SHared automation Operating models for Worldwide adoption
SHOW

Grant Agreement Number: 875530

D2.5: Scalability and transferability of business / operating models

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under Grant Agreement number 875530

Legal Disclaimer

Executive Summary

The scalability of a Business Model (BM) is pivotal in determining its long-term viability and success in expanding operations or entering new markets. This study has meticulously analysed scalability through structured expert interviews, and the analysis scalability canvas, providing a comprehensive understanding of the potential and challenges associated with scaling automated shuttle services. The structured interviews with SHOW Pilot sites representatives across various SHOW pilot sites revealed key challenges identified include:

1. **Technological Advancements**: Achieving higher levels of automation is essential but currently hindered by technological limitations.
2. **Social Acceptance**: Public trust in driverless vehicles is crucial for adoption, requiring targeted efforts to increase attractiveness and accessibility.
3. **Economic Sustainability**: High capital expenditure poses a significant barrier, necessitating secure funding sources and a robust business ecosystem.
4. **Regulatory Adaptations**: Navigating and adapting to regulatory frameworks is essential for broader acceptance and legal clarity.
5. **Environmental Considerations**: Addressing service interruptions due to weather conditions requires technological advancements.
6. **Communication and Stakeholder Engagement**: Effective communication with stakeholders is necessary to garner support and address concerns.
7. **Demonstrating Benefits**: More pilot projects are needed to build trust and demonstrate the benefits of automated transportation services.

Transferability is crucial for the broad adoption and success of automated vehicle (AV) Business Models. It enables the replication, adaptation, and implementation of these models across diverse locations and business environments, leveraging successful practices and innovations to create value and drive societal progress. This study's comprehensive analysis using PESTLE (D2.4), SWOT, and Porter's Five Forces frameworks provides valuable insights into the factors influencing the transferability of AV Business Models.

Document Control Sheet

Start date of project:	01 January 2020
Duration:	57 months
SHOW Del. ID & Title:	D2.5: Scalability and transferability of business / operating models
Dissemination level:	PU
Relevant Activities:	A2.3: Business / operating Models application in Pilot sites and their validation – VEDECOM
Work package:	WP2 - Business / operating models
Lead authors:	Ignacio Magallon (Bax), Victor Ferran (Bax)
Other authors involved:	-
Internal Reviewers:	Clarisse de Cerjat (Eurocities), Brunella Caroleo (LINKS Foundation), Maria Gkemou (CERTH)
Actual submission date:	01/10/2024
Status:	FINAL
File Name:	D2.5_Scalability_and_transferability_of_BM_final

Document Revision History

Version	Date	Reason	Editor
0.1	04/06/2024	Internal revision of IESTA	Jenny Weidenauer (IESTA)
0.2	07/06/2024	Internal revision of Bax	Ignacio Magallon (Bax)
1.0	10/06/2024	Version sent for internal peer review.	Ignacio Magallon (Bax)
1.1	18/06/2024	Internal peer review Eurocities	Clarisse de Cerjat (Eurocities)
1.2	19/06/2024	Internal peer review LINKS Foundation	Brunella Caroleo (LINKS Foundation)
1.3	23/06/2024	Internal peer review CERTH	Maria Gkemou (CERTH)
2.0	30/09/2024	Peer reviewed version sent for submission.	Paola Rodriguez, Víctor Ferran (Bax)

Table of Contents

List of Tables

List of Figures

Abbreviation List

Abbreviation	Definition
AI	Artificial Intelligence and
AV	Automated Vehicle
AVRI	Autonomous Vehicle Readiness Index
BMC	Business Model Canvas
CBA	Cost-Benefit Analysis
CCAV	Cooperative Connected Automated Vehicle
CEA	Cost-Effectiveness Analysis
DRT	Demand-responsive transport
EV	Electric Vehicle
ICT	Information and Communication Technology
IoT	Internet of Things
LaaS	Logistic as a service
MaaS	Mobility as a service
PESTLE	Political, Economic, Sociological, Technological, Legal and Environmental
SAVs	Shared Automated Vehicles
SMEs	Small and medium-sized enterprises
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TCO	Total Cost of Ownership
WEF	World Economic Forum

1 Introduction

1.1 Background and objectives of WP2 tasks

The focus of WP2 is on Cooperative Connected Automated Vehicle (CCAV) deployment business and operating models as a base WP2 focuses on developing business and operating models to support the economic growth of mobility-as-a-service (MaaS) and modern transportation systems. It comprises three main tasks: A2.1, which establishes foundational business models and evaluates existing ones; A2.2, which develops new models based on pilot site inputs; and A2.3, which evaluates these models' progress and scalability. The development and refinement of these models involve interviews and workshops with mega sites, ensuring innovation and continuity in the project.

D2.5 analyses the transferability and scalability of these models, particularly in the context of mega pilot and satellite sites, with considerations for actual costs and revenues. Finally, the objectives include evaluating conditions for scaling business models, studying financial scenarios, and understanding the transferability of models to different locations, supported by comprehensive data collection and various testing methods. The structure of the document includes these sections: (i) introduction; (ii) methodology; (iii) research and context; (iv) scalability assessment; (v) transferability assessment; (vi) recommendations and (vii) conclusions.

1.2 Intended audience

The deliverable will engage relevant project partners within the SHOW consortium, focusing on business and operating models that encompass development, evaluation, demonstration, deployment, and exploitation aspects throughout the project's duration.

For the external audience, the deliverable will be valuable to those involved in business modelling for Connected and Automated Vehicles (CCAV), whether they are engaged in research, studies, or deployment activities.

1.3 Interrelations

Internal interrelations:

Due to the complexity of the internal relations of A2.3 within the SHOW project, we developed the model shown in Figure 2 displaying the input and output of the activity and development. The following information has been identified and used in this deliverable:

- **WP1 – A1.1 (D1.1): SHOW Ecosystem.** This task involves identifying and categorizing the various stakeholder groups, along with determining which consortium partners belong to each category. It also includes analysing their needs, wants, and priorities regarding automated vehicles and mobility services for passengers and freight. This information is crucial to know the needs and boundary conditions for scalability.
- **WP1 – A1.3 (D1.3): SHOW Use Cases.** This task involves detailing the use cases for various test sites and providing essential information for customizing assessments for each site. This includes identifying stakeholders and their associated use cases (UCs), as well as the different test sites and their related UCs.
- **WP2 - A2.1 (D2.1): Benchmarking of Existing Business/Operating Models and Best Practices.** Includes a comprehensive literature review and collection of best practices from other innovation initiatives, including academic research and recent commercial consultancy insights. The primary goal was to understand the success and failure factors of current CCAV solutions, focusing

on a user-centric perspective while also considering technical and organizational aspects like the deployment environment.

- **WP2 - A2.2 (D2.2): Novel Business/Operating Models' Development.** This task involved revisiting and elaborating on a provisional list of novel business and operating model approaches identified by SHOW, mapping them to the models recognized in A2.1. Using detailed status quo and trend analyses at various levels (corporate, competition, industry, global ecosystem), future scenarios and business opportunities were derived.
- **WP2 – A2.3. (D2.4): Final validated business/operating models.** Includes the Outcomes from the validation of the applied business models in SHOW test sites against the KPIs defined.
- **WP9 – A9.1 (D9.1 and D9.2): Plans for pilot evaluation.** This revisits and refines the WP1 Use Cases, turns them into experimental cases and defines the testing framework, including vehicles, infrastructure, use cases to be realized, involved project partners, and the relevant evaluation parameters. All this information will be used for Total Cost of Ownership (TCO), Cost-Benefit Analysis (CBA), and Cost-Effectiveness Analysis (CEA) calculations for both the use cases and the test sites that are addressed in WP16.
- **WP9 – A9.4 (D9.2): Impact Assessment Framework, Tools & KPIs Definition.** The KPIs defined in WP9 form the foundation for the impact assessment in SHOW, encompassing business and economic perspectives. These KPIs are crucial for the CBA, demonstrating how individual parameters within the business environment can influence mobility services and their value chains.
- **WP10 – A10.1 Simulation framework for the extension of SHOW test sites.** Identify the available simulation tools for the potential simulation of shared CCAVs from vehicle level up to mobility level.
- **WP10 – A10.2 Vehicle and traffic simulations.** Vehicle simulation is used to represent the proposed shared CCAV services at Pilot sites and the assessment of safety, traffic, energy and environmental changes for several
- traffic mix scenarios.
- **WP10 – A10.3 Person, mobility, freight and environment-related simulations.** Focus on conducting simulations related to people, mobility, energy and environment. It sheds light on a user's behaviour (driver's simulations) when automated features are present, and it will present the differences noticed in behaviour between vehicles of different automation levels and conventional vehicles.
- **WP10 – A10.4 Combination of simulations and integration of results.** Efficiently combine several types and scales of simulations, with a focus on micro/macro level traffic and driving simulations, to achieve the holistic simulation, highlighting the safety level and the economic benefits of highly automated vehicle fleets – using state-of-the-art simulation tools.
- **WP12 (A12.1 to A12.8).** Real-life large-scale trials.
- **WP13 – A13.1 - Road safety assessment for all user groups.** A thorough review and analysis of the existing or simulated CCAV fleets' safety performance worldwide will be conducted together with the estimation of their road safety impact on all user groups
- **WP13 – A13.2 - Traffic efficiency, energy and environmental impact assessment.** Mobility concepts based on CCAVs can impact traffic efficiency, energy use and emissions in many ways.
- **WP13 – A13.3 - Societal, employability and equity issues assessment.** Understanding of the defined emerging BM and roles (WP2) and scenarios of adoption (WP13), derived from the integration of CCAVs on existing mobility

solutions, we will develop a dedicated analysis to assess the scope and magnitude of their impact on mobility-related occupations.

- **WP13 – A13.4 - Impact assessment on logistics.** The Automated Logistics as a Service (ALaaS) concept framework is modelled, developed and tested during the project pilot cases.
- **WP13 – A13.5 - User experience, awareness and acceptance impact assessment.** Utilising several relevant weighted scales (i.e. Heino & Van der Laan) for usability and acceptance, the collected material from the Pilots on travellers and stakeholders' experience, acceptance, WtH/WtP will be analysed.
- **WP13 – A13.6 - Overall impact assessment and cross-pilot comparisons. -** Building upon the user profiling and impact modelled defined for different mobility solutions in WP2 (BM), apply sensitivity analysis for the generation of future scenarios of demand adoption (high, medium, low) considering the influence of technological trends (tracked under specific KPIs and parameters) and the impact of specific groups of policies on user response, as analysed for specific BM configurations (under WP2).
- **WP16 – A16.1 (D16.1): SHOW Market Analysis.** This task involves analysing SHOW's positioning within the CCAV market. It provides crucial information for business impact calculations, including existing cost structures within the business ecosystem, market shares, and specific economic data, such as the implemented mobility services at the test sites.
- **WP16 - A16.2 (D16.2): Economic and Business Impact Assessment.** The report presents initial results on business and exploitation plans for the mobility services, use cases, test sites, and stakeholder groups involved in SHOW. Ultimately, SHOW aims to provide a manageable and traceable method for determining the costs, revenues, and benefits associated with its test sites, stakeholder groups, use cases, and mobility services. These will be assessed using various tools and aggregated into viable business and exploitation plans, with a special focus on SMEs, new market entrants, and operational expenditure-driven economic aspects.
- **WP16 – A16.3 (D16.3): Exploitation Plans per Partner and Stakeholder Groups.** Building on the results from A16.2, this task develops business exploitation models and strategies for individual partners and stakeholder groups (both internal and external). It also creates roadmaps for large-scale deployment.

External interrelations

- External stakeholders working on all fields/types of mobility: Providing on one hand relevant additional input to the existing BM and ecosystem, also being multipliers for the results (together with WP15).
  External stakeholders were also included in the executed online survey to collect relevant information about business ecosystems, missing links like user roles or low-level parts of the value chain as well as information about success and failure factors for the introduction of mobility services

2 Methodological Approach

The following sub-chapters outline the general approach and methodology for the activity (Chapter 2.1), the Scalability assessment (Chapter 2.2), and the transferability assessment (Chapter 2.3). This chapter shows the methods and tools (see Figure 1) which are used to assess the scalability and transferability of businesses and their connection to each other.

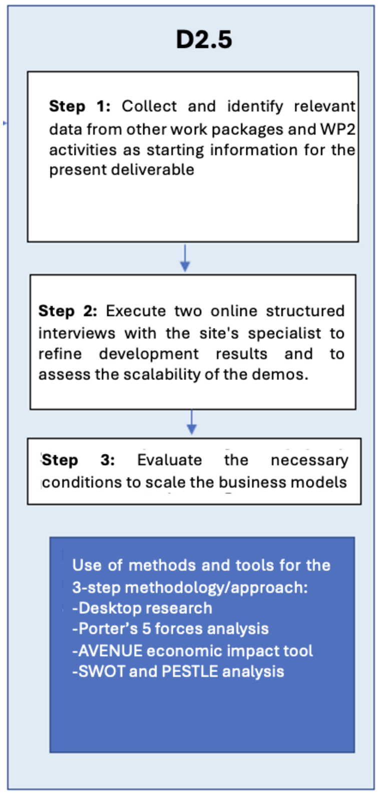


Figure 1: Methodology of D2.5.

2.1 General Approach for A2.3

The general approach of A2.3 is that in each site, the entire ecosystem is mobilised to apply and assess the appropriateness of alternative BM. The transferability and scalability of these models, particularly between Mega pilot project[1] and Satellite site[2], will be analysed, considering SHOW's planned twinning activities. Validated and optimised BM will be enriched with real cost and revenue data from A16.2's economic and business impact assessment.

In **Figure 2** the general approach within A2.3 as well as the input side and the output side of the task can be seen.

[1] SHOW includes five Mega Sites, with good geographical balance (Sweden in North Europe, Germany, France, Austria in Central Europe and Spain in South Europe). Mega Pilots constitute a City or an agglomeration of them (within the same country), that collectively satisfy the majority of SHOW UCs and cover all vehicle types, traffic environments (urban, peri-urban, corridors) of varying population and traffic density as well as all key traveller groups.

[2] SHOW has six Satellite Sites, each with a unique characteristic, focusing upon specific SHOW UC's and being complementary to the Mega Site, in terms of UC's, applying technologies, traffic environments and geographical coverage.

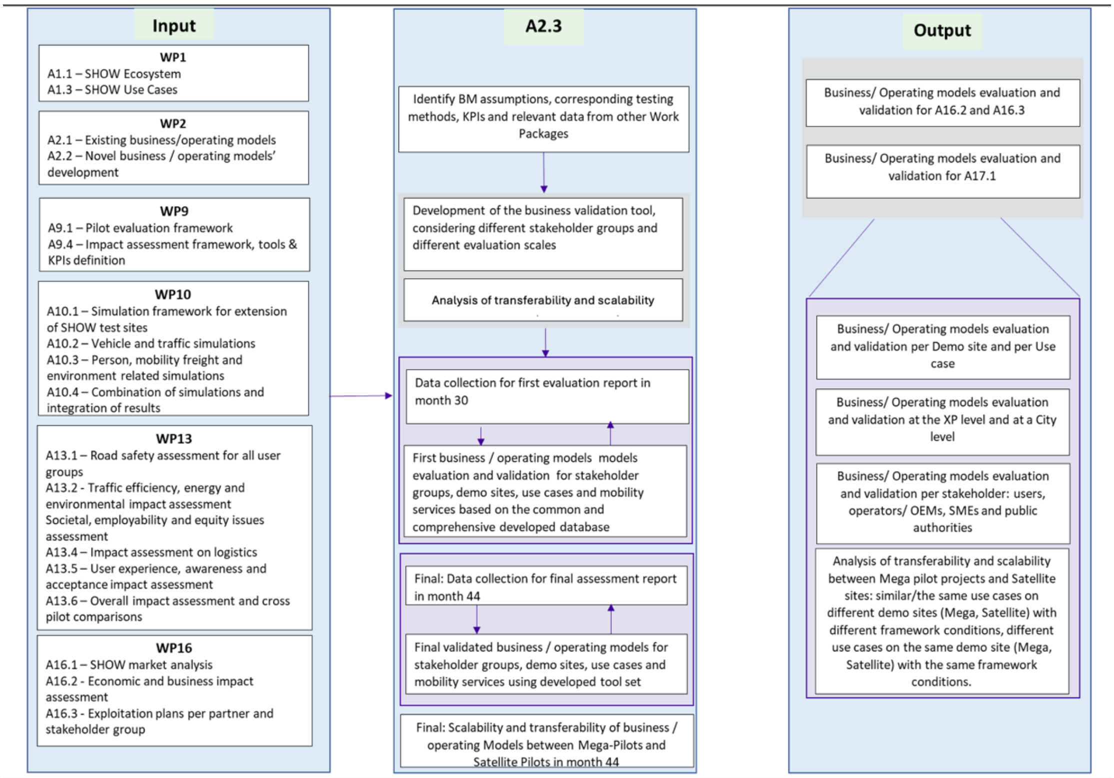


Figure 2: Methodology and interrelations of A2.3.

