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SHared automation Operating models for Worldwide adoption

SHOW

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D2.3: First version of validated business/operating models

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Legal Disclaimer

Executive Summary

D2.3 presents the first results of the evaluation of SHOW business/ operating models. SHOW brings together all key stakeholder across 13 EU states, with the vision to support the deployment of shared connected and electrified automation in urban transport chains through demonstration of real-life CCAV scenarios to promote seamless and safe sustainable mobility. Therefore, the evaluation of the business models within D2.3 relies heavily on the feedback of consortium partners that are interested in operating tested services long term.

A comprehensive methodology is then constructed, based on seven steps, and breaking down each business/ operating model into several assumptions and goals, which are then assessed one by one. The assumptions are defined starting from the business canvas described in D2.2. They are then consolidated and prioritized based on feedbacks of consortium partners.

A scoring model is established to calculate the final score of business/ operating models. It relies on the analysis of interviews, acceptance surveys, vehicle's data collected, simulation results and/ or production costs.

D2.3 describes the assumptions and goals for all SHOW business/ operating models. It identifies the assumptions that are critical for each business/ operating model. The scoring is performed in this deliverable for three selected different SHOW business/ operating models, namely: BM7 - Sustainable living areas with autonomous public transportation, BM8 - First/Last mile autonomous transportation to mobility HUBs, and BM10 – Interoperable IoT platforms for automated mobility. These three business/ operating models are those for which the data collection from the corresponding test sites is the most advanced, data collected is reliable, while in those three ones, business / operating models related to shared automated person and freight transport as well as a new one that is identified in D2.2 are represented. For other business / operating models, and considering the progress of trials, data collected was not sufficient to perform an evaluation/scoring analysis at this phase. However, all remaining business/ operating models will be fully evaluated in *D2.4: Final validated business/ operating models*. Finally, most of KPIs are calculated, and the rest will be estimated more precisely in *D2.4: Final validated business/ operating models"* when data will be available for all business models.

Thanks to this first analysis, we identified several improvements for the analyzed business/ operating models, including considering additional business/ operating assumptions, covering other strategic objectives, and/ or increasing the performances of calculated indicators. The methodology should be also improved especially regarding the approach for prioritizing goals of business/ operating models. The evaluation of the three business/ operating models revealed that the BM7 is fulfilling its objectives with higher scores than BM8 and BM10. In future steps, this methodology will be improved and applied on all business/ operating models in order to compare their performances across SHOW pilot sites (*D2.4: Final validated business/ operating models*). The transferability and scalability of tested business/ operating models will be based on the same methodology and will be addressed by *Deliverable 2.5: Scalability and transferability of business/ operating models"*

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Abbreviation List

Abbreviation	Definition
APT-ODS	Automated public transport and on-demand service
AV	Automated Vehicle
B2B	Business-to-Business
B2B2C	Business-to-Business-to-Customers
B2C	Business-to-Customers
BM	Business Model
BMC	Business Model Canvas
C-ITS	Connected Intelligent Transport System
DRT	Demand Responsive Transport
IoT	Internet of Things
ITS	Intelligent Transport System
KPI	Key Performance Indicator
LaaS	Logistics-as-a-Service
MaaS	Mobility-as-a-Service
NA	Non Applicable
ODS	On-Demand-Service
OEM	Original Equipment Manufacturer
OPEX	Operating Expenditures
PT	Public Transport
PTO	Public Transport Operator
SAE	Society of Automotive Engineers
SME	Small and Medium-sized Enterprises
TBD	To Be Done
VPC	Value Proposition Canvas

Glossary

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.

Testing business models

Business models are built by considering, implicitly or explicitly, several assumptions. These assumptions can be identified through analyzing the business model canvas. For instance, consider a first/last-mile that aims to be provided during peak-hours. One assumption is that users are mainly transit passengers. That assumption should be verified through testing. Testing business models corresponds then to this process of testing (through questionnaires, observations, data collection, etc.) given assumptions.

Validating business models

Testing business models measures its performances regarding all its components: existence of partners, value for customers, availability of key resources, generation of revenues or reduction of costs, etc. The validation of the business model is obtained through validating the main assumptions regarding all these components.

Robustness of business models

The analysis of business model robustness should be approached as part of a business model design process [1]. The business models' robustness is defined by as "the business model's ability to fend off external threats from interactions with competitors and partners, and to cope with changes in the business environment including user requirements, regulatory regimes, target groups and scale of operation [2].

1 Introduction

1.1 Purpose and structure of the document

The SHOW project aims to explore sustainable business schemes that are cost efficient and modular; in accordance with the existing/planned infrastructure and fleets and each city/region as well as the relevant operational and legal framework. The previous document **D2.2: Proposed business / operating models and mapping to UCs and Pilot sites** [3] builds eight business models which are directly linked to the mega and satellite test sites and their use cases and proposes two additional models, covering then different types of services within SHOW (e.g. PT, MaaS, LaaS and DRT) at the different pilot sites of SHOW.

The current document, the so-called **Deliverable 2.3: First version of validated business/operating models**, aims to evaluate the proposed business/ operating models in terms of sensitivity and robustness through validating the main assumptions regarding their main components (e.g. value for customers, availability of key resources, generation of revenues or reduction of costs, etc.). The evaluation methodology is established in this document. It is based on (1) the generation and prioritization of the assumptions for different use cases, mobility services and business / operating models, (2) the identification of relevant key performance indicators (KPI), and (3) the construction of a scoring model that measures KPIs and the quality the robustness and efficiency of tested business / operating models. The methodology is then applied to fully evaluate three selected business/ operating models. The outcomes of these evaluations will be used to improve and finalize the methodology for an application on all SHOW business/ operating models. The methodology is in addition designed to be generic and to allow cross-pilots evaluation. Thus, this deliverable represents also the basis for **Deliverable 2.4: Final validated business/ operating models** and **Deliverable 2.5: Scalability and transferability of business/ operating models.**

D2.3 is structured according to the following approach:

- Chapter 2: Describes the methodology used more in depths. It relies on a literature review of previous works to build a seven-steps based framework that enables to conduct a cross-pilots evaluation.
- Chapter 3: Applied the evaluation methodology on all SHOW business / operating models.
    - In particular, five steps of the methodology are performed for all SHOW business/ operating models: identification of business/ operating assumptions, description of business/ operating goals, weighting goals, description of testing methods to validate business / operating models.
    - In a second step, three business/ operating models are fully evaluated through the application of the last two steps of the methodology.
- Chapter 4: discusses conclusions and limitations and describes next steps for the evaluation of all SHOW business/ operating models.

1.2 Intended Audience

The deliverable will address the relevant project partners within the SHOW consortium regarding business and operating models covering development, evaluation/demonstration, deployment and exploitation aspects during the whole duration.

Regarding external audience, the deliverable is interesting for those that are active in the business modelling field of CCAV, either with regard to the research/study part or the deployment part.

1.3 Interrelations

The internal interrelations of A2.3 are presented in Figure 1 and detailed below:

- WP1 – A1.1: SHOW Ecosystem
  Providing important information such as the definition of the different stakeholder groups and which consortium partners are falling under which stakeholder category as well as their gaps, needs, wants and priorities for automated vehicles and mobility services (person and freight). It also describes the procedures and mechanisms that will be developed to accommodate user opinion discovery regarding SHOW services.
  Important deliverables: D1.1

- WP1 – A1.2: SHOW Use cases
  The use cases of the different test sites contain information that are needed for test site specific customization of the cost assessment calculation (e.g. stakeholders and the relevant UC(s) for them or the different test sites and which UC(s) apply to them).
  Important deliverables: D1.2

- WP2 –business / operating models'
  The SHOW business / operating models are defined and described based on the methodology defined by A2.1: using business models canvas, value proposition canvas, success / failures factors analysis, etc.
  The identified business / operating models are tested and validated after their instantiation in SHOW test sites (Mega and Satellite).
  Important deliverables: D2.1, D2.2

- WP6 – A6.1: SHOW marketplace
  Data, sub-data of mobility services
  Important deliverables: D6.1, D6.2, D6.3

- WP9 – A9.4: Impact assessment framework, tools & KPIs definition
  Provides the final version of the KPIs needed for the evaluation of business models performances and success metrics. It also provides relevant information regarding the test sites and which services they are operating, which stakeholders and targeted end users they have.
  Important deliverables: D9.2, D9.3

- 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 evaluation.
  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.
  Important deliverables: D10.1, D10.2, D10.3, D10.4

- WP10 - A10.3: Person, mobility, freight and environment related simulations
  This focuses on conducting simulations related to people, mobility, energy and environment. It also shows the user' behaviour when automated features are present and show the behavioural differences vehicles of different automation level and conventional vehicles.
  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 highlighting the safety level and the economic benefits of highly automated vehicle fleets.
  Important deliverables: D10.3, D10.5

- WP12 – Real-life demonstrations
  Performs the SHOW Pilots, performs data gathering during the Pilots and provides detailed reporting of Pilot results to WP2 for business/ operating models evaluation and validation.
  Important deliverables: D12.1, D12.2, D12.3, D12.4, D12.5, D12.6, D12.7, D12.8, D12.9

- 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 new cost structures.
  Important deliverables: D16.1

- WP16 – A16.2: Economic and business impact assessment
  Total-Cost-of-Ownership (TCO) and Cost Benefit Assessment (CBA) and Cost Effectiveness Assessment methodologies (CEA) will be applied for business models that are tested in A2.3. Economic indicators will be used to (in)validate business models.
  Important deliverables: D16.2

- WP16 – A16.3: Exploitation plans per partner and stakeholder groups
  The results from A2.3 will feed A16.3, which generates business exploitation models and strategies per cluster as well as roadmaps for large-scale deployment.

- WP17 – A17.1: Best practices and application guidelines for different stakeholder groups
  This task has the aim to create 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 different SHOW WPs, among them the results coming from A2.3.

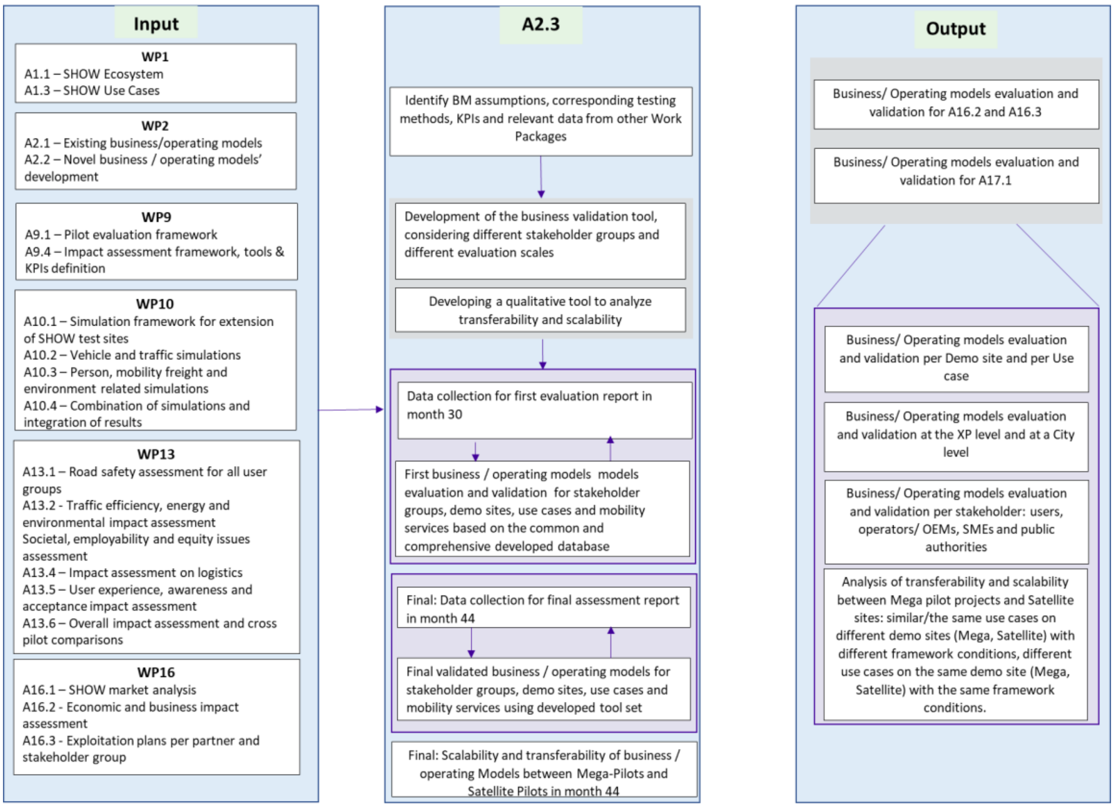

Figure 1: Description of interaction with SHOW WPs and Activity A2.3

2 Methodological approach

In previous deliverables D2.1 [4] and D2.2 [3], we have identified ten business and operating models, eight of them were planned in SHOW and two of them are novel.

The aim is to (in)validate the relevance, robustness and scalability of the identified business/ operating models from the perspective of main stakeholders, including SMEs and new market entrants.

This validation will be achieved through the instantiation of business/ operating models in SHOW test sites.

2.1 Related works

Business model evaluation domain has not been investigated sufficiently. Although there have been several research studies on business models, e.g., defining business model, taxonomy of business models, decomposing business models into its constituents, ontology, design tools [2], [5]–[10]; the evaluation of business models, especially before they are introduced to the market, is still an area that has not been sufficiently investigated.

2.1.1 Evaluation and validation concepts

Three main contexts for the evaluation of business models could be discerned:

(a) The evaluation of a business model that is already running for many years, with the goal to optimize its performances. This evaluation is mainly based on a data-driven analysis [11] but could also rely on a strategic management approach.
(b) The evaluation of a future business model, by considering long-term scenarios in order to analyse trends and uncertainties. This evaluation is performed through simulation-based approaches, in particular system dynamics models [12].
(c) The evaluation of emerging business models, that are under-experimentation in order to identify their strengths/ weaknesses and to facilitate their implementation in the market.

Within the SHOW project, we focus on the last case where business/ operating models are tested through demonstrations.

2.1.1.1 Strategic management approach

Osterwalder and Pigneur [8] proposed to assess business models by considering two perspectives: firstly, providing a big picture assessment using the Business Model Canvas, and secondly breaking down the business model into “building blocks” and assessing each one of them through performing a SWOT analysis (i.e., analyzing Strengths, Weaknesses, Opportunities, and Threats).

A similar approach had been proposed by Haaker et al. [13] within the H2020 European Project ENviSION[1], where the components of the Business Model Canvas are analyzed regarding different assumptions that are reflecting the trends and uncertainties. These assumptions are derived from existing scenarios and evaluated through specific sessions with involved stakeholders. A heat map enables to visualize the impact of outcomes of uncertainties on the business model’s components and suggests ways to increase the robustness of the business model. This approach has however two main limitations. Firstly, it considers all assumptions without any prioritization. The heat map could then guide to improve or to ignore some components of the business model that are not important or critical. Secondly, the evaluation is based only on internal sessions, without real testing, which is far from being reliable.

[1] https://cordis.europa.eu/project/id/645791

More recently, Bland and Osterwalder [14] proposed a new evaluation framework in order to reduce the risk and increase the likelihood of success for business projects. This framework builds on the popular Business Model Canvas (BMC) and Value Proposition Canvas (VPC) and integrates assumptions mapping and other lean startup-style experiments. In particular, three types of assumptions are generated based on Business Model Canvas and Value Proposition Canvas: desirability assumptions, feasibility assumptions and viability assumptions. Testing and experimenting are focusing then only on important and riskiest assumptions, for which the business will fail if they are false. Several testing approaches are proposed by Bland and Osterwalder [14] depending on the business typology (B2B vs B2C vs B2B2C, software vs hardware vs service). These include for instance customer interview, paper prototype, online ad, storyboard, learning cards, etc. The main advantage of this evaluation framework is its simplicity. Also, since it is based on popular methods (e.g., Business Model Canvas), it is then intuitive and applicable for different types of business models. It had been applied within the H2020 European Project R2PI[2] [15] and TRUSTS[3] [16]. Nevertheless, its very openness guides to a conceptual evaluation [17]. In addition, it is not clarified how the outcomes of this approach could be used to validate or invalidate the business model.

Lüdeke-Freund et al. [18] proposed another conceptual framework for sustainability-oriented business model assessment by combining the Business Model Canvas with the Sustainability Balanced Scorecard as a controlling tool [19]. In order to integrate sustainability indicators, their framework considered in addition to the model of [19] a non-market perspective and defined indicators based on the Global Reporting Initiative (GRI) standard [20].

2.1.1.2 Engineering approach

Other studies have focused on the measurement of business models success factors. Horsti [21] presented an evaluation tool for e-business models. He adopted the categorization of Hedman & Kalling's [22] framework as a basis, considering seven components that are causally related: customers, competitors, offering, activities and organization, resources, supply of factor and production input, and management scope. In a second step, he identified through a literature review 42 prerequisites of success and 15 measures of success. Each success factor gets a quantitative value, after having been prioritized and put in an order according to its importance. If a success factor is bigger than a pre-determined threshold value, then this business model is good regarding that specific success factor. The most important feature of this method is that the success factors are analyzed very deeply. However, he does not give weights to the values of success factors. The interrelations between success factors are ignored. Another weak point is that the evaluation is based on only one business model.

The framework of Wohltorf [23] "Scoring-Model for Success Evaluation of Ubiquitous Services" uses the same logic as Horsti's tool. Three domains are considered, to which the success factors can be allocated: user, competition, and technology. As for Horsti's tool, Wohltorf gives quantitative values to success factors, but also proposed weighting them according to their importance. If the overall value is bigger than a threshold, then the business model is successful. The main limitation of this framework is related to the domains considered for the evaluation (users, competition, and technology). Many components are ignored such as value proposition, profitability, and so on, which may be critical to some services. Wohltorf's Scoring Model seems to be appropriate to evaluating new services, rather than evaluating business models [17]. The classification of success factors according to the business models' goals is recommended especially for transportation projects [24].

Gordijn and Akkermans [25] base their evaluation of business models on e3-value ontology [26]: "a value model which shows actors who are exchanging things of economic value with

[2] https://cordis.europa.eu/project/id/730378
[3] https://cordis.europa.eu/project/id/871481

each other". The model focuses on the analysis of the allocation of costs, benefits and risks across actors in the ecosystem. The elements and relationships encompass the actor, value object, value port, value interface, value activity and value exchange of a business model [27]. Their evaluation criterion is financial feasibility of an e-business model, which means that all actors involved can make a profit or increase their economic utility. Sensitivity and financial risk analysis could be also performed through considering different scenarios with different market assumptions about occurrences of consumer needs, price of value objects, and investments per actor, to estimate revenues and expenses for the actors in the model. Unlike previous evaluation tools, Gordijn & Akkermans [25] focus on the profitability aspect and do not use success factors. Furthermore, since it is relying on what-if scenarios, it is difficult to find a generic scenario for all business models, which could be considered as a limit of this evaluation method.

