of a TCO and CBA tool covering new mobility requirements regarding automated driving or SUMP	NTUA, IESTA, VUB	Further research, research paper, Consulting – just after
Policy	Multi perspective policy recommendations (end-user, PTO, city & authority)	UITP, JRC	Consulting – just after
	Ensuring the transfer of the project results and gained knowledge to the public sector in order to subsequently shape (national) legal and institutional framework conditions accordingly.	ATE	Consulting – just after
Verification and Guidance	Demonstrates the relevance of fully driverless operation	Transdev	Operation and integration into PTO's core business, strategy, guidance for

Category	Exploitable result	Owner	Provisional strategy – Months (M) to market after project end
	for specific use-cases while demonstrating the reachable economic case		authorities and general consulting – 12M
	A verification and validation procedure that can be used as guidance by EU local authorities	ATE, EPF	Development of guidelines/ procedure, research paper & consulting – just after
	The analysis of people expectations and concerns about new mobility solutions that can inform future EU strategies in the field.	JRC, EPF	Research paper & consulting – just after
	Promoting recommendations for the implementation of automated services in medium sized cities and more rural and peripheral areas as well as to authorities in general	SRFG	Service to authorities, consulting – just after
	Analysis of the business interest of the partners and development of sustainable, feasable business plans to act as a guideline for PTOs and authorities	T-Systems, IESTA, VUB, BAX	Service to stakeholders of all kind, consulting – just after
	Users engagement and co-creation initiatives like hackatons	EPF	Further research/ consulting – just after

4.3 Results to be exploited by project partners

Within this chapter the Consortium partners were given the opportunity to report on significant developments made within the SHOW project connected to a business case, meaning an idea of the solution, the business case and the impact in 3-year time.

4.3.1 C-ITS enhanced vehicle perception

C-ITS technology, combined with smart sensor systems is used to increase the collective perception of automated vehicles. (awareness of vulnerable road users, information about obstacles on the road). Multiple SHOW partners are collectively working on this topic, e.g. CERTH, Yunex, Swarco and Valeo.

C-ITS technology is expected to improve the capacity of its module for the perception of the environment by improving hardware and software performances. This is aligned with the goal to increase vehicles' safety, it is also a step further towards safe automated vehicles. SHOW will also be an opportunity to collect data on sites to improve the performance of algorithms for the perception of the vehicle's environment.

In SHOW, shuttles are enhanced with a detection module that will serve as an additional input for exterior perception and hence improve the robustness. E.g. Valeo is developing a perception algorithm of the modules together with the CEA. The ITS-G5 Road Side Unit as well as the awareAI smart camera system of Yunex Traffic are already commercial products available on the market.

By joining SHOW, partners can improve their bonds with the players of the industry and tighten them for later collaborations. In particular, SHOW has been an opportunity to demonstrate the increased performances of surround-view fisheye camera's sixth generation. By providing a diversity of use cases, SHOW will also improve the module's perception of various ODD and thus help to broaden partners portfolios of use cases for future clients. he ITS infrastructure is capable to support automated vehicles by monitoring hard-to-see locations from a different angel to improve the collective perception. The combination of C-ITS equipment and smart sensor systems enables the monitoring & information sharing of such specific locations. The goal of these infrastructure systems is to increase the collective perception of automated vehicles to ensure a high level of traffic safety to all kind of road users.

Beyond hardware and software, partners could also take advantage of the data the services hold. By partnering with the players that share the same vision and building appropriate synergies it could thus put forward its values and vision for greener, smarter and safer mobility.

4.3.2 SPY tool for social media analytics

The exploitation strategy and actions are based on the use of the know-how generated in this project to maintain and expand the visibility in machine learning and sentiment analysis. Additionally, partner are connecting first with local and then with the EU potential stakeholders, offering to provide their assets and services (big data management tools, services and processes) for use in their real-world applications in the transportation domain and beyond.

SHOW also aims to deliver and transfer knowledge regarding technological advancements to the academic partners and built new collaborations and partnerships in the research domain of Europe.

As far as IPR concerns, e.g. ITML's current IPR scheme supports that any knowledge and assets already developed by ITML and brought to the project belong to ITML for exploitation and commercialization purposes. For any further advancements of individual ITML's offerings within SHOW, ITML plans to keep the IPR of those assets and continue to exploit them.

Data analytics in the web landscape it is extremely important due to the fact that enormous amount of data is available across several social media platforms and are publicly available. In addition, these publicly available data is the main source to extract metadata and information which lead to meaningful insights for the stakeholders with relevant interest. The later, can be used for instance to report and inform about activities in the social media landscape but also to assist or improve the decision-making procedures that are linked to the web data analytics. The benefits from such a social media analytics complex process can be seen either on business-related aspects or not. Social media analytics can be used to measure the social media traffic (e.g. user analysis); to optimize and track the dissemination and exploitation activities, either in a R&D or B2B project; to identify the correct target audience, either in a R&D or B2B project; to reveal new creative ideas.

4.3.3 Driverless automated public transportation

A main discussion point with the PTOs during the phase of analysis is the challenge of operating automated public transport services economically. Already the state of art public transportation provided in every country is a huge cost factor for every city. Offering automated shuttles which are observed by a "driver" (safety operator) is a huge cost factor additionally to the established services. PTO's like Transdev and Bahnen der Stadt Monheim are working closely with the industry to fasten the technological development towards driverless automation, but also involve the whole ecosystem to enable new regulations.

The business case will be reached when operating an automated mobility service will be less expensive than operating traditional driven services. The economic case can only be reached if the operations are fully driverless (without on-board safety operator) and remotely supervised by one supervision operator for a fleet of automated shuttles. The main challenges are to demonstrates safety of fully driverless operations while increasing the performance (speed and availability) of the shuttles.

In order to safely deploy automated mobility services, PTOs will need to work closely with tech providers, certification bodies, and PTAs.

Among Tech providers, many SME's and start-ups can be involved in the process including not only the automated driving system providers and shuttle manufacturer but also providers of technologies required to insure smooth operation of a service without drivers (in cabin-monitoring, sensors providers, MaaS and ticketing solutions etc.)

Financing projects to deploy automated mobility services will require external incentives from local PTAs, national government and EU for the coming years as technologies are not yet mature and still expensive as production is not yet scaling up

Services will be promoted through projects deployment and advertisement about automated mobility benefits

4.4 Technical and business exploitation plans of SHOW test sites

This chapter reports on the technical and business exploitation plans of the SHOW mega and satellite sites and aggregates them to the site-specific overview, which will be analysed for optimization and application potentials (especially for the demo phase & follower sites) in D16.3. It is to note that Monheim has not officially joined to Consortium but already started to work and report within the SHOW project since January 2022, which is why they are included in this report. Any changes to the test sites made (e.g. “new”, “on-hold”) after April 2022 will be mentioned within D16.3 .

Table 71 – Exploitation plans of SHOW test sites

Test Site	Technical innovation developed and tested	Main result	Continuation of activities
Rouen	Project on hold at the moment – looking for replacement of i-cristal shuttles		
Vernon-Giverny	Fully driverless operation of 2 EZ10 shuttleS on private site in mixed traffic operated with remote supervision	Demonstrates the relevance of automated services and show the use case for public transportation as well as conducting the technical development towards a future economic case (driverless, without safety operator)	Technical: The technical goal is to develop and validate steps towards a driverless operation of automated vehicles (including, but not only shuttles) Business: Close contact to authorities and development in close partnership with the OEMs to meet the needs of PTOs Build and calculate an economic business case without the safety operator
Karlsruhe	The FZI-shuttles demonstrate an innovative public transport service that bridges the first and last mile using electrical, connected and automated shuttle buses. The innovative concept thereby is breaking free from formerly used fixed routes and fixed trajectories. The shuttles can dynamically determine new routes for on-demand services and furthermore blend into everyday traffic through bypassing obstacles while complying with safety	In previous projects, 68% of the trips started or ended at the tram, which underlines the use-case of the last mile. To increase the number of trips, the average velocity of the shuttles should be further increased. Also 72% of the passengers asked during a demonstration of previous projects and participants wished for a higher speed. Only a velocity of up to 20 km/h could be achieved. The	Technical: The technical goal is to increase the average speed of the shuttles. This is achieved by better planning algorithm which handles tight corners and difficult traffic situations better. Also, side-effect of the planning improvements is an increase in ride comfort. The increase in average speed poses challenges to perception and localization. Especially the localization is validated through SLAM and GPS. Business: Preparations for the cargo and passenger-transport are ongoing. Further improvements in the

Test Site	Technical innovation developed and tested	Main result	Continuation of activities
	regulations. Due to this fact, the number of interventions of the safety operator can be decreased to a minimum.	challenging parts were mostly narrow roads, where the shuttle reduced its velocity because of the safety-cell size and tight corners.	integrations of the passenger app into the automated driving stack are planned.
Monheim	Automated driving strategies for vehicle decision making , e.g. at roundabouts/ intersection. Further research for steps towards fully automated driving (driverless), automatic door opening. Low carbon mobility management and covid safe public transportation.	Demonstrates the relevance and feasibility of automated PT services and show the willingness to use for inhabitants. Development towards a future economic case (driverless, without safety operator), as there's a shortage on available bus drivers Application for sustainable driving behavior (low carbon mobility management).	Technical: The technical goal is to show the feasibility of operating a public transportation service in real road conditions with other vehicles and VRUs and test which steps are needed, so the car is able to make its own decisions and go fully driverless. Business: More and more the shortage on bus drivers is measured, the shortage is another market driver to aim for fully automated services. The driver is also one of the main cost factors. Being able to run a PT service without a safety operator would make the use case more sustainable and economic.
Carinthia	Operating automated shuttle in mixed traffic areas with high fraction on VRUs and on public road. Evaluation and public relations for the public acceptance.	Integration of automated shuttle in last mile transport, connecting the train station of Pörtschach with the city center and the lake with an automated shuttle service on mixed traffic and on public roads. Klagenfurt will connect the train and bus station of Klagenfurt West with the university of Klagenfurt, a science park, a work hub and residential area etc. with two automated shuttle. Conditions of mixed traffic, public roads and high traffic demand.	Technical: Operating an automated shuttle in a complex traffic situation including real-time communication with traffic lights etc. via C-ITS. Combining MaaS and LaaS in public transport. Developing and evaluating a covid-save and hygienic environment for public transport. Business: The business model is focused on first/last mile automated transport from/to mobility hubs, such as the train station, to reduce individual traffic, parking spaces and emissions in the business area. Another business model is based on providing MaaS and LaaS solutions based on automated vehicles and integrated in the existing mobility supply (transit network, **shared mobility services**, logistic hubs, etc.).

Test Site	Technical innovation developed and tested	Main result	Continuation of activities
Graz	Automated driving strategies for locations with a large number of pedestrians and integration into public transport.	Automated shuttle service between a public transport hub and a shopping center demonstrating the benefits of automated driving.	Technical: Feasibility of automated driving with own technology in a public urban area Business: Provide technical consulting and engineering services for automated vehicles and infrastructure for industry and communities
Salzburg	Retrofitting the electric vehicles for the operation under challenging road and weather conditions (e.g. heavy rain, bad road conditions).	Provision of an automated shuttle service serving as a First-/Last-Mile-transport option connecting a peri-urban area with the city of Salzburg via an intermodal mobility hub and a C-ITS enabled bus corridor.	Technical: Feasibility of automated transport service (First-/Last-mile) in a peri-urban area with a retrofitted, electrified passenger mini-van under challenging road and weather conditions. Business: Provision of organizational and technical consulting as well as engineering services for the deployment of automated vehicles to interested municipalities, public transport authorities or private organizations that require automated passenger services.
Linköping	In Linköping three buses/shuttles connect an urban living area with a school as well as an elderly living area (special needs) the whole week.	The development of the buses/shuttles basic public transportation has finished and the technical development to be done concerns the DRT applications, the route suggestions as well as the passenger suggestions.	Technical: Finalize the realization of the missing three use cases and demonstrate (demo phase) all use cases successfully. Business: Raise awareness for passengers, get feedback on passenger satisfaction and cooperate with the cities authorities to reach the awareness of the municipality and higher.
Gothenburg	Demonstrate automated shuttles on open road with mixed traffic.	High automated mode rate	Technical: Operation of automated shuttles in relation with 5G mobile connectivity. Gradually prepare for automated vehicle experimentation without safety driver on board.

Test Site	Technical innovation developed and tested	Main result	Continuation of activities
			Business: Provision of technical feasibility as well as deployment of automated vehicles in other interested cities. Cooperation with mobile network operators
Madrid	SAE L3-4 level of automation development and validation on three different vehicles (12m bus, minibus and passenger), i.e. integrating Tecnalia's decision-making algorithms as well as V2x cooperative manoeuvres, availing information exchange between the SAEL3-4 automated vehicles and the network.	SAE L3-4 level automation in mixed traffic under normal and complex urban traffic conditions.	Technical: Development of shuttles with SAE L4-5 level of automation driving in real urban road conditions as well as decision making algorithm. Business: EMT, as a public company, does not intend to develop any market product nor business out of the automation experience but to keep exploring the benefits of CCAM in terms of road safety and increase of efficiency of operations at the bus depots (automated functions of buses/shuttles). IRIZAR plans to continue working on developing ADAS functional packages to increase their product line and comply with the new regulations. INDRA – the CCAM services developed within the project (e.g. services to send traffic light information to connected vehicles) will be included at Indra's portfolio, with the objective of commercializing them with our potential clients: public administrators, private infrastructure operators, etc.
Tampere	The activities and innovations in Tampere will focus on the following novel functionalities that go beyond the state-of-the-art: ○ integration of automated feeder services to trunk line services ○ for the future (after SHOW) integration of the above mentioned integrated system in the city's traffic management system (de facto with the regional traffic management centre)	Through exploitation and business development activities Tampere plans to build an integrated transport and mobility service system in cooperation with public and private operators and service providers. In this system automated transport is planned to have an important role. Tampere aims at creating integrated seamless mobility services, where	Technical: • The City of Tampere is developing fast and has secured next to 10 billion € worth of investments for the next 10 years in multiple different projects, • Full integration into Tampere transport system • The condition of lane markings is normally good, but not so good in special conditions for instance in occasional winter conditions (snow, ice, ruts, etc.).