2.2 Scalability assessment methodology

Scalability is part of the BM exploitation; it describes the ability of a system to adapt to increased workload or demand [1]. BM scalability is seen thus as its ability to benefit from economies of scale. For instance, the ratio between the costs/efforts and the revenues/benefits of putting a new service in place as a proxy to determine a scalability potential can be used.

According to [2], the BM dimension evaluates an automated vehicle operator's ability to create a scalable business that will result in sustainable profitability. Identifying and assessing scalable BM is complex, especially in consumer transportation. For example, robo-taxis offering rides to and from major airports may combine price/mile with in-vehicle advertising, allowing them to charge lower prices while still showing higher profits. This can be applied to the present cases like daily commute rides such as on-site private demand and last-mile services. One way to assess a BM's scalability is by evaluating the ratio between the costs and efforts required to implement a new service versus the resulting revenues and benefits. This ratio serves as a useful proxy for determining the scalability potential of the BM.

There is a differentiation between internal and external BM scalability, as illustrated in **Figure 3** (this report discusses both). Internal scalability focuses on the BM design, key partners, and resources. Conversely, external scalability is influenced by the broader business ecosystem, including customers (narrow ecosystem) as well as policies, laws, competitors, technologies, and culture (wider ecosystem).

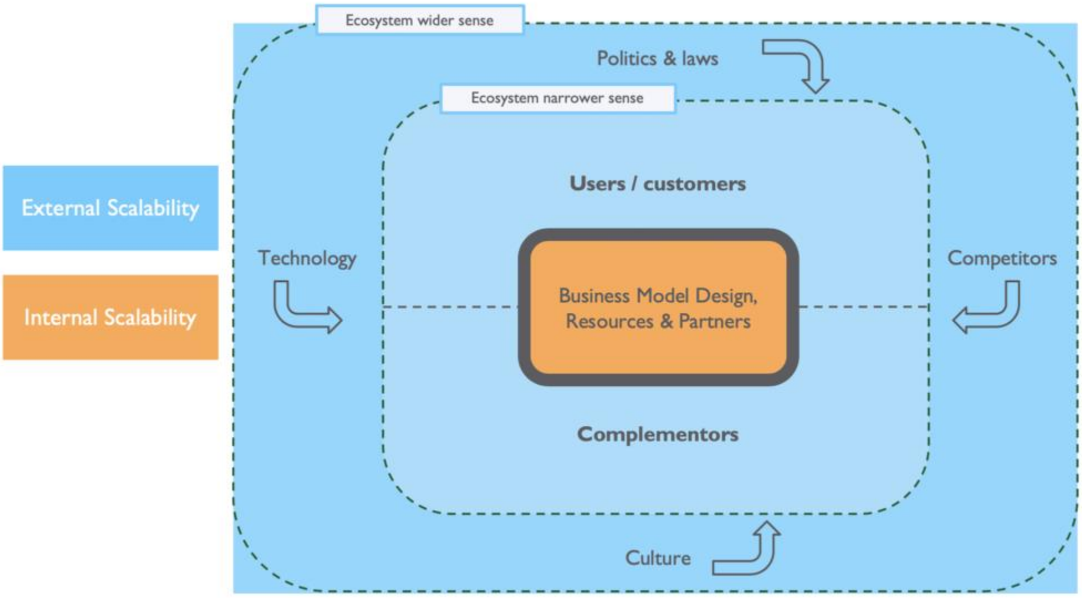


Figure 3: Internal and external BM factors affecting BM scalability **[3]**.

The scalability and transferability evaluation of business and operational models in SHOW involves more than just the number of vehicles used in pilots. It requires the creation of a comprehensive database incorporating data from vehicles, infrastructure, users, stakeholders, and investors. Various methods are applied to derive relevant results for different parameters and conditions. Key activities include:

- Testing similar use cases at different test sites with varying conditions.
- Testing different use cases at the same test site with consistent conditions.
- Creating defined vehicle pools to be used across test sites.
- Selecting representative users and stakeholders for test sites.
- Conducting stakeholder analysis, go-to-market strategy evaluation, and investment behaviour studies.
- Enriching test results through simulation to assess potential business impacts.
- Expanding Automated Vehicles (AV) communities on a European and global scale.
- Using methods like Cost-Benefit-Analysis (CBA), total cost of ownership (TCO), and Cost-Effectiveness-Analysis (CEA) with expert involvement to assess factors such as comfort and acceptance.
- Focusing on Small-Medium-Enterprises (SMEs) and start-ups, particularly regarding Quality of Service, pricing, user acceptance, and willingness to pay.
- Studying the optimisation and scalability of BM, considering industry-specific conditions.
- Ensuring close cooperation between different work packages.

To evaluate the scalability of a BM it has been compiled the following set of criteria based on the literature [2] [4]: (i) define the growth vision, identifying where the business will be in a specified timeframe; (ii) analyse the current capacity and identify bottlenecks, by understanding current operational limits (technology, human resources, capital, regulatory issues, infrastructure); (iii) analyse how the variable vs. fixed costs could behave as the business expands. If costs increase linearly with growth, scalability will be challenging; (iv) assess if the current technology stack (e.g., sensors, etc.) and resource availability (e.g., more vehicles, skilled technicians) support rapid scaling, and can be easily obtained as the business grows; (v) evaluate if operational processes are streamlined and can be replicated easily in higher volumes; and (vi) study potential markets or demographics not currently being served by revising if there are robust systems in place for collecting and analysing user feedback as the BM scales.

To determine the scalability potential of SHOW BM, we have preliminarily identified a list of factors that influence BM scalability. These factors are further elaborated in this Deliverable (see **Section 3.2**). The methods used for the analysis of scalability include structured Interviews and the description of the scalability canvas.

2.2.1 Interviews

To assess the scalability of various BM, according to the definitions above, two distinct series of online structured interviews with local transport operators (PTOs) of 13 SHOW pilot sites (satellite - Table 1 and mega sites -Table 2). In particular:

- The first was a session in April-May 2023 aimed at understanding the intricacies of the BM (value proposition, key partners, channels, cost structure, etc.) and the initial learnings from the field trials.
- The second round in April – May 2024 was another session with a 1.5-hour duration with the same sites to explore deeper into their perception of the critical aspects of viability for various stakeholders, as well as the factors influencing the scalability of the BM (see Table 3).

Table 1: Local transport operators (PTOs) of SHOW pilot satellite sites.

Satellite Sites	
Site (City, country)	**Interviewee**
Brno, Czech Republic	Adam Skokan (CDV)
Tampere, Finland	Mika Kulmala (Tampere)
Trikala, Greece	Elena Patatouka (Trikala)
Frankfurt, Germany	Sofia Pavlakis (RMS consult)

Table 2: Local transport operators (PTOs) of SHOW pilot Mega sites.

Mega Sites	
Site (City, country)	**Interviewee**
Karlsruhe, Germany	Katharina Karnahl (DLR)
Carinthia, Austria	Petra Schoiswohl (Suraaa)
Carabanchel, Spain	Sergio Fertnandez (EMT Madrid)
Linkoping, Sweden	Anna Anund (VTI)
Gothenburg, Sweden	Cilli Sobiech (VTI)
Les Mureaux, France	Nicolas Moral (Transdev)
Graz, Austria	Dominik Schallauer (Austria tech), Karl Lambauer (V2C2)
Monheim, Germany	A. Holermueller (Bahnen Monheim)
Salzburg, Austria	Markus Karnutsch (Salzburg research)

Table 3 presents the structure and objectives of the interviews with the different SHOW sites:

Table 3: Structure and rounds of the interviews.

Interview	Objectives	Structure
First round (10 sites)	Understanding the BM and initial learnings	**Section 1:** Presentation of city case: motivation, strategy **Section 2:** Main assumptions of the BM

Interview	Objectives	Structure
		Section 3: results and Lessons learned **Section 4:** BM, pilot details **Section 5:** Future plans
Second round (13 sites)	Exploring viability and scalability conditions	**Section 1:** Presentation of city case: BM in place and change of BM in the future **Section 2:** Viability measurement and conditions **Section 3:** Scalability and replicability conditions **Section 4:** Societal impact (not relevant for this deliverable) **Section 5:** SUMPs and regulations (not relevant for this deliverable)

2.3 Transferability assessment methodology

Transferability is the ability of a BM to be successfully adapted and implemented in a different location or business environment, below is described the information on the methodologies[3] and variables used to evaluate the transferability of the sites are described:

2.4 SWOT Analysis

SWOT analysis is a strategic tool used to identify and analyse the internal and external factors that can affect an organization or project. It stands for Strengths, Weaknesses, Opportunities, and Threats. Here's how a SWOT analysis can be applied to the transferability of automated vehicle (AV) pilots in **Figure 4**:

[3] The results of the PESTLE analysis carried out in D2.4 of validity of BMs, are used in this deliverable to analyze scalability (see **section 5.1**).

Figure 4: SWOT analysis of UITP on the future of AVs [5].

- **Strengths:** Internal attributes that are advantageous for the transferability of AV pilots. Including advanced technology, proven success, collaboration and Partnerships, and Scalability Potential.
- **Weaknesses:** Internal attributes that could be detrimental to the transferability of AV pilots. Including the high costs, Limited Infrastructure, Regulatory Hurdles, Public Perception and Trust:
- **Opportunities:** External factors that can be leveraged for the successful transferability of AV pilots. Including Market Expansion, Government Support, Technological Advancements, and sustainability Goals.
- **Threats:** External factors that could pose challenges to the transferability of AV pilots. Including the regulatory and legal challenges, competitive landscape, technological risks, and economic and social barriers.

2.5 Porter's 5 forces analysis

Porter's Five Forces analysis highlights the complex and challenging environment faced by the automated vehicle industry. High barriers to entry and supplier dependency limit flexibility, while intense competition and the threat of substitutes create additional pressures [6]. Understanding these forces helps identify the operational limits and strategic priorities for players in the AV market. Adapting to regulatory requirements, managing supply chain dependencies, fostering consumer trust, and differentiating through technological innovation are critical for navigating this dynamic landscape. The five forces include [7] (i) the threat of new entrants, (ii) the bargaining power of suppliers, (iii) the bargaining power of buyers, (iv) the threat of substitutes, and (v) industry rivalry (see **Figure 5**).

Figure 5: Porter`s 5 Forces framework.

This framework helps understand the competitive pressures and the strategic approaches necessary to navigate the AV market effectively. By applying this methodology to the automated vehicle (AV) industry, we can qualitatively assess its current capacity and operational limits.

3 Research and Context

This section includes the context and description of factors that influence scalability and transferability.

3.1 Overview of the Business Models

This first section shows an overview of the BM identified in previous deliverables D2.1 [8] and D2.2 [9]. Business Models describe the methods by which an organization or sector seeks to create and capture value. This includes strategies for revenue generation, value proposition, competitive positioning, and customer engagement. Effective BM in CCAM must navigate the complex interplay of rapidly evolving technologies, a shifting regulatory landscape, and changing consumer preferences, all while striving to achieve sustainability and profitability.

To evaluate BM in Shared Automated Vehicles (SAV), four different perspectives can be considered:

- Users' Perspective: Analysis of acceptability.
- Service Provider's Perspective: Efficiency and cost estimation.
- Quality of Service: Treatment and analysis of collected data.
- Society's Perspective: Environmental impacts, safety, and quality of life.

In previous deliverables D2.1 [8] and D2.2 [9], it was identified ten business and operating models, eight of them were planned in SHOW and two of them are novel ones (BM9 and BM10) – see **Table 4**. The mapping of SHOW business and operating models to test sites has been conducted based on discussions with test pilots. Specifically, the test pilots identified the business and operating models most relevant to their real-life large-scale trials. They described any deviations from the original descriptions of the chosen models, where applicable.

Table 4: SHOW Business Model.

BM	Description
BM1	Autonomous PT in combination with additional on-demand services
BM2	Autonomous bus depots
BM3	Advanced MaaS in urban environments
BM4	Combined MaaS and LaaS
BM5	Peri-urban automated transportation and C-ITS connectivity
BM6	Robotaxi services for short distance trips
BM7	Sustainable living areas with autonomous public transportation
BM8	Fist/Last mile autonomous transportation to mobility hubs
BM9	Integrated automated and electric shuttle buses for large scale events
BM10	Interoperable IoT platforms for automated mobility

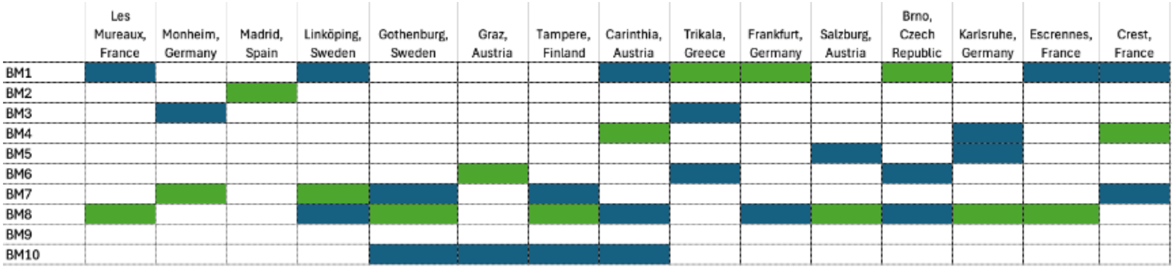


Figure 6: Business Models per site (**green** is the closest BMs or primary BMs, and **blue** is the corresponding BM or secondary BMs).

By examining the current state and plans of the pilot sites previously presented, we can gain insights into the feasibility, scalability, and potential challenges of integrating automated transport services into the existing BM of Public Transport Operators (PTOs). This integration involves adding automated services to established fleets, thereby expanding the mobility portfolio.

The Business Model Canvas (BMC) includes nine blocks (Customer Segments, Value Propositions, Channels, Customer Relationships, Revenue Streams, Key Resources, Activities, Partnerships and Cost Structure) that describe the main components of a company, providing a consistent framework for discussions with shareholders. The next
Figure 7 and **Figure 8** illustrate the BM of two pilot sites (Monheim am Rhein (Germany) and Les Mureaux (France)), highlighting their current operations, tasks, and goals. However, expert interviews revealed that the capabilities enabled by current technology and regulations represent only the initial phase. Additional information on the BMC can be found in the deliverables D2.2 [10] and D2.4 [11].

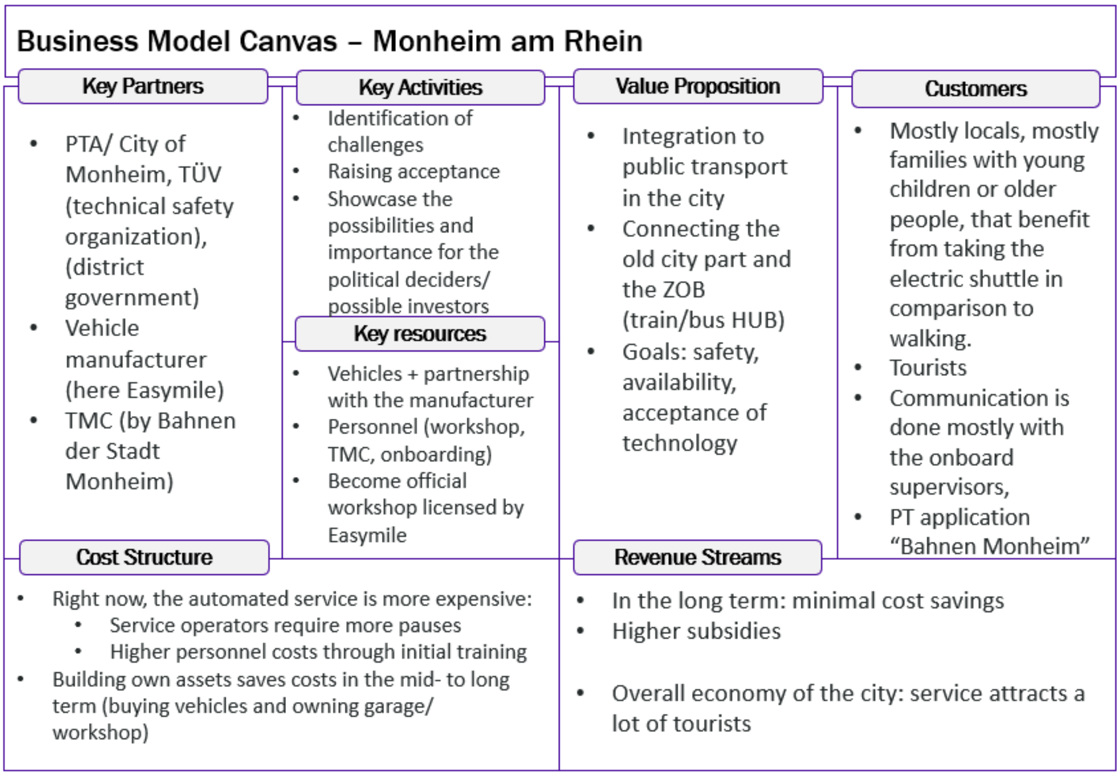


Figure 7: Business Model Canvas of Monheim am Rhein.