2.1.2 Indicators for the evaluation of BM

Due to the business model concept's historical background, which is partly in the domain of strategic management, the evaluation of business models is closely related to economic oriented performances. Wirtz [10], for instance, proposed a financial business model framework, which considers as main assessment criteria the achievement of a promised value proposition, the degree of customer satisfaction, and profitability. The model of Osterwalder [8], [14] considered that the performance of a business model has to be expressed in terms of financial costs and revenues. The e3 model of Gordijn and Akkermans [25] is also centered on the profitability.

A few studies proposed to consider also non-monetary aspects, especially social and/ or ecological performances for the evaluation of business models [18], [28], [29]. The social and / or ecological performances should be adapted so they are relevant for the organization's strategy and the definition of corresponding strategic objectives and performance drivers.

Other indicators to evaluate business models' success are linked to concepts of viability, feasibility and robustness [30]. Viability can be operationalized through a business case that assesses the financial implications of a BM [13]. Feasibility relates to the question if a BM can actually be implemented and deployed in practice. A BM is feasible if required resources are available, such as finance, technology, human resources or intellectual property. Also, legal, regulatory or moral barriers should not prevent implementing the BM. Robustness is defined by Bouwman et al. [1] as "the ability to cope with changes in the business environment", by Casadesus-Masanell and Ricart [2] as "the business model's ability to fend off external threats from interactions with competitors and partners", by Snihur and Zott [31] as "the business model's ability to provide a high familiarity to users and partners, while being sufficiently novel as a protection against imitation" and by [13] as 'the long-term viability and feasibility of a BM in a given future environment". Overall, the scarce literature on business model robustness has not converged towards a common understanding and has not yet yielded a comprehensive perspective for designing robust business models.

2.1.3 Summary and proposed approach

As a summary, two types of approaches are proposed in the existing literature for the evaluation of business models:

1) A strategic management approach: relying on breaking down the business model into its components and performing an evaluation of assumptions according to each component. This approach is holistic, conceptual and does not propose a clear and deterministic method to validate or invalidate business models.
2) An engineering approach: aiming at proposing a scoring model to measure performance indicators and using success factors to validate or invalidate business models. These indicators are mainly considered as economic in previous studies. This

approach is more adapted to analyse a specific business model, and less transferable and generalizable.

In the SHOW project, we propose to combine these two approaches. Our objective is to assess ten distinct business / operating models. Thus, a generic approach should be developed, which is replicable from business model to another, and which enables in addition a cross-pilots and cross-business models' evaluations. On the other hand, each SHOW business/ operating model has specific strategies and goals (e.g. economic viability, reducing congestion, supporting business ecosystem development, etc.). Our methodology proposes then to formulate the success factors through performance indicators and weighting them depending on the goals of each business model.

This methodology is developed exclusively within the SHOW project based on the combination of management and engineering approaches. This methodology is still under-development. It is applied in this report D2.3 on three SHOW business/ operating models to identify improvement paths. It will be finalized and applied to all SHOW business models in D2.4 and could be used as basis for the evaluation of transferability and scalability in D2.5.

2.2 Framework for SHOW business models' validation methodology

The SHOW business models' validation methodology is combining existing approaches based on management methods (Business Model Canvas, Assumptions prioritization, etc.) and engineering methods (Scoring models, KPIs measurement).

It is structured into seven steps, which are the following:

- **Step 1:** Describing business / operating models and mapping with test sites/ use cases
- **Step 2:** Identifying critical assumptions of each business/ operating model
- **Step 3:** Identification KPIs in order to assess defined assumptions
- **Step 4:** Design of testing methods
- **Step 5:** Testing/ Data collection and KPIs measurement
- **Step 6:** Scoring assumptions and business / operating models
- **Step 7:** Analysing results and formulating recommendations

These steps are visualized in **Figure 2**.

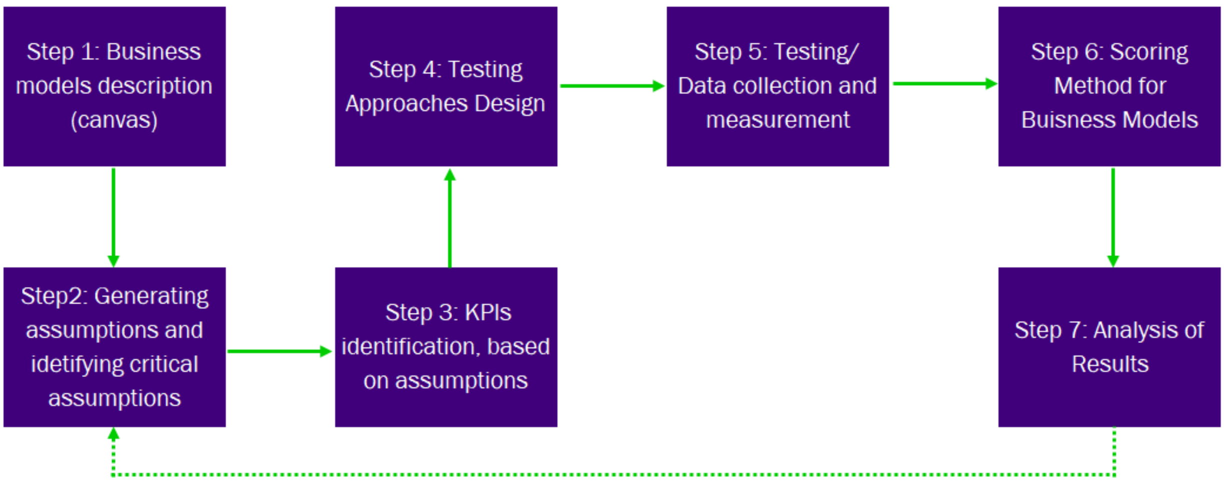

Figure 2: Steps for business/ operating models' validation

In the following, steps are described in more detail.

2.2.1 Step 1: Describe business models and mapping with pilot sites

Business models' validation requires a structured and coherent description of the business model and a relevant and representative collection of key success and failure factors. This description had been performed in D2.2, where ten business / operating models had been identified. **Figure 3** shows the template used to describe and mapping them with pilot sites.

1. Autonomous PT in combination with additional on-demand services
2. Autonomous Bus Depots
3. Advanced MaaS in urban environments
4. Combined MaaS and LaaS (for the hospital campus)
5. Peri-urban automated transportation and C-ITS connectivity
6. Robotaxi services for short distance trips
7. Sustainable living areas with autonomous public transportation
8. First/Last mile autonomous transportation to mobility HUBs
9. Integrated automated and electric shuttle buses for large scale events
10. Interoperable IoT platforms for automated mobility

Mapping BMs with pilot sites

USE CASE Nº: ______
SITE ______
PARTNER ______
RESPONSIBLE ______

Pilot Site	Name of pilot site		
	Service Description	Selection	Deviation from Main Description
1. Autonomous PT in combination with additional on-demand services		☐	
2. Autonomous Bus Depots		☐	
3. Advanced MaaS in urban environments		☐	
4. Combined MaaS and LaaS (for the hospital campus)		☐	
5. Peri-urban automated transportation and C-ITS connectivity		☐	
6. Robotaxi services for short distance trips		☐	
7. Sustainable living areas with autonomous public transportation		☐	
8. First/Last mile autonomous transportation to mobility HUBs		☐	
9. Integrated automated and electric shuttle busses for large scale events		☐	
10. Interoperable IoT platforms for automated mobility		☐	

Figure 3: Mapping Business Models with Pilot Sites

2.2.2 Step 2: Generate and Identify critical assumptions

So far, business/ operating models are built on a list of assumptions or hypothesis. It is through testing and validating, wholly or partially, these assumptions that the business project starts becoming a reality.

In order to identify assumptions to be tested/ validated, it is crucial to generate all of them and then to choose which ones are critical for the business model viability.

Generation of assumptions

An assumption is defined as an hypothesis "that the value proposition, business model, or strategy builds on and what it is needed to learn about to understand if your business idea might work" [14]. A well-formed business assumption describes a testable, precise, and discrete object that is investigated. For instance, one assumption related to customer satisfaction could be that "the business model is focused on pains that really matter to customers" or that "the segments that are targeted exist and are big enough".

The generation of assumptions is a challenging and complex task since they are in general made implicitly by the service/product provider or manager. A first challenge is then to make the implicit mental models explicit in order to understand the structure and its potential behavior.

Several techniques to reveal the assumptions exist and are effective such as the 5-whys and a fishbone diagram [32]. Assumptions can also be derived from existing situations (similar operating services) or from brainstorm sessions with involved stakeholders. Frameworks like PESTLE can be used to assure that multiple perspectives are covered. Bland and Osterwalder [14] propose to start from the main building blocks of the business model canvas to generate assumptions block by block: customer and market, market growing strategies, channels, competition, partners' capabilities, investment, etc. Adopting these "conventional" approaches ensures that assumptions are tailored to the use case at hand, but does pose the risk of bias as people tend to select the assumptions they are already familiar with. An alternative approach is to generate assumptions based on previous/ similar experiences and/ or best practices [15], [16]. While collected developments are less tailored, blind spots can be avoided.

Considering these two approaches, the generation of assumptions in SHOW is performed in following steps. **Figure 4** describes the steps in more detail.

1) Firstly, the business model canvas and value proposition canvas as proposed by D2.2 will be a starting point to identify main assumptions. In addition, the interviews that had been conducted by D2.2 with main pilot sites touch on indirectly several assumptions that could be revealed when describing the business model, its proposition value, success keys, failure risks, etc. The outcome of this analysis will be an objective and non-exhaustive list of assumptions.
2) Secondly, additional assumptions could be identified by SHOW partners based on their previous experience or/and best practices.

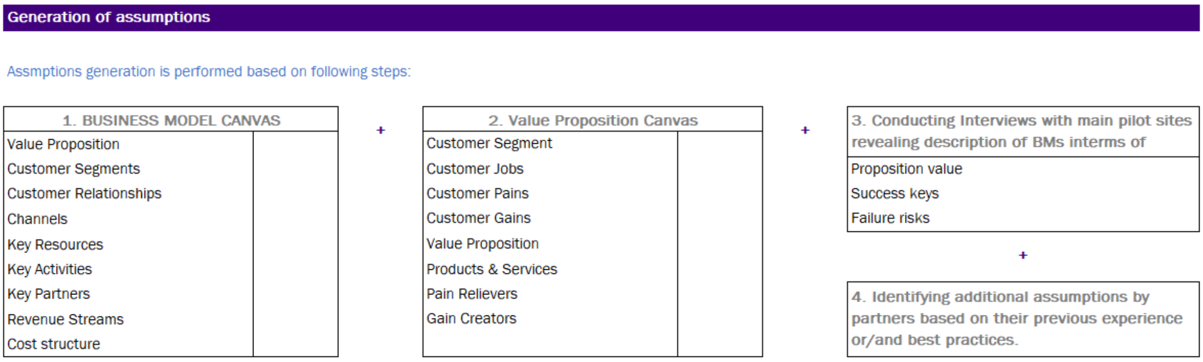

Figure 4: Procedure to generate assumptions

Mapping assumptions with objectives of business/ operating models

Through analyzing business/ operating models that had been identified for SHOW business/ operating models, it is observed that they could be classified into ten specific goal areas:

Goal 1: Accessibility and Equity – Ensures that all people can access to their destination using safe, healthy, convenient, and affordable transportation choices

Goal 2: Service quality – Provides passengers a service allowing to reach in an efficient, rapid, and comfortable way to their destination

Goal 3: Community vitality and Local priorities – Supports communities, enhances quality of life, and improves accessibility of residents who live in the vicinity of the service.

Goal 4: Economic – Proposes more cost-effective solution for passengers and service providers as well.

Goal 5: Congestion and Modal share – Improves the travel time reliability, which is affected by uncertainties caused by the congestion, reduces the traffic flows and contributes to the modal shift to shared and sustainable mobility solutions.

Goal 6: Safety and security – Enhances the safety of mobility services' users by providing for the safe movement of people and goods and reducing injuries and fatalities.

Goal 7: Environment – Improves the sustainability through saving more space and reduction of noise, of emissions of greenhouse gases and pollutants, and of energy consumption.

Goal 8: Business ecosystem and Development – Involves new players, including OEMs, ITS providers, SMEs, associations, and local authorities, and allows creating collaborations that support their respective development and growth.

Goal 9: Technology – Proves the technical feasibility of the service and tests its reliability.

Goal 10: Efficiency and productivity – Ensures better vehicles' utilization through providing higher supplied traffic (e.g. seat-kilometers), better quality of service (e.g. higher speeds, higher frequencies, lower delays, etc.) and then attracting more passengers.

Depending on each business/ operating model's specifications, the weighting metrics of these goals should be established **(Figure 5)**. One method to estimate weightings is considering that they are proportional to the number of assumptions that are generated by goal. This method is simple and is applied in this document. However, it does not reflect necessary the importance of the goal for the tested business/ operating model. In the next deliverable D2.4, this estimation will be based on questionnaires directed at tests pilots in order to measure their sensitivity against all business/ operating model's goals.

Calculation - For Each Assumption of the Buisness Model determine the Goals, their Weight and its applicability

For each assumptions, score the relative goals:	Typology - Defined weigth of goals by Pilots	Weight of Goals	Applicability of goal for assumption	Score of each assumption
Goal 1: Accessibility and Equity		-	☐	-
Goal 2: Service quality		-	☐	-
Goal 3: Community vitality and Local priorities		-	☐	-
Goal 4: Economic		-	☐	-
Goal 5: Congestion and Modal share		-	☐	-
Goal 6: Safety and security		-	☐	-
Goal 7: Environment		-	☐	-
Goal 8: Business ecosystem and Development		-	☐	-
Goal 9: Technology		-	☐	-
Goal 10: Efficiency and productivity		-	☐	-

Legend	
	Low
	Medium
	High

Figure 5: Procedure to determine goals, their weights, and its applicability for assumptions

Prioritization of assumptions

In general, the number of assumptions should be limited to keep the testing/ validation approach manageable. Stakeholders are invited to select those assumptions that require being tested in sites (i.e., less evident), and which would have the highest impact on the business model (i.e., more important). The results of the business models' validation will, at least to some extent, depend on this selection. In addition, this will influence the discussions, reasoning, testing protocols, data collection and analyses. Therefore, the prioritization requires estimating how each assumption affects the business model. It also depends on how much evidence supports or refutes a specific assumption. An assumption for which a relevant, observable, and recent evidence is produced will not be less prioritized compared to an assumption for which evidence is less clear and requires to be generated and tested.

Consequently, critical assumptions that should be tested in priority are those with high impact on the business/ operating model and with light evidence. In order to achieve this prioritization for all sites, a workshop had been organized to explain in detail the methodology, its objectives and expected outcomes. In a second step, bilateral meetings were organized by A2.3 and directed at test pilots and their ecosystem. During these meetings, they are indicating for each assumption if it is important and evident (**Figure 6**). They are then positioning, by using the assumption map [14], each generated assumption regarding the importance level and the evidence degree **(Figure 7)**. The outcome of this interaction is the final list of assumptions that should be tested in SHOW for each business/ operating model in order to (in)validate its robustness (i.e., top right quadrant of the assumption map in **Figure 7**).

Prioritization of assumptions

For each BM - Priotization

Assumptions/Hypothesis	Importance		Evidence	
	YES	NO	YES	NO
Assumption 1				
Assumption 2				
Assumption 3				
Assumption 4				
Assumption 5				
.				

Figure 6: Procedure for prioritization of assumptions

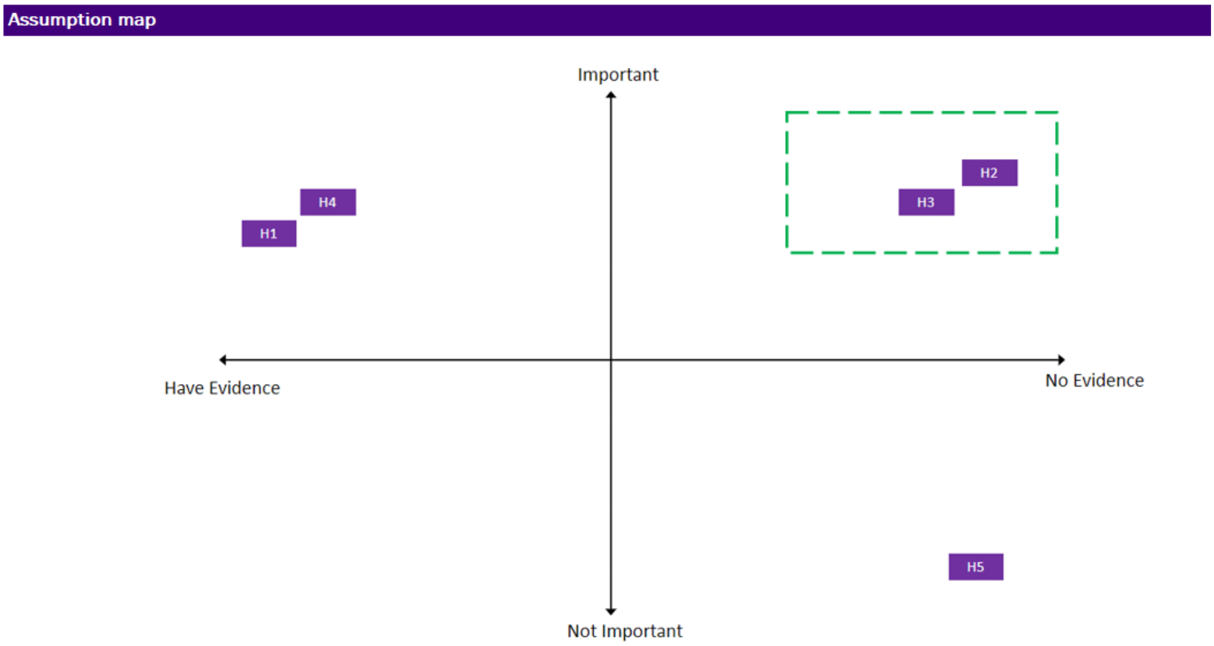

Figure 7: Assumption map [14]. ***The top right quadrant identifies which assumptions are critical. In this example the critical assumptions are H2 and H3.***

2.2.3 Step 3: KPIs identification, mapping with objectives and assumptions

KPIs are used to measure the achievement of business objectives for given deployment assumptions. Tracking irrelevant KPIs will distract us from focusing on what truly matters. Thus, it is required to determine for each business model which are the performance metrics that need to be measured in priority according to its objectives and to identified assumptions **(Figure 8)**.

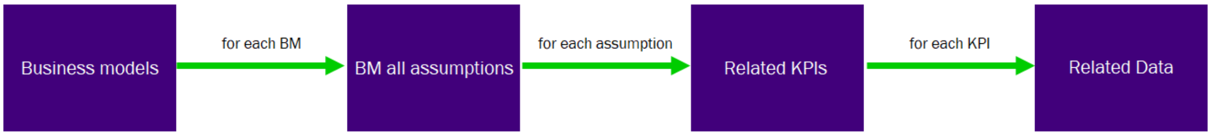

Figure 8: Procedure for KPI identification

Data that is required for the calculation of the KPI is then identified (Figure 9). The test pilots are indicating then if the data collection is feasible or not, and therefore, if the assumption could be evaluated or no.