Test Site	Technical innovation developed and tested	Main result	Continuation of activities
	in order to optimise and prioritise the PT system service levels ○ integration of micro-mobility solutions to the feeder system and the whole traffic system (after SHOW) ○ combining automated passenger and logistics services (after SHOW) ○ measuring the sustainability indicators (emissions, reliability) of the integration and assessing the potential towards carbon-neutrality and enabling emission trading schemes (after SHOW) ○ assessing and measuring the impacts on citizens' mobility patterns, level of satisfaction and distributional effects on citizens' perceived well-being (during and after SHOW) ○ demonstrating sustainable people-public-private partnerships and highlighting critical societal success factors such as user acceptance, political consensus, ecosystem stability (during and after SHOW) ○ developing and demonstrating systems that will help to reach the carbon neutrality targets (during and after SHOW)	automated transport, both road and rail have a significant role and that support the objectives of Tampere. Tampere aims to support and promote the development work in Tampere Sustainable Urban Mobility Plan (SUMP) will be prepared and used.	• The City of Tampere has already identified sites/environments and mobility HUBs, where automated services can be developed and tested, for instance two hospital campus areas (Hatanpää Hospital and Tampere University Hospital campus) • The remote operation of the fleet • If specific roadside units (RSU) are needed these are subject to development and/or procurement. Business: • Tampere is planning and will carry out activities that are related to the development of the seamless and integrated urban transport system including new mobility services such as MaaS, shared automated & electric means, e-scooters, city bikes, etc, tram transport network, local train system, advanced bus transport system, high level public transport service, advanced micro mobility.
Brainport	The use of C-ITS services for crossing intersections at normal operational speed	Anticipating control with smooth speed adjustment for traffic events at intersection.	Technical: Integreation of automated transport services into TMCs, TM2.0 Business: Creating a portfolio of results to disseminate to industry partners for integration in their system or vehicles
Trikala	No reporting was done in this period		

Test Site	Technical innovation developed and tested	Main result	Continuation of activities
Turin	The use of a fleet of automated shuttles for on-demand transport of passengers in mixed traffic.	Transport service running in the hospital area, aimed at hospital patients and employees, and any other passengers above the age of 18.	Technical: Development an infrastructure ready for potential AV experiments in the future, test logistic use cases Business: During the project a network of partners can be developed, know-how generated (e.g. in terms of administrative procedure) to be able to sell and license results
Brno	Teleoperation solution enabling remote driving and assistance of automated vehicles over short and long distance.	Teleoperation system.	Technical: Adding new functionalities based on user feedback received throughout deployment of the solution. Business: Utilizing existing partner network and establishing new partnership with partners from automotive and transportation industries.

4.5 Business and exploitation plan for stakeholder groups

The following chapter analyses the stakeholder ecosystem and market within the SHOW project. Based off the answers of the exploitation questionnaire, the stakeholder groups present in the Consortium and the stakeholder groups addressed by the Consortium can be identified.

To evaluate the business behind the operation of automated vehicles for the different stakeholders, a mapping of the ecosystem and interrelations are shown. This chapter gives an outlook to the main business enablers and disruptors and shows future possibilities for further exploitation of the SHOW results.

4.5.1 Stakeholder target groups

Using the defined M3ICA stakeholder groups and the answers of the exploitation questionnaire the following stakeholders relevant for the ecosystem are identified within the SHOW consortium:

- Authorities, Public Transport Authorities, Cities, Municipalities
- University and Research Institutes, RTO (Research Technology Operator)
- ICT providers
- Tier 1 Suppliers / Technology providers
- ITS Infrastructure provider
- Mobility Service provider
- Operator (Public Transport Operator & Mobility operator)
- Associations
- OEM, Automated vehicles manufacturers,
- Civil society organisation, Federal agency
- Consultancies

Based on the different organizations represented by the above listed stakeholder groups, the following stakeholders are targeted for the results of the SHOW project:

- PTO's: Public and private mobility operators
- End-Users: Inhabitants, passengers of all demographics
- SME's: Mostly OEMs of automated vehicles, as well as the service industry
- Ministries: Very important to be involved and consulted as the ministries will decide on regulations for the uptake of automated vehicles
- Software providers: Stakeholders from the technological domains of Big Data; Data Analytics; Web Analytics; Open Source Intelligence, and applications that address data discovery and visualization in the web (not exclusively), advanced data analytics and others (e.g. data preparation)
- OEMs: OEMs are an important target group of the project as multiple services are tested, which will be important for further development of the vehicle

4.5.2 Recommendations on an action plan

The exploitation strategy and actions are based on the use of the know-how generated in this project to maintain and expand the visibility. The superior project result will be to test and validate further technical advancement in cooperation with raising the awareness of the importance of business cases for the partners. Once the technology reaches a readiness threshold, the partners need to have an action plan ready with the knowledge of a business case for their specific technology. E.g. a partner stated that they are in the process of analysing the potential revenue streams to validate the

Return of Investment (RoI) plans. A starting point for this would be the final year of the project. They anticipate that the company revenue would be based on a mix of licensing fees and consulting services. This awareness needs to be raised and validated for at least the majority of partners.

An important action for the specific A16.3 partners, who will further exploit the project and finalize the exploitation is, is to apply for the next Horizon Result Booster service, which teaches about the development of business cases and the go-to-market phase. This application will be realized in cooperation with the project management and A16.3.

The following possible follower projects have been named by the partners. In general 83% of the partners answered that they are interested in further research and funding possibilities.

- SAM project (France)
- IN2CCAM (EU)
- Safestream (German)

Multiple partners stated the interest in the funding from Horizon Europe.

Most relevant for these partners could be the Horizon Europe (2021-2027) framework. Most relevant would be a call from clusters CL4 (Digital, Industry and Space) and CL5 (Climate, Energy and Mobility).

The following barriers for the project runtime were identified and need to be overcome in the remaining project time:

- Limited data provided by OEMs and huge delays in procurements due to COVID
- Missing harmonized regulation framework / permits differentiate per vehicle type
- Significant infrastructure developments and personnel costs for pilot operations

The following Table 72 shows the identified market enablers and disruptors.

Table 72 - Market enablers and disruptors

	Enabler	Disruptors
Market	• The service must be better with same cost or same service with lower costs.	• Financing, how to find a way to production use. Prices, quality of service and financing.
	• Better availability of material	
Technology	• The key technical components (hardware and software)	
	• Meaningful real-world use cases for further trialing.	• Further development and validation is needed
	• Enhanced detection capacity and environment perception	
Costs	• Another important enabler is the availability of capital for covering mostly personnel costs for further development until market readiness	
	• Pre conditions are the legislative framework and reaching the expecting safety levels for some automated driving functions	• Facing a lot of technical challenges due to the complexity of automated driving.

	Enabler	Disruptors
	• Strong engagement to technological advancements	• Some technical challenges with the general traffic environment and some lack of data needed.
Environment	• Prior knowledge and experienced as regard technical and operational aspects gained from several ITS projects.	• Data sharing from shuttle providers needs negotiations and consumes resources.
	• Consultancy synergy with the Ministries of Transport for advancing the regulation framework	
Regulatory/ Administrative	• Further allowance for testing (and driving) automated vehicles under real road conditions	
	• Political support from authorities.	
Data	• Availability of (public or other) data for opinion mining and sentiment analysis	

5 Discussion on new business plans

During the number of analyses which have been done up to this point in the project and mainly during the development of the business models which was conducted in WP2, it became clear that even beyond the SHOW use cases and addressed driving modes/ scenarios, partners had needs and interests, which are very new developments or slightly out of scope of the project. This chapter, continuing the work that has started in D2.2, analyses "new" business models and develops very basic business plans, based on the market drivers and the needs of the Consortium partners.

5.1 Driverless automation and tele-operated driving

Multiple partners stated that the upper goal in automated mobility is to be finally able to operate AVs without a safety driver onboard. First of all, the safety driver is a huge cost factor, which makes the business plan almost impossible to generate profit. Even more so, compared to a traditional bus, where one driver can transport on average 50 to 100 people with ease. With automated shuttles a PTO needs one driver per eight passengers. In numbers, that would mean, in order to transport as many people with automated shuttle, PTOs would need approximately 7 times more driver than before. Nevertheless, this scenario cannot be translated in a 1:1 ratio, as automated shuttles will, in the beginning years, mainly be used for feeder services of not as busy (and shorter) routes.

But what cannot be overlooked is the counter product market trend of driver shortage. Less and less people are likely to become bus drivers and stay in business less long. This drives PTOs to be able to operate their services without drivers.

These factors result in the partners saying that the way to full automation is the only economic business case for PTO's that offer classical public transportation.

Before we can reach full automation, next to the legal restrictions, also the technical development has to be a success for remote supervision, but also teleoperated driving, as teleoperated driving needs to get advanced a lot in order to fully remotely operate AVs at a satisfactory speed and quality of service, allowing at the same time to preserve passengers (and other road users) safety and security.

Technology advancements include, but are not restricted to, improved perception (detection of obstacles via sensors including cameras which have to be used with very short runtimes and latencies to fulfill an automated driving scenario), seamless robust telecommunication, etc..

Especially collision warning is one use case which many companies showcased during the ITS world congress 2021 in live demonstrations. Collision warning relies heavily on the 5G network, in order to function together with complex sensors for driverless automated driving.

It can be said that setting up 5G to enable collision warning will sum-up an investment alone between three to five million euros, plus co-financing for the early stages of development.

It can also be said that besides technical cost elements and project costs, the software components and technology to implement tele operated driving scenarios is about to be ready to be put in operation.

A fully operational teleoperated driving center has additional costs for the operation center as well as to the technology which is state of the art in such operation centers

and this also includes telecommunication and AV costs ; required to have a fully automated driverless bus in operation.

5.1.1 Additional cost modules for teleoperated driving

- Cost 1: 5G-Network, MEC, cellular V2X
- Cost 2: 4K-Video cameras safety video streams sent to tele-operation center
- Cost 3: Plan-Build tele-operation
- Cost 4: Run tele-operation

5.1.2 Additional revenues, benefits, and potential savings for teleoperated driving

- Revenue 1: Salary savings per employee (~100k€)
- Revenue 2: Additional digital advertisement per year (~50 k€)
- Revenue 3: Carbon credits and environmental ticket sponsoring (50%)

5.1.3 Exploitation path

Action to sustain	Technical activities/ product development	Promotional activities	Continuation through other activities
Short term (Until the end of the project)	Usage of 5G technology for obstacle detection	I.T.S. conferences (EU, World-Wide)	SHOW, 5G-Loginnov
Medium term (2-3 years after the project)	AI / ML initiative and feasibility	CCAM program (DG Move, DG Connect)	5G/6G I.T.S. programs and projects
Long term (Strategies towards 2030)	5G/6G Internet of Senses, 4k Video, Teleoperation	5G Roll-Out, 6G	6G-IA program, roll-out MNO

5.2 Improved infrastructure for urban use cases

As stated in D2.2 an important development for automated vehicles which cannot be overlooked is the connection and communication with infrastructure which is expected to significantly raise the comfort of travel, speed and safety.

Demonstrated on the SHOW use case of robo taxis, which is very advanced, this chapter shows how different software services like automated valet parking and platooning can be used to realize the use case.

The idea would be to make rental cars/ robo-taxis available to visitors (and inhabitants) of the city. Within the city center multiple car sharing/ taxi stations are available for the vehicles, where they can be maintained and loaded. The service itself is free floating. Passengers are able to book and locate a vehicle of their choosing over the application and drive their trip. Once finished, the vehicle can be left at any official parking space.

If needed, an operator with a lead vehicle is able to collect all other vehicles around the city area applying the platooning concept. The lead vehicle approaches the parked cars, enables the automated valet parking, while the robo taxi will get in line behind the lead vehicle. It can now be brought to a loading station, where it parks itself. In the end, the operator will only have to connect the car with the loading station.

The connection to urban infrastructure e.g. traffic lights is important for this use case and can be strengthened with a latitude of other RSUs, e.g. cameras, connection to smart devices., other vehicles.

This use case has for example been successfully tested in the City of Versailles, France.