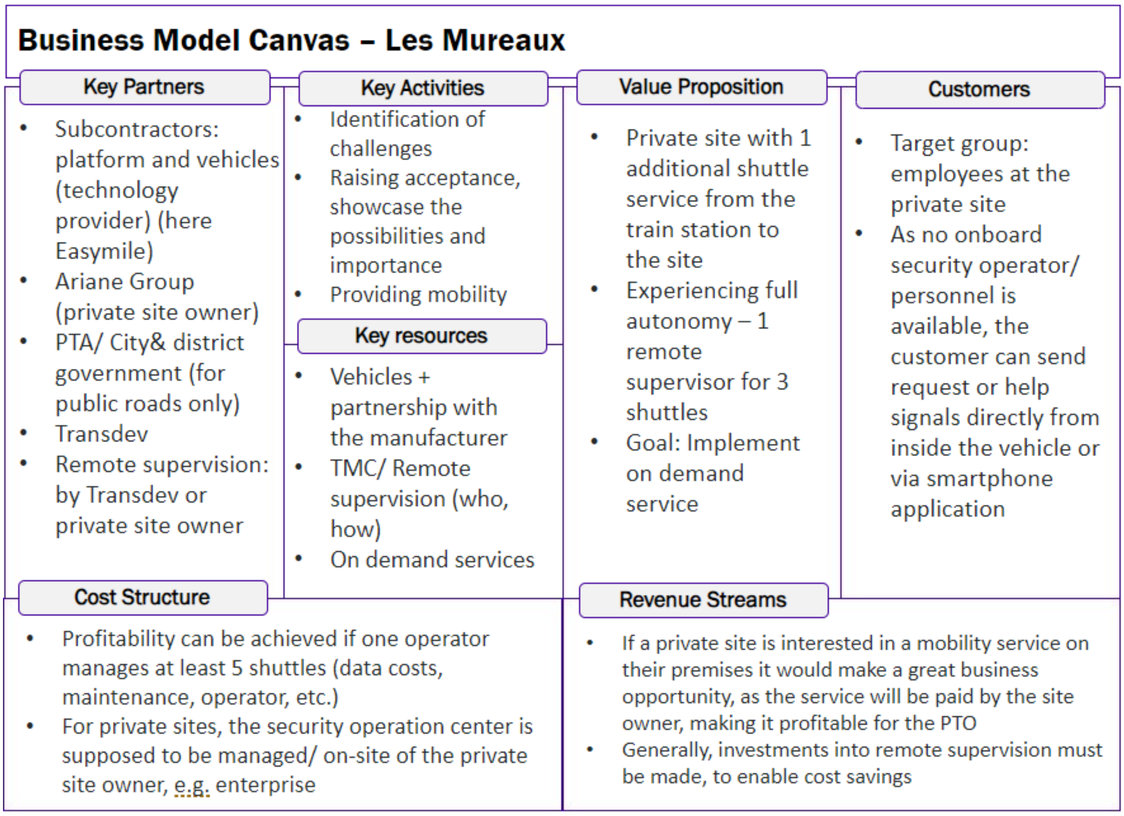


Figure 8: The Business Model Canvas of Les Mureaux.

3.2 List of identified factors influencing scalability and transferability

To determine the scalability and transferability potential of SHOW BMs, SHOW has identified a list of factors (technological, economical, policy, user/customer acceptance, Business Environment/Ecosystem and Cost & Revenue structure) and its sources that influence BM scalability and transferability, which will be further analysed for the above-mentioned methodologies.

This section describes a list of identified factors that influence transferability and scalability, as well as important information compiled to analysis based on an Overview of the BM, KPMG's Autonomous Vehicle Readiness Index (AVRI) [12] for the 7 countries where pilots take place (Austria, Czech Republic, Finland, France, Germany, Spain, and Sweden). This section describes 4 pillars, with 28 variables: Policy and Legislation (7 variables), Technology and Innovation (9 variables), Infrastructure (6 variables), and Consumer Acceptance (6 measures), its corresponding description and sources:

Policy and legislation

- AV regulations: On AV regulations, countries that have regulations that support AV use and place few restrictions on when, where and how testing of AVs may occur are scored higher. Countries that place greater restrictions on testing are scored lower.
- Government-funded AV pilots: Similar approach as AV regulations.
- AV-focused agency: Governments that spread the responsibility for AVs across many government entities are given lower marks; those that take the most common approach, of placing responsibility in an existing agency, gain middling marks; and those establishing an AV or transportation technology and innovation-focused agency that has sole responsibility gain the highest marks.

- The future orientation of government: The World Economic Forum (WEF) Global Competitiveness Index, is based on the average measures of policy stability, responsiveness to change, and adaptability of legal framework.
- The efficiency of the legal system in challenging regulations: The ability of AV manufacturers and others to challenge unfavourable government rules
- Government Readiness for change: KPMG's Change Readiness index is a composite index that assesses regulation, government strategic planning and the rule of law among other measures.
- Data-sharing environment: based on "WWW Foundation Open Data barometer"

Technology and innovation

- Industry partnerships: Those countries that are home to companies that have established many partnerships are given higher scores.
- AV technology firm headquarters: Based on lists published by Topio Networks and Crunchbase Pro, updated with new ones.
- AV-related patents: data from PatSteer
- Industry investments in AV: Using investments listed in Topio Networks and Crunchbase Pro, this is based on the countries of investing organisations, rather than where the investment is made, and scaled by national populations.
- Availability of the latest technologies: "WEF Executive opinion survey"
- Innovation capability: "WEF Global Competitiveness Index", judged by business executives in each country
- Cybersecurity: From" International Telecoms Union's Global Cybersecurity Index"
- Assessment of cloud computing, Artificial Intelligence (AI) and Internet of Things (IoT): Drawn from the average of 3 of 4 'technology enabler' indicators within the "Global connectivity index" from Huawei
- Market share of Evs: Data from EV-Volumes.com.

Infrastructure

- Electric Vehicle (EV) charging stations: Data from "IEA's Global EV outlook" & European Alternative Fuels Observatory & country-specific data. Scaled by population
- 4G coverage: Data from researcher OpenSignal
- Quality of roads: From "WEF Global competitiveness report" assessed by business executives
- Technology infrastructure change readiness: Based on KPMG "Change Readiness Index"
- Mobile connection speed: Data from Ookla (Speedtest service)
- Broadband: Using the broadband tech. enabler indicator from the "Global Connectivity Index" from Huawei.

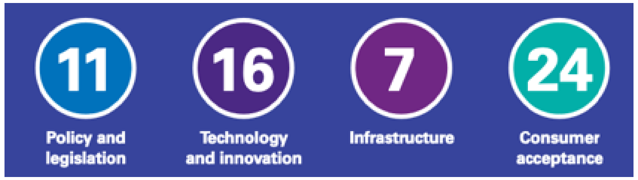
Consumer acceptance

- Population living near test areas: Cities doing testing use data from Bloomberg Philanthropies and Aspen Institute. The proportion of the national population living in test areas is based on McKinsey Global Institute's Urban World app. The more people see AVs on the road, the more comfortable
- Civil society technology use: Based on the people and civil society technology use sub-indicator of the "KPMG Change Readiness Index"
- Consumer Information and Communication Technology (ICT) adoption: "WEF Global Competitiveness Report" includes mobile telephone and broadband subscriptions and overall internet users
- Digital skills: From the "WEF Global Competitiveness Report" survey of executives carried out by the forum.

- Individual readiness: Based on “Portulan’s Institute’s Network readiness index”. Data from the International Telecommunication Union on internet users and mobile broadband subscriptions, using Social and Hootsuite on active social media users and UNESCO on tertiary education enrolment, adult literacy rate and proportion of youth and adults with ICT skills
- Online ride-hailing market penetration: Data from Statista on % of people who have used ride-hailing services, based on nationally representative surveys.

Based on the KPMG 2020 AVRI [12] these are the scores[4] and descriptions of the countries where pilots of SHOW are running (Austria, Czech Republic, Finland, France, Germany, Spain, and Sweden):

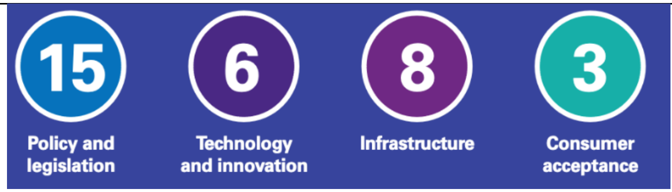
Table 5: AVRI 2020 scores for countries sites (the lowest the score the better ranked) [12].

Country	Description	Score
Austria	In March 2019, the Austrian government updated regulations to permit the use of automated features in cars, buses, and trucks. Drivers can now use hands-free driving on highways within a single lane and self-parking systems outside the vehicle under specific conditions. Werner Girth of KPMG Austria appreciates these legislative changes but notes that Austria is still catching up in AV legislation. In June 2019, Vienna's public transport provider, Wiener Linien, started a trial with Navya's self-driving minibuses. The trial was briefly paused due to an accident but resumed after it was found that the vehicle had functioned correctly. The Austrian government has also increased funding for seed and innovation projects, although Girth calls for even more investment. Austria's strengths in AV development include numerous small research-focused companies and significant scientific talent, particularly in Vienna and Graz.	
Czech Republic	The Czech Republic is recognized for its strong government-funded AV pilots and testing capabilities. In 2020, construction is expected to begin on BMW's EUR 300 million (US$ 340 million) AV test site at Sokolov, set to open in the second half of 2022. This site will feature 100km of roads for city, highway, and rural testing and will create around 700 jobs. BMW has also partnered with the University of West Bohemia for this project. Several other test facilities are being developed in the country. Czech investment group Accolade plans to open a site near Stříbro in 2022 at a cost of EUR 180 million (US$ 200 million), providing diverse road environments. Additionally, Skoda, TÜV, and Valeo Group are working on converting various sites into AV testing facilities.	

[4] The variables under each pillar were combined to arrive at an aggregate score for each pillar. An equal weighting scheme was applied, where all variables were given equal weight in arriving at the overall pillar score.

Country	Description	Score
	Pavel Kliment, Partner at KPMG in the Czech Republic, highlights the country's existing automotive industry as a key strength, focusing on test sites rather than research and development. Notable R&D collaborations include Porsche and Marelli with the Czech Technical University in Prague. However, the Czech Republic lacks a comprehensive legal framework for AV use. While the technology gains attention with major announcements, such as BMW's test site plans, Kliment believes the strategic importance of AVs will grow, especially once the test sites are operational.	
Finland	Finland's high ranking in the Autonomous Vehicle Readiness Index (AVRI) is largely due to its government's strong performance, particularly in AV regulations and the efficiency of its legal system. The Finnish government has prepared the country for AVs by opening the entire road network for trials and enacting a new Road Traffic Act in June 2020. Finland is also advocating for changes in EU legislation to facilitate the use of driverless vehicles. Local and national authorities are promoting AVs to reduce environmental impacts and private car use, with driverless minibuses being a key focus. Helsinki's transport authority trialed driverless minibuses in 2015, and Espoo began operating the all-weather Gacha driverless bus in 2019. Espoo plans to have driverless shuttle buses in permanent commercial service by 2021. Finland has a strong public-private ecosystem, supported by events like the annual Slush startup and tech event. This ecosystem includes established companies, startups, public sector organizations, and government-driven entities. Finland also benefits from advanced technology use, including 5G, and a significant talent pool, particularly engineers with experience from Nokia. Despite lacking a major vehicle manufacturer, Finland's smaller companies have more freedom to innovate. The government is advised to continue improving strategy deployment in legislation and AV subsidies, although it is already performing well.	

Country	Description	Score
France	In February 2019, President Emmanuel Macron reaffirmed his commitment to having AV-based transport services operational in France by 2021. The French parliament passed two laws in 2019 to support this goal. The first law transfers liability for accidents involving experimental AVs from the driver to the organization conducting the experiment. The second law allows the government to modify other legislation to facilitate AV services, such as exempting automated truck platoons from the rule requiring vehicles to stay 50 meters apart. France's AV development benefits from a unique legal framework in Europe, robust collaboration between government and private sectors, a strong automotive industry, and a supportive environment for start-ups. Notable projects include Peugeot's collaboration with Vinci Autoroutes on AV technology and the opening of an AV test site at Montlhéry in July 2019. Despite these strengths, France's lack of large technology companies emphasizes the importance of partnerships, such as the one between Renault and Waymo.	
Germany	Germany remains strong in technology and innovation, retaining fourth place in the AVRI, leading in innovation capability and industry partnerships, and ranking high in AV-related patents and investments. Key developments include Daimler Trucks unveiling the Freightliner Cascadia in January 2019, and BMW and Daimler's collaboration on AV technology. Despite these advancements, Germany's overall ranking has dropped due to weaker performance in other areas. In December 2019, the National Platform Future of Mobility released recommendations on AV-related actions. PT providers have begun testing automated buses on public roads in cities like Berlin, Hamburg, and Leipzig. Moritz Püstow of KPMG Law in Germany notes that while there is significant activity at the municipal level, a cohesive national strategy is lacking. This fragmented approach may hinder Germany’s progress in AV adoption, compounded by a national skepticism towards new technologies and a cultural emphasis on driving as an expression of freedom.	

Country	Description	Score
Spain	Spain is actively involved in various AV trials and programs. The automated Ready Spain innovation program, launched in December 2019, involves the Spanish Directorate General of Traffic (DGT), Barcelona City Council, Ferrovial, and Mobileye, focusing on reducing accidents with driving assistance technologies. Notable trials include: Tourist AV Buses: (i) Malaga: Avanza's AutoMost pilot service uses a 12-meter electric bus connecting the cruise terminal to the city center, and (ii) Lanzarote: Cities Timanfaya, an automated electric minibus, offers multimedia tours in Timanfaya National Park. University Service: Madrid: Universidad Autónoma de Madrid introduced a regular driverless bus service on a 3.8km route to its Cantoblanco campus, the first at a Spanish university. The Spanish government announced work on a comprehensive mobility law at the start of 2020, covering AVs and promoting electric vehicles (EVs), including more recharging sites. Spain is on the third level of a 15-point scale for AV regulations. Despite advancements, Spain needs more initiatives for AV testing and promotion and a national framework for development, as responsibility for transport is split between the national government and powerful regions. There are also efforts to improve 5G connectivity, with networks now live in some cities, and to increase the number of EV charging points.	
Sweden	Sweden has expanded its AV testing on public roads, increasing the maximum speed to 80 km/h and allowing human supervisors to operate hands-free. Major Swedish companies like Scania, Volvo Cars, and Volvo Trucks are actively involved in these trials, particularly focusing on logistics. Notable developments include: Einride Pod: In May 2019, an Einride driverless electric truck operated at DB Schenker's facility in Jönköping. In June 2019, an Einride pod delivered goods in Stockholm, marking its first urban journey using a network provided by Ericsson.	

Country	Description	Score
	Christoffer Sellberg, Head of Automotive at KPMG in Sweden, believes 5G will boost AV adoption but suggests the government should accelerate regulatory development and public transport trials, noting that some agencies plan to start testing driverless buses only in 2022. Sweden excels in technology adoption and digital skills, contributing to high consumer acceptance of AVs. The country ranks high in ICT adoption and innovation capability. However, Sellberg emphasizes the need for greater collaboration among AV stakeholders, including technology providers, OEMs, and authorities, to strengthen the AV ecosystem.	

Based on the four above-mentioned dimensions: Policy and legislation, technology and innovation, infrastructure, policy, and Consumer acceptance, and 2 additional dimensions are included for the analysis in this report: Business ecosystem and Cost & Revenue structure, the next list of identified factors is created:

Table 6: List of identified factors influencing BM scalability.