KPIs identification, Data required and Feasibility

For each BM

Assumptions/Hypothesis	KPI	Data	Type of Hypothesis		Feasibility (Yes or no)
			Qualitative	Quantitative	
Assumption 1	-	-	-	-	-
Assumption 2	-	-	-	-	-
Assumption 3	-	-	-	-	-
Assumption 4	-	-	-	-	-
Assumption 5	-	-	-	-	-
.	-	-	-	-	-
.	-	-	-	-	-

Figure 9: KPIs identification, data required and feasibility

2.2.4 Step 4: Design of testing methods

Methods of testing are designed to test the business models in terms of desirability, viability and/or operational feasibility. Different testing methods are used in SHOW project. They include performing:

- Expert Surveys
- Acceptance surveys (a priori and during)
- Static and dynamic data collection: Vehicle data, Traffic Efficiency Data, Infrastructure Data, Passenger Data, Logistics Data, Trip Itinerary Data, Environment Data and Energy Data
- Economic and socioeconomic analysis: Cost-Benefit Analysis, Total Cost Ownership Analysis, Cost Efficiency Analysis
- Simulation: Microscopic simulation, Agent-based simulation
- Project Success KPIs

These methods could be defined based on main aspects as proposed by [14], such as the cost, the energy and the time that are required for testing a specific assumption. They outline that these aspects are sensitive to the level of evidence for the tested assumption. **Figure 10** indicates in addition the WP in SHOW which is responsible of designing and applying each method.

Testing methods and interaction of SHOW WPs

For each assumption

		Source of Information	Activity	Relevence
Check for relevent KPI identified by:	1	WP 1	User Acceptability	☐
	2	WP 2	Business Oriented KPIs	☐
	3	WP 9	Impact Assessment and KPI Definition	☐
	4	WP 10	Simulation	☐
	5	WP 16	Economic and Business Factors	☐
	6	.	.	
For each KPI, determine raw Data	1	WP 1	Surveys	☐
	2	WP 5	Data Collection Platform	☐
	3	WP 10	Simulation	☐
	4	WP 16	Cost-Benefit Analysis	☐
	5	.	.	

Figure 10: Testing methods and interaction of SHOW WPs

2.2.5 Step 5: Testing/ Data collection and measurement

As presented in the previous steps (Step 3: KPIs identification, mapping with objectives and assumptions and Step 4: Design of testing methods), data required to validate business / operating models is also collected by other SHOW WPs (**Figure 8**). A close coordination is then necessary to ensure that all required data is included in the collection process. The measurement of KPIs is also a joint work with other WPs. In particular:

- The willingness to pay, the willingness to share and the sensitivity to the quality of service are calculated based on the survey by WP2,
- The performances of vehicles and proposed services are compiled by using dynamic collected data by WP5,
- The performance indicators for future and upscaled services are measured by WP10,
- The environmental indicators are provided by WP13,
- The economic indicators are estimated by WP16.

2.2.6 Step 6: Scoring model

The business/ operating models are scored in order to (in)validate their robustness and provide a cross-evaluation. The scoring model utilizes the static and dynamic test data, surveys, qualitative responses of test leaders, and forecasted data to evaluate the business/ operating model.

For each assumption, weight is defined based on the prioritization of assumptions. An assumption with maximal importance and minimal evidence will have a weight of 5 **(Figure 11).** On the other hand, an assumption with minimal importance and maximal evidence will have a weight of almost 0. If the assumption is not applicable at all to the test sites, then the weight is 0.

In addition, the assumption is evaluated through at least one KPI. This KPI could be:

- **Qualitative:** in that case it is scored 0 or 1 depending on if it is validated or not. For instance, a qualitative KPI could be the “Existence of common user application providing real time information on service state” or the “involvement of new OEMs in the pilot”.
- **Quantitative:** in that case, it is scored based on data collected. The raw value is compared to that of other existing alternatives. In order to obtain the score on a scale from 0 to 1, each value is divided by the highest value among alternatives’ values.

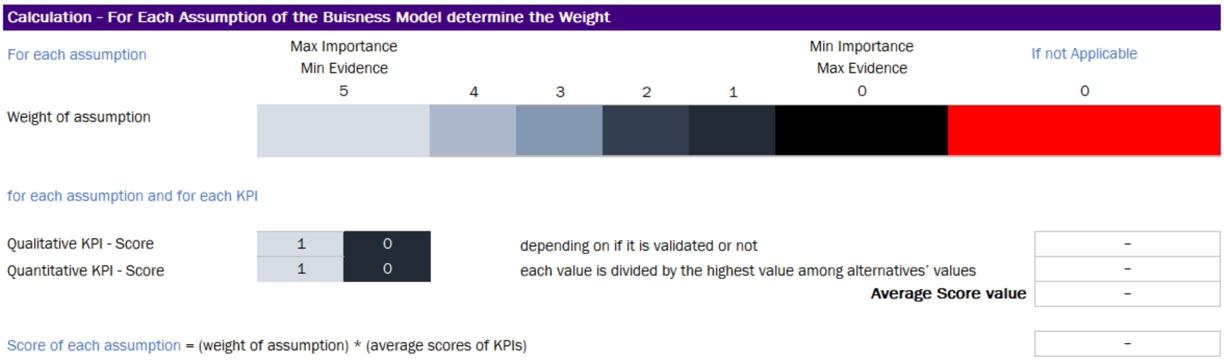

Figure 11: Testing methods in SHOW Project

The score of the assumption is then calculated as the mean of all KPIs scores, multiplied by its weight. In a second step, the business/ operating model's goals are scored by grouping all assumptions that contribute to them. Finally, the total score of the business / operating model is deduced by summing the weighted scores of goals (Figure 12).

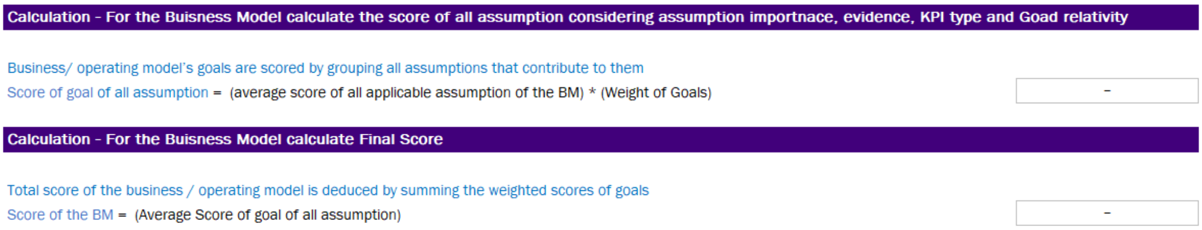

Figure 12: Testing methods in SHOW Project

2.2.7 Step 7: Analyse results and formulate recommendations and improvement actions

The analysis of results will be performed through evaluating performances of each business / operating model regarding each of its goals and contributing to a discussion on its performances compared to other business/ operating models.

After analysing the results of the BM, the final step is to define actionable conclusions. Recommendations are typically made on how to improve weak business models or improve consistency across its components.

The analysis of future situations could rely on simulation, with defining the best- and worst-case scenario of the business model's development and evaluate the impact on KPIs and success indexes. This step should be performed together with WP16 to ensure that all results for business and economic impact fits together.

3 Application on SHOW business models and first results

3.1 Mapping business/ operating models with test sites

The mapping of SHOW business/ operating models with test sites has been performed based on discussions with test pilots. In particular, they have indicated for their demonstration which are the closest business/ operating models and described - when it is relevant - the deviation from the original description of chosen business/ operating models.

3.1.1 Mega sites

3.1.1.1 The German Mega Pilot

3.1.1.1.1 Monheim Pilot Site

Corresponding business / operating models:

- BM3 - Advanced MaaS in urban environments

Closest business / operating models: BM3 - Advanced MaaS in urban environments

Deviation from the original description: No deviation

3.1.1.1.2 Karlsruhe Pilot Site

Corresponding business / operating models:

- BM4 - Combined MaaS and LaaS
- BM5 - Peri-urban automated transportation and C-ITS connectivity
- BM8 - First/Last mile autonomous transportation to mobility HUBs

Closest business / operating models: BM8 - First/Last mile autonomous transportation to mobility HUBs

Deviation from the original description: No deviation

3.1.1.2 The French Mega Pilot – Rouen Pilot Site

Corresponding business / operating models:

- BM3 - Advanced MaaS in urban environments
- BM8 - First/Last mile autonomous transportation to mobility HUBs

Closest business / operating models: BM3 - Advanced MaaS in urban environments

Deviation from the original description: No deviation

3.1.1.3 The Spanish Madrid Mega Pilot – Madrid Pilot Site

Corresponding business / operating models:

- BM2 - Autonomous Bus Depots

Closest business / operating models: BM2 - Autonomous Bus Depots

Deviation from the original description: No deviation

3.1.1.4 The Swedish Mega Pilot

3.1.1.4.1 Linkoping Pilot Site

Corresponding business / operating models:

- BM1 - Autonomous PT in combination with additional on-demand services
- BM7 - Sustainable living areas with autonomous public transportation
- BM8 - First/Last mile autonomous transportation to mobility HUBs

Closest business / operating models: BM7 - Sustainable living areas with autonomous public transportation

Deviation from the original description: No deviation

3.1.1.4.2 Gothenburg Pilot Site

Corresponding business / operating models:

- BM7 - Sustainable living areas with autonomous public transportation
- BM8 - First/Last mile autonomous transportation to mobility HUBs
- BM10 - Interoperable IoT platforms for automated mobility

Closest business / operating models: BM8 - First/Last mile autonomous transportation to mobility HUBs

Deviation from the original description: No deviation

3.1.1.5 The Austrian Mega Pilot

3.1.1.5.1 Salzburg Pilot Site

Corresponding business / operating models:

- BM1 - Autonomous PT in combination with additional on-demand services
- BM5 - Peri-urban automated transportation and C-ITS connectivity
- BM8 - First/Last mile autonomous transportation to mobility HUBs

Closest business / operating models: BM5 - Peri-urban automated transportation and C-ITS connectivity

Deviation from the original description: No deviation

3.1.1.5.2 The Graz Pilot Site

Corresponding business / operating models:

- BM6 - Robotaxi services for short distance trips
- BM10 - Interoperable IoT platforms for automated mobility

Closest business / operating models: BM6 - Robotaxi services for short-distance trips

Deviation from the original description: No deviation

3.1.1.6 The Carinthia Satellite Pilot

Corresponding business / operating models:

- BM4 - Combined MaaS and LaaS
- BM8 - First/Last mile autonomous transportation to mobility HUBs
- BM10 - Interoperable IoT platforms for automated mobility

Closest business / operating models:

- BM4 - Combined MaaS and LaaS
- BM8 - First/Last mile autonomous transportation to mobility HUBs

Deviation from the original description:

- BM4 - Combined MaaS and LaaS

MaaS and LaaS provided with the same automated vehicle.

- BM8 - First/Last mile autonomous transportation to mobility HUBs

In Klagenfurt the train station is connected with the university, a business/science park, residential area, recreation area and shops/restaurants. In Pörtschach the train station is connected with the lake, hotels, shops, restaurants and the town center.

3.1.2 Satellite sites

3.1.2.1 The Brno Satellite Pilot

Corresponding business / operating models:

- BM1: Autonomous PT in combination with additional on-demand services
- BM6: Robotaxi services for short distance trips
- BM8: First/Last mile autonomous transportation to mobility HUBs

Closest business / operating models: To be informed by the pilot leader (ongoing)

Deviation from the original description: To be informed by the pilot leader (ongoing)

3.1.2.2 The Tampere Satellite Pilot

Corresponding business / operating models:

- BM8 - First/Last mile autonomous transportation to mobility HUBs
- BM10 - Interoperable IoT platforms for automated mobility

Closest business / operating models: BM8 - First/Last mile autonomous transportation to mobility HUBs

Deviation from the original description: No deviation

3.1.2.3 The Trikala Satellite Pilot

Corresponding business / operating models:

- BM1 - Autonomous PT in combination with additional on-demand services
- BM3 – Advanced MaaS in urban environments
- BM6 – Robotaxi services for short distance trips

Closest business / operating models: BM1 - Autonomous PT in combination with additional on-demand services

Deviation from the original description: No deviation

3.1.2.4 The Brainport Satellite Pilot

Corresponding business / operating models:

- BM9: Integrated automated and electric shuttle buses for large scale events

Closest business / operating models: To be informed by the pilot leader (ongoing)

Deviation from the original description: To be informed by the pilot leader (ongoing)

3.1.3 Summary

For each SHOW test site, at least one business / operating model is identified. To give an overview of all business / operating models developed within SHOW and beyond, Figure 13 shows the mapping between test sites and business / operating models. The business/ operating model which is best corresponding to each site is marked in green color. We note that all business/ operating models are tested in at least one test site. Note however that for Brainport, the business/ operating model is proposed by the WP2 evaluation team but could be adjusted in the next deliverable (D2.4) based on the discussion with the pilot site.

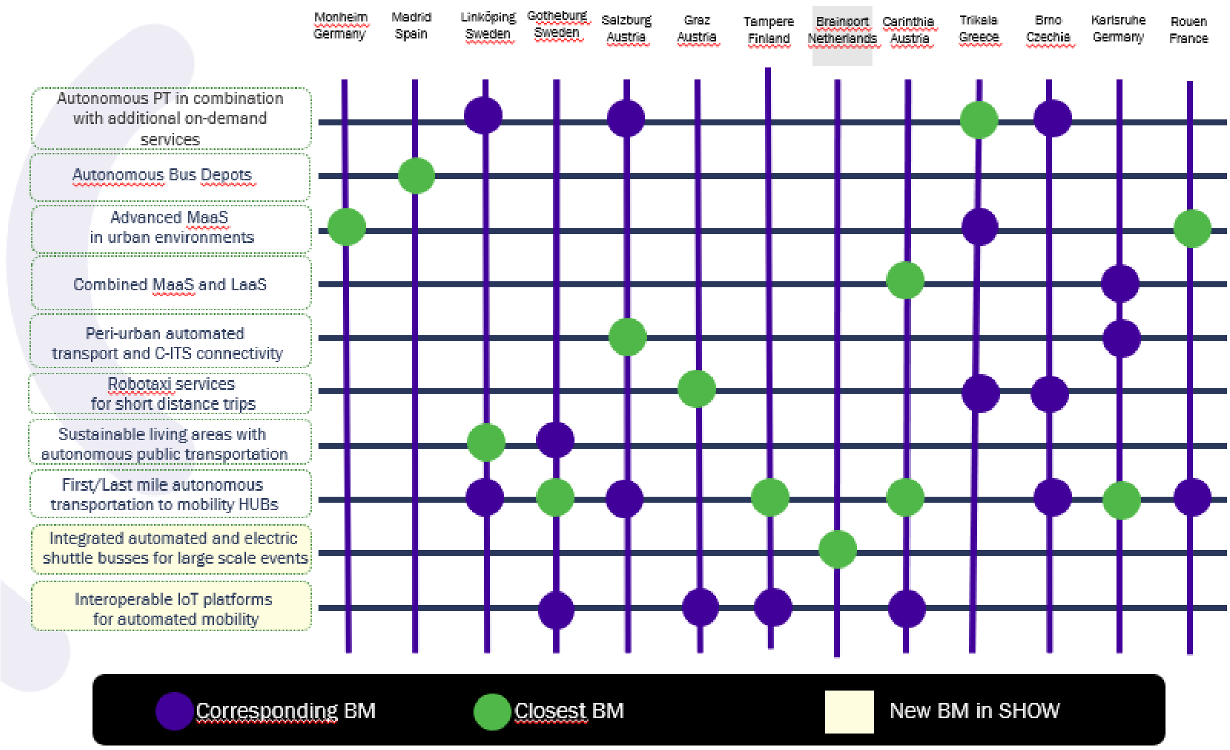

Figure 13: Mapping business/ operating models and test sites

3.2 Generation of assumptions for business models

3.2.1 BM1 – Autonomous PT in combination with additional on-demand services

The assumptions for BM1 are generated based on the Proposition value canvas and the Business model canvas described respectively in Table 1 and Table 2 of D2.2.

This business model is based on 17 assumptions as presented below:

H1: We believe that we could generate a fully integrated (physically and digitally) autonomous PT and on-demand operation (APT-ODS).

H2: We believe that we could generate an automated shuttle bus fixed line at peak time that connects the different facilities around the campus area and reduce travel times.

H3: We believe that we could generate an on-demand services at off peak times that reduce travel times.

H4: We believe that we could generate an integrated operation (APT-ODS) that serves students, commuters and personnel within the service area.

H5: We believe that through integrated operation (APT-ODS) we can reduce the waiting time of service users at peak time.

H6: We believe that through integrated operation we can increase service frequency.

H7: We believe that through integrated operation (APT-ODS) we can provide comfortable and at-standard seating capacity to service users.

H8: We believe that through integrated operation (APT-ODS) we can provide cheap and flexible service to users.

H9: We believe that through integrated operation (APT-ODS) we could guarantee standing and seating capacity to users if using pre-booking services.

H10: We believe that users can use USB charging while commuting.

H11: We believe that through integrated operation we could provide real-time information about traffic volume in the area and riders for the shuttle.

H12: We believe that by introducing integrated APT-ODS we can build a sustainable urban environment in the area: by reducing emissions.

H13: We believe that by introducing integrated APT-ODS we can build a sustainable urban environment in the area: by reducing noise.

H14: We believe that by introducing integrated APT-ODS we can build a sustainable urban environment in the area: by increasing safety.

H15: We believe that by introducing integrated APT-ODS we can eliminate existing mobility gaps in the area.

H16: We believe that by introducing integrated APT-ODS we can reduce private car usage in the area.

H17: We believe that by introducing integrated APT-ODS we can provide a better cost-effective operation compared to private cars.

3.2.2 BM2 – Autonomous Bus Depots

The assumptions for BM2 are generated based on the Proposition value canvas and the Business model canvas described respectively in Table 3 and Table 4 of D2.2.

This business model is based on 14 assumptions as presented below:

H1: We believe that through an autonomous bus depot OPEX costs will decrease significantly.

H2: We believe that through an autonomous bus depot there will be associated space savings.

H3: We believe that through an autonomous bus depot the safety within the depot will increase.

H4: We believe that through an autonomous bus depot we will reach lower levels of idle times and increase vehicle usage, increase productivity/speed of depot operations.

H5: We believe that PTOs and city and regional authorities will be interested in the implementation of an autonomous bus depot**.**

H6: We believe that through an autonomous bus depot we will contribute to a PT ticket price reduction in the near future, which suppose a benefit from social side.

H7: We believe that through an autonomous bus depot we will increase services (frequency and variety) as more vehicles will be available and drivers will have extra hours too**.**

H8: We believe that PTOs and city and regional authorities will contribute to the cost reduction we can deliver via an autonomous bus depot.

H9: We believe that homologation and authorization for an autonomous bus depot should not be extremely lengthy and complicated (controlled environment).

H10: We believe that through an autonomous bus depot we will contribute to reducing tedious labor and job satisfaction (also contributing with new jobs in control tower for instance).

H11: We believe that through a autonomous bus depot operations will be easier to handle and coordinate.

H12: We believe that an autonomous bus depot will not be severely conditioned for functioning due to weather issues.