5.2.1 Additional cost modules for platooning

- Cost 1: 5G-Network, platform, cellular V2X
- Cost 2: 4K-Video cameras safety video streams sent to Operation Center
- Cost 3: Plan-Build-Run costs

5.2.2 Additional revenues, benefits, and potential savings for platooning

- Revenue 1: Salary savings per employee (~100k€)
- Revenue 2: Additional digital advertisement per year (~200 k€ per event)
- Revenue 3: Carbon credits and sustainability brand awareness (50%)

5.2.3 Exploitation path

Action to sustain	Technical activities/ product development	Promotional activities	Continuation through other activities
Short term (Until the end of the project)	Usage of 5G technology for obstacle detection, Electronic and Automated Valet Parking (EAVP) deployment in close cooperation with Continental	I.T.S. conferences (EU, World-Wide), EAVP promotional campaigns	SHOW, 5G-Loginnov, partnership with Test track for Automated Driving
Medium term (2-3 years after the project)	AI / ML initiative and feasibility	CCAM program (DG Move, DG Connect)	5G/6G I.T.S. programs and projects

Action to sustain	Technical activities/ product development	Promotional activities	Continuation through other activities
Long term (Strategies towards 2030)	5G/6G Internet of Senses, 4k Video, Teleoperation	5G Roll-Out, 6G	6G-IA program, roll-out MNO

5.3 Public transportation during large scale events

Large scale events such as expositions, Olympics or festivals taking place in dedicated environments for multiple weeks with a number of participants have the need for extended fleet management and telecommunication services.

The business model resembles the DRT service described in chapter 4.1.2, nevertheless public transportation for large scale events needs to be addressed in a separate manner.

Large scale events are an important booster and gate to publicity for new innovations and technologies, e.g. the first TV and phone were also presented on expositions. Therefore it is pointed out that:

- No large scale event up to date had the support of an OEM with a fully automated fleet
- This business model doesn't focus on economy day to day operation rather than a sponsoring deal and the market entry phase

The expo in Shanghai in 2010 included not only the huge investment of the expedition area but also additional infrastructure needs for phone and internet equipment, as well as vehicles operated by a sponsor OEM.

In a similarly complex organizational environment, sports events are held on a recurring basis and attract large crowds of spectators. These include, for example, the finals of the European football leagues, which take place at different international locations, as well as famous car races, e.g. "Le Mans" in France with a duration of 1 week. (24-hour races).

All of these events have in common that they can be planned and estimated in terms of effort, but the number of spectators can only be estimated cautiously, especially venues of supra-regional importance without full integration of local public transport require enormous logistical effort.

The movement of visitors from the camps, parking areas, team spaces and other points of interest are often walks up to 15 minutes. Connecting the different points of interests with shuttle stations gratefully enhances the satisfaction and comfort of the visitor. The use of automated and electrically operated transport options is inevitable for the future, as seen on many ITS congresses in the past.

The service enables transport from one end to the other at high frequency on exclusive paths outside the main trails. The small vehicles are flexible and, thanks to their quiet electric drive, could also drive through residential areas and thus reduce the considerable traffic and noise pollution. All actors involved can thus make a significant contribution to traffic calming and dispersal, thereby relieving everyone involved.

5.3.1 Additional cost modules for large-scale events

- Cost 1: 5G-Network, platform, cellular V2X
- Cost 2: 4K-Video cameras safety video streams sent to Automated Fleet Operation Center for Large Scale Event Managers

- Cost 3: Plan-Build-Run Automated Fleet Operation Center for Large Scale Event Managers

5.3.2 Additional revenues, benefits, and potential savings for large-scale events

- Revenue 1: Salary savings per employee (~100k€)
- Revenue 2: Digital Advertisement and OEM Co-Branding, e.g. Volkswagen Group for the Olympic Games 2008 in Beijing (China), revenues for visitor per logo partnership (~up to million€)
- Revenue 3: Carbon credits and sustainability brand awareness

6 Conclusion

This deliverable provides the work conducted within Activity 16.2 “Economic and business impact assessment“ as well as parts of Activity 16.3 “Exploitation plans per partner and stakeholder group” as described in the grant agreement of SHOW. The first business impact assessment results by the TCO, CBA and CEA as well as partner surveys and key expert interviews were used to analyze the project and its test sites, partners, ecosystem, use cases and scenarios to build:

a. Business plans based on the developed WP2 business models, feedback to costs and possible savings/ revenues from the pilots,
b. Exploitation plans based on the technical development of the test sites, ecosystem of stakeholders and partners as well as enablers and disruptors which are important for the future uptake of the developed and tested results.

Summarizing the TCO, CBA and CEA considerations, the first results show that the number of observed and therefore available customers is not high enough and needs to be significantly raised. Also, the small size of the shuttles as well as the availability of them is a challenge. During the calculation of the basic scenarios it was seen that multiple million euros could not be activated. No matter if public transportation services generate a positive result or a profit, cost savings and additional revenues are important for the operators to limit down the costs. Only with additional services the entirety of the ecosystem can generate profit. Working on end to end mobility solutions with a variety of partners is crucial for the uptake of future mobility services.

Based on the first results the following certain potentials which can be used to increase the revenues and reduce OpEx costs were identified:

- The work in the exploitation task confirmed that the input of the local stakeholders is equally crucial to the weight of the technical development. Next to raising the robustness of the service, as well as the speed of the vehicles, the regulations need to make demonstrations and testing as well as operation easier and less costly in terms of operation.
- Mobility-as-a-service as well as Logistics-as-a-service value chains and their business environment are complex; so their optimization is a challenge. First and foremost more players need to come forward with investment and market representation, for early adopters to make their move. An example identified and analyzed thoroughly since benchmarks in D2.1, but also for the basic TCO/ CBA scenario, is the current business model of a MaaS-platform provider.
- SMEs are participating in the value chains and offer a great potential to optimize the service and cost/benefit structure, as they are represented in a variety of stakeholder groups (e.g. OEMs, software and service operators).
- It is very important to know as much as possible about the customers to integrate, update and present the right interfaces (HMI) to activate the full customer potential as well as to update the technology (mainly the vehicles) in operation. Additional services will only raise the availability, the comfort and optimize the costs of the automated driving solutions.

Based on assessment results and together with all SHOW partners the exploitation plans were developed. At the beginning of the SHOW project, partners had to state their expected exploitation interest which led to a preliminary list of key exploitable results with 18 entrances. This initial list has been updated, now stating 46 key exploitable results using the methodology of the European Horizon Booster. The results have been further evaluated in this deliverable with an expected final update in D16.3, with the final list of key exploitable results.

In addition, D16.2 developed in total eight business plans deriving from the business models of D2.2. Five of these scenarios are directly linked SHOW results based on the mobility scenarios exploited within the project. Additional three business plans are upscaled for further and more novel applications of automated public transportation.

SHOW offers a wide portfolio of business and exploitation opportunities covering the mobility ecosystem with e.g., technology providers, technology operators, public transport operators, cities and city authorities, road operators and research organizations.

The assessment of results in D16.2 represents the current status of the project and test sites until June 2022. This deliverable lays the foundation for further analysis in the project runtime and after. The work continues within A16.3 and will be reported in D16.3 “Final business and exploitation plans”. The preliminary results, meaning the data collection and calculations will be validated with the project partners and test sites, to be able to build full business cases. The business case will report all four factors. The realizable time frame of a business model, the costs of operating the business model, the potential savings/ revenues with this business model, as well as the risks going to market.

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Annex I Tool Development and Data Collection

Methodology and approach

Basic boundary conditions

The following paragraphs describes the relevant boundary conditions for the three main activities within A16.2 (tool development, data collection and assessment) for the business and economic exploitation plans.

Basic boundary conditions for TCO and CBA

Our approach requires the following basic **boundary conditions**:

- Time plan (please refer to chapter “Time plan” for more details)
- Availability of data
- Completeness of collected data

Basic boundary conditions for CEA

The basic boundary conditions for the CEA can be summarized as follows:

- Time plan (please refer to chapter “Time plan” for more details)
- Availability of data
- Completeness of collected data

Basic boundary conditions for data collection

The basic boundary conditions for the data collection can be summarized as follows:

- Time plan (please refer to chapter “Time plan” for more details)
- Completeness of collected data

Basic boundary conditions for the assessment

See chapter 3.1.

Methodology

The following chapters describe the specific methodologies used for the assessment, impact analysis and build-up of business and exploitation plans.

TCO

Total Cost of Ownership (TCO) is an accounting method designed to help consumers and businesses estimate all the costs incurred by capital goods (such as software and hardware in IT). The idea is to obtain a statement that includes not only the acquisition costs, but all aspects of the subsequent use (energy costs, repair and maintenance) of the components in question. Thus, known cost drivers or even hidden costs can possibly be identified in advance of an investment decision. The most important basis for further understanding of TCO is the distinction between direct and indirect costs.

For SHOW and the target groups, the relevant modules have to be developed by using the results of D2.1.

CBA

Cost-benefit analysis (also benefit-cost analysis) is an umbrella term for various analyses that compare benefits and costs. Cost-benefit analyses are used in numerous areas of public services to support decision-making. Cost-benefit analysis in a very broad sense is a class of procedures to evaluate, compare and make decisions based on their consequences from the point of view of an analyzing planner, who may also be a governmental body.

For SHOW and the target groups, the relevant modules have to be developed by using the results of D2.1.

CEA

The aim of cost-effectiveness analysis is to compare the efficiency of a technology, a service, or a policy to different alternatives [7]. For this purpose, two elements are needed: the total cost of each alternative and the outcome on which the alternatives can be compared. These two elements are then computed as a ratio. The most cost-effective alternative is the one that brings one unit of this (positive) outcome at the least possible cost. For SHOW, these outcomes are measured through the KPIs developed in WP13 and they are compared to the costs collected for the TCO. As with TCO and CBA, the CEA is developed with Microsoft Excel tool.

Impact – Methodology

The methodology to analyze the impact is a comparison between the baseline and the final results created by the application of the TCO, CBA and CEA to the collected data.

Tool development

The following sub-chapters describe the relevant basics about the tools development (TCO, CBA and CEA) used for the assessment. Every tool is described in an own sub-chapter, which contains an overview about tool approach and is detailed in the following chapters.

TCO and CBA tool development – The Modul Construction Kit (MCK)

See chapter 2.2.

CEA tool approach

As with TCO and CBA, the CEA is developed with Microsoft Excel tool. Two types of inputs are necessary. On one side the costs, which come from the TCO and on the other side the KPI's which are collected mainly by WP13. The integration of both will lead to the cost-effectiveness ratios.

In this deliverable, the analysis is computed for the person transport and the freight transport scenarios. In a later stage, it is computed for test sites to allow for the comparison of how these different implementations led to different outcomes.

In a first stage, KPI's were selected from WP13 to represent the outcomes of person transport, on one side, and freight transport, on the other side. Then, estimates were given to these KPI's. Finally, the cost-effectiveness ratios were computed for each cost and each KPI.

The outcomes have different units, and therefore the KPI's are transformed such that the lower the ratio, the more cost-effective the service is for this specific outcome. Since the KPI's values are not yet available, results presented in this deliverable are

based on the assumed KPI's. These are computed based on the grant agreement targets value or are new assumed for the KPI's that were developed within WP13.

Data collection approach

In general the data collection is divided in two phases linked to two demo phases and finalized by the deliverables (D16.2 and D16.3) within SHOW. The first phase collects the data of the "pre-demo"-phase and focus on data representing the existing business and ecosystems and laying the base for the assessment and the improvements initiated by the project.

The second and last iteration collects the business and economic data including the progress initiated by the deployment results of SHOW.

Assessment approach

According to the tool development and data collection, the assessment is also organized in two phases and reports the results in the deliverables D16.2 and D16.3 respectively.

The first assessment shows the business and economic baseline of the "existing" mobility systems and services and gives feedback regarding the improvement of the data collection and the tools. Furthermore, it lays the base for the A17.1 as starting point for the development of the business guidelines.

The second assessment provides the final results for the business and economic impact by comparing the baseline (data collection and assessment of the first phase) and the results (data collection and assessment of the second phase) initiated by the development results of SHOW.

Time plan

The following paragraphs give an overview about the time plans for the A16.2, the tool development, the data collection and the (impact) assessment.

Overall time plan including assessment

In Table 73 the overall time plan can be seen. It starts with the first draft of the methodology document in M15 and ends with the final assessment report in M48.

Table 73 - A16.2 Time plan

Date	Project Month	Activity
31-March-2021	M15	First draft of the Methodology for TCO, CBA, CEA
31-May-2021	M17	Next version Methodology for TCO, CBA and CEA
01-May-2021	M17	Start of data collection for the tool development and baseline assessment
31-December-2021	M24	First version of TCO, CBA and CEA tool
31-March-2022	M27	Data collection end and first results for D16.2
30-June-2022	M29	First report on business and exploitation plans (D16.2)
30-July-2022	M31	Data collection start
31-January-2023	M37	Final version of TCO, CBA and CEA tool
31-October-2023	M46	Data collection end and end results for D16.3
31-December-2023	M48	Final report on business and exploitation plans (D16.3)

For a better overview about the timing and working periods the following figure gives the relevant Gantt charts for the planning including the two phases for development, data collection and assessment:

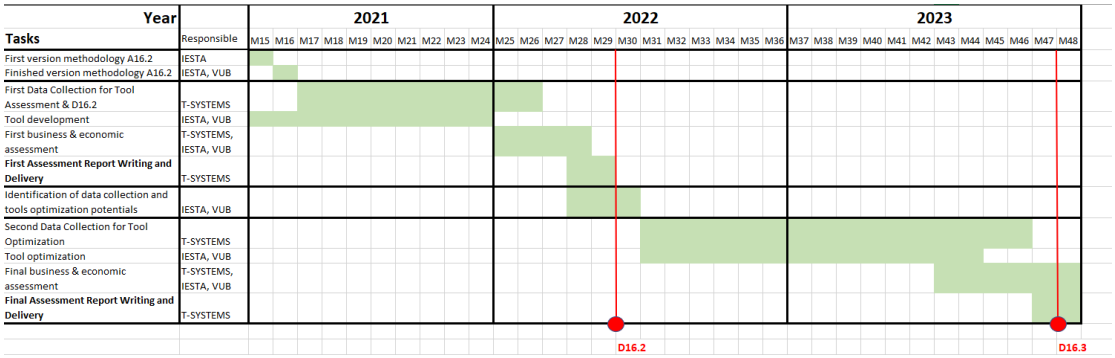

Figure 12: Overall Gantt plan for A16.2

As mentioned before, the approach is organized in two phases focused on the delivery of the reports for D16.2 and D16.3 (red lines). It also includes an optimization for the data collection and the tool optimization (between M28 and M30), so improvements of the tool and the data collection are considered for the final data collection starting with M31. Please note that the assessment of the data as well as the tool development is fully included in the overall time plan, executed in optimization (M28-M30) as well as in the period of M46 to M48 and not considered separately.