Short factor name	Description	Dimension	Data acquisition method (DAM)
Automation of processes	Level of process automation from manual work to fully automated work. In the case of automated vehicles, the SAE levels (0-5) are taken as reference.	Technology and innovation	SHOW UCs fact sheet
Technical infrastructure	How easily can the infrastructures needed be extended to meet higher demand	Infrastructure	Stakeholder Workshops / Interviews
Technology readiness level (TRL)	Level of technological development of a certain technology according to standard TRL definition	Technology and innovation	Pilot observation
Return to scale	Variation in productivity that is the outcome from a proportionate increase of all the input	Cost & Revenue structure	Stakeholder Workshops / Interviews or Pilot observation
High revenue for low costs	How well is the BM able to generate high revenue while keeping costs low (usually shown at the beginning of a venture)	Cost & Revenue structure	BMC
Minimum number of passengers/goods transported	The minimum amount needed to meet costs with paying customers	Cost & Revenue structure	Pilot observation / post-processing
Legal barriers or boosts	How is the legal setting shaping the BM	Policy and legislation	WP3 / WP16
Customer lock-in effect	Ability to retain customers (cost - monetary or not - of user to switch to competition)	Consumer acceptance	Pilot observation (WP13)
Viral factor	Is the attractiveness of the service impacted exponentially with the in-/decrease of users	Consumer acceptance	BMC / Value proposition Canvas (WP13)

Short factor name	Description	Dimension	Data acquisition method (DAM)
Need-pull/Technology push	Degree to which the product/service is driven by a user need or by gains that a technology provides	Consumer acceptance	Mobility Service Canvas / User acceptance survey (WP13)
Service ease-of-use	How easily can the service/product be used by the average user	Consumer acceptance	User acceptance survey (WP13)
Familiarity	How close is the service/product from something the user already know/use	Consumer acceptance	Mobility Service Canvas / User acceptance survey (WP13)
Willingness-to-pay	How much are the users willing to pay for the service offered	Cost & Revenue structure	Pilot observation / User acceptance survey (WP13)
Unique value proposition	How unique and difficult to reproduce is the value proposition	Business ecosystem	BMC / Value proposition Canvas
Incentives or subventions associated	BM dependency on government regulations or policies that incentivize the use of the service	Policy and legislation	SHOW UCs fact sheet / Pilot observation
Market share	Percentage of actual market to its maximum potential size	Business ecosystem	WP16
Market volatility	How stable or volatile is the market under consideration	Business ecosystem	WP16
Business team/ecosystem experience	How experienced and performant is the business team/ecosystem	Business ecosystem	Stakeholder Workshops / Interviews or Pilot observation
Location (resources, customers & employees)	How well positioned is the company's location for resources, customers and staff pool?	Business ecosystem	Stakeholder Workshops / Interviews or Pilot observation

BM transferability is defined as the capability of the BM designs itself to be transferred to a different Business environment, including a different business ecosystem. The list of factors that influence it are:

Table 7: List of identified factors influencing SHOW BM transferability.

Short factor name	Description	Dimension	Data acquisition method (DAM)
Strengths	Possessed resources and/or skills offering a competitive lead	SWOT Analysis	WP16
Weaknesses	Barriers preventing business from operating at optimum level performance	SWOT Analysis	WP16
Opportunities	Favourable external factors offering competitive advantage	SWOT Analysis	WP16
Threats	External factors with potential harm	SWOT Analysis	WP16
Political similarity	Similarity of governmental and political conditions	PESTLE Analysis	WP16
Economic similarity	Similarity of economic conditions	PESTLE Analysis	WP16
Social similarity	Similarity of social conditions	PESTLE Analysis	WP16
Technological similarity	Similarity of technological conditions	PESTLE Analysis	WP16
Legal similarity	Similarity of legal conditions	PESTLE Analysis	WP16
Environmental similarity	Similarity of environmental conditions	PESTLE Analysis	WP16
Operational Design Domain (ODD) similarity	Similarity of operational conditions under which a given driving automation system or feature thereof is specifically designed to function	Business ecosystem	SHOW UCs fact sheet
Customer habits	How well do users habits match with service/product offered or how well does it match what has proven to work so far	Consumer acceptance	Pilot observation / User acceptance survey
Customer purchasing power	What is the average income of people in targeted area/segment	Cost & Revenue structure	Pilot observation / User acceptance survey

Short factor name	Description	Dimension	Data acquisition method (DAM)
Customer density	What is the density of potential customers within the area of reach	Business ecosystem	SHOW UCs fact sheet
Customer PPP	Average power purchase parity of the customers	Cost & Revenue structure	User acceptance survey (WP13)
Number of market competitors	How many other BM are competing for the same customer base?	Porter's 5 forces	WP16
Size and reach of competitors	How big are those competing BM / For how long have they been around?	Porter's 5 forces	WP16
Competitor relationship immutability	Are competitors doomed to stay as-is or could they be turned into partners or even customers?	Porter's 5 forces	WP16

4 Scalability Assessment

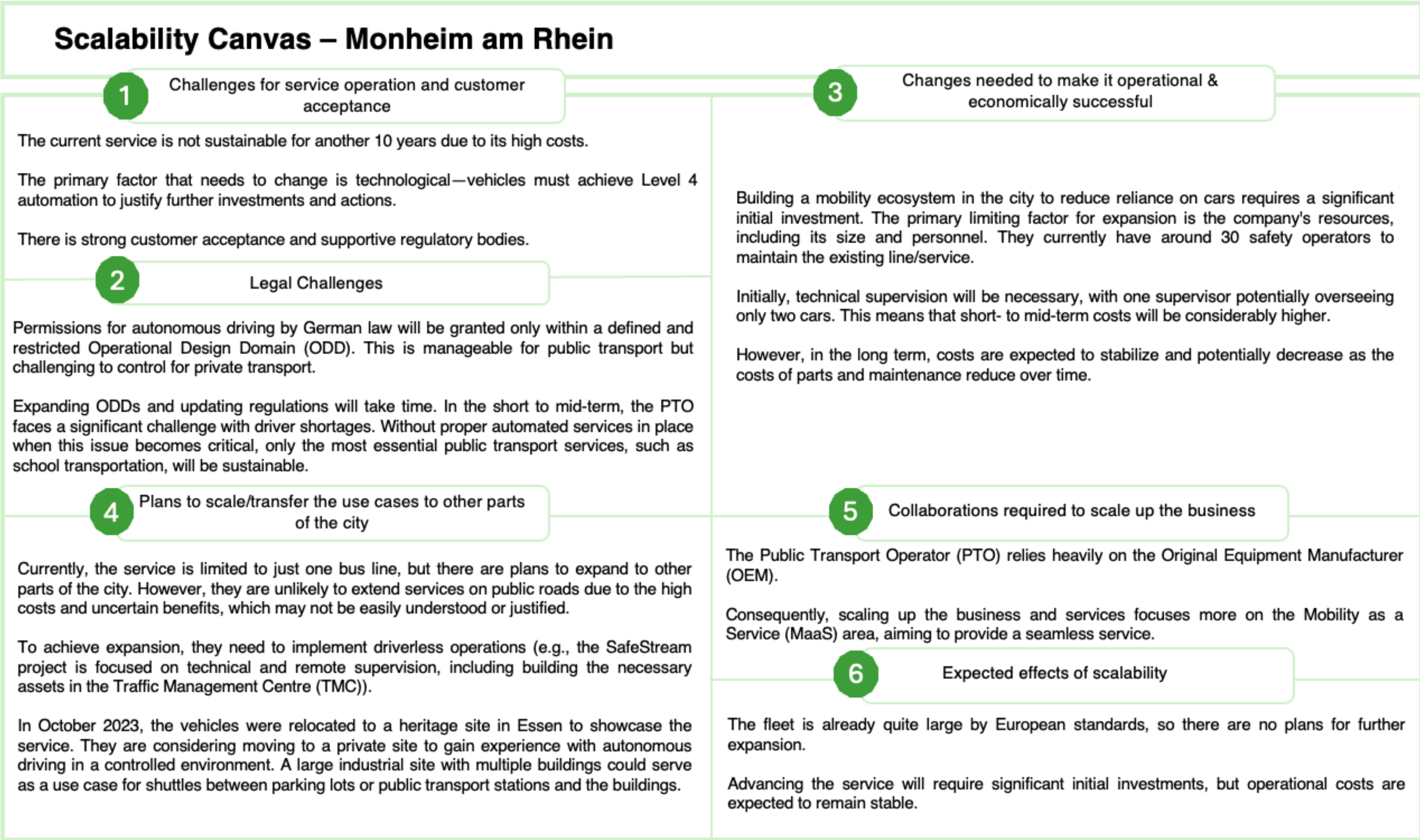
Studying the scalability of a BM involves examining how effectively and efficiently the business can grow to meet increasing demand or enter new markets without a proportional increase in costs. This section includes the analysis of the structured expert interviews and the analysis of the scalability canvas.

4.1 Interviews: Scalability canvas

The next scalability canvas considers different parameters that were obtained through the structured interviews with the SHOW Pilot sites representatives, it includes:

1. Challenges: we identify potential threats from emerging competitors and regulatory changes, to know where the potential limitations or constraints might hinder growth.
2. Regulatory and legal challenges: in industries like transportation, regulatory and legal considerations can be significant scalability factors. Scaling to other regions or countries involves complex regulatory challenges. This topic is also considered in A3.3 with regulations & standardisation.
3. Changes needed to escalate the pilots: Analyse current capacity to understand the current operational limits. For automated shuttle service, this could involve looking at the number of shuttles, technological infrastructure, maintenance capabilities, etc. It evaluates if operational processes are streamlined and can be replicated easily in new locations or at higher volumes, as automated and standardized processes often support better scalability.
4. Plans to scale the use case: define the growth vision by identifying where you want the business to be in a specified timeframe. This can be in terms of geographical presence, user base, revenue, or any other relevant metric. This also examines if the current technology stack supports rapid scaling, and whether can it handle a sudden surge in users, as well as if technological components need an overhaul to support growth.
5. Required collaborations: based on pilots' experience, the sites can consider whether they can easily obtain the necessary resources as the business grows, and what collaborations with different stakeholders are needed for a smooth scalation.
6. Expected effects of scalation: possible results of scalation, including information on how costs behave as the business expands. If costs increase linearly with growth, scalability might be challenging. Ideally, variable costs should decrease or remain constant as volume increases.

Based on the structured interviews carried out with the SHOW Pilot sites representatives the next information compiled in Canvas was captured:



Scalability Canvas – Monheim am Rhein

1 Challenges for service operation and customer acceptance

The current service is not sustainable for another 10 years due to its high costs.

The primary factor that needs to change is technological—vehicles must achieve Level 4 automation to justify further investments and actions.

There is strong customer acceptance and supportive regulatory bodies.

2 Legal Challenges

Permissions for autonomous driving by German law will be granted only within a defined and restricted Operational Design Domain (ODD). This is manageable for public transport but challenging to control for private transport.

Expanding ODDs and updating regulations will take time. In the short to mid-term, the PTO faces a significant challenge with driver shortages. Without proper automated services in place when this issue becomes critical, only the most essential public transport services, such as school transportation, will be sustainable.

3 Changes needed to make it operational & economically successful

Building a mobility ecosystem in the city to reduce reliance on cars requires a significant initial investment. The primary limiting factor for expansion is the company's resources, including its size and personnel. They currently have around 30 safety operators to maintain the existing line/service.

Initially, technical supervision will be necessary, with one supervisor potentially overseeing only two cars. This means that short- to mid-term costs will be considerably higher.

However, in the long term, costs are expected to stabilize and potentially decrease as the costs of parts and maintenance reduce over time.

4 Plans to scale/transfer the use cases to other parts of the city

Currently, the service is limited to just one bus line, but there are plans to expand to other parts of the city. However, they are unlikely to extend services on public roads due to the high costs and uncertain benefits, which may not be easily understood or justified.

To achieve expansion, they need to implement driverless operations (e.g., the SafeStream project is focused on technical and remote supervision, including building the necessary assets in the Traffic Management Centre (TMC)).

In October 2023, the vehicles were relocated to a heritage site in Essen to showcase the service. They are considering moving to a private site to gain experience with autonomous driving in a controlled environment. A large industrial site with multiple buildings could serve as a use case for shuttles between parking lots or public transport stations and the buildings.

5 Collaborations required to scale up the business

The Public Transport Operator (PTO) relies heavily on the Original Equipment Manufacturer (OEM).

Consequently, scaling up the business and services focuses more on the Mobility as a Service (MaaS) area, aiming to provide a seamless service.

6 Expected effects of scalability

The fleet is already quite large by European standards, so there are no plans for further expansion.

Advancing the service will require significant initial investments, but operational costs are expected to remain stable.

Figure 9: Scalability canvas – Monheim.

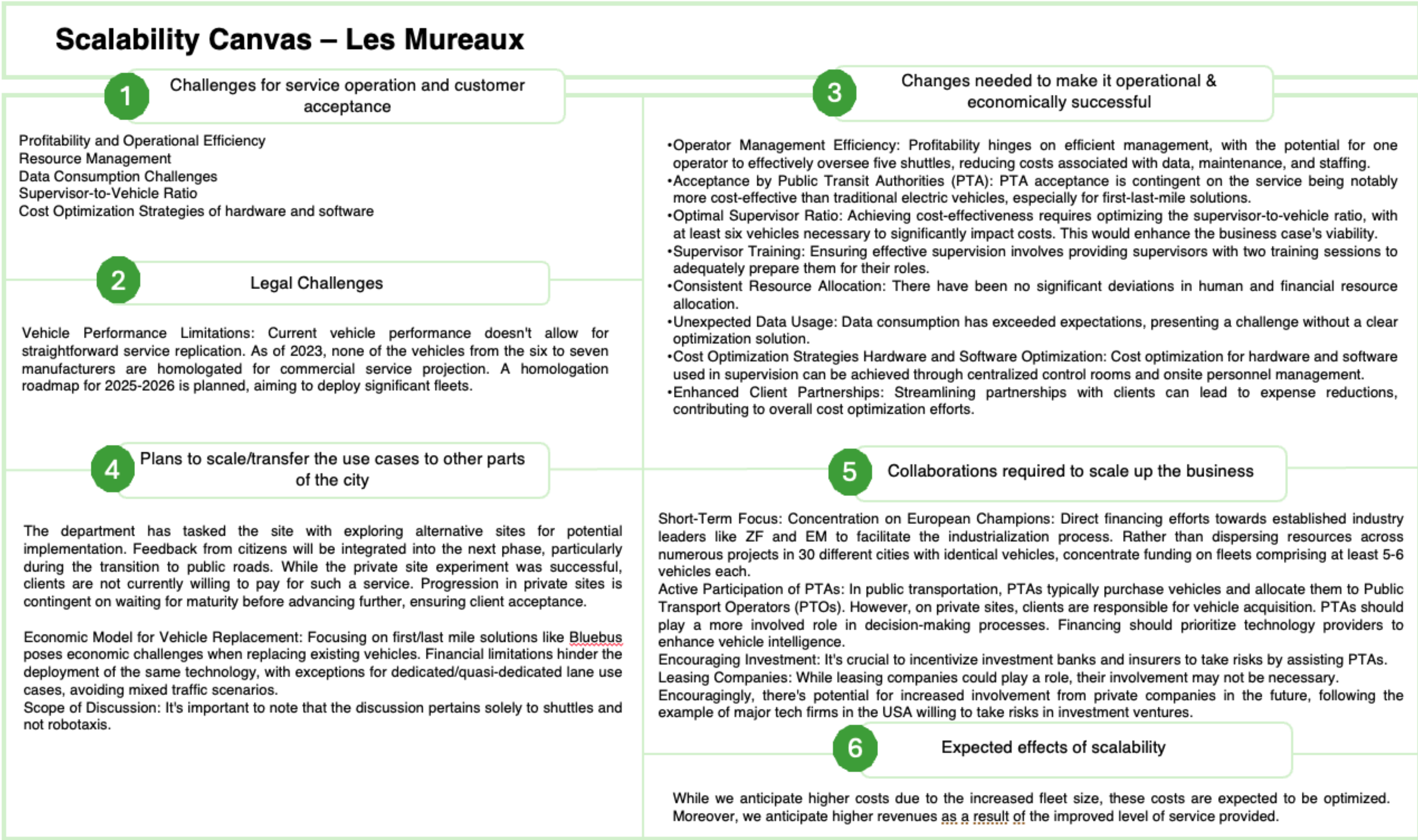


Figure 10: Scalability canvas – Les Mureaux.