H13: We believe that initial investment & maintenance costs for an autonomous bus depot will be higher than a regular one, but the increase will not be drastic.

H14: We believe that improved connectivity in the area (i.e. 5G) will allow teleoperation of the buses.

3.2.3 BM3 – Advanced MaaS in urban environments

The BM3 relies on 13 assumptions, based on Table 5 and Table 6 of D2.2. These assumptions are:

H1: We believe that we could generate a mobility as a service (MaaS) operation integrated with existing conventional services.

H2: We believe that we could generate an autonomous mobility service for population ranging from urban areas to rural areas.

H3: We believe that we could generate a mobility service for different trip purposes including commuting, shopping, groceries leisure and tourism.

H4: We believe that we can provide a real-time information about traffic volume in the area and riders for the shuttle (with application).

H5: We believe that a real-time information about traffic volume in the area and riders for the shuttle can provide added value to the passengers.

H6: We believe that we could generate a pre-booking application for ticketing and seat selection.

H7: We believe that by introducing MaaS services we could reduce private car usage in urban areas and decrease level of congestion.

H8: We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing less noise.

H9: We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing less emission.

H10: We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing more safety.

H11: We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing more space and more comfortable services to passengers.

H12: We believe that by introducing MaaS services we could have control over fleet operation and monitoring of network status.

H13: We believe that by introducing MaaS services we could reduce delays.

3.2.4 BM4 – Combined MaaS and LaaS (for the hospital campus)

Based on Table 7 and Table 8 of D2.2, the assumptions of BM4 are generated:

H1: We believe that we could generate autonomous services connected through all available mobility services including train, metro, bus (conventional and autonomous shuttle), bike and private vehicles (include taxi).

H2: We believe that we could generate autonomous services connected through all available logistic services.

H3: We believe that we could generate sequential services; mobility for passengers and logistics for goods.

H4: We believe that mobility services are for population for visiting or living in the testing area.

H5: We believe that users can access to service information at stations and website; through on-site intelligent signs and totem for passengers (use of ITS, 5G networks).

H6: We believe that the sequential MaaS and LaaS service model can provide less congestion.

H7: We believe that the sequential MaaS and LaaS service model can provide less noise.

H8: We believe that the sequential MaaS and LaaS service model can provide less emission.

H9: We believe that the sequential MaaS and LaaS service model can provide more safety.

H10: We believe that we can provide an integrated ticketing system among autonomous and existing public transport modes.

H11: We believe that mobility service will be used mainly by existing public transport users.

H12: We believe that mobility service will attract almost all private car users by transforming area into a private car free zone (Reduction of private car usage in urban areas).

H13: We believe that we could generate autonomous services that can provide cost effectiveness in comparison to the private car.

H14: We believe that autonomous services can attract more users and increase revenue by optimising transit time.

H15: We believe that with autonomous mobility services more reliable service can be provided between train stations and business hubs (i.e. commercial area, hospitals, campus, …).

H16: We believe that with autonomous mobility services can increase the comfort of reduced mobility passengers.

3.2.5 BM5 – Peri-urban automated transportation and C-ITS connectivity

Based on Table 9 and Table 10 of D2.2, the assumptions of BM5 are generated:

H1: We believe that the peri-urban on-demand service could connect the sub-urban area with the well-established transit network.

H2: We believe that the established regional transit network could be benefiting from C-ITS cooperative traffic management features such as in-vehicle speed limits, emergency electronic braking light, road works warnings, weather conditions and intersection safety.

H3: Business environment: We believe that we can implement on-demand passenger transport for commuting, leisure, tourism and business reasons for the population at peri-urban areas.

H4: Business environment: We believe that we can implement an on-demand passenger transport for PT users with additional mobility needs.

H5: We believe that with the implementation of an on-demand service higher flexibility is given to the residents.

H6: We believe that with the implementation of an on-demand service higher frequencies could be achieved.

H7: We believe that with the electric buses used for the on-demand service sustainability can be boosted, through reduction of noise.

H8: We believe that with the electric buses used for the on-demand service sustainability can be boosted, through reduction of emissions.

H9: We believe that with the electric buses used for the on-demand service sustainability can be boosted, through providing more safety.

H10: We believe that with the on-demand service the challenges of a hilly area (especially for elder people) can be tackled.

H11: We believe that with the implementation of the on-demand service the walking distances in peri-urban areas can be reduced to 1 – 2 km to the next PT line with higher frequencies.

H12: We believe that by introducing an on-demand service we can reduce private car usage in the peri-urban area.

H13: We believe that by introducing an on-demand service we can provide a better cost-effective operation compared to private cars.

3.2.6 BM6 – Robotaxi services for short distance trips

The assumptions for BM6 are generated based on the Business model canvas and the Proposition value canvas described respectively in Table 11 and Table 12 of D2.2.

H1: We believe that with the implementation of the robotaxi service the transportation efficiency can be increased.

H2: We believe that the robotaxi service will be attractive.

H3: We believe that we can implement a robotaxi service for different patterns including commuting, leisure, and shopping.

H4: We believe that the integration of the robotaxi service is especially valuable for PT users with additional mobility needs (Buses are often complicated to enter for people with these needs).

H5: We believe that with the implementation of the robotaxi service waiting times can be reduced.

H6: We believe that with the implementation of robotaxis the usage of public modes will increase.

H7: We believe that the implementation of robotaxis will increase the comfort in public modes, in particular concerning the maximum load section.

H8: We believe that we could synchronize robotaxis operations given demand and real-time state of public modes.

H9: We believe that robotaxis passengers will be satisfied.

3.2.7 BM7 – Sustainable living areas with autonomous public transportation

Based on Table 13 and Table 14 of D2.2, the assumptions of BM7 are generated:

H1: We believe that fewer parents will drive their children to school by car, which will increase the accessibility for paratransit and other critical road users.

H2: We believe that fewer relatives will drive their car for visits at the elderly home and increasing accessibility for relatives in rush hour.

H3: We believe that children, elderly and users with special needs will have an increased transport offer through providing a first and last mile solution.

H4: We believe that general users will have an increased transport offer through providing a first and last mile solution.

H5: We believe users will accept this solution – regardless of vehicles' low speeds.

H6: We believe that the AV shuttle will contribute to increase the quality of life in the area.

H7: We believe that efficient autonomous first and last mile solutions will increase land and facility value and increase ability for employers to retain and attract new employees.

3.2.8 BM8 – First/Last mile autonomous transportation to mobility HUBs

Based on Table 15 and Table 16 of D2.2, the assumptions of BM8 are generated:

H1: To create a connected and automated passenger transport service between station-to-station and stations-to-university and stations-to-shopping mall.

H2: To create a connected and automated passenger transport service between different organizations as shopping mall-to-university, shopping mall-to-business district, and business district -to-university.

H3: To create a connected and automated cargo transport service between shopping mall-to-stations.

H4: To serve for the passengers as students, workers, visitors, and shoppers.

H5: To provide the information about the transportation (such as arrival/departure time, shuttle location, estimated travel time, etc.) by using a digital platform such as an application and/or website (5G connection).

H6: The deployment of connected and automated vehicle will reduce the congestion around mobility HUBs thanks to dedicated lines or some promotions.

H7: The deployment of connected and automated vehicle will reduce the travel time to mobility HUBs thanks to dedicated lines or some promotions.

H8: To reduce parking-area-use and illegal parking, the connected automated shuttle would avoid any time-loss for parking.

H9: To be preferred, the automated shuttle service would provide a cheaper service to the users by saving travel and waiting time.

H10: The users may reach the free Wi-Fi and USB Charging stations on the automated shuttle

H11: To provide a promotion, the public transport tickets and subscriptions would be accepted for automated shuttle service without any additional payment required.

H12: To reduce the time-loss that caused by parking and congestion, the connected automated shuttle would serve as comfortable as private transport.

H13: To be more reliable, the connected and automated service would be supported by providing current location of the vehicle (5G connection).

H14: To increase the accessibility of the connected automated shuttle, IoT and 5G digital assistance systems would be provided for users who need assistance.

3.2.9 BM9 – Integrated automated and electric shuttle buses for large scale events

The assumptions of BM9 are generated based on Table 17 and Table 18 of D2.2:

H1: We believe that the automotive industry will be interested in testing AV-based services during large events.

H2: We believe that automated services deployed for large scale events will be used by event visitors and inhabitants as well.

H3: We believe that testing automated services during large events will involve the automotive industry, event associations, ITS providers, infrastructure providers and SMEs.

H4: We believe that testing automated services during large-scale events will challenge the limits of the service in terms of capacity and service performances.

H5: We believe that service automation will be safe for visitors of the event.

H6: We believe that providing an automated service during large scale events will promote the technology and create a great image to show around the world.

H7: We believe that testing and sponsoring automated services during large scale events will be costly and only big corporations would be able to pay.

H8: We believe that using autonomous services during the event will improve the experience of visitors and their satisfaction.

3.2.10 BM10 – Interoperable IoT platforms for automated mobility

The assumptions of BM9 are generated based on Table 19 and Table 20 of D2.2:

H1: We believe that IoT interoperability for connected and automated driving will increase safety.

H2: We believe that IoT interoperability for connected and automated driving will provide more comfort for driving.

H3: We believe that the possibility of interconnecting surrounding sensors (e.g. cameras, traffic light radars, road sensors) in addition to on-board sensors (e.g., LiDAR, radar, cameras) will add detection robustness.

H4: We believe that the possibility of interconnecting surrounding sensors will reduce implementation costs.

H5: We believe that the possibility of interconnecting surrounding sensors will enable pushing the SAE (Society of Automotive Engineers) level of driving automation to full automation.

H6: We believe that the possibility of interconnecting surrounding sensors will enhance the traffic flow, therefore also reducing emissions and noise.

H7: We believe that IoT interoperability for connected and automated driving will enhance the possibility for new players to join the market and contribute with new data-driven business models.

H8: We believe that to stay profitable OEMs will have to enter digital ecosystems (joint acquisition of HERE from Daimler, Audi and BMW; alignment of BMW with Intel/ Mobileye).

H9: We believe that IoT interoperability for connected and automated driving will allow for higher speed (due to higher safety and higher detection rate).

3.3 Characterization of business/ operating models based on their assumptions

3.3.1 Mapping assumptions and business/ operating models' goals

As presented in section 3, ten goals are considered. Each assumption among those defined above have at least one goal. The objective is then to assign each assumption to at least one goal. On the other hand, some goals could not have any assumption identified, which means that this goal is not a priority of the business/ operating model and do not require to be tested. In the following, we present for each business/ operating model the assumptions that are assigned to each goal.

3.3.1.1 BM1 – Autonomous PT in combination with additional on-demand services

Table 1 presents the assumptions per goal for BM1. Regarding the number of generated assumptions per goal, it results that the main goals of BM1 are to provide high service quality, to improve accessibility and to reduce congestion.

Table 1: Assumptions per goal for BM1

Goal	Assumptions
Goal 1: Accessibility and Equity	**H1:** We believe that we could generate a fully integrated (physically and digitally) autonomous PT and on-demand operation (APT-ODS). **H4:** We believe that we could generate an integrated operation (APT-ODS) that serves students, commuters and personnel within the service area. **H15:** We believe that by introducing integrated APT-ODS we can eliminate existing mobility gaps in the area.
Goal 2: Service quality	**H2:** We believe that we could generate an automated shuttle bus fixed line at peak time that connects the different facilities around the campus area and reduce travel times. **H3:** We believe that we could generate an on-demand services at off peak times that reduce travel times. **H5:** We believe that through integrated operation (APT-ODS) we can reduce the waiting time of service users at peak time. **H6:** We believe that through integrated operation we can increase service frequency. **H7:** We believe that through integrated operation (APT-ODS) we can provide comfortable and at-standard seating capacity to service users. **H8:** We believe that through integrated operation (APT-ODS) we can provide cheap and flexible service to users.

Goal	Assumptions
	H9: We believe that through integrated operation (APT-ODS) we could guarantee standing and seating capacity to users if using pre-booking services. **H10:** We believe that users can use USB charging while commuting.
Goal 3: Community vitality and Local priorities	**H4:** We believe that we could generate an integrated operation (APT-ODS) that serves students, commuters and personnel within the service area.
Goal 4: Economic	**H8:** We believe that through integrated operation (APT-ODS) we can provide cheap and flexible service to users. **H17:** We believe that by introducing integrated APT-ODS we can provide a better cost-effective operation compared to private cars.
Goal 5: Congestion and Modal share	**H2:** We believe that we could generate an automated shuttle bus fixed line at peak time that connects the different facilities around the campus area and reduce travel times. **H3:** We believe that we could generate an on-demand services at off peak times that reduce travel times. **H16:** We believe that by introducing integrated APT-ODS we can reduce private car usage in the area.
Goal 6: Safety and security	**H14:** We believe that by introducing integrated APT-ODS we can build a sustainable urban environment in the area: by increasing safety.
Goal 7: Environment	**H12:** We believe that by introducing integrated APT-ODS we can build a sustainable urban environment in the area: by reducing emissions. **H13:** We believe that by introducing integrated APT-ODS we can build a sustainable urban environment in the area: by reducing noise.
Goal 8: Business ecosystem and Development	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and does not require to be tested.
Goal 9: Technology	**H1:** We believe that we could generate a fully integrated (physically and digitally) autonomous PT and on-demand operation (APT-ODS). **H11:** We believe that through integrated operation we could provide real-time information about traffic volume in the area and riders for the shuttle.
Goal 10: Productivity and Efficiency	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and does not require to be tested.

3.3.1.2 BM2 - Autonomous Bus Depots

Table 2 presents the assumptions per goal for BM2. Based on the number of generated assumptions per goal, it results that the main goals of the autonomous bus depots are to reduce production costs while providing better service quality.

Table 2: Assumptions per goal for BM2

Goal	Assumptions
Goal 1: Accessibility and Equity	**H6:** We believe that through an autonomous bus depot we will contribute to a PT ticket price reduction in the near future, which suppose a benefit from social side.
Goal 2: Service quality	**H7:** We believe that through an autonomous bus depot we will increase services (frequency and variety) as more vehicles will be available and drivers will have extra hours too**.** **H11:** We believe that through autonomous bus depot operations will be easier to handle and coordinate. **H12:** We believe that an autonomous bus depot will not be severely conditioned for functioning due to weather issues.
Goal 3: Community vitality and Local priorities	**H10:** We believe that through an autonomous bus depot we will contribute to reducing tedious labor and job satisfaction (also contributing with new jobs in control tower for instance).
Goal 4: Economic	**H1:** We believe that through an autonomous bus depot OPEX costs will decrease significantly. **H2:** We believe that through an autonomous bus depot there will be associated space savings. **H4:** We believe that through an autonomous bus depot we will reach lower levels of idle times and increase vehicle usage, increase productivity/speed of depot operations. **H8:** We believe that PTOs and city and regional authorities will contribute to the cost reduction we can deliver via an autonomous bus depot. **H13:** We believe that initial investment & maintenance costs for an autonomous bus depot will be higher than a regular one, but the increase will not be drastic.
Goal 5: Congestion and Modal share	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 6: Safety and security	**H3:** We believe that through an autonomous bus depot the safety within the depot will increase.
Goal 7: Environment	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 8: Business ecosystem and Development	**H5:** We believe that PTOs and city and regional authorities will be interested in the implementation of an autonomous bus depot**.** **H8:** We believe that PTOs and city and regional authorities will contribute to the cost reduction we can deliver via an autonomous bus depot. **H9:** We believe that homologation and authorization for an autonomous bus depot should not be extremely lengthy and complicated (controlled environment).
Goal 9: Technology	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 10: Productivity and Efficiency	**H4:** We believe that through an autonomous bus depot we will reach lower levels of idle times and increase vehicle usage, increase productivity/speed of depot operations.

3.3.1.3 BM3 - Advanced MaaS in urban environments

Table 3 presents the assumptions per goal for BM3. The main goals of the deployment of MaaS in urban environment are to improve the community vitality, to satisfy local priorities, while providing good service quality to travellers.

Table 3: Assumptions per goal for BM3

Goal	Assumptions
Goal 1: Accessibility and Equity	**H2:** We believe that we could generate an autonomous mobility service for population ranging from urban areas to rural areas. **H4:** We believe that we can provide a real-Time information about traffic volume in the area and riders for the shuttle (with application).
Goal 2: Service quality	**H1:** We believe that we could generate a mobility as a service (MaaS) operation integrated with existing conventional services. **H5:** We believe that a real-time information about traffic volume in the area and riders for the shuttle can provide added value to the passengers. **H6:** We believe that we could generate a pre-booking application for ticketing and seat selection.
Goal 3: Community vitality and Local priorities	**H2:** We believe that we could generate an autonomous mobility service for population ranging from urban areas to rural areas. **H3:** We believe that we could generate a mobility service for different trip purposes including commuting, shopping, groceries leisure and tourism. **H11:** We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing more space and more comfortable services to passengers. **H13:** We believe that by introducing MaaS services we could reduce delays.
Goal 4: Economic	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 5: Congestion and Modal share	**H7:** We believe that by introducing MaaS services we could reduce private car usage in urban areas and decrease level of congestion.
Goal 6: Safety and security	**H10:** We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing more safety.
Goal 7: Environment	**H8:** We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing less noise. **H9:** We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing less emission.
Goal 8: Business ecosystem and Development	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 9: Technology	**H1:** We believe that we could generate a mobility as a service (MaaS) operation integrated with existing conventional services. **H4:** We believe that we can provide a real-Time information about traffic volume in the area and riders for the shuttle (with application).

Goal	Assumptions
	H5: We believe that a real-time information about traffic volume in the area and riders for the shuttle can provide added value to the passengers. **H6:** We believe that we could generate a pre-booking application for ticketing and seat selection.
Goal 10: Productivity and Efficiency	**H12:** We believe that by introducing MaaS services we could have control over fleet operation and monitoring of network status. **H13:** We believe that by introducing MaaS services we could reduce delays.

3.3.1.4 BM4 - Combined MaaS and LaaS

Table 4 presents the assumptions per goal for BM4. The combination of MaaS and LaaS, relying on advanced technologies, aims at providing higher service quality and reducing congestion.

Table 4: Assumptions per goal for BM4

Goal	Assumptions
Goal 1: Accessibility and Equity	**H15:** We believe that with autonomous mobility services more reliable service can be provided between train stations and business hubs (i.e. commercial area, hospitals, campus, …).
Goal 2: Service quality	**H1:** We believe that we could generate autonomous services connected through all available mobility services including train, metro, bus (conventional and autonomous shuttle), bike and private vehicles (include taxi). **H2:** We believe that we could generate autonomous services connected through all available logistic services. **H10:** We believe that we can provide an integrated ticketing system among autonomous and existing public transport modes. **H13:** We believe that we could generate autonomous services that can provide cost effectiveness in comparison to the private car. **H15:** We believe that with autonomous mobility services more reliable service can be provided between train stations and business hubs (i.e. commercial area, hospitals, campus, …). **H16:** We believe that with autonomous mobility services can increase the comfort of reduced mobility passengers.
Goal 3: Community vitality and Local priorities	**H4:** We believe that mobility services are for population for visiting or living in the testing area. **H11:** We believe that mobility service will be used mainly by existing public transport users.
Goal 4: Economic	**H13:** We believe that we could generate autonomous services that can provide cost effectiveness in comparison to the private car. **H14:** We believe that autonomous services can attract more users and increase revenue by optimising transit time.