On the basis of this overall time plan the following sub plans for the tool development and the data collection were developed.

Tool development

The following figure show the Gantt-plan for the tool development:

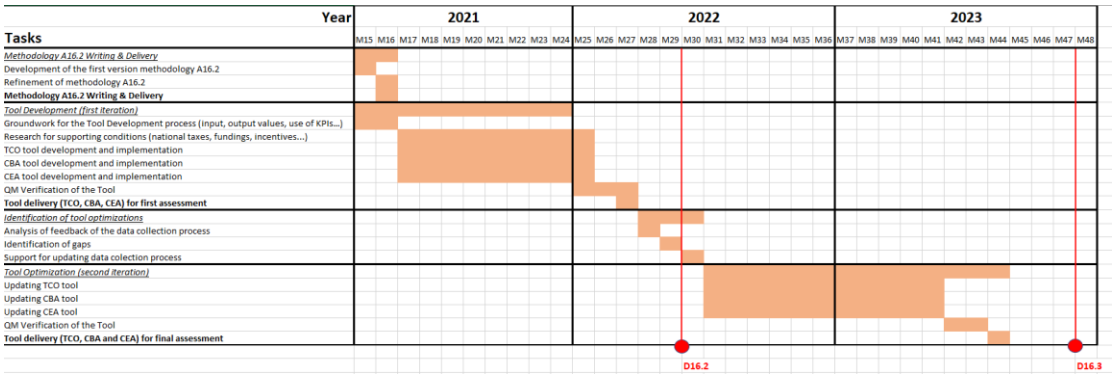

Figure 13: Gantt plan for the tool development in A16.2

The tool development has started with the definition of the relevant input and output data (interfaces) until M16 including several meetings with relevant other WPs like WP2, WP9 and WP13 to create a stable data structure for the tool development as well as for data collection. After this, the tool development itself is executed including some desktop researches regarding national funding schemes or taxes. Finally, the development phase ends with a quality assurance of the tool using the collected data from phase 1, so it can be used for the first assessment. The second phase will follow the same approach using the information of the optimization phase for the

developments as well as considering changes initiated by the SHOW deployment/pilot results of SP2 and SP3, finished by a quality assurance of the tools, so they are ready for the final assessment.

Data collection

The following figure shows the Gantt-plan for the tool development:

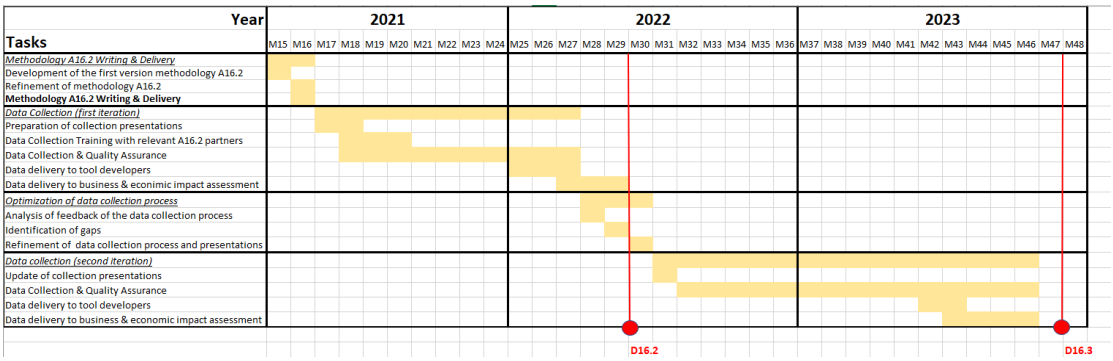

Figure 14: Gantt plan for the data collection in A16.2

The data collection started with the definition of the data to be collected together with the tool developers using the input of SHOW WP2, WP9 and WP13, followed the data collection phase starting with M16 until M27, which is managed by the data collection administrator T-SYSTEMS. The collected data is used for the assessment and the lessons learned during the first data collection is analysed and used to update the data collection templates and as feedback for the tool developers. After this optimization, the second data collection will start in M32, also managed by the data collection administrator T-SYSTEMS and executed with the partner of A16.2. This data collection will be finished in M46.

Roles within the business and exploitation plans including impact assessment

For the business and exploitation plans including the impact assessment within SHOW the following roles are necessary to fulfil the required tasks:

- A16.2 Activity Leader / Overall Leader
- Tool developer & Impact Assessor
- Data Collection Administrator
- Data Collector
- Business and exploitation plan creator

A16.2 Activity leader / Overall Leader

The activity leader (IESTA) is responsible for all activities to assess business and economic impact within SHOW.

This includes the following tasks:

- Tool development for TCO, CBA and CEA
- Data collection
- Resource planning of the partners (personnel)
- Time planning for development, collection and assessment

- Risk management (synchronization, tool interfaces) for the main activities development, data collection and assessment of the collected data for the target groups

Data Collector

This role will collect the relevant data including the communication with the relevant information source (SHOW partner or external stakeholder). The responsibilities for this role are defined as follows:

- Creation of presentations and communication tools derived from the basic input sheet of the tool developer, adapted to the specific partner and its role in SHOW and the mobility value chain or business model
- Executing the data collection by organizing meetings, communication and answering questions of the “data source” within the defined time plan
- Communication with the data collection administrator regarding content, timing and possible questions and clarification on regularly base

To sum up the task, the data collector is the operative partner collecting the data for both phases.

Tool developer & Impact Assessor

The tool developers (IESTA, VUB) will provide the relevant tools for TCO, CBA (MCK) and CEA and will assess the project results regarding the business and economic impact by comparing the data of both phases and analyses regarding costs, revenues and KPIs. Both roles together include:

- Development of the tools for TCO, CBA and CEA including quality assessment and improvements
- Providing the input sheets/data for the data collector
- Proving basic presentations for the data collector
- Support the training of the data collector
- Provide answers to the questions of the data collectors
- Execution of impact assessment
- Support of the business and exploitation plan developer

To sum up, the tool development as well as the (impact) assessment is the focus of this role.

Data Collection Administrator

Due to the sheer amount of data that is necessary for the TCO, CBA and CEA calculation, it was decided to determine a WP16 project partner - the tool development partners IESTA and VUB are exempted – with enough PMs to act as Data Collection Administrator. T-SYSTEMS agreed to take on this role and its tasks.

The task of the Data Collection Administrator are the following:

- Organization of the data collection process (two phases) by
    - identifying A16.2 partner for the collection of data of the mobility services within SHOW
    - if necessary execution of meetings for single partner to make them familiar with the excel tables for data collection
- Supervision of the collection activities according to the time plan
- Support for the partners during their data collection activities including trainings if necessary

- Be the first contact point (collector and filter) for the questions of the data collecting partners and establishing communication with the tool developers
- Completeness check of collected data and transfer to tool developers (and evaluators)
- Communication with the tool developer / assessor for questions of the data collector

To sum up the role the administrator is responsible for the organization of the data collection and serves as central communication interface between data collector and tool developer.

Business and exploitation plan developer

This role focuses on the development of business and exploitation plans for the target groups of SHOW. The responsibilities for this role are defined as follows:

- Collect relevant business ecosystem data and trends (e.g. from D16.1, expert interviews and desktop research)
- Development of "bankable" business and exploitation plans for the SHOW beneficiaries as well as the external stakeholder groups (defined by D2.1 and D2.2) using the results of A16.2, D16.1 and D2.3 – D2.5.

Data collection

The complexity of the analysed mobility services, the corresponding business models and value chains leads to an intense and detailed impact assessment (methodology), especially to cover the relevant aspects for identifying entry points for SME/new market entrants. Because of the complexity, confidentiality and inter-dependencies, the analyses are quite extensive and therefore will need a lot and detailed input data, that has to be collected from the Data Collection Administrator between M17 and M46.

In this chapter the data collection considering the kind of data, which is collected as well as the collection process containing the single process steps and a risk analysis are described.

Relevant business and economic assessment data

This chapter gives an overview about defined data categories, which influences the data collection and the relevant business and economic data, which have to be collected.

Data to be collected

The following section gives an overview about the data, which is necessary for different assessments (TCO, CBA and CEA) and which is collected. Since a lot of partners and target groups are included in the collection and to maximize synergy between WP16 and WP2, synchronization of the data collection has been done. So, the following sub-chapters represent the relevant input data for the different tools of WP16 and where possible for WP2 to reduce amount for the collection, reduce its complexity and increase the easiness to handle.

TCO-related input data

For the TCO the following data tables represent the essential data, which must be collected via the defined data collection process (see chapter 7.5) to ensure an optimal and reliable assessment:

- General Input

- Module Leasing
- Module Personnel
- Module Maintenance
- Module Insurance
- Module Depreciation
- Module Marketing
- Module IT
- Module Material (Only SAMS(F))
- Module Supplies
- Module Billing
- Module CapEx
- Additional Information
- End users/Customers

General Input for vehicles

The general input for vehicles focuses on the holding period per vehicle (category) and the mileage. Here is the table (Table 74) for cars:

Table 74 - General input for TCO – Cars data

Category	Value	Unit
Holding period		months
Mileage mild-Hybrid gasoline vehicles		km/year
Mileage mild-Hybrid diesel vehicles		km/year
Mileage Hybrid (HEV) gasoline vehicles		km/year
Mileage Hybrid (HEV) diesel vehicles		km/year
Mileage plug-in-Hybrid gasoline vehicles		km/year
Mileage plug-in-Hybrid diesel vehicles		km/year
Mileage Electric vehicles		km/year
Mileage Fuel cell vehicles		km/year
Mileage CNG/LPG vehicles		km/year

Here the table (Table 75) for the shuttles or buses:

Table 75 - General input for TCO – Buses/Shuttles

Category	Value	Unit
Holding period		months
Mileage mild-Hybrid gasoline vehicles		km/year
Mileage mild-Hybrid diesel vehicles		km/year
Mileage Hybrid (HEV) gasoline vehicles		km/year
Mileage Hybrid (HEV) diesel vehicles		km/year
Mileage plug-in-Hybrid gasoline vehicles		km/year
Mileage plug-in-Hybrid diesel vehicles		km/year
Mileage Electric vehicles		km/year
Mileage Fuel cell vehicles		km/year
Mileage CNG/LPG vehicles		km/year

Module Leasing

This following table (Table 76) collects all rent costs regarding the different infrastructure assets that could be used by the mobility service. Please give the average costs over all listed infrastructure categories (per line):

Table 76 - Input for TCO – Leasing related data

Category	Value	Unit
Leasing charging stations		€/month
Leasing car garages		€/month
Leasing bus garages		€/month
Leasing public stations (station-based Car Sharing or PT stations)		€/month
Leasing public parking spaces		€/month
Leasing business owned service/repair workshop		€/month
Leasing warehouses (SAMS(F))		€/month
Leasing train depots		€/month
Leasing train tracks		€/month
Leasing bike/scooter depots		€/month
Leasing other buildings		€/month
Leasing grounds		€/month
Other leasing		€/month
Total module costs		€/month

Module Personnel

This table (Table 77) lists all personnel costs necessary for the operation of the shared automated mobility service. Please give an average value per personnel cost category (per line):

Table 77 - Input for TCO – Personnel related data

Category	Value	Unit
Vehicle driver/Vehicle Safety Observer salary		€/month
Customer service Personnel salary		€/month
IT Personnel salary		€/month
Vehicle workshop Personnel salary		€/month
Delivery Personnel salary		€/month
Marketing Personnel salary		€/month
Infrastructure maintenance Personnel salary		€/month
Security Personnel salary		€/month
Re-Parking Personnel salary		€/month
Vehicle fleet Personnel (station and vehicle care) salary		€/month
Service team Personnel (Small repairs/maintenance of vehicles) salary		€/month
Damage Management Personnel salary		€/month
Training costs		€/month
Other personnel costs (salary)		€/month
Total module costs		€/month

Module Maintenance

This table (Table 78) lists the maintenance costs of the different infrastructure/system of the shared automated mobility service. Please give an average value per maintenance cost category (per line):