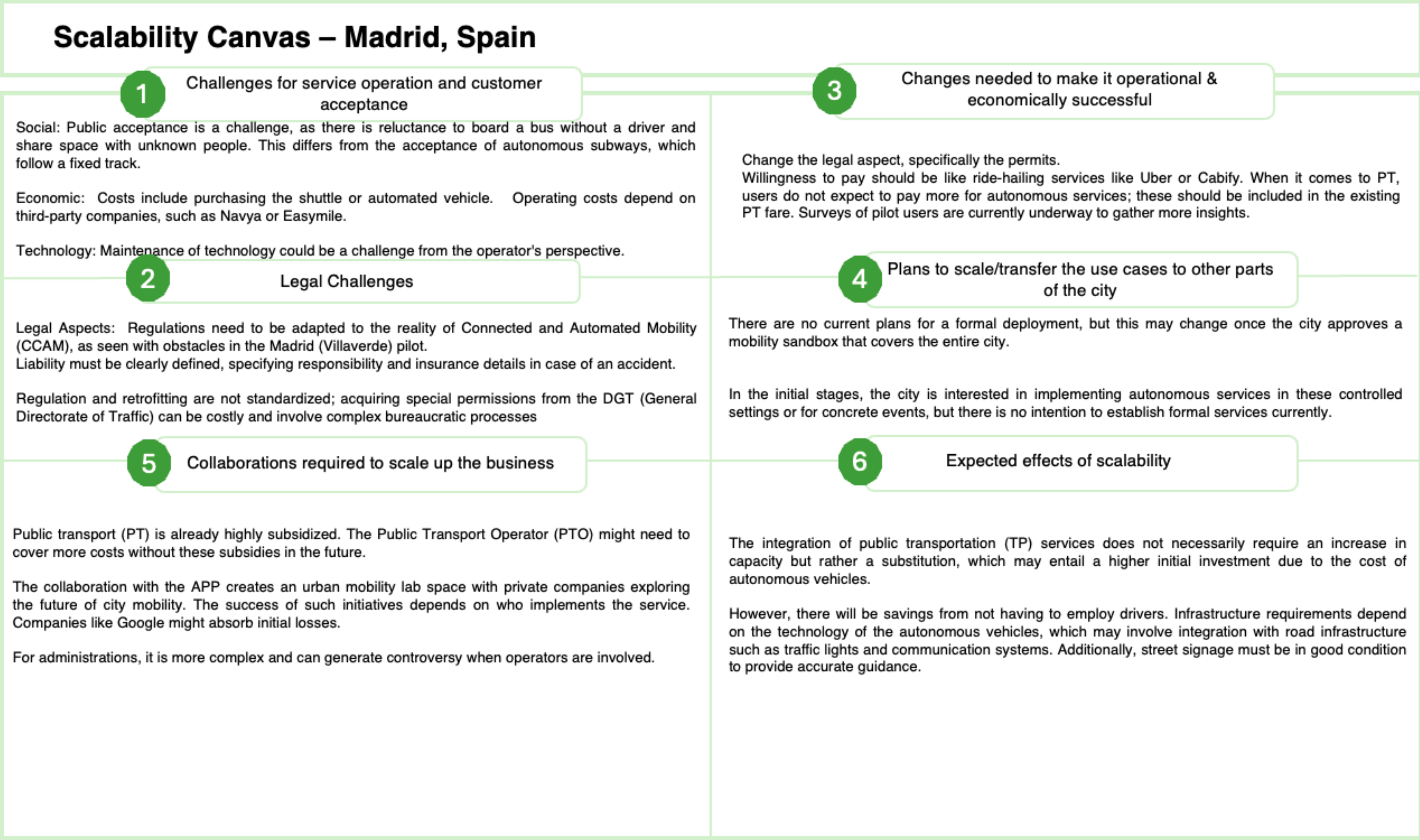


Figure 11: Scalability canvas – Madrid, Spain.

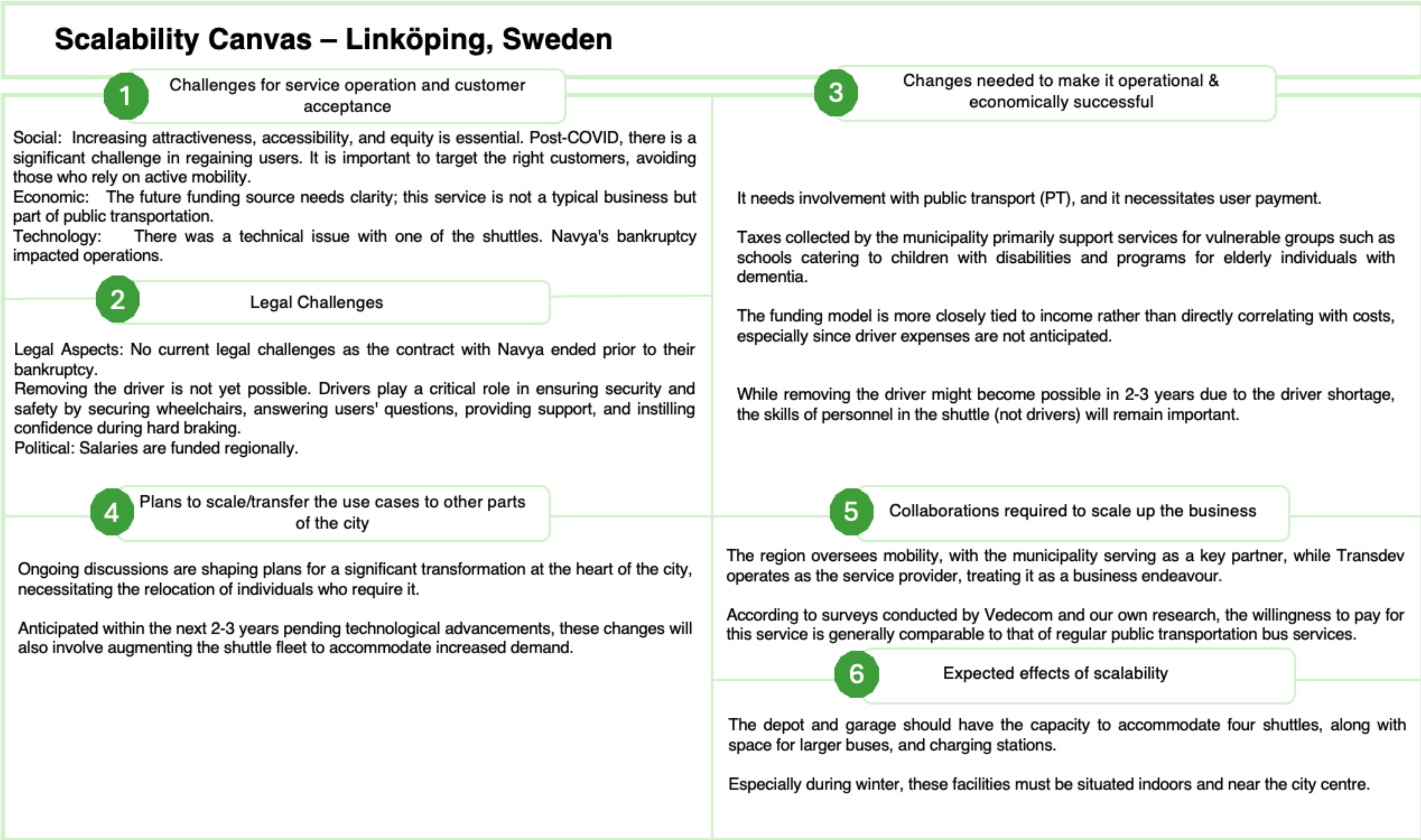


Figure 12: Scalability canvas – Linköping, Sweden.

Scalability Canvas – Gothenburg, Sweden

1 Challenges for service operation and customer acceptance

Improving attractiveness and accessibility involves enhancing reliability and speed, as well as identifying routes that encourage private car owners to opt for public transportation.

Investing in accessibility for individuals with disabilities is paramount. While removing the driver is an important step forward, it's crucial to provide adequate assistance and guidance to ensure passengers, especially those with mobility challenges, can safely navigate the vehicle, particularly during sudden stops.

2 Legal Challenges

For shuttles to become integrated into public transit, they must exhibit higher levels of reliability.

While Ericsson is advancing in 5G technology and remote operation capabilities, regulatory permissions still mandate a safety driver. The current state of shuttle technology is not advanced enough to operate without a driver. However, with improvements in vehicle technology, regulatory authorities may eventually permit driverless operations. This approach is already possible with other vehicles, such as trucks on open roads, operating under special permits.

Remote service capabilities are being explored, but currently lack a dedicated control room.

3 Changes needed to make it operational & economically successful

Implementing driverless technology is the next step in the evolution of public transportation, seamlessly integrating it into the existing public transit system without requiring additional payment from passengers.

This initiative focuses on fixed urban routes rather than on-demand services, with fares remaining consistent with standard transportation fees.

Focusing on scenarios where there is a demonstrated willingness to pay will ensure the service meets public demand and drives the project forward.

4 Plans to scale/transfer the use cases to other parts of the city

Keolis does not consider it feasible. It was the last in a series of trials, with several tests conducted in Gothenburg using Level 3 automation.

Unfortunately, it was not possible to continue operating on this route.

5 Collaborations required to scale up the business

Public transportation authorities are key stakeholders and operators in this initiative, and cities need a clear vision and strong leadership from local authorities. Identifying practical and sensible use cases is essential for advancing this pilot project.

6 Expected effects of scalability

Level 3 automation requires infrastructure improvements; we need vehicles that can better adapt to existing conditions. This includes cutting trees and grass to ensure clear pathways.

However, transitioning to Level 4 automation would allow vehicles to better adapt to the current infrastructure, potentially generating more revenue due to these enhancements.

Figure 13: Scalability canvas – Gothenburg, Sweden.

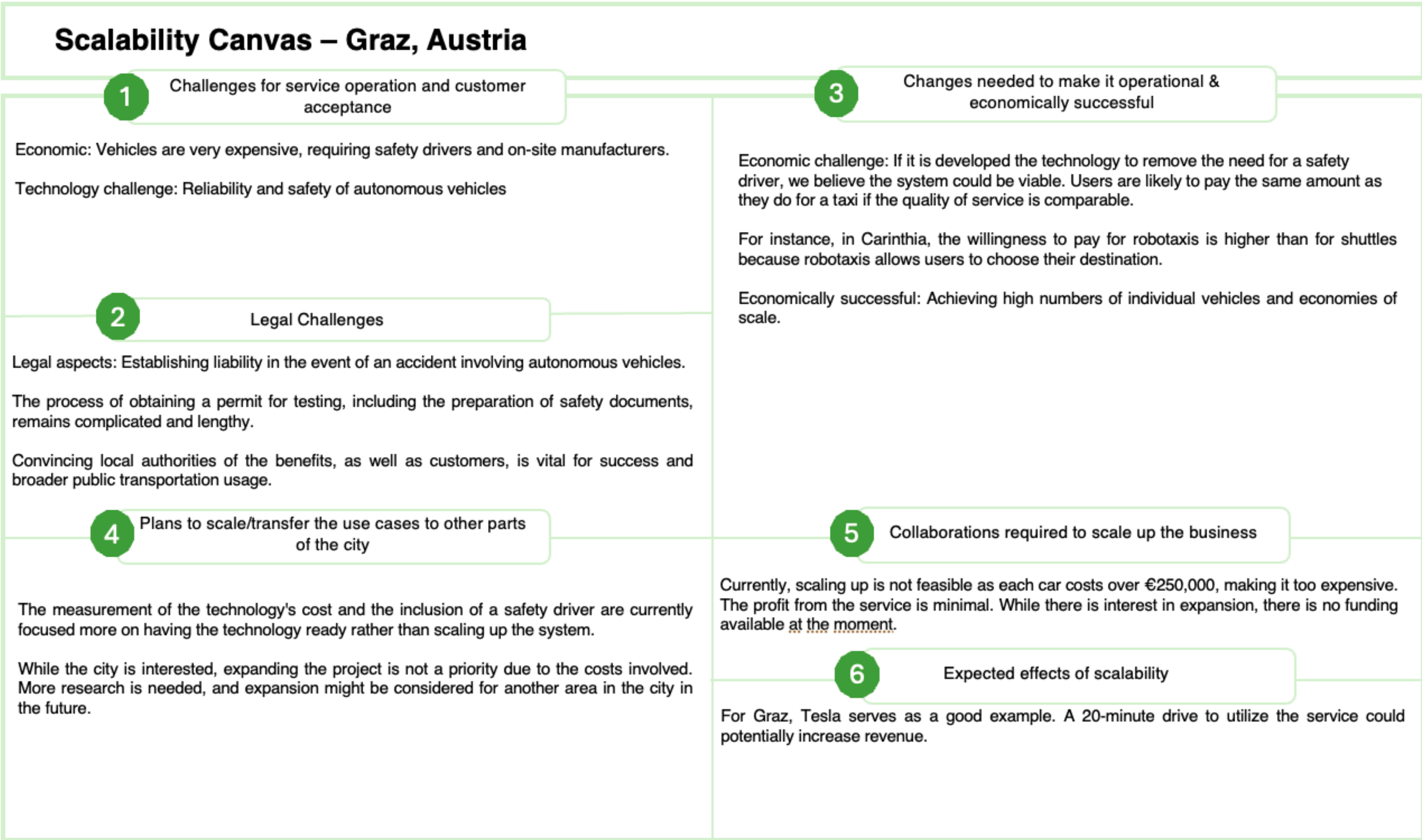


Figure 14: Scalability canvas – Graz, Austria.

Scalability Canvas – Tampere, Finland

1 Challenges for service operation and customer acceptance

Technology-wise, the prospect of centralized automotive charging coupled with remote control is promising.
The possibility of operating without a safety driver might materialize within the next two years, even amidst mixed traffic scenarios.

2 Legal Challenges

From a technical standpoint, this transition could be imminent, particularly considering that Finnish regulations do not mandate driver presence. Moreover, the possibility of remote drivers overseeing multiple vehicles adds to the feasibility.
While legislation may permit autonomous driving without a safety driver, questions of accountability remain paramount.
The Ministry of Transport and Communication collaborates with companies to navigate legislative frameworks, ensuring unhindered adoption of autonomous vehicles.

4 Plans to scale/transfer the use cases to other parts of the city

Feeder transport with AVs has garnered a positive reception, as the pilot phase is cost-free for users. The service boasts a high-quality level, complete with a reliable timetable. Plans are underway to replicate this success in other city zones, necessitating infrastructure adjustments and comprehensive planning for expansion into the South, North, and East areas.
Currently, the operating services are: (i) In Tampere there is one line operated by Remoted & Auvetech shuttle; (ii) In Lempäälä (very near Tampere) there is one line operated by Remoted & Karsan; (iii) in Kuopio, there is one line operated by remoted & Ohmio shuttle; (iv) in Lahti there is one line of Auvetech.

Addressing the crucial last mile, particularly for distances like 2km, requires thoughtful planning that minimises space consumption, thereby reducing reliance on private cars and parking areas. Integrating feeder routes with parking facilities is pivotal for future city planning, although this aspect is still in its developmental stages.

As the fleet of AV vehicles grows, a bidding process follows the pilot phase, inviting participation from multiple companies. Some companies opt for electric buses, albeit at a higher cost with an initial 8-year contract. However, post-contract, competition among bus providers becomes more prevalent.

3 Changes needed to make it operational & economically successful

With the inclusion of more vehicles, the cost of each vehicle decreases, particularly with the removal of safety drivers. The economic success of autonomous vehicles hinges greatly on their affordability.

Before the onset of COVID-19, manufacturing companies faced challenges, but the post-pandemic landscape has seen improvements. Companies are now capitalizing on enhanced economic opportunities to leverage autonomous vehicles more effectively.

There's a willingness to pay comparable rates to public transport services, albeit slightly higher, but not exceeding the current pricing thresholds.

5 Collaborations required to scale up the business

Collaborating with companies is essential to discern the diverse requirements across various organizations for scaling up operations effectively.

Operators require investors to facilitate expansion and improvement initiatives.

Figure 15: Scalability canvas – Tampere, Finland.

Scalability Canvas – Carinthia, Austria

1 Challenges for service operation and customer acceptance

Social (to enhance attractiveness, accessibility, equity, etc.): SURAAA actively engages citizens through numerous events to bolster acceptance of the autonomous shuttle.
Economic: The shuttle offers free access, eliminating charges for riders.
Environmental: During winter, service interruptions occur due to snow accumulation, presenting a challenge for the shuttle. However, a recent software update has improved braking performance.
Technological: Addressing operational challenges, such as snow accumulation during winter, remains a priority. Additionally, recent software updates have enhanced braking capabilities.

2 Legal Challenges

Legal Aspects: No significant legal hurdles have been encountered. Rigorous risk assessments have facilitated regulatory approvals. No teleoperation is allowed on public streets. Speed limit 20km/h. Safety driver mandatory

Political: The initiative enjoys robust political support, providing a conducive environment for its implementation and growth.

3 Changes needed to make it operational & economically successful

The current technology remains prohibitively expensive, encompassing high initial purchase costs and ongoing expenses like licensing and maintenance fees.

Moreover, Austrian regulations mandate the presence of a safety operator onboard autonomous buses, further increasing operational expenses for public transport operators compared to traditional buses. Only when these costs diminish will autonomous technology become financially viable for PTOs to adopt.

4 Plans to scale/transfer the use cases to other parts of the city

Yes, the 2.7km route is constantly being developed to expand the network. In response to citizen requests, the current test track in Pörtschach was extended in 2022.

Additionally, a second test track has been established in Klagenfurt. There is no additional information on further network expansion.

5 Collaborations required to scale up the business

There is a need for government funding, as all public transport is subsidized by the government.

6 Expected effects of scalability

Expanding the fleet increases costs, necessitating subsidies and the implementation of service charges.

Figure 16: Scalability canvas – Carinthia, Austria.