Goal	Assumptions
Goal 5: Congestion and Modal share	**H6:** We believe that the sequential MaaS and LaaS service model can provide less congestion. **H11:** We believe that mobility service will be used mainly by existing public transport users. **H12:** We believe that mobility service will attract almost all private car users by transforming area into a private car free zone (Reduction of private car usage in urban areas).
Goal 6: Safety and security	**H9:** We believe that the sequential MaaS and LaaS service model can provide more safety.
Goal 7: Environment	**H7:** We believe that the sequential MaaS and LaaS service model can provide less noise. **H8:** We believe that the sequential MaaS and LaaS service model can provide less emission.
Goal 8: Business ecosystem and Development	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 9: Technology	**H1:** We believe that we could generate autonomous services connected through all available mobility services including train, metro, bus (conventional and autonomous shuttle), bike and private vehicles (include taxi). **H2:** We believe that we could generate autonomous services connected through all available logistic services. **H5:** We believe that users can access to service information at stations and website; through on-site intelligent signs and totem for passengers (use of ITS, 5G networks). **H10:** We believe that we can provide an integrated ticketing system among autonomous and existing public transport modes.
Goal 10: Productivity and Efficiency	**H3:** We believe that we could generate sequential services; mobility for passengers and logistics for goods.

3.3.1.5 BM5 – Peri-urban automated transportation and C-ITS connectivity

Table 5 presents the assumptions per goal for BM5. The main goals of BM5 are to improve the community vitality, to satisfy local priorities and to increase the service quality. That should also benefit the global efficiency and productivity.

Table 5: Assumptions per goal for BM5

Goal	Assumptions
Goal 1: Accessibility and Equity	**H1:** We believe that the peri-urban on-demand service could connect the sub-urban area with the well-established transit network. **H4:** We believe that we can implement an on-demand passenger transport for PT users with additional mobility needs.
Goal 2: Service quality	**H5:** We believe that with the implementation of an on-demand service higher flexibility is given to the residents.

Goal	Assumptions
	H6: We believe that with the implementation of an on-demand service higher frequencies could be achieved. **H11:** We believe that with the implementation of the on-demand service the walking distances in peri-urban areas can be reduced to 1 – 2 km to the next PT line with higher frequencies.
Goal 3: Community vitality and Local priorities	**H3:** We believe that we can implement on-demand passenger transport for commuting, leisure, tourism and business reasons for the population at peri-urban areas. **H4:** We believe that we can implement an on-demand passenger transport for PT users with additional mobility needs. **H5:** We believe that with the implementation of an on-demand service higher flexibility is given to the residents. **H10:** We believe that with the on-demand service the challenges of a hilly area (especially for elder people) can be tackled. **H11:** We believe that with the implementation of the on-demand service the walking distances in peri-urban areas can be reduced to 1 – 2 km to the next PT line with higher frequencies.
Goal 4: Economic	**H13:** We believe that by introducing an on-demand service we can provide a better cost-effective operation compared to private cars.
Goal 5: Congestion and Modal share	**H12:** We believe that by introducing an on-demand service we can reduce private car usage in the peri-urban area.
Goal 6: Safety and security	**H9:** We believe that with the electric buses used for the on-demand service sustainability can be boosted, through providing more safety.
Goal 7: Environment	**H7:** We believe that with the electric buses used for the on-demand service sustainability can be boosted, through reduction of noise. **H8:** We believe that with the electric buses used for the on-demand service sustainability can be boosted, through reduction of emissions.
Goal 8: Business ecosystem	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 9: Technology	**H2:** We believe that the established regional transit network could be benefiting from C-ITS cooperative traffic management features such as in-vehicle speed limits, emergency electronic braking light, road works warnings, weather conditions and intersection safety.
Goal 10: Productivity and Efficiency	**H1:** We believe that the peri-urban on-demand service could connect the sub-urban area with the well-established transit network. **H2:** We believe that the established regional transit network could be benefiting from C-ITS cooperative traffic management features such as in-vehicle speed limits, emergency electronic braking light, road works warnings, weather conditions and intersection safety. **H6:** We believe that with the implementation of an on-demand service higher frequencies could be achieved.

3.3.1.6 BM6 - Robotaxi services for short distance trips

Table 6 presents the assumptions per goal for BM6. The main goals of BM6 are to improve the community vitality, to satisfy local priorities and to increase the service quality.

Table 6: Assumptions per goal for BM6

Goal	Assumptions
Goal 1: Accessibility and Equity	**H4:** We believe that the integration of the robotaxi service is especially valuable for PT users with additional mobility needs (Buses are often complicated to enter for people with these needs).
Goal 2: Service quality	**H2:** We believe that the robotaxi service will be attractive. **H5:** We believe that with the implementation of the robotaxi service waiting times can be reduced. **H7:** We believe that the implementation of robotaxis will increase the comfort in public modes, in particular concerning the maximum load section. **H9:** We believe that robotaxis passengers will be satisfied.
Goal 3: Community vitality and Local priorities	**H2:** We believe that the robotaxi service will be attractive. **H3:** We believe that we can implement a robotaxi service for commuting, leisure, and shopping reasons for the visitors of the Shopping Center West. **H4:** We believe that the integration of the robotaxi service is especially valuable for PT users with additional mobility needs (Buses are often complicated to enter for people with these needs).
Goal 4: Economic	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 5: Congestion and Modal share	**H6:** We believe that with the implementation of robotaxis the usage of public modes will increase.
Goal 6: Safety and security	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 7: Environment	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 8: Business ecosystem	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 9: Technology	**H8:** We believe that we could synchronize robotaxis operations given demand and real-time state of public modes.
Goal 10: Productivity and Efficiency	**H1:** We believe that with the implementation of the robotaxi service the transportation efficiency from the train station to the Shopping Center West can be increased.

3.3.1.7 BM7 - Sustainable living areas with autonomous public transportation

Table 7 presents the assumptions per goal for BM7. The goals of this BM are more social, aiming at improving the community vitality, the accessibility and the equity.

Table 7: Assumptions per goal for BM7

Goal	Assumptions
Goal 1: Accessibility and Equity	**H1:** We believe that fewer parents will drive their children to school by car, which will increase the accessibility for paratransit and other critical road users. **H2:** We believe that fewer relatives will drive their car for visits at the elderly home and increasing accessibility for relatives in rush hour. **H3:** We believe that children, elderly and users with special needs will have an increased transport offer through providing a first and last mile solution. **H7:** We believe that efficient autonomous first and last mile solutions will increase land and facility value, and increase ability for employers to retain and attract new employees.
Goal 2: Service quality	**H2:** We believe that fewer relatives will drive their car for visits at the elderly home and increasing accessibility for relatives in rush hour. **H4:** We believe that general users will have an increased transport offer through providing a first and last mile solution. **H5:** We believe users will accept this solution - regardless of vehicles' low speeds.
Goal 3: Community vitality and Local priorities	**H3:** We believe that children, elderly and users with special needs will have an increased transport offer through providing a first and last mile solution. **H4:** We believe that general users will have an increased transport offer through providing a first and last mile solution. **H5:** We believe users will accept this solution - regardless of vehicles' low speeds. **H6:** We believe that the AV shuttle will contribute to increase the quality of life in the area.
Goal 4: Economic	**H7:** We believe that efficient autonomous first and last mile solutions will increase land and facility value and increase ability for employers to retain and attract new employees.
Goal 5: Congestion and Modal share	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 6: Safety and security	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 7: Environment	**H6:** We believe that the AV shuttle will contribute to increase the quality of life in the area.
Goal 8: Business ecosystem	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 9: Technology	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 10: Productivity and Efficiency	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.

3.3.1.8 BM8 - First/Last mile autonomous transportation to mobility HUBs

Table 8 presents the assumptions per goal for BM8. Its main goas are to improve the accessibility to / from mobility hubs and to improve the overall quality of service of public modes.

Table 8: Assumptions per goal for BM8

Goal	Assumptions
Goal 1: Accessibility and Equity	**H1:** To create a connected and automated passenger transport service between station-to-station and stations-to-university and stations-to-shopping mall. **H2:** To create a connected and automated passenger transport service between different organizations as shopping mall-to-university, shopping mall-to-business district, and business district -to-university. **H5:** To provide the information about the transportation (such as arrival/departure time, shuttle location, estimated travel time, etc.) by using a digital platform such as an application and/or website (5G connection).
Goal 2: Service quality	**H7:** The deployment of connected and automated vehicle will reduce the travel time to mobility HUBs thanks to dedicated lines or some promotions. **H8:** To reduce parking-area-use and illegal parking, the connected automated shuttle would avoid any time-loss for parking. **H9:** To be preferred, the automated shuttle service would provide a cheaper service to the users by saving travel and waiting time. **H10:** The users may reach the free Wi-Fi and USB Charging stations on the automated shuttle. **H11:** To provide a promotion, the public transport tickets and subscriptions would be accepted for automated shuttle service without any additional payment required. **H12:** To reduce the time-loss that caused by parking and congestion, the connected automated shuttle would serve as comfortable as private transport.
Goal 3: Community vitality and Local priorities	**H3:** To create a connected and automated cargo transport service between shopping mall-to-stations **H4:** To serve for the passengers as students, workers, visitors, and shoppers.
Goal 4: Economic	**H3:** To create a connected and automated cargo transport service between shopping mall-to-stations **H11:** To provide a promotion, the public transport tickets and subscriptions would be accepted for automated shuttle service without any additional payment required.
Goal 5: Congestion and Modal share	**H6:** The deployment of connected and automated vehicle will reduce the congestion around mobility HUBs thanks to dedicated lines or some promotions. **H12:** To reduce the time-loss that caused by parking and congestion, the connected automated shuttle would serve as comfortable as private transport.

Goal	Assumptions
Goal 6: Safety and security	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 7: Environment	**H8:** To reduce parking-area-use and illegal parking, the connected automated shuttle would avoid any time-loss for parking.
Goal 8: Business ecosystem	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 9: Technology	**H1:** To create a connected and automated passenger transport service between station-to-station and stations-to-university and stations-to-shopping mall. **H2:** To create a connected and automated passenger transport service between different organizations as shopping mall-to-university, shopping mall-to-business district, and business district -to-university. **H5:** To provide the information about the transportation (such as arrival/departure time, shuttle location, estimated travel time, etc.) by using a digital platform such as an application and/or website (5G connection). **H13:** To be more reliable, the connected and automated service would be supported by providing current location of the vehicle (5G connection). **H14:** To increase the accessibility of the connected automated shuttle, IoT and 5G digital assistance systems would be provided for users who need assistance.
Goal 10: Productivity and Efficiency	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.

3.3.1.9 BM9 - Integrated automated and electric shuttle buses for large scale events

Table 9Table 5 presents the assumptions per goal for BM9. Through the deployment of automated services within large scale events, the aims are to facilitate the involvement of new actors in the ecosystem, the promotion of the technology and of its benefits to the community.

Table 9: Assumptions per goal for BM9

Goal	Assumptions
Goal 1: Accessibility and Equity	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 2: Service quality	**H8:** We believe that using autonomous services during the event will improve the experience of visitors and their satisfaction.
Goal 3: Community vitality and Local priorities	**H1:** We believe that the automotive industry will be interested in testing AV-based services during large events. **H2:** We believe that automated services deployed for large scale events will be used by event visitors and inhabitants as well. **H8:** We believe that using autonomous services during the event will improve the experience of visitors and their satisfaction.
Goal 4: Economic	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.

Goal	Assumptions
Goal 5: Congestion and Modal share	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 6: Safety and security	**H5:** We believe that service automation will be safe for visitors of the event.
Goal 7: Environment	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 8: Business ecosystem and Development	**H3:** We believe that testing automated services during large events will involve the automotive industry, event associations, ITS providers, infrastructure providers and SMEs. **H6:** We believe that providing an automated service during large scale events will promote the technology and create a great image to show around the world. **H7:** We believe that testing and sponsoring automated services during large scale events will be costly and only big corporations would be able to pay. **H8:** We believe that using autonomous services during the event will improve the experience of visitors and their satisfaction.
Goal 9: Technology	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 10: Productivity and Efficiency	**H4:** We believe that testing automated services during large-scale events will challenge the limits of the service in terms of capacity and service performances.

3.3.1.10 BM10 – Interoperable IoT platforms for automated mobility

Table 10 presents the assumptions per goal for BM10. This BM aims to validate the social and environmental impacts of IoT technologies.

Table 10: Assumptions per goal for BM10

Goal	Assumptions
Goal 1: Accessibility and Equity	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 2: Service quality	**H2:** We believe that IoT interoperability for connected and automated driving will provide more comfort for driving. **H9:** We believe that IoT interoperability for connected and automated driving will allow for higher speed (due to higher safety and higher detection rate).
Goal 3: Community vitality and Local priorities	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 4: Economic	No assumption related to this goal is identified. This goal is not a priority of the business/ operating model and do not require to be tested.
Goal 5: Congestion and Modal share	**H4:** We believe that the possibility of interconnecting surrounding sensors will reduce implementation costs.

Goal	Assumptions
	H6: We believe that the possibility of interconnecting surrounding sensors will enhance the traffic flow, therefore also reducing emissions and noise.
Goal 6: Safety and security	**H1:** We believe that IoT interoperability for connected and automated driving will increase safety.
Goal 7: Environment	**H6:** We believe that the possibility of interconnecting surrounding sensors will enhance the traffic flow, therefore also reducing emissions and noise..
Goal 8: Business ecosystem and Development	**H7:** We believe that IoT interoperability for connected and automated driving will enhance the possibility for new players to join the market and contribute with new data-driven business models. **H8:** We believe that to stay profitable OEMs will have to enter digital ecosystems (joint acquisition of HERE from Daimler, Audi and BMW; alignment of BMW with Intel/ Mobileye).
Goal 9: Technology	**H3:** We believe that the possibility of interconnecting surrounding sensors (e.g. cameras, traffic light radars, road sensors) in addition to on-board sensors (e.g., LiDAR, radar, cameras) will add detection robustness. **H5:** We believe that the possibility of interconnecting surrounding sensors will enable pushing the SAE (Society of Automotive Engineers) level of driving automation to full automation.
Goal 10: Productivity and Efficiency	**H9:** We believe that IoT interoperability for connected and automated driving will allow for higher speed (due to higher safety and higher detection rate).W

3.3.2 Business / operating models typology

The previous analysis shows that for each business / operating model, some goals are involving more assumptions than others. These goals could be then considered as more critical and important for the considered business/ operating model.

Table 11 presents for each business/ operating model, which goals are involving more assumptions (green colour) and which are involving less (yellow colour). For instance, if we consider BM1, service quality is one of the main goals. Similarly, the business development is one of the main goals of BM9.

Table 11: Weights of goals per business/ operating model

Goal	BM1	BM2	BM3	BM4	BM5	BM6	BM7	BM8	BM9	BM10
Goal 1: Accessibility and Equity	0,14	0,07	0,11	0,05	0,11	0,09	0,31	0,13	0,00	0,00
Goal 2: Service quality	0,33	0,20	0,16	0,27	0,16	0,36	0,23	0,30	0,10	0,18
Goal 3: Community vitality and Local priorities	0,05	0,07	0,21	0,09	0,26	0,27	0,31	0,09	0,30	0,00
Goal 4: Economic	0,10	0,33	0,00	0,09	0,05	0,00	0,08	0,09	0,00	0,00
Goal 5: Congestion and Modal share	0,14	0,00	0,05	0,14	0,05	0,09	0,00	0,09	0,00	0,18
Goal 6: Safety and security	0,05	0,07	0,05	0,05	0,05	0,00	0,00	0,00	0,10	0,09
Goal 7: Environment	0,10	0,00	0,11	0,09	0,11	0,00	0,08	0,04	0,00	0,09

Goal	BM1	BM2	BM3	BM4	BM5	BM6	BM7	BM8	BM9	BM10
Goal 8: Business ecosystem and Development	0,00	0,20	0,00	0,00	0,00	0,00	0,00	0,00	0,40	0,18
Goal 9: Technology	0,10	0,00	0,21	0,18	0,05	0,09	0,00	0,22	0,00	0,18
Goal 10: Productivity and Efficiency	0,00	0,07	0,11	0,05	0,16	0,09	0,00	0,04	0,10	0,09

3.4 Prioritization of assumptions

The assumptions are prioritized according to two criteria: importance and evidence. When the assumption is considered by the site as important and not evident (requires testing), then it is critical for the business/ operating model and is prioritized. When the assumption is indicated by the site as not applicable, then it is not considered in the evaluation of the business/ operating model (weight of the assumption equal to 0).

In this section, we focus on business/ operating models that had been selected by sites as closest to their test pilot (section 4.1). The critical assumptions for these business/ operating models are presented.

3.4.1 Mega sites

3.4.1.1 The Monheim Mega Pilot: BM3 - Advanced MaaS in urban environments

Not applicable assumptions

H2: We believe that we could generate an autonomous mobility service for population ranging from urban areas to rural areas: **vehicles are not suitable for operation in rural areas (long distances).**

H4: We believe that we can provide a real-time information about traffic volume in the area and riders for the shuttle (with application).

H11: We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing more space and more comfortable services to passengers.

H13: We believe that by introducing MaaS services we could reduce delays.

Critical assumptions

H3: We believe that we could generate a mobility service for different trip purposes including commuting, shopping, groceries leisure and tourism.

H5: We believe that a real-time information about traffic volume in the area and riders for the shuttle can provide added value to the passengers.

H8: We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing less noise.

H9: We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing less emission.

H10: We believe that by introducing MaaS services we could achieve sustainability in urban cities by providing more safety.

Additional comments of pilot leaders to clarify/ enrich critical assumptions

H3: The non-evidence concerns in particular commuting. For now, all of other trip purposes could be fulfilled.

3.4.1.2 The Madrid Mega Pilot: BM2 - Autonomous Bus Depots

Not applicable assumptions

H6: We believe that through an autonomous bus depot we will contribute to a PT ticket price reduction in the near future, which supposes a benefit from social side [consider eliminating]: **prices al already very adjusted, and PT service is already subsidized.**

H7: We believe that through an autonomous bus depot we will increase services (frequency and variety) as more vehicles will be available and drivers will have extra hours too.

H8: We believe that PTOs and city and regional authorities will be willing to pay up to X% of the cost reduction we can deliver via an autonomous bus depot: **it is not quite likely to happen.**

Critical assumptions:

H1: We believe that through an autonomous bus depot OPEX costs will decrease significantly.

H2: We believe that through an autonomous bus depot there will be associated space savings.

H3: We believe that through an autonomous bus depot the safety within the depot will increase.

H4: We believe that through an autonomous bus depot we will reach lower levels of idle times and increase vehicle usage, increase productivity/speed of depot operations.

H9: We believe that homologation and authorization for an autonomous bus depot should not be extremely lengthy and complicated (controlled environment).