Table 78 - Input for TCO – Maintenance related data

Category	Value	Unit
Maintenance charging stations		€/month
Maintenance gas stations		€/month
Maintenance public stations (Station-bases Car Sharing and PT stations)		€/month
Maintenance applications, booking platforms		€/month
Maintenance hardware (e.g. Ticket machines for PT, additional hardware for cars)		€/month
Maintenance software (e.g. in vehicles)		€/month
Maintenance communication mesures (e.g. Websites, Social media, etc.)		€/month
Maintenance service owned infrastructure		€/month
Maintenance distribution system (SAMS(F))		€/month
Maintenance vehicles		€/month
Other maintenance costs		€/month
Total module costs		€/month

Module Insurance

This table (Table 79) lists all insurance costs that could be necessary for the operation of the shared automated mobility service. Please give an average value per insurance cost category (per line):

Table 79 - Input for TCO – Insurance related data

Category	Value	Unit
Charging stations (liability) insurance		€/month
Gas station insurance		€/month
Public stations insurance		€/month
Accident insurance		€/month
Personnel insurance		€/month
Theft Insurance		€/month
Non-life insurance (Liability insurance)		€/month
Mobility Insurance		€/month
Legal expenses insurance		€/month
Passenger transport insurance (PT)		€/month
Insurance other infrastructure		€/month
Vehicles insurance		€/month
Other insurance costs		€/month
Total module costs		€/month

Module Depreciation

This table (Table 80) lists all depreciation costs of the different infrastructure/systems of the shared automated mobility service. Please give an average value per depreciation cost category (per line):

Table 80 - Input for TCO – Depreciation related data

Category	Value	Unit
Depreciation charging stations		€/month
Depreciation gas stations		€/month
Depreciation public stations		€/month
Depreciation applications/booking platform software		€/month
Depreciation hardware		€/month
Depreciation software (e.g. in vehicles)		€/month
Depreciation distribution system (SAMS(F))		€/month
Depreciation vehicles*		€/month
Other depreciation costs		€/month
Total module costs		€/month

Module Marketing

This table (Table 81) lists all marketing costs that the shared automated mobility service could use for advertising reasons. Please give an average value per marketing cost category (per line):

Table 81 - Input for TCO – Marketing related data

Category	Value	Unit
Physical advertising (e.g. billboards, flyers, etc.)		€/month
Digital advertising (e.g. online adds)		€/month
Social media advertising (e.g. Instagram, FB, etc.)		€/month
TV/radio advertisement		€/month
Other advertisement costs		€/month
Total module costs		€/month

Module IT

This table (Table 82) lists all IT costs that are necessary for operating the shared automated mobility service. Please give an average value per IT cost category (per line):

Table 82 - Input for TCO – IT related data

Category	Value	Unit
Landline/mobile phone costs		€/month
Internet provider costs		€/month
Digital security measures costs		€/month
Renewable licences costs		€/month
Application/booking platform costs		€/month
Website costs		€/month
Social media account costs		€/month
Cloud service costs		€/month
Monthly hardware costs		€/month
Remote control service costs		€/month
Total module costs		€/month

Module Material (SAMS(F)-specific)
This table (Table 83) lists all material costs considered in SAMS(F). Please give an average value per SAMS(F) cost category (per line):

Table 83 - Input for TCO – SAMS(F)-Material related data

Category	Value	Unit
Packaging material (SAMS(F))		€/month
Unit cost of delivery (SAMS(F))		€/km
Total module costs		€/month

Module Supplies
This table (Table 84) lists the different supply costs which are applying for the shared automated mobility service. Please give an average value per supplies cost category (per line):

Table 84 - Input for TCO – Supplies related data

Category	Value	Unit
Country the service is located		Country
Electricity consumption charging stations		kWh/month
Electricity consumption gas stations		kWh/month
Electricity consumption public stations (station-based Car Sharing, PT stations)		kWh/month
Electricity consumption IT		kWh/month
Electricity consumption car garages		kWh/month
Electricity consumption bus garages		kWh/month
Electricity consumption workshops		kWh/month
Electricity consumption warehouses		kWh/month
Electricity consumption train depots		kWh/month
Electricity consumption bike/scooter depots		kWh/month
Water consumption		€/month
Gasoline (bought for business owned gas stations)		l/month
Gasoline price		€/l
CNG/LPG (bought for business owned gas stations)		kg/month
CNG/LPG price		€/kg
Oils		€/month
Spare parts		€/month
Repaired materials		€/month
Tyres		€/month
Cleaning supplies		€/month
Other supplies		€/month
Total module costs		€/month

Module Billing
This table (Table 85) lists all billing costs that are relevant for the shared automated mobility service. Please give an average value per Billing cost category (per line):

Table 85 - Input for TCO – Billing related data

Category	Value	Unit
Bank: account costs		€/month
Bank: Money transfer costs		€/month
Credit institute: account costs		€/month
Credit institute: Money transfer costs		€/month
Other institutes (e.g. PayPal): Account costs		€/month
Other institutes (e.g. PayPal): Money transfer costs		€/month
Total module costs		€/month

Module CapEx
This table (Table 86) lists all CapEx costs that are relevant for the calculations:

Table 86 - Input for TCO – CapEx related data

Category	Value	Unit
Buildings		€
Properties		€
Assets under construction		€
Charging and gas stations		€
Technical machinery and equipment		€
Digital Equipment such as Computers		€
Furniture and office equipment		€
Other digital equipment (e.g. Fax)		€
Licences for computer software (e.g. Microsoft Office, AutoCAD, PTV Visum/Vissim etc.)		€
Licences for software needed for other equipment		€
Material costs (e.g. for membership cards)		€
Total module costs		€

Module Additional Information
This table (Table 87) should include information that were not listed before but are relevant for the impact.

Table 87 - Input for TCO – Additional Information

Category	Value	Unit
VAT of a specific country or area		%
Circular tax (Vignette)		

Module end users/customer
This table (Table 88) contains the data related to SHOW relevant end users/customers (planned and evaluated):

Table 88 - Input for TCO – end users/customers related data

Category	Number of Planned users	Number of Really observed users
Commuters		
Residents		
Students		
Children/young adults		
Elderly		
Tourist/Visitor		
Hospital Visitors		
VRU		
PRM		

CBA-related input data

For the CBA the following data tables represent the essential data, which must be collected to ensure an optimal business and economic assessment:

- Person Transport

Person transport is divided into the following sub-areas:

- General Input Vehicles
- General Input Passengers
- General Input Prices
- Other Cost "Potentials"
- Revenues
- Benefits

The general input for vehicles focuses on the holding period per vehicle (category) and the mileage. Here the same tables are used as with the TCO (see Table 74 and Table 75).

The next tables (see Table 89 and Table 90) list the relevant input data for the transported passengers:

Table 89 - Input for CBA – Passenger related data

Category	Value	Unit
Passenger Car-Sharing		Persons/year
Passenger (E-)Bike-Sharing		Persons/year
Passenger Car-Rental		Persons/year
Passenger Ride-Sharing		Persons/year
Passenger Taxi-Service		Persons/year
Passenger DRT-Service		Persons/year
Passenger (E-)Scooter-Sharing		Persons/year
Passengers Bus (PT)		Persons/year
Passengers Trolleybus (PT)		Persons/year
Passengers Tram (PT)		Persons/year
Passengers Metro (PT)		Persons/year

Table 90 - Input for CBA – Trip-related data

Category	Value	Unit
Average number of trips taken per passenger Car-Sharing		# of Trips/person
Average number of trips taken per passenger Bike-Sharing		# of Trips/person
Average number of trips taken per passenger Car-Rental		# of Trips/person
Average number of trips taken per passenger Ride-Sharing		# of Trips/person
Average number of trips taken per passenger Taxi-Service		# of Trips/person
Average number of trips taken per passenger (E-)Scooter		# of Trips/person
Average number of trips taken per passenger DRT-Service		# of Trips/person
Average number of trips taken per passenger Public Transportation		# of Trips/person

The following table (Table 91) shows the relevant input regarding income/revenues generated by mobility services:

Table 91 - Input for CBA – income/revenue-related data

Category	Value	Unit
Average income per business transaction Car-Sharing		€/transaction
Average income per business transaction through other fees Car-Sharing		€/month
Average income per business transaction (E-)Bike-Sharing		€/transaction
Average monthly income through other fees (E-)Bike-Sharing		€/month
Average income per business transaction Taxi-Service		€/transaction
Average monthly income through other fees Taxi-Service		€/month
Average income per business transaction Ride-Sharing		€/transaction
Average monthly income through other fees Ride-Sharing		€/month
Average income per business transaction DRT-Service		€/transaction
Average monthly income through other fees DRT-Service		€/month
Average income per business transaction (E-)Scooter-Sharing		€/transaction
Average monthly income through other fees (E-)Scooter-Sharing		€/month
Average public transportation single ticket price		€
Average public transportation weekly/monthly/yearly ticket price		€

Category	Value	Unit
Passengers using PT single tickets in %		%

The next table (Table 92) is for collecting information not mentioned before or for additional information:

Table 92 - Input for CBA – Additional data

End user/customer		
Category	**Value**	**Unit**
Additional transport costs (Door-to-Door-Service)		
SAMS operator		
Category	**Value**	**Unit**
xxx		

The following table (Table 93) collects all relevant revenues and savings of the mobility service:

Table 93 - Input CBA - Cost savings

End user/customer		
Category	**Value**	**Unit**
Savings by using service instead of own car		
Average operation cost savings		€/month
Average workshop costs savings		€/month
Average depreciation cost savings		€/month
Average fixed cost savings		€/month
SAMS operator		
Category	**Value**	**Unit**
Subsidies/Grants from public hand		€/year
Selling marketing space on/at vehicles/stations		€/year
Income from investors		€/year
Rent/lease from other companies		€/year
Other revenues (e.g. tickets)		€/year

The next table (Table 94) lists the relevant business KPIs, which are collected:

Table 94 - Input for CBA – KPI related data

D9.3 KPI #	Updated #	Category	Value	Unit
B1	B1	Road accidents		Accidents/km
B14	B13	Km travelled without travellers		
B26	B25	Energy use		kWh/km, l/km, J/km
B27	B26	CO2, PM, NOx Emissions		g/km
A10	A3	Person km travelled		Total #
A11	A4	Empty vehicle km		%

D9.3 KPI #	Updated #	Category	Value	Unit
A12	A5	Operative costs		cost/km
B31	B30	Shared mobility rate		%
B32	B31	Vehicle utilisation rate		%
		Pricing strategy		€/ticket and/or €/service
		Revenue growth		%
		Return on investment after 3 years		%
		Vehicle utilization efficiency		%
		Occupancy rate		%
		Fleet replacement rate		years

- Freight Transport

The person transport is structured in the following sub-areas:

- General Input Customers & Freight
- General Input Prices
- Other Cost "Potentials"
- Revenues
- Benefits

The next table (Table 95) collects relevant data related to the freight:

Table 95 - Input for CBA – Freight related data

Category	Value	Unit
Number of customers		#/
Average number of cargo for each customer		#/customer/
Average price per cargo*		€/cargo
Average monthly income through other fees SAMS(F)**		€/month

The next table (Table 96) is for collecting information, which are not mentioned before or for additional information:

Table 96 - Input for CBA – Additional information

End user/customer		
Category	**Value**	**Unit**
Additional transport costs (Door-to-Door-Service)		
SAMS operator		
Category	**Value**	**Unit**
xxx		

This table (Table 97) collects the information for the CBA focussing on specific benefits.

Table 97 - Input for CBA – revenues related data

End user/customer		
Category	**Value**	**Unit**
Cost optimization of orders (just-in-time)		€/month
Cost savings through flat-rates instead of paying per delivery		€/month
SAMS operator		
Category	**Value**	**Unit**
Subsidies/Grants from public hand		€/year
Selling marketing space on/at vehicles/stations		€/year
Income from investors		€/year
Other revenues		€/year

The next table (Table 98) lists the relevant business KPI and aspects regarding the business models, which are collected:

Table 98 - Input for CBA – KPI related data

D9.3 KPI #	**Updated #**	**Category**	**Value**	**Unit**
A13	A6	Ratio of average load		m3/m3%
B39	B38	Unit cost of delivery		€/km; €/shipments; €/vehicle
B40	B39	Load factor patterns		%
B43	B42	Number of accidents on site		Accidents/km
B44	B43	Accidents in AV UFT facility		Accidents/km
B45	B44	Incidents of crime/theft in AV UFT facility		# of crime incidents
B46	B45	Number of incidents involving vandalism in AV UFT facility		# of vandalism incidents

CEA-related input data

For the CEA the following data tables (Table 99) represent the essential data, which must be collected to ensure an optimal business and economic assessment. These KPIs are defined in D9.3.