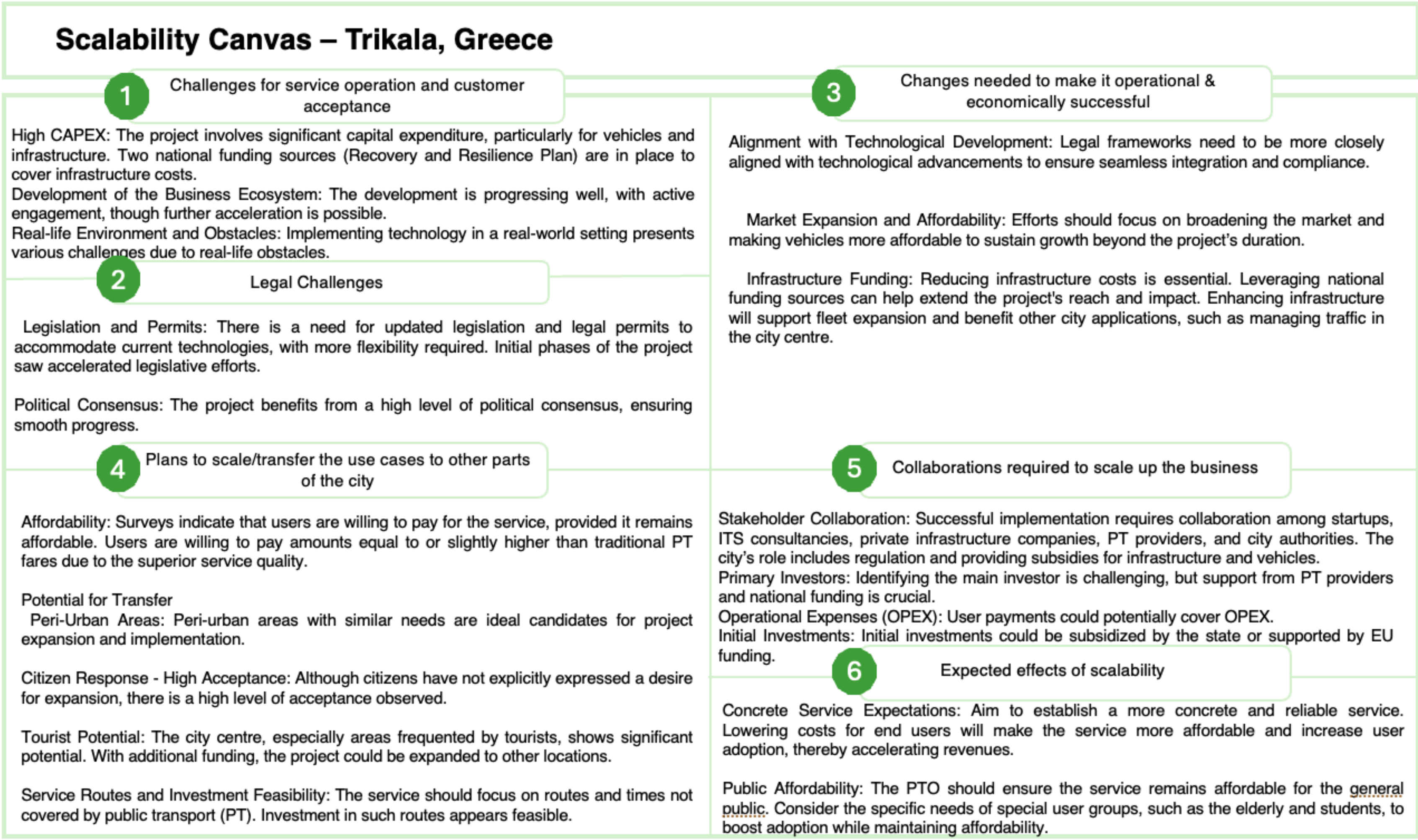


Figure 17: Scalability canvas – Trikala, Greece.

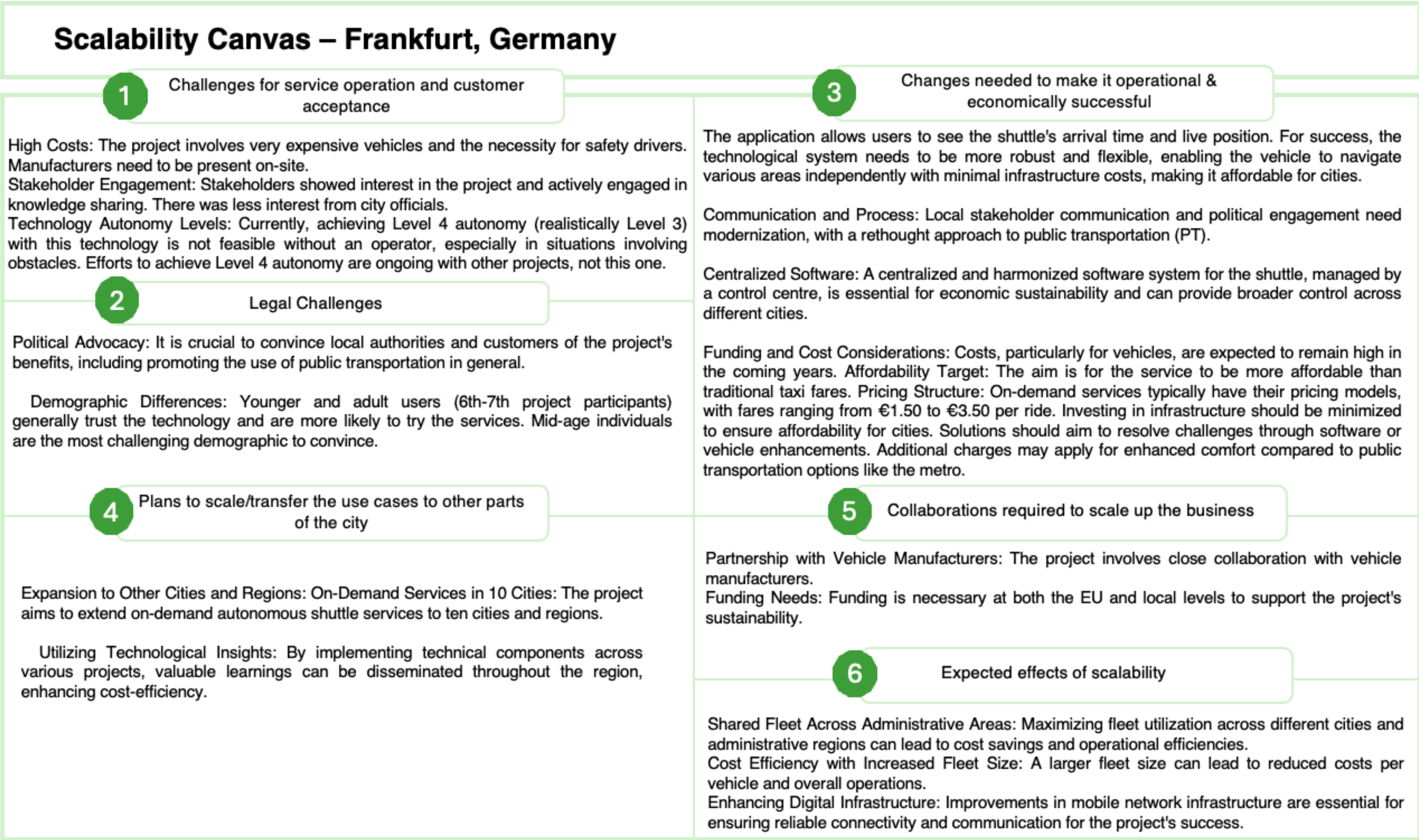


Figure 18: Scalability canvas – Frankfurt, Germany.

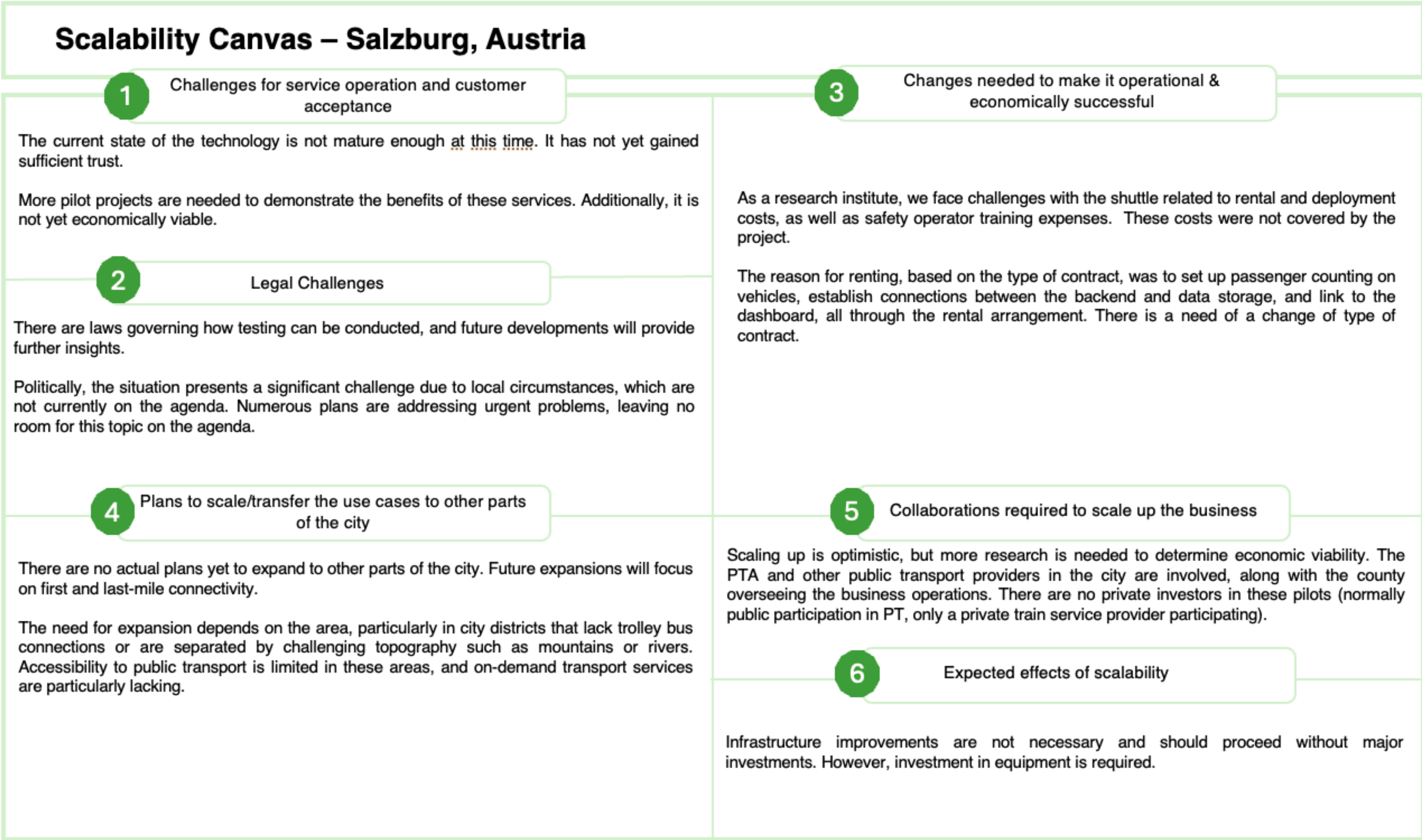


Figure 19: Scalability canvas – Salzburg, Austria.

Scalability Canvas – Brno, Czech Republic

1 Challenges for service operation and customer acceptance

Beneficial with Stakeholder Support: The project is economically viable, particularly when stakeholders recognize its value.
Technology advancements Needed: Eliminating the need for safety drivers, implementing artificial intelligence, and reducing costs associated with pre-mapping are key technological goals.
Lack of Citizen Engagement: Despite these efforts, there has been minimal citizen engagement or participation in the project.
Currently, shared routes, particularly in city centres, face challenges due to space constraints. Finding solutions to optimize these routes is crucial for effective service delivery.

2 Legal Challenges

Cooperative Approach: Legal aspects are being addressed collaboratively with stakeholders to ensure that all parties recognize the added value of the project, fostering cooperation in governance.
Strong Political Support: The project enjoys robust political backing, facilitating its progress.

3 Changes needed to make it operational & economically successful

Transforming Societal Perspectives: The project aims to change societal mindsets to embrace the commercial delivery of autonomous vehicle (AV) products. Despite the operational use cases, there's a persistent effort to downplay the potential of these technologies.

Lack of Awareness in SUMP: The Sustainable Urban Mobility Plan (SUMP) does not mention autonomous vehicles, indicating a broader lack of awareness among the public regarding the benefits of this technology.

4 Plans to scale/transfer the use cases to other parts of the city

Current City Expansion: Transfer to other parts of the city is underway, but future challenges remain uncertain, and feasibility is not guaranteed. Operations in various scenarios, including graveyard routes, are being evaluated. However, there has been no increase in the number of routes or services.

Interest from Other Cities: Some cities have expressed interest in the service, indicating potential expansion opportunities.

5 Collaborations required to scale up the business

Affordability Imperative: The service must be more cost-effective than traditional public transportation, especially considering that public transport is currently free.

Scaling Strategies: To scale up, collaboration with end users or operators such as sellers' logistics operators could be explored (cargo hailing with bikes)

6 Expected effects of scalability

Navigating Legal Constraints: Adapting to new legal requirements is essential, especially regarding limitations on operating on roads not owned by cities and restrictions on public road use.
Safety and Economic Benefits of Dedicated Lanes: Implementing dedicated lanes can significantly enhance safety and bolster the economic viability of operators by ensuring smoother operations.

Figure 20: Scalability canvas – Brno, Czech Republic.

Scalability Canvas – Karlsruhe, Germany

1 Challenges for service operation and customer acceptance

One of the biggest challenges in the adoption of autonomous vehicles (AVs) is the high cost of the required technology and infrastructure.

Additionally, the lack of affordable shuttles and reliable providers poses a significant challenge.

2 Legal Challenges

There is considerable political support for autonomous vehicles, with laws in place that allow AVs on public roads. However, obtaining the necessary permits from local authorities remains a hurdle, indicating room for regulatory improvement.

Germany has led the way in Europe by being the first country to implement a comprehensive legal framework for AVs, setting a benchmark for other nations.

3 Changes needed to make it operational & economically successful

Despite this progress, continuous enhancements and harmonization of regulations at both national and local levels are essential to fully harness the potential of AV technology.

4 Plans to scale/transfer the use cases to other parts of the city

Users appreciated the service, and road users were pleased with its conclusion.

The pilot project has finished, and there are no plans to extend it due to economic constraints.

Currently, there are no other similar projects on the horizon. The focus now shifts to further developing the AI algorithms (neural networks and reinforcement learning).

5 Collaborations required to scale up the business

There's uncertainty regarding the next steps. The technological aspects are being effectively addressed on well-established roads. However, there's a need for greater acceptance of legal frameworks, particularly at the city level.

In Manheim, where similar initiatives have been running for years, there have been notable issues, such as parts breaking down and requiring service from original equipment manufacturers (OEMs), so strong collaboration with them is required for a smooth scalation.

6 Expected effects of scalability

The focus now shifts to further developing the AI algorithms of the vehicles.

Figure 21: Scalability canvas – Karlsruhe, Germany.

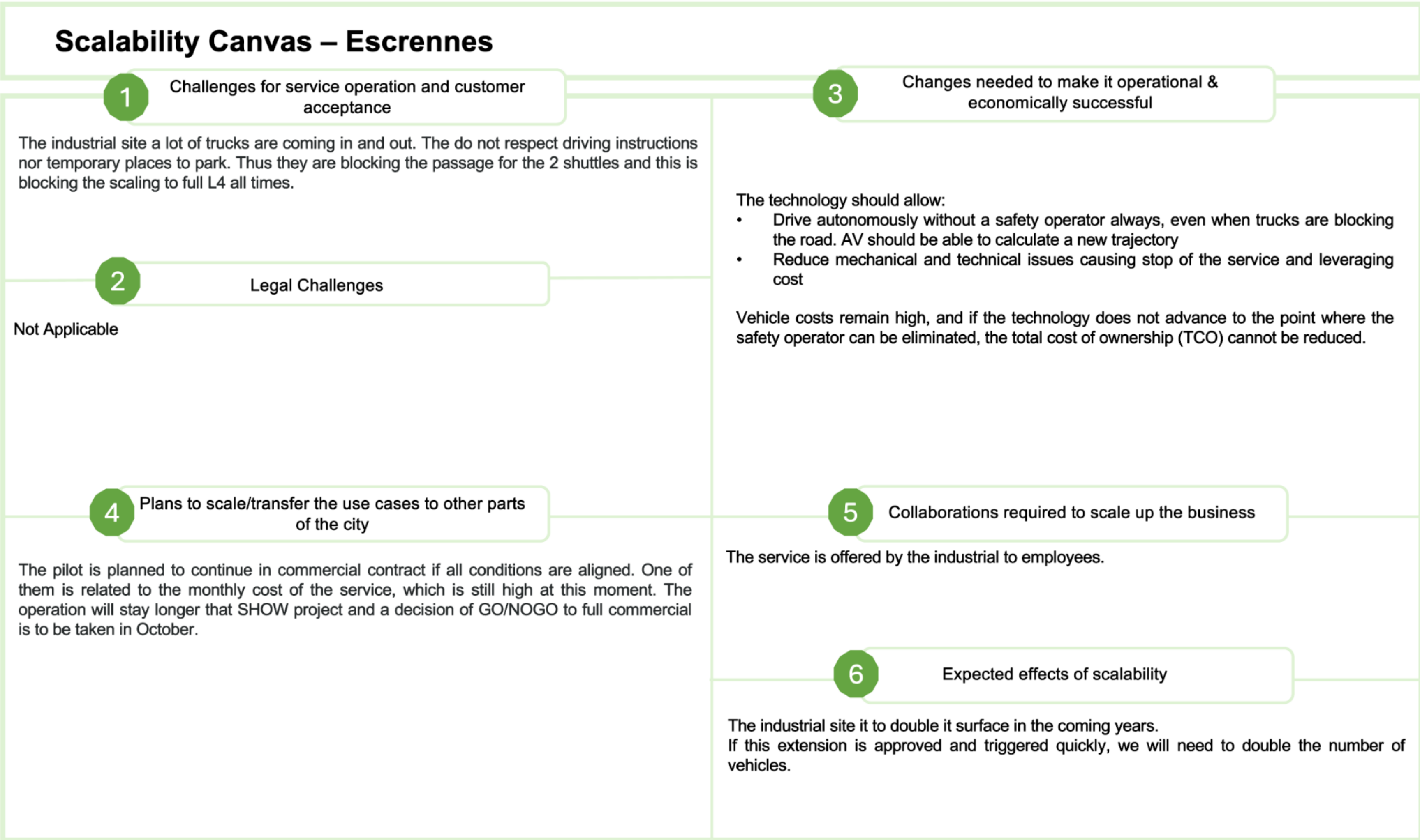


Figure 22 Scalability canvas – Escrennes, France

Scalability Canvas – Crest Val de Drome

1 Challenges for service operation and customer acceptance

Shortage of safety operators. The job has become less attractive, and public transport operators (PTOs) are struggling to recruit drivers.