H10: We believe that through an autonomous bus depot we will contribute to reducing tedious labor and job satisfaction (also contributing with new jobs in control tower for instance).

H11: We believe that through an autonomous bus depot operation will be easier to handle and coordinate.

H13: We believe that initial investment & maintenance costs for an autonomous bus depot will be higher than a regular one, but the increase will not be drastic.

Additional comments of pilot leaders to clarify/ enrich critical assumptions

H1: The decrease of OPEX costs for the autonomous bus depot will decrease is mostly caused by savings of non-productive driver hours.

H2: Expected space savings are due to reducing space between buses.

H4: The increase productivity/speed of depot operations is linked to the reduction of non-productive driver hours.

H11: Due to the reduction of bus driver's time for non-productive tasks and the possibility of programming automated tasks (for instance coordination).

3.4.1.3 The Linkoping Mega Pilot: BM7 - Sustainable living areas with autonomous public transportation

Not applicable assumptions

Critical assumptions

H1: We believe that fewer parents will drive their children to school by car, which will increase the accessibility for paratransit and other critical road users.

H2: We believe that fewer relatives will drive their car for visits at the elderly home and increasing accessibility for relatives in rush hour.

H3: We believe that children, elderly and users with special needs will have an increased transport offer through providing a first and last mile solution.

H4: We believe that general users will have an increased transport offer through providing a first and last mile solution.

H5: We believe users will accept this solution - regardless of vehicles' low speeds.

H6: We believe that the AV shuttle will contribute to increase the quality of life in the area.

H7: We believe that efficient autonomous first and last mile solutions will increase land and facility value and increase ability for employers to retain and attract new employees.

Additional comments of pilot leaders to clarify/ enrich critical assumptions

No additional comment.

3.4.1.4 The Gothenburg Mega Pilot: BM8 - First/Last mile autonomous transportation to mobility HUBs

Not applicable assumptions

H2: To create a connected and automated passenger transport service between different organizations as shopping mall-to-university, shopping mall-to-business district, and business district -to-university.

H3: To create a connected and automated cargo transport service between shopping mall-to-stations.

H6: The deployment of connected and automated vehicle will reduce the congestion around mobility HUBs thanks to dedicated lines or some promotions.

H8: To reduce parking-area-use and illegal parking, the connected automated shuttle would avoid any time-loss for parking.

Critical assumptions

To be informed by the pilot leader (ongoing).

Additional comments of pilot leaders to clarify/ enrich critical assumptions

No additional comment.

3.4.1.5 The Salzburg Mega Pilot: BM5 - Peri-urban automated transportation and C-ITS connectivity

Not applicable assumptions

H4: Business environment: We believe that we can implement an on-demand passenger transport for PT users with additional mobility needs.

H5: We believe that with the implementation of an on-demand service higher flexibility is given to the residents.

H7: We believe that with the electric buses used for the on-demand service sustainability can be boosted, through reduction of noise.

H8: We believe that with the electric buses used for the on-demand service sustainability can be boosted, through reduction of emissions.

H9: We believe that with the electric buses used for the on-demand service sustainability can be boosted, through providing more safety.

H13: We believe that by introducing an on-demand service we can provide a better cost-effective operation compared to private cars.

Critical assumptions

H2: We believe that the established regional transit network could be benefiting from C-ITS cooperative traffic management features such as in-vehicle speed limits, emergency electronic braking light, road works warnings, weather conditions and intersection safety.

H10: We believe that with the on-demand service the challenges of a hilly area (especially for elder people) can be tackled.

H12: We believe that by introducing an on-demand service we can reduce private car usage in the peri-urban area.

Additional comments of pilot leaders to clarify/ enrich critical assumptions

No additional comment.

3.4.1.6 The Graz Mega Pilot: BM10 - Interoperable IoT platforms for automated mobility

Not applicable assumptions

H2: We believe that IoT interoperability for connected and automated driving will provide more comfort for driving: **Comfort for passengers are not expected to increase with safety-related IoT interoperability**

H4: We believe that the possibility of interconnecting surrounding sensors will reduce implementation costs: **For Graz test site, it will be difficult to reduce the sensor vehicle costs to the expense of infrastructure costs in our case**

H6: We believe that the possibility of interconnecting surrounding sensors will enhance the traffic flow, therefore also reducing emissions and noise: **For a larger amount of automated vehicles this is still quite far in the future.**

Critical assumptions

H1: We believe that IoT interoperability for connected and automated driving will increase safety.

Additional comments of pilot leaders to clarify/ enrich critical assumptions

No additional comment.

3.4.1.7 The Carinthia Satellite Pilot: BM4 - Combined MaaS and LaaS

Not applicable assumptions

H2: We believe that we could generate autonomous services connected through all available logistic services: **The logistics use case is limited through the capacity available in the tested automated shuttle.**

H3: We believe that we could generate sequential services; mobility for passengers and logistics for goods: **Passengers and goods are transported with the same vehicle.**

H5: We believe that users can access to service information at stations and website; through on-site intelligent signs and totem for passengers (use of ITS, 5G networks)**: Bus stops are provided with service information, but there are no on-site intelligent signs. The service and bus schedule is also available on the website, also with live tracking of the bus.**

H6: We believe that the sequential MaaS and LaaS service model can provide less congestion**: It depends on the vehicles used (electric or conventional)**

H7: We believe that the sequential MaaS and LaaS service model can provide less noise**: It depends on the vehicles used (electric or conventional)**

H8: We believe that the sequential MaaS and LaaS service model can provide less emission**: It depends on the vehicles used (electric or conventional)**

H9: We believe that the sequential MaaS and LaaS service model can provide more safety**: It depends on the technology used.**

Critical assumptions

H1: We believe that we could generate autonomous services connected through all available mobility services including train, metro, bus (conventional and autonomous shuttle), bike and private vehicles (include taxi)

H4: We believe that mobility services are for population for visiting or living in the testing area

H11: We believe that mobility service will be used mainly by existing public transport users

H12: We believe that mobility service will attract almost all private car users by transforming area into a private car free zone (Reduction of private car usage in urban areas)

H13: We believe that we could generate autonomous services that can provide cost effectiveness in comparison to the private car

H14: We believe that autonomous services can attract more users and increase revenue by optimising transit time

H15: We believe that with autonomous mobility services more reliable service can be provided between train stations and business hubs (i.e. commercial area, hospitals, campus, …)

H16: We believe that with autonomous mobility services can increase the comfort of reduced mobility passengers

Additional comments of pilot leaders to clarify/ enrich critical assumptions

H1: We believe that mobility services are for population for working, studying or living in the testing area.

H11: The assumption is relevant in the first phase of the pilot. The final objective is to be attractive with short intervals to attract more private car users.

H16: We believe that autonomous mobility services can increase the comfort of reduced mobility passengers, especially when there is an operator on board to assist reduced mobility passengers.

3.4.2 Satellite sites

3.4.2.1 The Brno Satellite Pilot

Not applicable assumptions: To be informed by the pilot leader (ongoing).

Critical assumptions: To be informed by the pilot leader (ongoing).

Additional comments of pilot leaders to clarify/ enrich critical assumptions: To be informed by the pilot leader (ongoing).

3.4.2.2 The Tampere Satellite Pilot: BM8 - First/Last mile autonomous transportation to mobility HUBs

Not applicable assumptions

H3: To create a connected and automated cargo transport service between shopping mall-to-stations.

H8: To reduce parking-area-use and illegal parking, the connected automated shuttle would avoid any time-loss for parking.

Critical assumptions

H9: To be preferred, the automated shuttle service would provide a cheaper service to the users by saving travel and waiting time

H12: To reduce the time-loss that caused by parking and congestion, the connected automated shuttle would serve as comfortable as private transport.

H14: To increase the accessibility of the connected automated shuttle, IoT and 5G digital assistance systems would be provided for users who need assistance.

Additional comments of pilot leaders to clarify/ enrich critical assumptions

H9: In Tampere service is free of charge. In the future, when the service will be integrated part of the public transport service concept, also the ticketing and payment system will be the same as in the all other PT modes. So far, there is no concrete evidence of the ticketing system, but the plans for the ticketing and payment exist.

H14: To increase the accessibility of the connected automated shuttle, IoT and 5G digital assistance systems would be provided for users who need assistance. This not yet the case in Tampere, but will be most likely in the future. The digital assistance is in the plans and the services to be piloted in the late summer/autumn are being planned also to be included in the Tampere City Transport route planner. So far there is no concrete evidence, but there are plans to have the 5G digital assistance, since the 5G network is available.

3.4.2.3 The Trikala Satellite Pilot: BM1 - Autonomous PT in combination with additional on-demand services

Not applicable assumptions: To be informed by the pilot leader (ongoing).

Critical assumptions: To be informed by the pilot leader (ongoing).

Additional comments of pilot leaders to clarify/ enrich critical assumptions: To be informed (ongoing).

3.4.2.4 The Brainport Satellite Pilot: BM9 - Integrated automated and electric shuttle buses for large scale events

Not applicable assumptions: To be informed by the pilot leader (ongoing).

Critical assumptions: To be informed by the pilot leader (ongoing).

Additional comments of pilot leaders to clarify/ enrich critical assumptions: To be informed (ongoing).

3.5 Results analysis and recommendations

3.5.1 BM7 - Sustainable living areas with autonomous public transportation

3.5.1.1 Calculating weights for assumptions

The weights are calculated based on the prioritization map that is positioning each assumption according to its importance and evidence. For this business/ operating model, the positioning map had been proposed by the WP2 evaluation team. In the next phase of the project, this proposition will be validated or modified based on discussions with test pilots.

A scale from -10 for not important/ too evident to 10 for high important/ not evident is introduced to quantify the degree of prioritization.

The prioritization of assumptions is presented in **Figure 14**. On the map, we can observe all the applicable assumptions of BM7 according to their ID as presented in the previous Section 4.2.7. The critical assumptions are on the top-right quadrant.

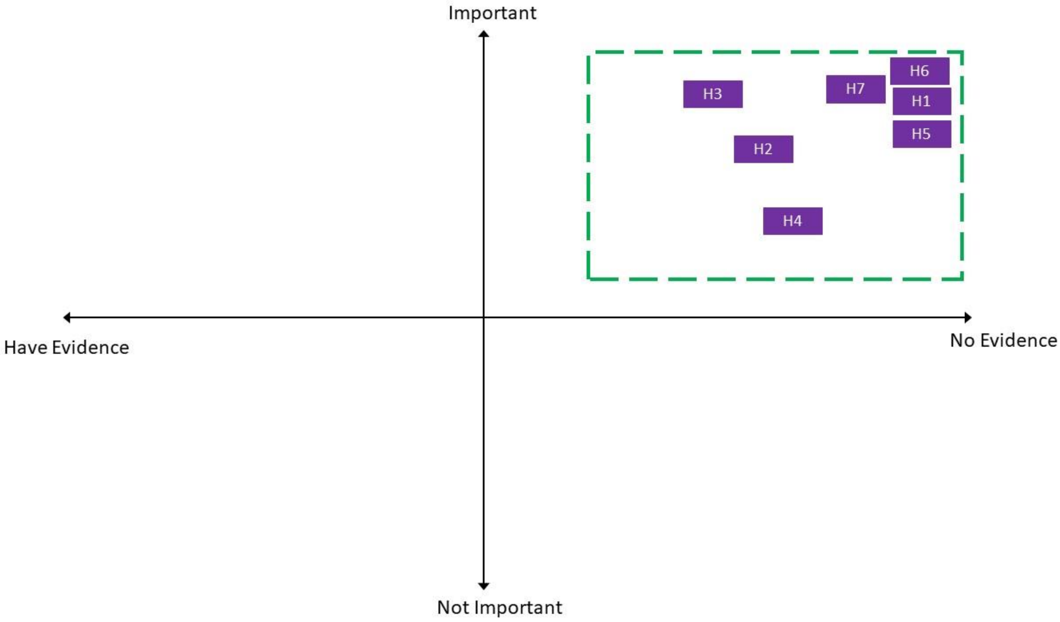

Figure 14: Prioritization map for BM7 - Sustainable living areas with autonomous public transportation

The values of weights are then normalized to obtain values on a scale from 0 to 5.

The obtained values of weights of each assumption are shown in Table 12. These values, being based on the assumption map above, are estimated by the WP2 evaluation team. The precise positioning of assumptions on the map will be performed with the site and validated/ modified in the deliverable 2.4.

Table 12: Weights of assumptions for BM7

ID	Description	Weights
H1	We believe that fewer parents will drive their children to school by car, which will increase the accessibility for paratransit and other critical road users.	4,65
H2	We believe that fewer relatives will drive their car for visits at the elderly home and increasing accessibility for relatives in rush hour.	3,5
H3	We believe that children, elderly and users with special needs will have an increased transport offer through providing a first and last mile solution.	4,05

H4	We believe that general users will have an increased transport offer through providing a first and last mile solution.	3,3
H5	We believe users will accept this solution - regardless of vehicles' low speeds	3,95
H6	We believe that the AV shuttle will contribute to increase the quality of life in the area	5
H7	We believe that efficient autonomous first and last mile solutions will increase land and facility value and increase ability for employers to retain and attract new employees.	4,5

3.5.1.2 Calculating scores of assumptions

The scores of assumptions are calculated based on the methodology presented in section 3.

Since the data collection is still ongoing and considering the agendas of other SHOW WPs, the scores are calculated based on:

- Firsts results of the a-priori survey, to estimate the expected users' profiles, the expected quality of service and modal shift,
- The average speeds of vehicles during the pilot.

The detail of calculation for quantitative assumptions is presented in Appendices.

Table 13 shows the values of scores for assumptions of BM8.

Table 13: Scores and weighted scores of assumptions for BM7

ID	Description	Scores	Weighted scores
H1	We believe that fewer parents will drive their children to school by car, which will increase the accessibility for paratransit and other critical road users.	**0,32**	**1,49**
H2	We believe that fewer relatives will drive their car for visits at the elderly home and increasing accessibility for relatives in rush hour.	**0,32**	**1,12**
H3	We believe that children, elderly and users with special needs will have an increased transport offer through providing a first and last mile solution.	**1**	**4,05**
H4	We believe that general users will have an increased transport offer through providing a first and last mile solution.	**1**	**3,3**
H5	We believe users will accept this solution - regardless of vehicles' low speeds	**0,67**	**2,64**
H6	We believe that the AV shuttle will contribute to increase the quality of life in the area	**1**	**5**
H7	We believe that efficient autonomous first and last mile solutions will increase land and facility value and increase ability for employers to retain and attract new employees.	**TBD**	**TBD**

3.5.1.3 Calculating score of goals and final business model score

Table 14 presents the scores measured for each goal. The economic impact is relative to the assumption H7. The measurement of related KPIs requires collecting and processing additional data. The final score of the business / operating model as the average value of all goals' scores that have a weight greater than zero. It is equal to **0,62**.

Table 14: Scores and weighted scores of goals for BM7

Goals	Goal weight	Average score of applicable assumption	Final score
Goal 1 – Accessibility and Equity	0,31	2,22	0,67
Goal 2 – Service quality	0,23	2,36	0,47
Goal 3 – Community vitality and Local priorities	0,31	3,22	1,00
Goal 4 – Economic	0,07	TBD	TBD
Goal 5 – Congestion and Modal share	0,01	0	0
Goal 6 – Safety and security	0,01	0	0
Goal 7 – Environment	0,07	5	0,35
Goal 8 – Business ecosystem and Development	0,01	0	0
Goal 9 – Technology	0,01	0	0
Goal 10 – Productivity and Efficiency	0,01	0	0

The scores per goal according to their weights are presented in Figure 15.

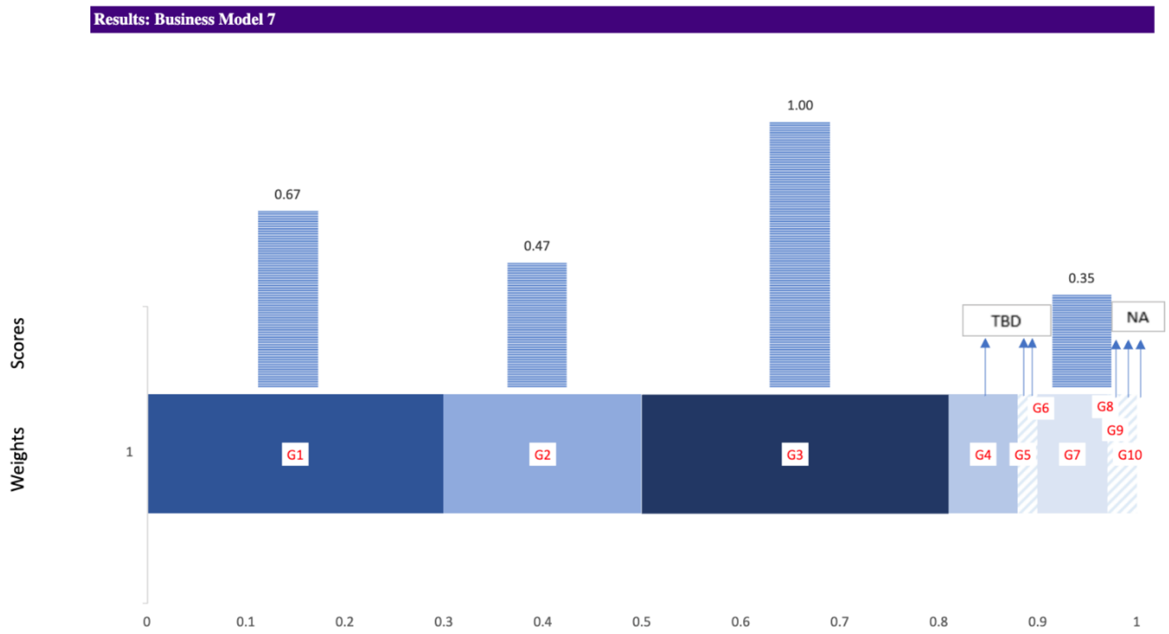

Figure 15: Results of BM7

This business/ operating model increases the accessibility for several groups of populations and would be able to enhance their quality of life. On the other hand, one of the main hypotheses of BM7 is to assume that users will accept the service regardless the vehicles' relatively low speed (H5). However, the first insights of the acceptance survey suggest that this will not be valid and that future passengers will be sensitive to vehicles' speed. That could have a great impact on the validation of this BM. In addition, considering the objectives of this business/ operating model, more attention should be paid by test pilots especially to goals 5 – Congestion, 6 – Safety and security and 7 – Environment. The economic goal concerns in particular the impact of the service on the land price, which is a novel and challenging question in the project.

3.5.2 BM8 - First/Last mile autonomous transportation to mobility HUBs

3.5.2.1 Calculating weights for assumptions

Similarly, the weights are calculated based on the prioritization map that is positioning each assumption according to its importance and evidence.

The prioritization of assumptions is presented in **Figure 16**.