Table 99 - Input for CEA – KPI related data

D9.3 KPI #	Updated numbers	Grant agreement	Impact Category	KPI
A1	A1	GA	Road safety	Safety Enhancement (%)
A10	A3	GA	Societal, employability and equity	Person km travelled (by special groups)
A11	A4	GA	Societal, employability and equity	Empty vehicle km
B31	B30	Non GA	Societal, employability and equity	Shared mobility rate
B32	B31	Non GA	Societal, employability and equity	Vehicle utilisation rate
A9	A2	GA	Traffic, Energy, Environment	Number of passengers
B12	B12	Non GA	Traffic, Energy, Environment	Service reliability
B14	B13	Non GA	Traffic, Energy, Environment	Kilometres travelled
B26	B25	Non GA	Traffic, Energy, Environment	Energy use
A15	A8	GA	User acceptance	Traveller acceptance
B49	B48	Non GA	User acceptance	User reliability perception
B50	B49	Non GA	User acceptance	User safety perception
B51	B50	Non GA	User acceptance	Travel comfort
B52	B51	Non GA	User acceptance	Perceived usefulness
B53	B52	Non GA	User acceptance	Willingness to pay
B54	B53	Non GA	User acceptance	Willingness to share a ride
A13	A6	GA	Logistics	Ratio of average load
A14	A7	GA	Logistics	Number of cargo transported
B36	B35	Non GA	Logistics	Punctuality of deliveries
B37	B36	Non GA	Logistics	Precision of deliveries
B38	B37	Non GA	Logistics	Customer satisfaction
B39	B38	Non GA	Logistics	Unit cost of delivery
B40	B39	Non GA	Logistics	Load factor patterns
B41	B40	Non GA	Logistics	Public acceptance
B42	B41	Non GA	Logistics	Willingness to pay for AV urban deliveries/logistics
B48	B47	Non GA	Logistics	Fair and equal access in AV UFT facility

Business model-related input data

All data described in Table 74 to Table 99 also includes all relevant business data, which can be used for the evaluation of the developed business models in chapter 4.1. Also the business KPI, defined by WP2, were considered.

For each of the different business models (see chapter 4.1.1 to 4.1.5) the relevant tables from the chapters 3.2 and 3.3 were used and specific business model parameters were modified for the business impact calculation. The specific parameters, which have to be modified for every single business model, were identified in close cooperation with WP2 (Business Model Evaluation Assumptions of D2.3). This means all identified values per business model differs in some aspects from the basic scenarios of chapter 3. These differences are:

- **(Automated) Public Transportation:** Considering the size and operating ratio of a PTO, it allows them to own more assets such as vehicles, personnel or infrastructure (e.g. buildings) in comparison to other SAMS operators who are renting or leasing instead. Meaning that CapEx costs are rising but leasing costs are decreasing. Beside that vehicle-related costs (fixed, workshop, depreciation, operating costs) rise due to the increase of vehicle number. Furthermore, PTOs are known to the inhabitants of the area/city they are operating, so savings of marketing costs can be made. This kind of SAMS is mainly used in SHOW as well as in real world situations and most probably will always be the main public transportation solution for bigger cities.
- **Demand Responsive Transportation:** Regarding costs a DRT-service is similar to the (automated) public transportation service but requires more capital for personnel (to support the service calling application and respond to customer problems) and IT (maintain service calling application). DRT-services are mainly used to cover the last-mile problem and to support the (automated) public transportation services in cities and rural areas at routes with higher volume of people.
- **Car Sharing (Robo Taxi):** Compared to the other business models this one uses cars instead of shuttles as vehicles. This leads to a reduction of vehicle-related costs such as the retail price, maintenance, workshop and fixed costs. But these savings are needed for other aspects, such as personnel and maintenance. The usage of normal cars instead of shuttles reduces the amount of people that can be transported at the same time. This business model can be used to bring people from a fixed point A to point B (Graz test site).
- **Mobility-as-a-Service (SAMS(P)):** A mobility service operator (no PT/PTO) does not have its own vehicle fleet and assets needed for the service itself. It only provides the platform for different SAMS and combines them – for example – in a single application (e.g. whim[1]). Therefore, in almost all cost categories (exempt marketing, IT and billing) costs can be saved. SAMS(P) is a concept that has potential in the future, provided it is well developed and the various mobility operators have sufficient capacity to handle the demand in cities. In addition, it should be easy to handle for customers of each age group so that it is used.
- **Logistic-as-a-Service (SAMS(F)):** Compared to the other listed business models, this one transports freight instead of people or transports people and freight at the same time. This leads to higher personnel costs because more skilled personnel is required as well as higher IT costs for the integration and maintenance of the booking platform. Such services can help to improve distributions in certain areas (such as hospitals or campuses) in the future. SAMS(F) can even support

[1] Experience freedom of mobility - Whim App

distribution services such as national and private logistic services contributing automated deliveries to households.

Risk analysis for the data collection process

It is assumed that there may be challenges or risks that arise during the data collection phases. Therefore, possible challenges, risks and their solutions are described here.

Confidentiality of data/Test sites cannot provide relevant data

It is possible that some test sites may not be able to provide relevant data. The reasons for this may vary: some partners may see the release of commercially relevant data as a strategic disadvantage for their future business, data may be confidential in principle, or data may simply not be available because its relevance and thus collection has not yet been recognized.

To deal with this possible problem, confidentiality agreements can be set up in which it is agreed that data provided is disclosed only to the tool developers (IESTA and VUB), the Data Collection Administrator and the respective test site. If this is not possible, calculations are performed using a sound experts' best guess as a substitute.

Time delays

Another issue that may arise during the course of the project is time delays in data collection processes that are impacted by COVID-19 or other events. This can result in needed data not being delivered in a timely manner to the extent required. This can have a major impact on the completion of the calculations and thus on both D16.2 and D16.3 as well as A2.3. In particular, the collection of CLTD from the test sites is very time critical. However, a well-managed collection process, supported by an escalation process involving relevant senior SHOW project partners such as project manager (UITP), technical project manager (CERTH) or demonstration manager (EUROCITIES) should keep this risk clearly under control.

Quality and Amount of data

For the quality of the calculations, the quality and also the scope of the input data are of crucial importance. Especially the dynamic data is critical here: If the provided data is of poor quality or not available to a certain extent, it is not possible to get good representative results from the TCO, CBA and CEA analyses and the business and exploitation plans.

To deal with this problem, the Data Collection Administrator checks the incoming data and reports back to the appropriate test site in a timely manner if the quality and/or that of the data provided is not sufficient for the assessment.

The identified risks are continuously analyzed and evaluated in cooperation with SHOW Project Risk Management and solutions/countermeasures are jointly developed and implemented.

Total Cost of Ownership (TCO) for tool development and assessment

The TCO assessment - assuming that the most substantial investments in vehicles, infrastructure, etc. (CapEx) have already been made - mainly on OpEx costs to identify new, lucrative opportunities within the business value chain of mobility services, especially for SMEs, start-ups or new entrants. The TCO assessment is used for the different SHOW test sites, the use cases as well as relevant stakeholder groups all in involved mobility services using CCAV.

Assumptions and Boundary Conditions

1) The cost assessment tool (created with Microsoft Excel) shall be able to calculate the TCO for the different **target groups** and **mobility services**. For this assessment the tool shall offer the possibility to focus on one services or one use case or test site as well as any useful combination of the different members of the target group.
2) A main focus is on supporting for the integration of SMEs/start-ups/new entrants and business opportunities, which are particularly suitable/manageable for them.
3) If necessary, the tool shall provide estimations about the CapEx to support the assessment.
4) Because the value chains for the target groups can be quite complex (e.g. test sites) **some cost values** of suppliers, operators, providers, etc. **may not be ascertainable with a reasonable effort**. In these cases **assumed cost values** based on literature research are used for the assessment.

Basic Methodology

See chapter 2.3.2.

Basic information for TCO

In this chapter relevant information About the business ecosystem within SHOW (D1.1 and D2.1) as well as results of general impact assessment (D9.3) adapted to the TCO analysis is presented.

Business ecosystem information for TCO

See chapter 3.1.3 and Table 4.

Basic structure of the TCO Excel tool

The TCO Excel tool consists of three different types of excel spreadsheets: Input-Spreadsheets, Output-Spreadsheets and Calculation-Only/Overview-Spreadsheets, which are described in the following sub-chapters.

General		
Holding period	96	months
	8	years
SAMS(P) service		
Used Vehicles		
Used Vehicles	Shuttle	
Mileage		
CAR: Mileage Combustion **gasoline** engine vehicles	0	km/year
CAR: Mileage Combustion **diesel** engine vehicles	0	km/year
CAR: Mileage Mild-hybrid **gasoline** vehicles	0	km/year
CAR: Mileage Mild-hybrid **diesel** vehicles	0	km/year
CAR: Mileage Hybrid (HEV) **gasoline** vehicles	0	km/year
CAR: Mileage Hybrid (HEV) **diesel** vehicles	0	km/year
CAR: Mileage Plug-in-hybrid **gasoline** vehicles	0	km/year
CAR: Mileage Plug-in-hybrid **diesel** vehicles	0	km/year
CAR: Mileage Electric vehicles	0	km/year
CAR: Mileage Fuel cell vehicles	0	km/year
CAR: Mileage CNG/LPG vehicles	0	km/year
SHUTTLE: Mileage Combustion **gasoline** engine vehicles	0	km/year
SHUTTLE: Mileage Combustion **diesel** engine vehicles	0	km/year
SHUTTLE: Mileage Mild-hybrid **gasoline** vehicles	0	km/year
SHUTTLE: Mileage Mild-hybrid **diesel** vehicles	0	km/year
SHUTTLE: Mileage Hybrid (HEV) **gasoline** vehicles	0	km/year
SHUTTLE: Mileage Hybrid (HEV) **diesel** vehicles	0	km/year
SHUTTLE: Mileage Plug-in-hybrid **gasoline** vehicles	0	km/year
SHUTTLE: Mileage Plug-in-hybrid **diesel** vehicles	0	km/year
SHUTTLE: Mileage Electric vehicles	15000	km/year
SHUTTLE: Mileage Fuel cell vehicles	0	km/year
SHUTTLE: Mileage CNG/LPG vehicles	0	km/year

Input-Spreadsheets

The input spreadsheet are structured according to the different modules and basic information (see chapter “Data to be collected”) and are used for checking the completeness. Some examples based on the general SAMS(P) scenario can be seen below. All numbers in these figures are average values of the test sites or assumptions based on desktop research (see chapter 3.2).

The basic information spreadsheet contains information about the holding period, mileage of the different vehicle types and fuel/energy prices etc. (Figure 15).

Figure 15: SAMS(P) - Input Basic Information

The OpEx Costs are defined in different modules, as was already described in previous chapters (Figure 16).

Input for OpEx		
Category	**Value**	**Unit**
Modul Leasing		
Leasing charging stations	1.200,00 €	€/month
Leasing car garages	- €	€/month
Leasing bus garages		€/month
Leasing for public stations (PT stations)	- €	€/month
Leasing public parking spaces	- €	€/month
Leasing business owned service/repair workshop	- €	€/month
Leasing other buildings	5.500,00 €	€/month
Leasing for grounds	250,00 €	€/month
Other Leasing	500,00 €	€/month
Total module costs	- €	€/month
Sum	7.450,00 €	total €/month
Modul Personnel		
Vehicle driver/Vehicle Saftey Observer	4.655,00 €	€/month
Customer service Personnel	2.725,00 €	€/month
Vehicle workshop personnel	2.170,00 €	€/month
IT Personnel	2.250,00 €	€/month
Marketing Personnel	2.000,00 €	€/month
Infrastructure Maintenance Personnel		€/month
Vehicle fleet Personnel (incl. Station and vehicle care)		€/month
Service team Personnel (Maintenance of vehicles)	1.350,00 €	€/month
Damage Management Personnel		€/month
Training costs	700,00 €	€/month
Other personnel costs	4.250,00 €	€/month
Total module costs	- €	€/month
Sum	20.100,00 €	total €/month

Figure 16: SAMS(P) - Input OpEx Cost Modules

CapEx is also represented in the Input Sheets and looks like the following (Figure 17):

Input for Business Costs (CapEx)		
Category	**Value (total)**	**Unit**
Buildings	187.000,00 €	€/total
Properties	- €	€/total
Assets under construction	- €	€/total
Charging and gas stations	- €	€/total
Technical machinery and equipment	- €	€/total
Digital Equipment such as Computers	14.375,00 €	€/total
Furniture and office equipment (except digital equipment)	16.000,00 €	€/total
Other digital equipment (e.g. Faxes)	- €	€/total
Licences for Computer software (Microsoft Office, AutoCAD, PTV Visum/Vissim etc.)	- €	€/total
Licences for Software needed for other eqipment	- €	€/total
Material costs (e.g. for membership cards	1.250,00 €	€/total
Sum of CapEx of Business (except vehicles)	218.625,00 €	total €

Figure 17: SAMS(P) - Input for CapEx

Due to the complexity of vehicle costs calculation the module vehicle has its own spreadsheet where all kinds of vehicle information needs to be implemented (see Figure 18). The following figure shows an operating costs input spreadsheet example of a combustion gasoline vehicle. The same approach applies to other vehicle types such as hybrids, electric vehicles, etc.

Beside the operating costs, maintenance, insurance and depreciation of the vehicles have own input spreadsheets (Figure 19).