Need to inform about the service in rural areas through stakeholders.

2 Legal Challenges

The authorization process is still in waiver mode, and there is no advocacy from all stakeholders. It took more than 5 month to go through this process: people moved, there was no official process but temporary procedures, and more than five institutions had to validate at their levels between ministries and local administrations. We needed to be part of the process to facilitate inter-institution communication and communicate results from one institution to another.
A new permanent process is under preparation by the ministry, and hopefully it will facilitate the process

4 Plans to scale/transfer the use cases to other parts of the city

After SHOW finishes, with phase 2 of the pilots, the plan is to prepare for the third phase just after SHOW, which will enlarge the coverage area, connect to the hospital and train station, regulate the frequency and flexibility of the service, increase the number of vehicles to seven, and install new types of vehicles that would allow Full L4 with no safety driver on board.

3 Changes needed to make it operational & economically successful

Vehicle costs remain high, and if the technology does not advance to the point where the safety operator can be eliminated, the total cost of ownership (TCO) cannot be reduced. Include Avs in the financial support from government as it is doing for EVs.

The technology should allow :

- Drive autonomously without a safety operator
- Reduce mechanical and technical issues causing stop of the service and leveraging cost

Legally, to have a short, smooth authorisation and legal process that are mastered by the institutions

5 Collaborations required to scale up the business

The third phase is already scheduled and financed through government support. It will last for two years and should allow the installation of FULL L4 service, which would reduce the TCO and prepare for sustainability towards permanent service. If the third phase is successful, the financing would be supported by the local government, with additional support from the national government, mobility taxes from companies in the area, and a smaller portion from passenger ticketi

6 Expected effects of scalability

The investment in CAPEX increases depending only on the number of vehicles. When we remove the safety driver, we will have one human operator in the supervision centre managing all the vehicles and one field operator covering on-site interventions when needed.

Figure 23 Scalability canvas – Crest, France

4.2 Analysis of scalability of operations

This section describes the pilot sites that plan to scale or have already scaled up their operations as well as the challenges that the rest of the sites faced to scale their operations:

4.3 Scalable pilots

According to the experts, the sites that plan to scale or have scaled their operations are:

(i) Monheim (mega-site): The service currently operates on a single bus line, with plans for city-wide expansion in the works. However, expanding onto public roads may not be feasible due to high costs and uncertain benefits. To achieve growth, the company is exploring driverless operations and considering a move to a private site for testing automated driving in a controlled environment, such as a large industrial site. This site could pilot shuttle services between parking lots, public transport stations, and buildings.

(ii) Tampere (satellite site): Plans are in motion to replicate this success in other city zones, necessitating infrastructure adjustments and thorough planning for expansion into the South, North, and East areas, addressing the crucial last mile. Currently, the operating services are: (a) In Tampere there is one line operated by Remoted & Auvetech shuttle; (b) In Lempäälä (very near Tampere) there is one line operated by Remoted & Karsan; (c) in Kuopio, there is one line operated by remoted & Ohmio shuttle; and (d) in Lahti there is one line of Auvetech.

(iii) Carinthia (mega-site): the 2.7km route is continuously evolving to expand the network, responding to citizen requests. In 2022, the current test track in Pörtschach was extended, and a second test track was established in Klagenfurt. There is no additional information on further network expansion.

(iv) Frankfurt (mega-site): The project aims to extend the automated shuttle services, to cities with on-demand services, to improve accessibility and transportation options.

4.4 Challenges of escalation

Sites that are analysing the opportunities/exploring alternatives of scaling but face challenges to materialize include Les Mureaux, Linköping, Graz, Trikala, and Brno. While the rest of the sites (Madrid, Gothenburg, Salzburg and Karlsruhe) do not consider feasible the option of scaling their operations. Overall, while there is interest and potential for expanding automated shuttle services to other parts of the city or even other cities and regions, various challenges must be addressed for successful implementation and scalability. The **biggest challenges** for seamless service operation and escalation of pilots compiled from the interviews include:

1. **Technological Advancements:** Achieving (actual) Level 4 automation is crucial to justify investments and actions due to high costs. However, current technology limitations hinder progress, such as the inability to operate without a safety driver in various situations like navigating obstacles.
2. **Social Acceptance:** Public acceptance poses a challenge, particularly regarding trust in driverless vehicles and sharing space with strangers. Targeting the right

customer demographics and addressing post-COVID concerns are essential for increasing attractiveness and accessibility.

3. **Economic Sustainability:** High capital expenditure, including vehicle costs and infrastructure, presents a significant economic challenge. Securing funding sources and developing the business ecosystem are vital for long-term viability.
4. **Legal and Regulatory Framework:** Regulations need adaptation to accommodate connected and automated mobility, addressing liability issues and ensuring clear responsibility in case of accidents. Political support is crucial for navigating regulatory hurdles and gaining broader acceptance.
5. **Environmental Considerations:** While no significant environmental challenges exist, service interruptions due to weather conditions like snow accumulation highlight the need for technological advancements to improve operational reliability.
6. **Communication and Stakeholder Engagement:** Effective communication with local stakeholders and politicians is necessary to garner support and address concerns, especially regarding traditional public transportation processes.
7. **Demonstrating Benefits:** More pilot projects are needed to demonstrate the benefits of automated transportation services and build trust among users, as the current state of technology may not yet be mature or economically viable enough for widespread adoption.

5 Transferability Assessment

Transferability refers to the capacity of a BM to be effectively replicated, adapted, and implemented in diverse locations or business environments beyond its original site. Transferability enables leveraging successful practices, innovations, and solutions developed in one context to create value and drive positive impact in diverse settings, contributing to broader innovation diffusion, economic development, and societal progress.

5.1 PESTLE Analysis

Based on the result of the PESTLE analysis carried out in D2.4 [11]. The SHOW project could identify opportunities and challenges associated with Political, Economic, Social, Technological, Legal and Environmental factors to transfer pilot sites to new locations, thereby informing strategic decision-making and maximizing the success of such transfers. It was found that the viability (D2.4) is sensitive to the costs of vehicles and supervision, the maturity of automation technology, and also to political support. Here is the description of the factors that included the following analysis:

- **Policy Factors**
  - Regulatory Environments: Examining how legal and policy frameworks can impact model adoption.
  - Governance Structures: The role of local governance in enabling or constraining model implementation. Supportive policies can accelerate development, while stringent regulations may hinder progress.
  - International Relations: Cross-border collaboration and harmonization of AV regulations can enhance scalability by creating larger markets and reducing regulatory barriers.
  - International political situations between different European countries can change and influence the implementation of cross-border collaborations.
  - Interoperability: Difference between nations in current testing (e.g. Austria is currently testing entire systems but Hungary is only testing functions for automated driving). No overall standardization for international automated driving is available.

- **Economic Factors**
  - Cost Structures: Variances in labour, land, and capital costs that affect economic feasibility.
  - Cost of Technology: The affordability of AV technology, including sensors, software, and hardware, affects scalability. Lower costs can lead to wider adoption.
  - Revenue Streams: Potential for generating revenue, considering local economic conditions and funding mechanisms.
  - Public Funding and Subsidies: The availability of public funding or subsidies for AV research and infrastructure development can significantly impact transferability.
  - Economic Incentives: Tax incentives, subsidies, and other economic benefits can encourage businesses and consumers to adopt AV technology.
  - Market Demand: Consumer demand for AVs and related services drives scalability. High demand can attract more investments and accelerate development.
  - Missing legal framework and regulations for introducing automated driving services (impacting the transferability) complicates the market introduction and necessary pre-investments.

- **Social Factors**
    - Cultural Acceptance: Local community's readiness and openness to adopt new mobility solutions.
    - Demographic Trends: Age distribution, urbanization rates, and population density influence demand.
    - Cultural Attitudes: Cultural attitudes towards technology and innovation can impact the adoption and transferability of AVs.
    - Workforce Impacts: Potential job displacement in driving-related professions needs to be addressed to ensure smooth transferability.
- **Technological Factors**
    - Digital Infrastructure: Availability of required technological support, like communication networks. Development of 5G and other connectivity infrastructure supports real-time data exchange and AV performance.
    - Technological Adaptability: Ease of integrating the service with existing transport and technological systems. Standardization and interoperability of AV technologies across different manufacturers and platforms facilitate transferability.
    - Vehicle technology: Depending on where the service is located, different vehicles have to be selected (flat land vs. Hilly area). The location as well could influence localisation such as DGPS, High-resolution digital maps, etc.
- **Environmental Factors:**
    - Sustainability Goals: AVs have the potential to reduce emissions and support sustainability goals, which can drive transferability.
    - Energy Efficiency: The energy efficiency of AVs, especially electric ones, impacts their environmental footprint and transferability.
    - Urban Planning: Integration of AVs into urban planning and public transport systems supports transferability.

The PESTLE analysis in D2.4 [11], explored the viability from different perspectives considering economic, technological, social, legal, and other aspects. It was found that vehicle costs must decrease substantially to achieve viability. Additionally, having one supervisor manage the operation of at least five vehicles would improve economic viability. Technological challenges remain, such as increasing safety and speed while eliminating trust and latency issues, particularly for remote supervision. This requires improvements in sensor accuracy and supervisor capabilities. Political support is crucial for advancing the project and ensuring its success, and current regulations need to be adapted to the realities of CCAM.

The PESTLE analysis revealed several critical external factors affecting the transferability of pilot sites: (i) Political Factors**:** Government support, regulatory frameworks, and political stability are essential for successful AV deployment in new locations. Assessing these elements helps mitigate risks and align with local laws; (ii) Economic Factors**:** Evaluating market demand, funding availability, and cost considerations ensures economic viability. Identifying financial implications and revenue streams is crucial for sustainable transfer; (iii) Social Factors**:** Public acceptance, cultural differences, and community engagement are pivotal in gaining societal support. Addressing societal attitudes and building trust is key to overcoming resistance; (iv) Technological Factors**:** Infrastructure readiness, technological advancements, and data security are vital for seamless AV operations. Ensuring technological compatibility and addressing cybersecurity concerns are necessary for successful implementation; (v) Legal Factors**:** Regulatory compliance, liability considerations, and the permitting process are critical for legal clarity. Navigating these legal aspects ensures smooth and lawful AV deployment; (vi) Environmental Factors**:** Assessing environmental impact and incorporating sustainability practices minimize the ecological footprint. Promoting eco-friendly AV solutions aligns with broader environmental goals.

5.2 SWOT Analysis

Based on the analysis of D16.1 (SHOW, 2021) the next updated SWOT analysis (see **Figure 24**) includes/expands to include the transferability of AV pilots, especially regarding the building and implementation of BM at the pilot sites. SWOT analyses play a crucial role in cultivating the development ecosystem, particularly when employing the SHOW approach. This strategy prioritizes Small and Medium Enterprises (SMEs), startups, and new market entrants while seamlessly integrating Public Transportation Operators (PTOs) without undermining their operations. Moreover, it deliberately overlooks fundamental investments, a significant barrier for any business, especially emerging ones.

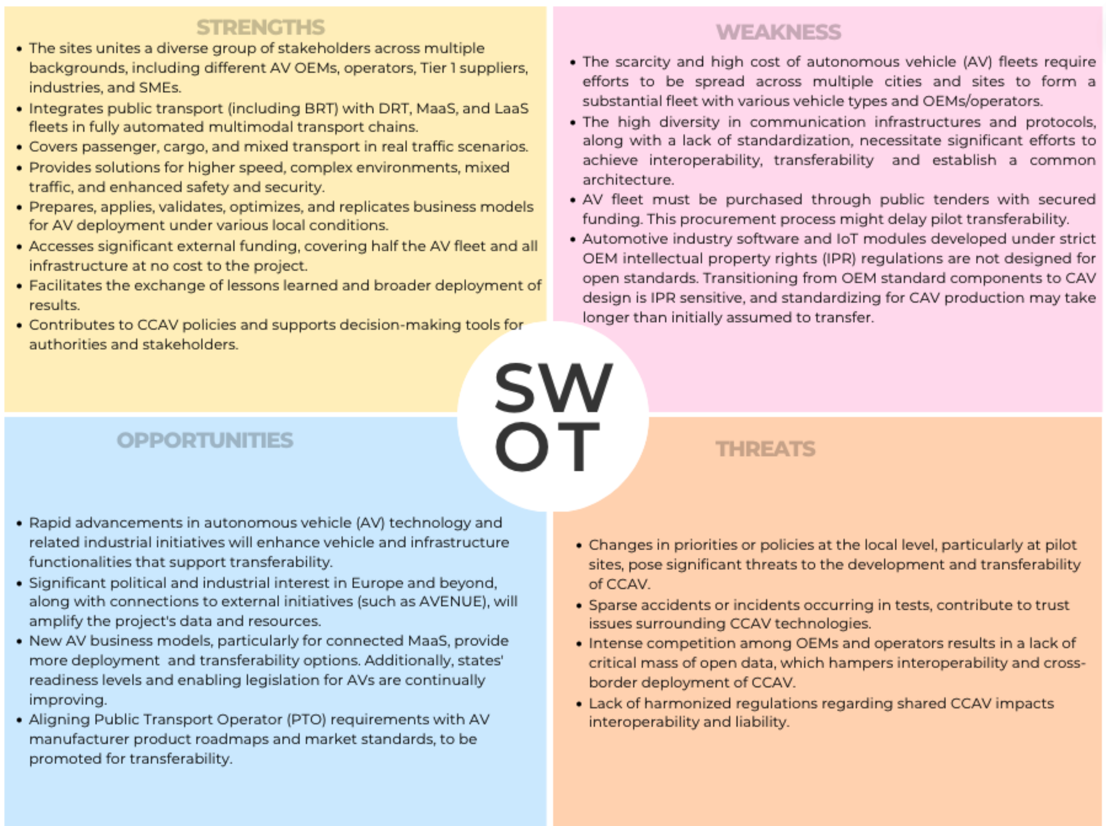


Figure 24: SWOT analysis of transferability of BMs**.**

By understanding and addressing these strengths, weaknesses, opportunities, and threats, stakeholders can develop effective strategies to ensure the successful transferability of automated vehicle pilots, fostering global advancements in automated transportation.

5.3 Competitive Forces: Porter's Five Forces

Porter's Five Forces analysis is a framework for analysing the competitive forces within an industry. Here's an application of Porter's Five Forces to the pilots of automated vehicles:

A. Threat of New Entrants

High Barriers to Entry: Developing automated vehicles requires significant technological expertise and innovation, which can be a substantial barrier for new entrants. Especially high costs associated with research and development, as well as manufacturing of automated vehicles, deter new entrants. Moreover, navigating complex regulatory landscapes and gaining necessary approvals can be challenging and resource-intensive.

Potential for Disruption (startups vs. Tech Giants): Despite high barriers, well-funded startups and large tech companies (like Waymo, and Tesla) are capable of entering the market, bringing innovation and competitive pressure.

SHOW D16.1 [13] described projects on specific topics of research for instance the projects associated with automation technologies include CO-EXIST; Galileo For Mobility (Operational, focuses on vehicle-specific location and navigation services); INFRAMIX; Interact; and L3Pilot, which address issues ranging from traffic signalling systems to specific vehicle technologies. Projects associated with social acceptance of AVs include BRAVE (Aims to provide a toolkit for stakeholders to ensure the safe operation of automated vehicles); and Drive2thefuture (Prepares drivers, passengers, and operators for future transport modes using pilots and simulators). Projects focused on driver and passenger safety include ADAS&me (Monitors and predicts driver states such as fatigue); AUTOMATE; and Headstart (Aims to standardize testing and validation procedures for automated transport). Projects associated with policy issues include Connected Automated Driving EU (A knowledge base for data, knowledge, and experiences on CAD in Europe) and LEVITATE (Develops a methodology for assessing the impacts of automated vehicles in urban environments).