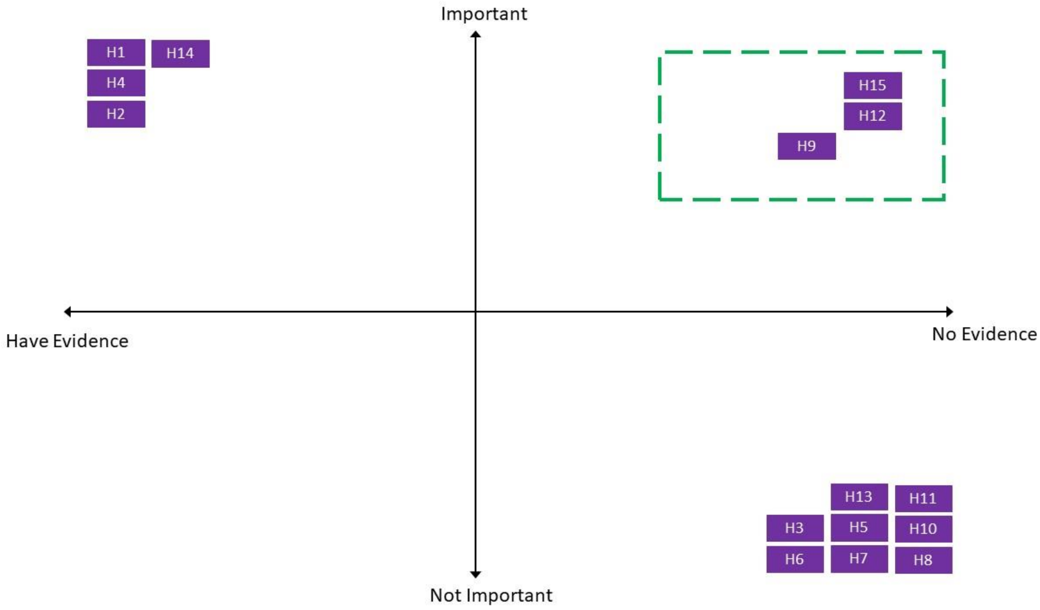

Figure 16: Prioritization map for BM8 - First/Last mile autonomous transportation to mobility HUBs

The values of weights are then normalized to obtain values on a scale from 0 to 5.

The obtained values of weights of each assumption are shown in the following Table 15.

Table 15: Weights of assumptions for BM8

ID	Description	Weights
H1	To create a connected and automated passenger transport service between station-to-station and stations-to-university and stations-to-shopping mall.	**3,45**
H2	To create a connected and automated passenger transport service between different organizations as shopping mall-to-university, shopping mall-to-Ericsson, and Ericsson-to-university.	**3,1**
H3	To create a connected and automated cargo transport service between shopping mall-to-stations.	**NA**
H4	To serve for the passengers as students, workers, visitors, and shoppers.	**3,27**
H5	To provide the information about the transportation (such as arrival/departure time, shuttle location, estimated travel time, etc.) by using a digital platform such as an application and/or website (5G connection).	**2,09**
H6	The deployment of connected and automated vehicle will reduce the congestion around mobility HUBs thanks to dedicated lines or some promotions.	**2,05**
H7	The deployment of connected and automated vehicle will reduce the travel time to mobility HUBs thanks to dedicated lines or some promotions.	**2,12**
H8	To reduce parking-area-use and illegal parking, the connected automated shuttle would avoid any time-loss for parking.	**NA**

ID	Description	Weights
H9	To be preferred, the automated shuttle service would provide a cheaper service to the users by saving travel and waiting time	**4,22**
H10	The users may reach the free Wi-Fi and USB Charging stations on the automated shuttle	**2,16**
H11	To provide a promotion, the public transport tickets and subscriptions would be accepted for automated shuttle service without any additional payment required.	**2,13**
H12	To reduce the time-loss that caused by parking and congestion, the connected automated shuttle would serve as comfortable as private transport.	**4,48**
H13	To be more reliable, the connected and automated service would be supported by providing current location of the vehicle (5G connection)	**3,43**
H14	To increase the accessibility of the connected automated shuttle, IoT and 5G digital assistance systems would be provided for users who need assistance.	**4,65**

3.5.2.2 Calculating scores of assumptions

Similarly, the scores of assumptions are calculated based on the methodology presented in section 3.

Since the data collection is still ongoing and considering the agendas of other SHOW WPs, the scores are calculated based on:

- Firsts results of the a-priori survey, to estimate the expected users' profiles, the expected quality of service and modal shift,
- Performances of vehicles during the pilot, mainly speeds and travel times,
- Conceptual and technological aspects indicated by the pilot leader.

The detail of calculation for quantitative assumptions is presented in Appendices.

Table 16 shows the values of scores for assumptions of BM8.

Table 16: Scores and weighted scores of assumptions for BM8

ID	Description	Scores	Weighted scores
H1	To create a connected and automated passenger transport service between station-to-station and stations-to-university and stations-to-shopping mall.	**0,75**	**2,59**
H2	To create a connected and automated passenger transport service between different organizations as shopping mall-to-university, shopping mall-to-Ericsson, and Ericsson-to-university.	**0,5**	**1,55**
H3	To create a connected and automated cargo transport service between shopping mall-to-stations	**NA**	**NA**
H4	To serve for the passengers as students, workers, visitors, and shoppers.	**1**	**3,27**
H5	To provide the information about the transportation (such as arrival/departure time, shuttle location, estimated travel time, etc.) by using a digital platform such as an application and/or website (5G connection).	**0**	**0**
H6	The deployment of connected and automated vehicle will reduce the congestion around mobility HUBs thanks to dedicated lines or some promotions.	**0,45**	**0,93**

ID	Description	Scores	Weighted scores
H7	The deployment of connected and automated vehicle will reduce the travel time to mobility HUBs thanks to dedicated lines or some promotions.	**0,68**	**1,45**
H8	To reduce parking-area-use and illegal parking, the connected automated shuttle would avoid any time-loss for parking.	**NA**	**NA**
H9	To be preferred, the automated shuttle service would provide a cheaper service to the users by saving travel and waiting time	**0,68**	**2,87**
H10	The users may reach the free Wi-Fi and USB Charging stations on the automated shuttle	**0**	**0**
H11	To provide a promotion, the public transport tickets and subscriptions would be accepted for automated shuttle service without any additional payment required.	**1**	**2,13**
H12	To reduce the time-loss that caused by parking and congestion, the connected automated shuttle would serve as comfortable as private transport.	**0,75**	**3,36**
H13	To be more reliable, the connected and automated service would be supported by providing current location of the vehicle (5G connection)	**1**	**3,43**
H14	To increase the accessibility of the connected automated shuttle, IoT and 5G digital assistance systems would be provided for users who need assistance.	**0**	**0**

3.5.2.3 Calculating score of goals and final business model score

Table 17 presents the scores measured for each goal. The final score of the business / operating model as the average value of all goals' scores that have a weight greater than zero. It is equal to **0,29**.

Table 17: Scores and weighted scores of goals for BM8

Goals	Goal weight	Average score of applicable assumption	Final score
Goal 1 – Accessibility and Equity	0,13	0,78	0,10
Goal 2 – Service quality	0,30	1,92	0,58
Goal 3 – Community vitality and Local priorities	0,08	3,28	0,26
Goal 4 – Economic	0,08	2,13	0,17
Goal 5 – Congestion and Modal share	0,09	3,36	0,30
Goal 6 – Safety and security	0,04	TBD	TBD
Goal 7 – Environment	0,01	0,00	0,00
Goal 8 – Business ecosystem and Development	0,01	0,00	0,00
Goal 9 – Technology	0,22	1,51	0,33
Goal 10 – Productivity and Efficiency	0,04	0	0

The scores per goal according to their weights are presented in Figure 17.

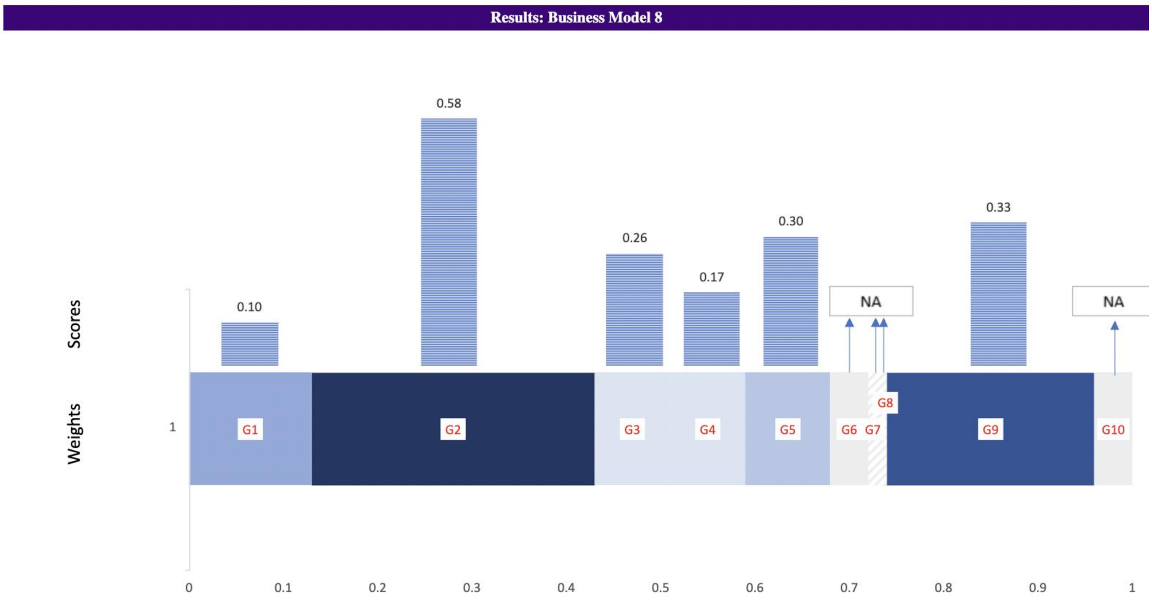

Figure 17: Results of BM8

This business/ operating model is using technology-based solutions to provide high quality service, which is integrated into the public transport supply. The impact on safety and security should be measured later based on data collected. The validation of this business / operating model will depend on its capability to provide a cheaper service to the users by saving travel and waiting time (H9). That will be analyzed thoroughly by considering post-demo surveys and data collected.

3.5.3 BM10 - Interoperable IoT platforms for automated mobility

3.5.3.1 Calculating weights for assumptions

Similarly, the prioritization of assumptions is presented in Figure 18.

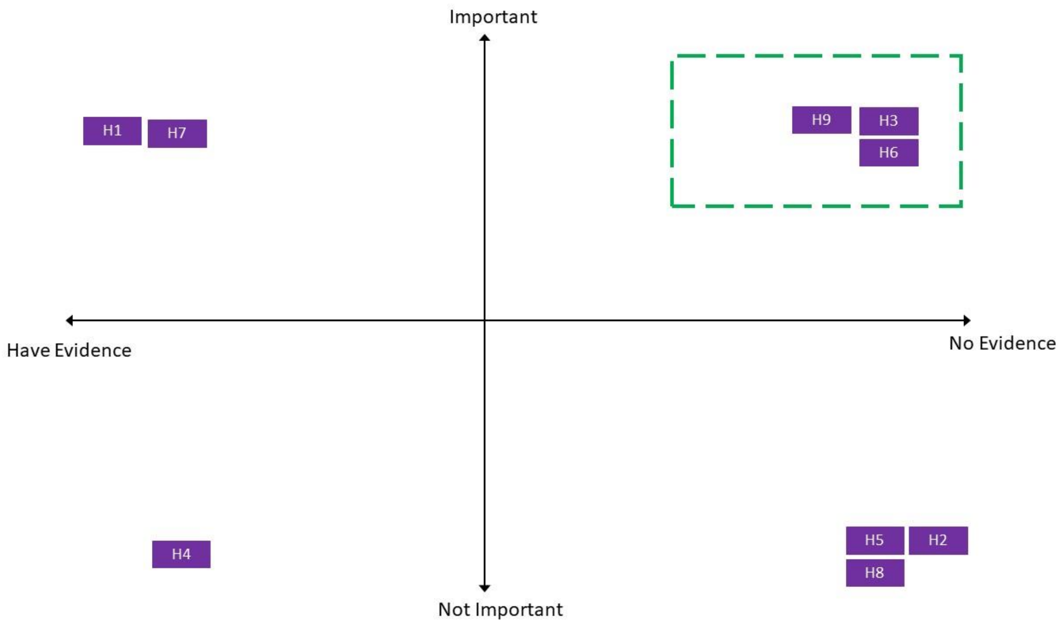

Figure 18: Prioritization map for BM10 - Interoperable IoT platforms for automated mobility

The values of weights are then normalized to obtain values on a scale from 0 to 5.

The obtained values of weights of each assumption are shown in Table 18.

Table 18: Weights of assumptions for BM10

ID	Description	Weights
H1	We believe that IoT interoperability for connected and automated driving will increase safety.	**3,8**
H2	We believe that IoT interoperability for connected and automated driving / traveling will provide more comfort for driving.	**2,13**
H3	We believe that the possibility of interconnecting surrounding sensors (e.g. cameras, traffic light radars, road sensors) in addition to on-board sensors (e.g., LiDAR, radar, cameras) will add detection robustness	**4,925**
H4	We believe that the possibility of interconnecting surrounding sensors will reduce implementation costs	**0,9**
H5	We believe that the possibility of interconnecting surrounding sensors will enable pushing the SAE (Society of Automotive Engineers) level of driving automation to full automation	**2,055**
H6	We believe that the possibility of interconnecting surrounding sensors will enhance the traffic flow, therefore also reducing emissions and noise,	**4,75**
H7	We believe that IoT interoperability for connected and automated driving will enhance the possibility for new players to join the market and contribute with new data-driven business models	**3,785**
H8	We believe that to stay profitable OEMs will have to enter digital ecosystems (joint acquisition of HERE from Daimler, Audi and BMW; alignment of BMW with Intel/ Mobileye)	**2,09**
H9	We believe that IoT interoperability for connected and automated driving will allow for higher speed (due to higher safety and higher detection rate).	**4,85**

3.5.3.2 Calculating scores of assumptions

The scores of assumptions are calculated based on the methodology presented in section 3.

Since the data collection is still ongoing and considering the agendas of other SHOW WPs (i.e. environmental impacts evaluation, traffic impacts, etc.), the scores are calculated based on:

- Firsts results of the a-priori survey, to estimate the expected perception of comfort,
- Performances of vehicles during the pilot in terms of safety,
- Conceptual and technological aspects indicated by the pilot leader.

The detail of calculation for quantitative assumptions is presented in Appendices.

Table 19 shows the values of scores for assumptions of BM10.

Table 19: Scores and weighted scores of assumptions for BM10

ID	Description	Scores	Weighted scores
H1	We believe that IoT interoperability for connected and automated driving will increase safety.	**0,9**	**3,42**
H2	We believe that IoT interoperability for connected and automated driving / traveling will provide more comfort for driving.	**0,75**	**1,5975**
H3	We believe that the possibility of interconnecting surrounding sensors (e.g. cameras, traffic light radars, road sensors) in addition to on-board sensors (e.g., LiDAR, radar, cameras) will add detection robustness	**TBD**	**TBD**
H4	We believe that the possibility of interconnecting surrounding sensors will reduce implementation costs	**TBD**	**TBD**

ID	Description	Scores	Weighted scores
H5	We believe that the possibility of interconnecting surrounding sensors will enable pushing the SAE (Society of Automotive Engineers) level of driving automation to full automation	**1**	**2,055**
H6	We believe that the possibility of interconnecting surrounding sensors will enhance the traffic flow, therefore also reducing emissions and noise.	**0,45**	**2,15**
H7	We believe that IoT interoperability for connected and automated driving will enhance the possibility for new players to join the market and contribute with new data-driven business models	**1**	**3,785**
H8	We believe that to stay profitable OEMs will have to enter digital ecosystems (joint acquisition of HERE from Daimler, Audi and BMW; alignment of BMW with Intel/ Mobileye)	**TBD**	**TBD**
H9	We believe that IoT interoperability for connected and automated driving will allow for higher speed (due to higher safety and higher detection rate).	**1**	**4,85**

3.5.3.3 Calculating score of goals and final business model score

Table 20 presents the scores measured for each goal. The final score of the business / operating model as the average value of all goals' scores that have a weight greater than zero. It is equal to **0,46**.

Table 20: Scores and weighted scores of goals for BM10

Goals	Goal weight	Average score of applicable assumption	Final score
Goal 1 – Accessibility and Equity	0,01	0	0
Goal 2 – Service quality	0,18	4,85	0,87
Goal 3 – Community vitality and Local priorities	0,01	0	0
Goal 4 – Economic	0,01	0	0
Goal 5 – Congestion and Modal share	0,18	2,15	0,39
Goal 6 – Safety and security	0,08	3,42	0,27
Goal 7 – Environment	0,08	2,15	0,17
Goal 8 – Business ecosystem and Development	0,18	3,78	0,68
Goal 9 – Technology	0,18	2,05	0,37
Goal 10 – Productivity and Efficiency	0,09	4,85	0,44

The scores per goal according to their weights are presented in Figure 19.

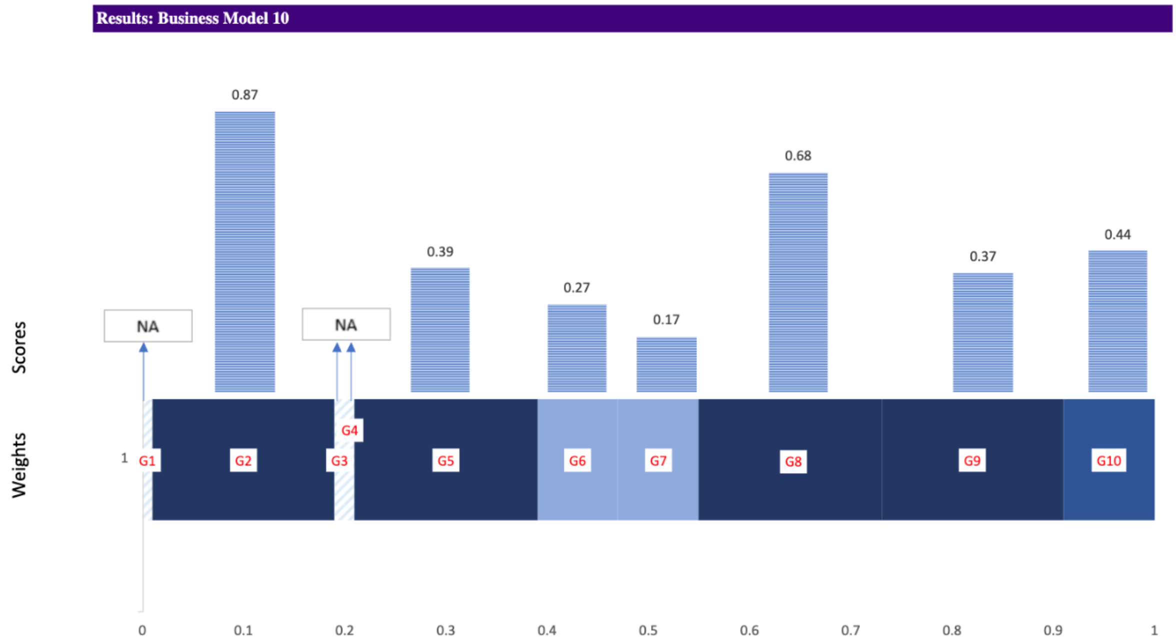

Figure 19: Results for BM10

This BM is well-balanced, covering fairly 60% of the main goals. Also, the three main critical assumptions (H3, H6 and H9) are obtaining high scores (more than 4 out of 5). That suggests that this BM is robust and could be validated. Further analysis should be conducted, however, to explore the importance of the economic goals and their impacts on the BM validity.