Shuttle: Electric vehicles		
Category	Value	Unit
Name of Vehicle 1	Electric Shuttle I	Name
Year of manufacture	2020	Year
Half of year	First	First/Second
Number of electric vehicles	2	#
Vehicle price (net)	250000	€
Input operating costs		
Energy consumption electric vehicles	1,5	kWh/km
Country the service is located	Austria	Country
Region		Region
Energy price	0,222	€/kWh
Energy costs private charging		€/kWh
Energy costs semi-public charging		€/kWh
Energy costs public charging	0,29	€/kWh
Private charging in %		%
Public charging in %	100%	%
Other operating costs	0	€/month
Input Taxes		
Vehicle weight	5000	kg
Fuel origin	EU-mix	Origin
Power of vehicle	120	kW

Figure 18: SAMS(P) - Input Module Vehicle

Maintenance Vehicles		
Shuttle: Maintenance Electric vehicle		
Name of vehicle 1	Electric Shuttle I	
Technical service	100	€/month
Repairs	50	€/month
Tyres	25	€/month
Car care	100	€/month
Insurance vehicles		
Shuttle: Insurance Electric vehicle		
Name of vehicle 1	Electric Shuttle I	
Comprehensive Insurance	2000	€/month
Liability insurance		€/month
Depreciation Vehicles		
Shuttle: Depreciation Electric vehicle		
Name of vehicle 1	Electric Shuttle I	
Depreciation	1164	€/month

Figure 19: SAMS(P) - Input Vehicle maintenance, insurance, depreciation

Colouring of the input spreadsheets

The colouring of the input spreadsheets is different to have a better overview over the sheets and cost categories when using the tool. Which colour is used for with category can basically be seen in the Figure 15 to Figure 19.

- White: Are cells which content cannot be changed (e.g. category names, cells referring to other cells, results …).
- Grey: Are cells where values can be written in.
- Dark Blue: This colour is only applying to the different modules under the category “OpEx” (except from this is the module vehicle).
- Yellow: Only used for the input of the operating costs of the module vehicle.
- Green: Only used for the input of the maintenance costs of the module vehicle.
- Orange: Only used for the input of the insurance costs of the module vehicle.
- Light Blue: Only used for the input of the depreciation costs of the module vehicle.

This colouring also applies to the output sheets.

Output-Spreadsheets

The output spreadsheets show the results of TCO. These sheets are locked because they include formulas and links to other sheets, which should not be modified. All figures below show the calculated results based on the input. All numbers shown in the next figures are testing numbers and not related to any test site, use case or stakeholder group.

In the figure below (Figure 20) the total OpEx costs for one year can be seen.

OpEx Costs Output (1 year)	
Module Leasing	89.400,00 €
Module Personnel	241.200,00 €
Module Maintenance	105.780,00 €
Module Insurance	148.200,00 €
Module Depreciation	66.216,00 €
Module Marketing	68.460,00 €
Module IT	18.900,00 €
Module Supplies	5.268,00 €
Module Billing	660,00 €
Module Vehicles (Operating costs)	12.600,00 €
Sum of 1 year	756.684,00 €

Figure 20: SAMS(P) - OpEx Output for 1 year

The results shown in Figure 20 are continued in Figure 21 where all costs are summed up (OpEx and CapEx).

CapEx Costs Output	
Sum of CapEx of Business (except vehicles)	218.625,00 €
Sum of CapEx of Vehicles (incl. Incentives)	600.000,00 €
Sum of CapEx total	818.625,00 €

Total costs	
Total OpEx Costs	6.053.472,00 €
Total CapEx costs	818.625,00 €
Total costs (OpEx + CapEx)	6.872.097,00 €

Figure 21: SAMS(P) - Output CapEx costs and all costs

Shuttle: Electric vehicle	
Name of Vehicle 1	Electric Shuttle I
Net price of 1 vehicle	250.000,00 €
Net price of all vehicles	500.000,00 €
New price inclusive incentives for 1 vehicle	300.000,00 €
New price inclusive incentives for all vehicles	600.000,00 €
Gross price of 1 vehicle	300.000,00 €
Gross price of all vehicles	600.000,00 €
Operating costs of 1 vehicle	50.400,00 €
Operating costs of all vehicles	100.800,00 €
Fixed costs of 1 vehicle	192.000,00 €
Fixed costs of all vehicles	384.000,00 €
Maintenance costs of 1 vehicle	26.400,00 €
Maintenance costs of all vehicles	52.800,00 €
Depreciation costs of 1 vehicle	111.744,00 €
Depreciation costs of all vehicles	223.488,00 €
Net price of all vehicles	500.000,00 €
Gross price of all vehicles (incl. Incentives)	600.000,00 €
New price of all vehicles (incl. Incentives)	600.000,00 €
Total operating costs	100.800,00 €
Total fixed costs	384.000,00 €
Total maintenance costs	52.800,00 €
Total depreciation costs	223.488,00 €

As with the input sheet (see Figure 22) the module vehicle has its own output category, where alle costs are described in detail for one and all vehicles.

Figure 22: SAMS(P) - Output vehicle

Calculation-Only/Overview-Spreadsheets

The data from the Input-Sheet is taken, calculated and the results are transferred to the Output-Sheets. Basically, these sheets are joints between the Input and the Output-Sheets (Input-Sheet → Calculation-Only-Sheet → Output-Sheet). The output spreadsheets are locked to avoid changes by the users.

In the following figures some calculation sheets can be seen. These sheets contain the calculations of taxes and incentives of different countries (mainly the ones test sites are located).

As an example in Figure 23 the calculation of the taxes when buying a vehicle can be seen.

Shuttle: Electric vehicle		
Taxes		
Sum Taxes in Austria		
Electric Shuttle I		50.000,00 €
	0	- €
	0	- €
Electric vehicles are except from the NoVa and Vehicle tax		
VAT		
	Electric Shuttle I	
Net list price of the vehicle		250.000,00 €
VAT rate		20%
VAT value		50.000,00 €
Incentives		
There are no incentives for shuttles.		

Figure 23: SAMS(P) - Calculation Taxes in Austria for an electric vehicle

Cost-Benefit-Analysis and Cost-Effective-Analysis (CBA and CEA) for tool development and assessment

This chapter contains the relevant information, conditions and data that are needed for calculating the CBA and CEA, such as the different costs, revenues and benefits of the end user/customer and mobility service operator as well as . Following that the boundary conditions and the methodology as well as further procedures and approaches of the mentioned analyses are defined.

Identified and allocated CBA and CEA data

In this chapter the needed data for the CBA and CEA calculation – costs, revenues and benefits – are identified and allocated accordingly.

Identified end users/customers per test site

Compared to the TCO in the CBA and CEA the end user/customer is also considered in the calculation. The next table (Table 100) includes the identified end users/customers and at which test site they are targeted from WP9 – D9.3.

Table 100 - Targeted end users/customers at each test site (from D9.3)

Mega site/ Satellites	City	Passengers								
		Commuters	Residents	Students	Children/ young adults	Elderly	Tourist/ Visitor	Hospital visitors	VRU	PRM
France	Rouen	x		x		x	x			X
Spain	Madrid - Villaverde	x							x	
	Madrid - Carabanchel								x	
Austria	Graz	x	x	x	x	x	x		x	
	Salzburg	x	x				x			
	Carinthia			x			x			x
Germany	Karlsruhe	x	x	x						
	Monheim		x			x	x			x
Sweden	Linköping	x	x	x	x	x				x
	Gothenburg	x		x			x		x	
Finland	Tampere	x*	x	x	x	x	x		x	x
Italy	Turin		x	x		x		x	x	x
Greece	Trikala	x	x	x		x	x		x	
Netherland	Brainport, Eindhoven	x		x			x		x	
Czech Republic	Brno	x		x	x	x	x			***

Comment: VRU (cyclist, pedestrians, kickboard users etc., PMR=persons with special mobility requirements; * immigrants; *** blind*

Identified costs, revenues and benefits for CBA and CEA

In the following table (Table 101) the identified cost, revenues and benefits for the two different points of view (end user/customer and mobility service operator) are listed.

The fat written headlines under the “Benefits” category are defined as “Benefit category”. Under these broader categories the single benefits are listed (with bullet points) which are part of a benefit category.

Table 101 - Identified costs, revenues and benefits for CBA and CEA of end users and mobility service operators

	End user/customer	Mobility service operator
Costs	• Ticket/service costs • Costs caused by self-inflicted accidents with mobility services • Other costs	• OpEx (incl. Taxes) • CapEx • Other costs potentials

Revenues	• Savings by using PT/mobility services instead of own car
	  ○ Operation cost savings
	  ○ Workshop costs savings
	  ○ Depreciation cost savings
	  ○ Fixed cost savings
	  ○ Time savings (due to traffic jams)
		• Income through service(s)
		• Subsidies/Grants from public hand
		• Selling marketing space on/at vehicles/stations (PT)
		• Income from investors
		• Rent/lease from other companies (having their shops e.g. in metro stations owned by PTOs)
		• Other revenues (e.g. selling of merchandise)

Benefits	**Passenger perception:** • User reliability perception • User safety perception • Travel comfort • Travel time (time savings) • Perceived usefulness • Willingness to pay • Willingness to share a ride	**CBA:** **Break-Even-Point:** • Profitability • Service Acceptance • Service Efficiency • Customer Segments • SAMS integration • Maintenance **Technical Aspect:** • Downtimes caused by technical vehicle issues • Downtimes caused by technical infrastructure issues **Environmental Aspect:** • Environmental friendliness **Economic Aspect:** • Real time information • Pricing strategy • Marketing influence • Operating times the service is not operating • Realised Use cases • Funding **Quality of Service** • Service information • Calling possibilities of service **Users & Stakeholders** • New actors/businesses • External know how

Cost-Benefit-Analysis (CBA)

Assumption and Boundary conditions CBA

1) The CBA is done from **different point of views** covering the defined target groups.
2) The benefits derived from the KPIs identified in **WP9** and **WP2** are compared to the **corresponding costs** and **revenues**.
3) It is assumed that some benefits cannot be monetized for the CBA. These non-monetizable benefits are handled in the CEA.

Basic methodology CBA

See chapter 2.3.3

Basic structure of the CBA

The CBA has – like the TCO – input, output and calculation/overview sheets. The descriptions can be found in the chapters “Input-Spreadsheets”, “Output-Spreadsheets” and “Calculation-only/Overview-Spreadsheets”.

The CBA is built on of the following parts:

- Costs
- Revenues
- Benefits
- KPI efficiency

Basic approach of the CBA calculation

This sub-chapter covers the basic calculation approach of the four CBA parts previously listed.

Each part of the CBA gets its own Excel sheet. In this sheet, the respective costs, revenues and benefits are shown based on the basic general scenario for person transport.

Costs

The costs calculated in the CBA are mainly the OpEx and CapEx costs from the TCO. Additionally to that there are the so called “Other cost potentials”. If there are any other costs arising, which were not considered in the TCO, this “Other cost potentials”

TCO costs	
Total OpEx costs	6.053.472,00 €
Total CapEx costs	818.625,00 €
Total costs	6.872.097,00 €

Other Cost Potentials	
Potential 1	
Potential 2	
Potential 3	
Potential 4	
Potential 5	
Sum Other Cost Potentials	- €

Total Costs	
TCO costs	6.872.097,00 €
Other Potential costs	- €
Total sum of costs	6.872.097,00 €

Figure 24: SAMS(P) - CBA cost categories

category is used. The sum of the TCO costs and other cost potentials are the sum of the total costs calculated for the CBA. The input data to calculate the costs have to come from the test site or mobility service operator. For the calculation of the costs is no own input sheet needed. The sheet shown in Figure 24 serves as input, calculation and output sheet.

Revenues

Revenues are going to be calculated by the tool based on input data coming from the test site or the mobility service operator. The origin of revenues for end users and mobility service operators can come from different sources, as shown in Table 101.

The calculation will have different complexity levels. Whereas revenue numbers from subsidies/grants, income from investments, selling marketing space, etc. need to be coming directly from the mobility service operator as whole numbers, revenues coming directly from the services are going to be calculated by the tool itself based on data

such as service pricing, number of passengers that use a week/month/year ticket/flat-rate, passenger km driven, unit cost of delivery, and cargo transported in total to name a few.

The input sheet for revenues can be seen in Figure 25 and the output based on the input is shown in Figure 26. The example shown in the figures is the basic overall scenario defined for p

Passengers			
Passengers SAMS(P) Service	50	Persons/day/week/month/year	
Average number of trips taken per passenger SAMS(P) Service	1	# of Trips/person/	Day
Average income per business transaction	2,00 €	€/transaction	
% of Passengers taking Abos	20%	%	
Average Price of Service Subscription per week/month/year	15,00 €	€/	Month
Average monthly income through other fees	2.977,00 €	€/month	

Revenues through other income		
Subsidies/Grants from public hand	200.000,00 €	€/year
Selling marketing space on/at vehicles/stations	10.000,00 €	€/year
Income from investors	50.000,00 €	€/year
Rent/lease from other companies	- €	€/year
Other revenues	- €	€/year

Figure 25: SAMS(P) - Revenue Input Sheet

Operational Revenues	
Revenues Person transport	174.400,00 €
Revenues through other fees	285.792,00 €
Revenues Freight transport	- €
Total operational revenues for holding period	460.192,00 €

Revenues through other income	
Subsidies/Grants from public hand	1.600.000,00 €
Selling marketing space on/at vehicles/stations	80.000,00 €
Income from investors	400.000,00 €
Rent/lease from other companies	- €
Other revenues	- €
Total revenues through other income	2.080.000,00 €

Total Revenues	
Operational Revenues	460.192,00 €
Revenues through other income	2.080.000,00 €
Total Revenues	2.540.192,00 €

Figure 26: SAMS(P) - Revenue Output Sheet

Benefit categories and Benefits

These KPIs need to be monetized before it can be compared to the costs and revenues. The monetization is different for each KPI, for example, the monetization value of CO_2 and other emissions are going to be according to official emission prices whereas the monetization of road accidents are measured according to the costs that were caused (people, vehicle and/or infrastructure damage) and revenues that are lost. Benefits that cannot be monetized are handled by the CEA.

Comparison of the costs and revenues to the benefits

After all costs and revenues are known as well as all benefits are monetized, the next step is the following:

The profit/loss is calculated based on Equation 1.

Equation 1 - Calculation of Profit or Loss in the CBA

$$Profit\ or\ Loss = Revenues - Costs$$

If the result is positive, it is a profit. If it is negative, it is a loss.

After the profit or loss is known the sum of the monetized benefits are added to this value for the end result as can be seen in Figure 27. This is done for all stakeholder groups, use cases and mobility services of the different test sites.

Total Revenues	2.540.192,00 €
Total Costs	6.872.097,00 €
Total turnover	- 4.331.905,00 €
Benefit category Break-even Point	- 84.119.832,00 €
Benefit category Technical	- 161.600,00 €
Benefit category Environmental	- 10.985,14 €
Benefit category Economic	385.392,00 €
Benefit category Quality of Service	8.824,04 €
Benefit category Users & Stakeholders	160.000,00 €
End result	**- 88.451.737,00 €**

Figure 27: SAMS(P) - CBA End result

KPI efficiency

See chapter 3.3.1

Risk analysis of CBA

Risks regarding the CBA are mostly incomplete or too less data for a proper calculation. (Completeness, Integrity, Quantity)

Cost-Effectiveness-Analysis (CEA)

The aim of cost-effectiveness analysis is to compare the efficiency of a technology, a service, or a policy to different alternatives [7]. For this purpose, two elements are needed: the total cost of each alternative and the outcome on which the alternatives can be compared. These two elements are then computed as a ratio. The most cost-effective alternative is the one that brings one unit of this (positive) outcome at the least possible cost.

Assumption and Boundary conditions CEA

1) Used for units of effectiveness that are defined based on different policy goals that are desirable and that can be represented by the relevant KPIs measured in WP13.
2) the basic boundary conditions for the CEA can be summarized as follows:
    - Time plan (please refer to chapter “Time plan” for more details)
    - Availability of data
    - Completeness of collected data

Basic methodology CEA

1) First, the **desirable outcomes** are identified through units of measurement based on each relevant KPI’s (cf. WP13). These belong to the following four impact areas:

    - Road safety,

- Societal, employability and equity,
- Traffic, Energy, and Environment,
- User acceptance

2) Then, **costs** and revenues from each end user, mobility service operator and the society are collected. These were collected in during the TCO and CBA calculations.

3) Next, the **effectiveness** of each test sites is calculated for the different outcomes. This effectiveness ratio is defined as the ratio of the total costs on the outcome.

4) Lastly, these effectiveness ratio is **compared** between all test sites belonging to a same M3ICA scenario, i.e. test sites dealing with similar mobility and logistics needs.

Basic structure of the CEA

As for TCO and CBA, the calculation are made with an Excel spreadsheet. Two kind of inputs are used. First the costs calculation, which is adapted from the TCO and CBA calculations and includes both costs incurred by the end users and costs incurred by the mobility operator. The other stream of inputs are coming from the KPIs (WP13) and are defining the different outcomes on which the costs effectiveness measurements are based.

Costs

Based on the data collected (cf. chapter 4), the cost of each service in the different pilots are computed. These costs are computed in accordance with the TCO and CBA methodologies (cf. Table 7 for the identification of costs).

Outcomes

The second key element of CEA is the identification of an outcome. Most cost effectiveness analyses focus only on one outcome (e.g.: ghg emissions reduction for the transport sector, as reviewed by Kok et al., 2011 [16]). In the context of this SHOW project, many outcomes, or potential impacts, are considered. The data therefore is collected in the form of KPIs and impact criteria. Here, the outcomes are analyzed in terms of benefits measured through the KPIs. These KPIs were identified in WP13.

Effectiveness

Then, with the costs and the outcome unit identified and calculated in 1 and 2, an effectiveness ratio can be created for each outcome and each test site or services (depending on the data availability).

$$Cost\ effectiveness = \frac{cost}{outcome}$$

Comparison

Finally, the services are compared in term of their effectiveness to reach each of the outcomes. To compare similar services from the test sites, the scenarios defined in WP 9 (D9.2) are used to categorize the services.

1) Feeder service to multi-modal and PT hubs
2) Shared point-to-point services
3) Mass transit AV services
4) Private point-to-point services

Risk analysis CEA

The delivery of the general cost-effectiveness ratio will depend on the KPI's received by the project partners. The cost calculation is limited by the costs value received by the test sites.

Annex II Business and exploitation plan survey

List of entities participating in the SHOW project (April 2022)

The updated list of entities in the SHOW project based on the status of April 2022 is provided below. It has to be noted that Amendment #2 has not been accepted yet, which means that the partner #71 “Bahnen der Stadt Monheim” has not officially joined the Consortium, but based on the project offices’ requests has already officially begun working and reporting towards the Consortium and project and can therefore be part of the evaluation.

Table 102 - List of partners April 2022

NO	LEGAL NAME	SHORT NAME	Questionnaire filled
1	UNION INTERNATIONALE DES TRANSPORTS PUBLICS - UITP	UITP	
2	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS	CERTH	
3	EUROPEAN ROAD TRANSPORT TELEMATICS IMPLEMENTATION COORDINATION ORGANISATION - INTELLIGENT TRANSPORT	ERTICO	
4	NAVYA	NAVYA	
5	EASYMILE	EASYMILE	
6	TRANSDEV GROUP	TRANSDEV GROUP	
6	ALSTOM FERROVIARIA SPA	ALSTOM FERROVIARIA	
7	KEOLIS SA	KEOLIS	
11	EMTE S.L.U.	EMTE	
12	IRIZAR E-MOBILITY SL	IRIZAR	
12	DATIK INFORMACION INTELIGENTE S.L.	DATIK	
13	SENSIBLE 4 OY	SENSIBLE 4 OY	
14	SOCIETE DES TRANSPORTS INTERCOMMUNAUX	STIB	
15	Gruppo Torinese Trasporti S.P.A	GRUPPO TORINESE TRASPORTI	
16	VALEO VISION sas	VALEO VISION	
17	Siemens Mobility GmbH	SIEMENS MOBILITY	
18	ERICSSON	ERICSSON	
18	ERICSSON GmbH	EAG	
19	T-SYSTEMS INTERNATIONAL GMBH	T-SYSTEMS	
20	ROBERT BOSCH GMBH	BOSCH	
21	EUROCITIES ASBL	EUROCITIES	
21	City of Bremen	CITY OF BREMEN	
22	INTERNATIONAL ROAD FEDERATION	INTERNATIONAL ROAD FEDERATION	
23	European Passengers’ Federation ivzw - EPF	EUROPEAN PASSENGERS’ FEDERATION	
24	POLE DE COMPETITIVITE IDFORCAR	ID4CAR	
24	GRUAU LAVAL SAS	GRUAU	
25	STADT AACHEN	STADT AACHEN	
28	ANAPTYXIAKI ETAIREIA DIMOU TRIKKAION ANAPTYXIAKI ANONYMI ETAIREIA OTA - E-TRIKALA AE	E-TRIKALA SA	
29	STATUTARNI MESTO BRNO	BRNO	
30	TAMPEREEN KAUPUNKI	TAMPEREEN	
31	CENTRE HOSPITALIER UNIVERSITAIRE DE RENNES	CHU RENNES	
32	Kontron Transportation GmbH	KONTRON AUSTRIA	

NO	LEGAL NAME	SHORT NAME	Questionnaire filled
33	AVL List GmbH	AVL LIST GMBH	
33	AVL SOFTWARE AND FUNCTIONS GMBH (AVL SW)	AVL SOFTWARE	
34	FEV GMBH	FEV EUROPE GMBH	
35	SWARCO MIZAR SRL	SWARCO MIZAR	
36	COMBITECH AB	COMBITECH AB	
38	INDRA SISTEMAS SA	INDRA	
40	EUROMOBILITA SRO	EUMO	
41	BAX INNOVATION CONSULTING SL	BAX & COMPANY	
42	IESTA - INSTITUT FUR INNOVATIVE ENERGIE - STOFFAUSTAUSCHSYSTEME	IESTA	
43	SITOWISE OY	SITOWISE	
44	ARTIN SPOL. S R.O.	ARTIN	
45	INFORMATION TECHNOLOGY FOR MARKET LEADERSHIP	ITML	
46	CTLUP SRL	CTLUP SRL	
47	Joint Research Center- European Commission	JOINT RESEARCH CENTER	
48	TNO - Nederlandse Organisatie Voor Toegepast Natuurwetenschappelijk Onderzoek	TNO	
49	STATENS VAG - OCH TRANSPORTFORSKNINGSINSTITUT	STATENS VAG	
50	INSTITUT VEDECOM	VEDECOM	
51	VTT Valtion Teknillinen Tutkimuskeskus	VALTION TEKNILLINEN TUTKIMUSKESKUS	
52	Vrije Universiteit Brussel	VRIJE UNIVERSITEIT BRUSSEL	
53	RISE SICS AB	RISE	
54	AUSTRIATECH -Gesellschaft Des Bundes Fur Technologiepolitische Massnahmen GMBH	ATE	
55	AIT Austrian Institute of Technology GMBH	AUSTRIAN INSTITUTE OF TECHNOLOGY	
56	IDIADA Automotive Technology SA	IDIADA	
57	INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS	ICCS	
58	FZI FORSCHUNGSZENTRUM INFORMATIK	FORSCHUNGSZENTRUM INFORMATIK	
59	NATIONAL TECHNICAL UNIVERSITY OF ATHENS - NTUA	NTUA	
60	Commissariat à l'énergie atomique et aux énergies alternatives	COMMISSARIAT CEA	
61	Tecnalia	TECNALIA	
62	SALZBURG RESEARCH FORSCHUNGSGESELLSCHAFT M.B.H.	SRFG	
63	links	FONDAZIONE LINKS	
64	Danmarks Tekniske Universitet	DANMARKS TEKNISKE UNIVERSITET	
65	Università degli Studi di Genova	UNIGENOVA	
66	CENTRUM DOPRAVNIHO VYZKUMU v.v.i.	CENTRUM DOPRAVNIHO VYZKUMU	
67	UNIVERSITE DE GENEVE	UNIGE	
68	Kompetenzzentrum - Das virtuelle Fahrzeug Forschungsgesellschaft GmbH	VIRTUAL VEHICLE RESEARCH	
69	Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)	DEUTSCHES ZENTRUM FÜR LUFT	
70	pdcp GmbH	PDCP	
71	BAHNEN DER STADT MONHEIM	BAHNEN DER STADT MONHEIM	

Exploitation questionnaire

Organization	Name of the organization
Stakeholder group	Vehicle manufacturer/ Mobility operator/ ITS Infrastructure provider/ ICT provider/ Service provider/ Authority/ University and Research Institutes/ other, please specify
Exploitable Key Result	Name **at least one** result you are expecting from the project/ you are testing/ developing yourself
Interest and expectation for further business	Shortly describe your expectation regarding SHOW – project **and** business expectation Describe the role of your organisation in SHOW – overall and locally
Business Cases	Please describe briefly your thoughts regarding the business that can derive for **your organization OR for your technology** out of your activities
Barriers	What are the main challenges and barriers you were facing during the project time?
Mobility service(s)	Which mobility service(s) are you targeting? ☐ Public Transportation ☐ Demand Responsive Transportation ☐ Car Sharing ☐ Logistics-as-a-service ☐ Mobility-as-a-service
"Market" – *Target market*	Describe the market in which your product/service will be used/can "compete", answering the following questions: - Which stakeholders are involved? - Do you plan on partnering with SME's/ start-ups? - How will you further finance the development? - How will you promote your service?
Value chain	Will the service enhance/ complement your current operation, or will you enter new fields of business?
Enablers	For the development of your service, what are the pre-conditions, key enablers to short-term and long-term development.
Disruptors	What are the barriers, challenges, and technical, financial and organizational issues you are facing during the development and implementation of your service?
Funding	Will you apply for further funding from a new research project or consultancy tender? ☐ Yes ☐ No Do you already know which? - please specify.
Research	Will SHOW deliver input to research led teaching for students? ☐ Yes ☐ No

	Will SHOW be part of PhDs and/ or student projects? ☐ Yes ☐ No
Consulting	Are you going to offer your learnings for networking with industry partners or administrations? ☐ Yes ☐ No Do you already have industry partner for" SHOW consulting"?

Exploitation roadmap questionnaire

Exploitation roadmap	
Actions	Briefly describe actions planned to be executed until the end of the project. Make sure you do not just focus on technical activities (realisation of a prototype, software interface, etc) but also consider the finalisation of a business plan, the protection of intellectual property, the collection of authorisations, all it will be needed to start implement what is in your exploitation plan
Roles	Roles of partners involved in the actions defined above.
Milestones	List the milestones and KPIs to be used for monitoring the implementation of the actions listed above.
Revenues	If applicable: Projected revenues and eventual profits once the result will be used (1 and 3 years after use) Consider revenues you will expect to collect by licensing, or thanks to service provision or sale of devices. They generate the cash flow that will make the use of the result sustainable over time (provide an estimation concerning the first year and what is expected after 3 years, if possible)
Impact in 3-year time	Describe impact in terms of growth/benefits for the society Impact is the objective of H2020. Impact should mobilise measurable changes in terms of growth/benefits for the society (i.e. jobs created, investments mobilized, turnover generated).