4 Conclusions

This document presents the first results of the evaluation of SHOW business/ operating models. A comprehensive methodology is proposed and tested. It is based on seven steps, breaking down each business/ operating model in several assumptions, which are then assessed one by one, and results in a global evaluation of the business / operating model. This methodology is combining two approaches (strategic management approach and engineering approach). It also relies on several areas since the business / operating model is evaluated from the perspective of different stakeholders.

In particular, KPIs for the evaluation of business/ operating models are measured:

- from the users' perspective, through the analysis of acceptability surveys that have been conducted by WP1,
- from the service provider's perspective, in terms of efficiency and costs estimation,
- regarding the quality of service, requiring the treatment and analysis of collected data,
- from the society's perspective, in terms of environmental impacts, safety and quality of life and enhancement.

In order to propose a methodology that is suitable for cross-evaluation among different cities and mobility services, a scoring model is established. It classifies each assumption according to its objectives and proposes accordingly their weights for each business / operating model. This scoring model constitutes the core of the business/ operating model tool that had been developed within the project SHOW. This tool relies then on interviews, surveys, vehicle's data collection, simulation, cost-benefit analysis, and combines their results to provide scores for each SHOW business/ operating model.

In this deliverable, we propose the evaluation of three different SHOW business/ operating models, namely: BM7 - Sustainable living areas with autonomous public transportation, BM8 - First/Last mile autonomous transportation to mobility HUBs, BM10 - Interoperable IoT platforms for automated mobility. These three business/ operating models are those for which the data collection and discussions with related test sites are the most advanced. Most of KPIs are then calculated, and the rest will be estimated more precisely when data will be collected.

The analysis of these three BM found that:

- BM7 promises better accessibility and equity but assumes that users will not be sensitive to vehicles' speeds (H5), which is invalidated by the evaluation.
- BM8 is using technology-based solutions to provide high quality service, which is integrated into the public transport supply. To be validated, it should prove its capability to provide a cheaper service to the users by saving travel and waiting time (H9).
- BM10 connects automated vehicles to the traffic environment outside of the cars. This BM is robust since the three main critical assumptions (H3, H6 and H9) are obtaining high scores (more than 4 out of 5).

Thanks to this first analysis, we identified several improvements for the evaluation of tested business/ operating models. In particular:

- BM7, on creating sustainable living areas, assumes a low weight for the environmental goal and does not include any assumption related to the congestion goal;
- BM8 does not include any assumption related to the environmental goal;
- BM10, aiming at the deployment of ITS solutions, does not include assumptions related to the economic goal.

The evaluation of the three business/ operating models shows that the BM7 is fulfilling its objectives with higher scores than BM8 and BM10.

However, this first analysis has some limitations, that will be addressed in the final deliverable. Firstly, the weighting of goals is based on the number of assumptions that had been generated by goal. This estimation does not reflect necessary the importance of the goal for the tested business/ operating model. In future steps, this estimation will be based on questionnaires directed at test pilots in order to measure their sensitivity against all business/ operating model's goals.

A second limitation is related to the KPIs measurement. Since all data is not yet collected, we focused for some KPIs (such as emissions, energy consumption, etc.) on static data. Dynamic data should be considered as well in D2.4 for the evaluation of all SHOW business / operating models. The relevant acceptance survey is also naturally ongoing. First collected data is used to measure the expectation of the services' performances in terms of comfort, reliability, safety, punctuality, and so on. In the next deliverable (Deliverable 2.4), the objective will be to consider the real perceptions of the performances after experiencing the SHOW solutions. This will be provided by the acceptance surveys that will be conducted during and after pilot phases. The willingness to pay will be one of the additional indicators that will be measured in the next deliverable.

Finally, the KPIs are measured based on the pilot scale and cannot be generalized at the city level. The methodology is adapted to compare business / operating models across sites. The transferability and scalability of tested business/ operating models is still ongoing (Deliverable D2.5) and will be based on the proposed methodology.

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Annex 1 - KPIs measurement : BM7 - Sustainable living areas with autonomous public transportation

The BM7 is evaluated for the test site of Linkoping. The methodology of scoring is detailed in Table 21.

Table 21: Calculation of KPIs and scores per assumption for BM7

Assumptions		KPI	Scoring	Comment on calculation	Final score of assumption	Comment on the calculation of the final score
H1	We believe that fewer parents will drive their children to school by car, which will increase the accessibility for paratransit and other critical road users.	Private car reduction	0,32	Ratio of cars' drivers (all profiles included) declaring that they will shift to AVs if they are deployed	0,32	Consider the mean value. Will be adjusted when the ratio of increased pedestrians will be available
		Increased # of pedestrians	TBD	Not possible to evaluate based on the results of the acceptance survey		
H2	We believe that fewer relatives will drive their car for visits at the elderly home, and increasing accessibility for relatives in rush hour.	Private car reduction	0,32	Number of cars reduced, calculated as the ratio of cars' drivers (all profiles included) declaring that they will shift to AVs if they are deployed	0,32	Consider the mean value. Will be adjusted when the number of visits will be available
		Number of visits at elderly home	TBD	Not possible to evaluate based on the results of the acceptance survey		
H3	We believe that children, elderly and users with special needs will have an increased transport offer through providing a first and last mile solution.	Number of trips	TBD	Passengers' data to be collected and analyzed	1	Consider the mean value. Will be adjusted based on pre-demo surveys results and by considering the trips per profile
		Alternative modes available to children and elderly persons	1	If alternatives modes available to elderly persons and are using them, then 1		
H4	We believe that general users will have an increased transport offer through providing a first and last mile solution.	Number of trips	TBD	Passengers' data to be collected and analyzed	1	Consider the mean value. Will be adjusted based on pre-demo surveys results and by considering the total trips volume
		Alternative modes available to users	1	If alternatives modes available to general users and are using them, then 1		

Assumptions		KPI	Scoring	Comment on calculation	Final score of assumption	Comment on the calculation of the final score
H5	We believe users will accept this solution - regardless of vehicles' low speeds	Average speed	0,22	The average speed is calculated for three months. It is equal to 13km/h. The max speed is 30km/h, which corresponds to a score of 1	0,32	Is equal to the ration between average speed and users' perception. (0.22/((0.7+0.64)/2))
		Sensitivity to speed	0,7	Mean value based on answers of respondents regarding their sensitivity to speed		
		Importance of speed	0,64	Mean value based on answers of respondents regarding the importance of speed		
H6	We believe that the AV shuttle will contribute to increase the quality of life in the area	CO2 Emissions	1	If vehicles are electric then it is 1, otherwise it is relative to emission of other modes.	1	Calculated as the mean value.
		Air quality	TBD	CO2, PM, NOx emissions		
		Reduction in CO2 (1 if electric, otherwise relative to other modes)	1	If vehicles are electric then it is 1, otherwise it is relative to emission of other modes.		
		Energy use	1	If vehicles are electric then it is 1, otherwise it is relative to emission of other modes.		
		Inhabitant quality of life score	TBD	Inhabitant quality of life score		
H7	We believe that efficient autonomous first and last mile solutions will increase land and facility value, and increase ability for employers to retain and attract new employees.	Land value	TBD	Cost per m2	1	Requires data from test pilots
		Facility value	TBD	Cost per m2		
		Employee attraction	TBD	Candidates per recruitment		

TBD: To be done

Annex 2 - KPIs measurement : BM8 - First/Last mile autonomous transportation to mobility HUBs

The BM8 is evaluated for the test site of Tampere. The methodology of scoring is detailed below.

Table 22: Calculation of KPIs and scores per assumption for BM8

Assumptions		KPI	Scoring	Comment on calculation	Final score of assumption	Comment on the calculation of the final score
H1	To create a connected and automated passenger transport service between station/stop-to-station/stop and stations/stop-to-housing area and stations/stop-to-shopping mall.	AV-stations/stops in Hervanta	1	1 if existing, 0 otherwise	0,75	Calculated as the mean value
		AV-station/stop at shopping mall in Hervanta	1	1 if existing, 0 otherwise		
		AV-stations/stops at business district area	0	1 if existing, 0 otherwise		
		AV-stations/stops at housing area	1	1 if existing, 0 otherwise		
H2	To create a connected and automated passenger transport service between different organizations	Access of passengers to university using AV	0	1 if served, 0 otherwise	0,5	Calculated as the mean value
		Access of passengers to shopping mall using AV	1	1 if served, 0 otherwise		
		Access of passengers to business district area using AV	0	1 if served, 0 otherwise		
		Access of passengers to housing area using AV	1	1 if served, 0 otherwise		
H3	To create a connected and automated cargo transport service between shopping mall-to-stations	Deliveries at university using AV	NA	1 if deliveries possible, 0 otherwise	NA	No cargo transport piloted in Tampere.
		Deliveries at shopping mall using AV	NA	1 if deliveries possible, 0 otherwise		
		Deliveries at business district area using AV	NA	1 if deliveries possible, 0 otherwise		
		Deliveries at housing area using AV	NA	1 if deliveries possible, 0 otherwise		

Assumptions		KPI	Scoring	Comment on calculation	Final score of assumption	Comment on the calculation of the final score
H4	To serve for the passengers as students, workers, visitors, and shoppers.	Socioeconomic profile of users (ratio of students, workers, non-active)	1	Based on the intention to use provided by the acceptance survey. 0.25 per category (students, workers, visitors, shoppers). If all categories concerned, then the score is 1	1	Calculated as the mean value
		Trip's purpose (number and ratio)	1	Based on the intention to use provided by the acceptance survey. 0.25 per category of trip purpose (studies, work, visiting family or friends, leisure and shopping). If all categories concerned, then the score is 1		
H5	To provide the information about the transportation (such as arrival/departure time, shuttle location, estimated travel time, etc.) by using a digital platform such as an application and/or website (5G connection).	- Existence of common user application providing real time information on service state	0	If application exists then 1, otherwise 0	0	Calculated as the mean value
		Users of the app	0	If no users then 0, otherwise relative to users of public transit apps		
H6	The deployment of connected and automated vehicle will reduce the congestion around mobility HUBs thanks to dedicated lines or some promotions.	Dedicated lanes	NA	No dedicated lanes in the Tampere site	0,43	Calculated as the mean value. Will be adjusted by considering data to be collected and processed within the project. Should consider the perception of speed and not only the expectation
		Vehicle-km	TBD	Data to be collected and processed		
		Vehicle Density	TBD	Data to be collected and processed		
		Average speed	0,6	Calculated by considering the average for the last three days of the pilot. It is equal to 19km/h. The score is then measured by comparing the speed to other modes. We assume that the speed of the bus is 18km/h and the max speed of cars is 30km/h. If		

Assumptions		KPI	Scoring	Comment on calculation	Final score of assumption	Comment on the calculation of the final score
				the speed of AVs reaches 30km/h, then the score is 1.		
		Vehicle delay	TBD	-		
		Total mileage	0	Calculated by considering the average headway for the last three days of the pilot. It is around 20min (3 vehicles per hour). The score is then measured by comparing it with values for other modes. It is not possible for us to measure headway for cars. For buses, we assume a headway of 10min. The score is equal to 0 if the headway is greater than for cars, otherwise it is 1.		
		Expectation of speed	0,7	Based on the acceptance survey. It is 1 if respondents strongly agree that the speed will be higher, otherwise it is 0)		
		Total network delay	TBD	-		
		Average network speed	TBD	-		

Assumptions		KPI	Scoring	Comment on calculation	Final score of assumption	Comment on the calculation of the final score
H7	The deployment of connected and automated vehicle will reduce the travel time to mobility HUBs thanks to dedicated lines or some promotions.	Average speed	0,6	Calculated by considering the average for the last three days of the pilot. It is equal to 19km/h. The score is then measured by comparing the speed to other modes. We assume that the speed of the bus is 18km/h and the max speed of cars is 30km/h. If the speed of AVs reaches 30km/h, then the score is 1.	0,65	Calculated as the mean value. Will be adjusted by considering data to be collected and processed within the project. Should consider the perception of speed and not only the expectation
		Expectation of speed	0,7	Based on the acceptance survey. It is 1 if respondents strongly agree that the speed will be higher, otherwise it is 0)		
H8	To reduce parking-area-use and illegal parking, the connected automated shuttle would avoid any time-loss for parking.	NA	NA	-	NA	-
H9	To be preferred, the automated shuttle service would provide a cheaper service to the users by saving travel and waiting time.	Average speed	0,6	Calculated by considering the average for the last three days of the pilot. It is equal to 19km/h. The score is then measured by comparing the speed to other modes. We assume that the speed of the bus is 18km/h and the max speed of cars is 30km/h. If the speed of AVs reaches 30km/h, then the score is 1.	0,65	Calculated as the mean value. Will be adjusted by considering passengers data on waiting and access times, to be collected and processed within the project. Should consider the perception of speed and not only the expectation. The values of time will be also measured
		Expectation of speed	0,7	Based on the acceptance survey. It is 1 if 100% respondents strongly agree that the speed will be higher. The score is then proportional.		

Assumptions		KPI	Scoring	Comment on calculation	Final score of assumption	Comment on the calculation of the final score
		Value of time	TBD	Calculated based on the analysis stated-preferences questions, included in the acceptance survey		
H10	The users may reach the free Wi-Fi and USB Charging stations on the automated shuttle.	On-board technology: Free Wi-Fi and USB charging stations	0	In Tampere no free WiFi or USB charging in vehicles.	0	-
H11	To provide a promotion, the public transport tickets and subscriptions would be accepted for automated shuttle service without any additional payment required.	Integrated fare	1	1 if integrated and / or free, 0 otherwise (for Tampere, it is free, and not yet integrated).	1	-
H12	To reduce the time-loss that caused by parking and congestion, the connected automated shuttle would serve as comfortable as private transport.	Travel comfort expectation	0,7	Based on acceptance survey, 1 if 100% strongly agree that the service will be comfortable. The score is then proportional.	0,75	Calculated as the mean value. Will be recalculated by considering the travel comfort perception instead of expectation
		Importance of comfort	0,8	Based on acceptance survey, 1 if 100% strongly agree that the comfort is important and could be a use barrier/ incentive. The score is then proportional.		
H13	To be more reliable, the connected and automated service would be supported by providing current location of the vehicle (5G connection)	Existence of comprehensive processes or application providing current location of the vehicle	1	1 if it exists, 0 otherwise	1	-
H14	To increase the accessibility of the connected automated shuttle, IoT and 5G digital assistance systems would be provided for users who need assistance.	- Existence of comprehensive digital assistance processes based on 5G	0	1 if it exists, 0 otherwise	0	Not in Tampere pilot
		Passengers using the digital assistance	0	0 if no users, otherwise relative to existing solutions performances		

TBD: To be done; NA: Not applicable

Annex 3 – KPIs measurement : BM10 - Interoperable IoT platforms for automated mobility

The BM10 is evaluated for the test site of Tampere. The methodology of scoring is detailed below.

Table 23: Calculation of KPIs and scores per assumption for BM10

Assumptions		KPI	Scoring	Comment on calculation	Final score of assumption	Comment on the calculation of the final score
H1	We believe that IoT interoperability for connected and automated driving will increase safety.	Conflicts	TBD	-	0,9	Calculated as the average value.
		Road accidents	1	If at least one accident, then 0, otherwise 1		
		Expectation of safety	0,8	Based on the acceptance survey. It is 1 if 100% of respondents strongly agree that AVs will be safe. The score is then proportional.		
		Importance of safety	0,9	Based on the acceptance survey. It is 1 if 100% of respondents strongly agree that AVs will be safe. The score is then proportional.		
H2	We believe that IoT interoperability for connected and automated traveling will provide more comfort for driving.	Travel comfort perception	0,7	Based on the acceptance survey. 1 if 100% strongly agree that the service will be comfortable. The score is then proportional.	0,75	Calculated as the mean value. Will be recalculated by considering the travel comfort perception instead of expectation
		Importance of comfort	0,8	Based on the acceptance survey, 1 if 100% strongly agree that the comfort is important and could be a use barrier/ incentive. The score is then proportional.		
H3	We believe that the possibility of interconnecting surrounding sensors (e.g. cameras, traffic light radars, road sensors) in addition to on-board sensors (e.g., LiDAR, radar, cameras) will add detection robustness	Detection robustness	TBD	Data to be provided by test pilots	TBD	-
H4	We believe that the possibility of interconnecting	Implementation costs of sensors	TBD	Data to be provided by test pilots	TBD	-

Assumptions		KPI	Scoring	Comment on calculation	Final score of assumption	Comment on the calculation of the final score
	surrounding sensors will reduce implementation costs					
H5	We believe that the possibility of interconnecting surrounding sensors will enable pushing the SAE (Society of Automotive Engineers) level of driving automation to full automation	SAE level	1	1 if at least the level 4 is reached, 0 otherwise	1	**-**
H6	We believe that the possibility of interconnecting surrounding sensors will enhance the traffic flow, therefore also reducing emissions and noise.	Traffic flow	TBD	Traffic flows for links used by AVs	0,45	Calculated as the average value for KPIs for which a value is estimated.
		Reduction in noise level	TBD	Traffic noise compared to other modes		
		Air quality	TBD	Emissions per km compared to other modes		
		Reduction in CO2	0,42	The average CO2 emissions for Toyota proace are 165g/km. By assuming on average 2 passengers per vehicle (results of the analysis of first results), then the average CO2 emissions is equal to 82.5g/pass.km. For a medium car, the value is assumed to be equal to 171g/km, so for 1.2 passengers per vehicle, 142.5g/pass.km. The score is then obtained following the equation 1-(82.5/142.5)		
		Energy use	0,28	The average energy consumption for Toyota proace is 6.5l/100km. By assuming on average 2 passengers per vehicle (results of the analysis of first results), then the average energy use is equal to 3.25l/pass.km. For a medium car, the value is assumed to be equal to 5.5l/100km, so for 1.2 passengers per vehicle, 4.5l/100km. The score is then obtained following the equation 1-(3.25/4.5)		
H7	We believe that IoT interoperability for connected and automated driving will	New actors in the mobility ecosystem	1	1 if at least one new actor join the ecosystem, 0 otherwise	1	**-**

Assumptions		KPI	Scoring	Comment on calculation	Final score of assumption	Comment on the calculation of the final score
	enhance the possibility for new players to join the market and contribute with new data-driven business models					
H8	We believe that to stay profitable OEMs will have to enter digital ecosystems (joint acquisition of HERE from Daimler, Audi and BMW; alignment of BMW with Intel/ Mobileye)	New markets	TBD	TBD	TBD	**-**
H9	We believe that IoT interoperability for connected and automated driving will allow for higher speed (due to higher safety and higher detection rate).	Average vehicle speed	1	1 if max speed or max allowed speed, 0 if less than 6km/h, and calculation between	1	**-**