According to [14] ongoing projects in Europe include topics on:

- **Policy and Regulatory Needs, and European Harmonisation:** The ARCADE project will conduct a detailed review of current initiatives and highlight achievable targets and best practices to ensure the safe and timely implementation of first AD use cases.
- **Socio-Economic Assessment and Sustainability:** The widespread use of common impact assessment methodologies, such as the FESTA Handbook, can harmonize evaluation efforts. Using a sound methodology helps to build the validity of evaluation results, as the work then follows the phases of a scientific study.
- **Safety Validation and Roadworthiness Testing:** Safety validation and roadworthiness testing require the review and update of existing regulations, methodologies, processes, and tools to address both foreseen and unforeseen situations. Collaboration between industry, service providers, and public authorities is essential. Developing commonly accepted safety validation frameworks, such as the HEADSTART and PEGASUS initiatives, is crucial.
- **Digital and Physical Infrastructure:** Infrastructure can support a variety of use cases, from vehicle support (e.g., in-lane merging) to advanced traffic management measures (e.g., strategic or tactical vehicle interactions) to maintenance activities. The requirements for physical and digital infrastructure strongly depend on the specific use case. A harmonized approach to describing scenarios and use cases is necessary to install appropriate sensors and provide the required data and quality communication channels. Several actions have been identified in the first year of the ARCADE project in the area of physical and digital infrastructure.
- **Big Data, AI, and Their Applications:** Big traffic data and artificial intelligence (AI) techniques are critical in developing Connected and Automated Driving (CAD)

technologies. CAD system sensors continuously produce big traffic data, complemented by data from other sources, such as road infrastructure sensors (e.g., cameras) and weather databases. In ARCADE, this technical area aims to highlight the current situation, debate the way forward with key stakeholders, and recommend concrete actions to address challenges, key uncertainties, and blocking issues to maximize the anticipated impact.

- **Human Factors:** Human-machine interaction/Interface (HMI) incorporates the interaction between humans and different types of machines and system components to achieve a common goal. Real-world studies and pilots include projects like L3Pilot and ENSEMBLE.
- **Connectivity:** Connectivity between vehicles and between vehicles and infrastructure is crucial for enhancing the benefits of automated driving in terms of safety, traffic efficiency, and comfort. In ARCADE, this technical area aims to highlight the current situation, debate the way forward with key stakeholders, and recommend concrete actions to address challenges, key uncertainties, and blocking issues to maximize the anticipated impact.
- **Deployment, Production, and Industrialisation:** The main challenges in production and industrialization include time to market, continuous software updates, cybersecurity, production tests and methodologies, quality assurance tests and certifications, and impacts on the aftermarket industry and vehicle maintenance. Early standardization efforts are crucial for accelerating the development of lower (L2 and L3) automation features, especially for trucks, as seen in projects like L3Pilot and ENSEMBLE.

Especially on the topic of business models The ARCADE project focuses on services using connected and automated vehicles (SAE L3 or L4), which operate on-demand or on a scheduled basis, integrated into city transport networks and MaaS platforms. These services are accessible via public transport or private operators' platforms or apps. The analysis conducted in the first year of ARCADE highlights several key conditions for the successful deployment of new CAD services:

- <u>Cost Reduction:</u> Research and investment should prioritize decreasing the cost of services, which remains prohibitively high.
- <u>Interoperability and Integration:</u> Ensuring interoperability and seamless integration with public transport systems is essential.
- <u>Safety Specifications:</u> Clear safety specifications must be established and adhered to.
- <u>Network Integration:</u> CAD services need to be effectively integrated with existing transport networks and MaaS platforms.
- <u>New Operators and Trust:</u> New types of operators may be required, and establishing trust among stakeholders is crucial.

Large-scale pilots and Field Operational Tests (FOTs) should be prioritized to address these conditions and facilitate the successful deployment of new mobility services.

B. Bargaining Power of Suppliers

Specialized Components: Suppliers of specialized hardware and software (e.g., LIDAR sensors, AI chips) hold significant power due to the limited number of alternative suppliers. Automated vehicle companies often rely on strategic partnerships with suppliers, which can influence pricing and supply conditions.

Mitigating Factors: Some companies may choose to develop their technology in-house (e.g., Tesla producing its chips), reducing dependency on suppliers, and may diversify their supplier base to mitigate the power of individual suppliers.

C. Bargaining Power of Buyers

Consumer Demand: As automated vehicles are a new technology, early adopters may have less price sensitivity, but mainstream consumers will demand high safety and reliability at competitive prices. Companies purchasing automated vehicles for ridesharing or logistics (e.g., Uber, Amazon) have significant negotiating power due to the volume of their purchases.

Product Differentiation: Companies that can offer superior technology, safety features, and user experience can reduce buyer power by creating a unique value proposition.

The previous delivery of SHOW D16.1 [13] describes the competition of the project with other large-scale AV projects that provided to that date similar technology including:

- **CityMobil2**: Implemented automated low-speed shuttles in various European cities, primarily on dedicated lanes, with remote vehicle control.
- **SB Drive (Japan)**: Established in 2016 by Softbank, demonstrating automated shuttles in four Japanese cities, with public road tests starting in 2018.
- **MAVEN**: An H2020 project developing algorithms and communication standards for automated urban transport, excluding big city pilots.
- **AUTOPILOT**: Focuses on IoT-enabled automated vehicle applications, linked to SHOW through several partners.
- **AVENUE**: The largest project before SHOW, with 4-10 automated shuttles intended in each of its four pilot cities, interfaced with the SHOW architecture and data collection platform.
- **L3Pilot:** The European research project L3Pilot tests the viability of automated driving as a safe and efficient means of transportation on public roads. It will focus on large-scale piloting of SAE Level 3 functions, with additional assessment of some Level 4 functions. The functionality of the systems will be exposed to variable conditions with 1,000 drivers and 100 cars across ten European countries, including cross-border routes.
- **ENSEMBLE:** The ENSEMBLE EU Project has defined two Platooning Levels: the Platooning Support Function (PSF) and the Platooning Autonomous Function (PAF). As a support function, the aim of the PSF is quick deployment and it has been demonstrated on public roads with a seven-truck platoon. The Platooning Autonomous Function, on the other hand, aims to give the vision of the ENSEMBLE Partners for the future of Platooning.

Other EU ongoing projects include 5G BALKANS, 5G DeLux, 5G NETC, 5G OpenRoad, AI4CSM, Althena, ALBUS, AUTOSUP, AWARE2ALL, BERTHACCAM-ERAS, CONNECT, ENVELOPE, ERASMO, FLOURISH, i4Driving, LogiSmile, MODI, MOVE2CCAM, RIMA, SAMEN, SELFY, SUNRISE, SURAAA, ToMove, ULTIMO, USMART ZONE, URBANE, amongst others [14].

However, it is important to highlight the strengths of SHOW, as it is unique due to its extensive fleet (over 70 vehicles), wide geographic coverage and highest number of sites (14, covering 22 European cities) operating in all-weather conditions in real traffic environments, and with integration of various automated transport services (Integration of automated Demand-Responsive Transport (DRT) with MaaS and LaaS fleets, combining passenger and cargo transport), making it a comprehensive and innovative project in the field of automated and shared mobility.

D. Threat of Substitute Products or Services

Traditional Vehicles: Conventional vehicles remain a viable and less expensive alternative, especially in regions where automated vehicle infrastructure is underdeveloped. Public transportation and human-driven ride-sharing services are established alternatives that may continue to compete with automated vehicles.

Evolving Mobility Solutions: Emerging transportation solutions, such as electric scooters, bike-sharing, and hyperloop technologies, present additional substitutes.

E. Industry Rivalry

Intense Competition: Major automotive manufacturers (e.g., GM, Ford), tech companies (e.g., Google, Apple), and new entrants (e.g., Waymo, Zoox) are all wanting market dominance. Established automotive brands with strong customer loyalty have an advantage, though new entrants can compete on innovation and technology.

The pace of innovation and frequent technological breakthroughs contribute to a highly competitive environment. There is a need for market dynamics and strategic alliances, with Partnerships and collaborations (e.g., between car manufacturers and tech firms), adding complexity to the competitive landscape.

According to the market analysis of competition done in [13] that focuses on automated PT vehicle manufacturers, all known original equipment manufacturers (OEMs) are developing electrified vehicles with advanced assistance systems (e.g., radar, speed limiters). Many are partnering with IT companies (IBM, Google, Microsoft) to develop automated driving technologies. Previously fierce competitors, such as BMW and Daimler, are now collaborating on automated services and communication interfaces for infrastructure. Ford and VW are co-developing an electric vehicle for global markets. Collaborations are essential to secure future business by advancing research, development, and engineering.

The market for automated shuttles, especially those seating up to 12 passengers, is highly competitive. Smaller automated shuttles are easier to integrate into existing PT systems than larger buses. Examples include the automated public service line in Monheim, Germany, which highlights significant competition in automated public transport. The competition in the automated PT vehicle sector is robust, with numerous partnerships and innovations aimed at advancing automated driving and integrating new mobility solutions into existing transport frameworks.

To sum up, applying Porter's Five Forces highlighted the competitive dynamics in the AV industry:

1. **Threat of New Entrants**: High barriers to entry due to technological expertise and regulatory requirements, but well-funded startups and tech giants pose potential competition.
2. **Bargaining Power of Suppliers**: Suppliers of specialized components hold significant power, but companies can mitigate this by developing in-house technology and diversifying suppliers.

3. **Bargaining Power of Buyers**: Consumers demand high safety and reliability, giving them negotiating power. Companies can reduce buyer power by offering differentiated, superior technology.
4. **Threat of Substitute Products or Services**: Traditional vehicles, public transportation, and emerging mobility solutions present alternatives to AVs.
5. **Industry Rivalry**: Intense competition among automotive manufacturers, tech companies, and new entrants drives innovation and strategic alliances.

6 City-Level Scalability Simulation: use case Brainport

To analyse the impact of scalability, at the city level in this section, we use as a case study the pilot of Brainport that was previously simulated in WP10. This activity aims to ensure that the chosen business models not only perform well individually but also contribute positively to the overall urban transport ecosystem. By simulating their impact at the city level, we can better understand their potential benefits and challenges, leading to more informed decision-making and strategic planning.

To evaluate scalability at the city level, we primarily relied on simulation work carried out in WP10. The simulations were conducted across three levels:

1. **Street-Level Simulations:** Based on microscopic simulation.
2. **City-Level Simulations:** Based on macroscopic simulation.
3. **Local VRU (Vulnerable Road Users) Simulations:** Based on microscopic simulation.

For analyzing scaling impacts, the macroscopic level is the most relevant. The macroscopic simulation for Brainport considered a fleet of 1,000 Demand-Responsive Transport (DRT) vehicles. Notably, most of the SHOW business models (BMs), such as BM1, BM3, BM5, BM6, BM7, BM8, and BM10, are based on DRT systems.

The simulations provide estimates for the following scenarios:

- **Vehicle Kilometres:** The evolution of vehicle kilometres for DRT and other modes of transport.
- **Passenger Numbers:** The number of passengers using DRT, inferred from the number of trips made and various vehicle occupancy rates.

The table below presents the operational values for Brainport during two morning peak hours, based on results from D10.4.

Table 8: KPIs of Brainport (SHOW, 2021)

KPI	Brainport	
Total number of km travelled in a network, using DRT (km)	35,253	1.233,85
Number of travelers (for 2 passengers per vehicle) (passengers)	20,906	73,171
Number of travelers (for 4 passengers per vehicle) (passengers)	41,812	146,342
Number of travelers (for 8 passengers per vehicle) (passengers)	83,624	292,684

The simulation found that 1,000 vehicles collectively travelled over 35,000 km over a span of 2 hours.

6.1 Evaluation of Business Model Performance

Based on the Cost-Benefit Analysis (CBA) conducted in A16.2, the cost per vehicle kilometre for Demand-Responsive Transport (DRT) is €3.5/vehicle.kilometre. The fare used in the simulation is calculated using the following formula:

Fare=1.5+0.5×km

With an average travel distance of 4 km per passenger (as determined by simulation), the resulting average fare is €3.5 per trip. This fare aligns with the users' willingness to pay, as established in the analysis conducted within D2.4. The following table presents the economic balance for scaling up operations:

Table 9: Economic balance to scale up operations

	OPEX (€)	Revenues (€)		
	1,233.86	Two passengers loading	Four passengers loading	Eight passengers loading
		73,171	146,342	292,684
Profit for two-peak hours		71.937	145.108	291.450

This evaluation provides a detailed financial perspective, ensuring the feasibility and sustainability of scaling up DRT systems in the target locations. It is recommended for future initiatives after SHOW to broaden the evaluation of city-level scalability by comparing the performance of each business model based on the defined KPIs and documenting the simulation results and their implications for city planning and transport policies to provide recommendations for optimizing the implementation of the business models to achieve the best outcomes.

Further research can be focused on optimizing and scaling business models, considering their dependencies and sensitivity analysis to specific conditions (including variations in OPEX and service fares), especially within industry sectors and their sector-specific approaches to market entry, and analysing revenue streams for transport operators.

7 Recommendations

By addressing the following factors/considerations, and implementing necessary changes, the future of automated transportation can be shaped towards operational efficiency, economic sustainability, and societal acceptance:

1. **Initial Investment and Long-Term Stability:** Building a mobility ecosystem necessitates significant initial investments, with short-term costs expected to be high but potentially stabilizing and decreasing in the long term.
2. **Profitability and Operational Efficiency:** Efficient operator management, acceptance by public transit authorities, optimal supervisor-to-vehicle ratios, and comprehensive supervisor training are crucial for cost-effectiveness and operational success. Furthermore, Hardware and software optimization, centralized control rooms, and streamlined client partnerships can contribute to cost-reduction efforts.
3. **Resource Management:** Consistent allocation of human and financial resources is vital for sustainable operations.
4. **Legal Aspects and Permits:** Aligning legal frameworks with technological developments is crucial for seamless integration and compliance, allowing regulatory sandboxes to advance in regulatory
5. **Affordability and Market Expansion:** Making automated vehicles more affordable and reducing infrastructure costs can sustain growth beyond initial projects and broaden the market.
6. **Societal Mindset Shift:** Changing societal perspectives and raising awareness about the benefits of automated vehicles are essential for widespread acceptance and commercial viability.
7. **Continuous Regulatory Enhancements:** Ongoing harmonization and enhancements of regulations at national and local levels are necessary to fully realize the potential of automated vehicle technology.
8. **Citizen Feedback and Transition to Public Roads:** Feedback from citizens will be integrated into future phases, particularly during the transition to public roads. However, the transition to public roads poses high costs and uncertain benefits.
9. **Vehicle Homologation and Deployment:** Manufacturers are working on homologation for commercial service projection, with a roadmap planned for significant fleet deployment.
10. **Market Expansion and Affordability:** Efforts should focus on broadening the market and making vehicles more affordable to sustain growth beyond initial projects.
11. **City Approval and Formal Deployment:** City approval is necessary for formal deployment, with the current interest in deploying automated services in controlled environments or during specific events.
12. **Project Conclusion and Future Developments:** Some projects have concluded due to economic constraints, with a focus on further developing algorithms for future projects.

Considering that one of the common challenges in the sites for scalation is achieving economic sustainability that needs substantial capital expenditure, encompassing vehicle costs and infrastructure development, this section includes the analysis of the tool EASI-AV© [16], which provides an Economic Assessment of Services with Intelligent Automated Vehicles. It is recommended to use the work-in-progress ULTIMO tool (economic impact tool from the AVENUE project)[5] to assess the feasibility of scaling up operations, for additional analysis not included in this deliverable.

7.1 AVENUE economic impact tool

AVENUE project applied the Total-Cost-of-Ownership (TCO) approach to develop a simulation tool to assess the economic impact of services using Automated Shuttles for Collective Transport. This tool operates on two levels: local (integrates internal costs for designing and implementing services with automated shuttles) and global (Integrates macro external costs for the city) [16].

This simulation tool, aimed at assessing the economic impact of automated shuttle services, was developed and validated by PTOs from the AVENUE project's pilot cities. The tool, named EASI-AV©, provides an Economic Assessment of Services with Intelligent Automated Vehicles by:

- Offering fleet dimensioning for the service.
- Calculating the total cost of ownership (CAPEX and OPEX) and comparing it to a baseline vehicle.
- Calculating local external costs for communities where shuttles are deployed, compared to a baseline vehicle.

EASI-AV© is designed to assist policymakers, regions, PTOs, and other interested stakeholders in implementing automated shuttle services, such as at private corporate sites or university/hospital campuses. Bax carried out a meeting with two partners involved in the AVENUE project from Université Paris – Saclay (Isabelle Nicolai) and the coordinator of the project (Dimitri Konstantas) to discuss how this tool can be used to evaluate the economic impact of different implementation scenarios (supply-pushed or demand-pulled strategy, fixed route or on-demand service).

The current work-in-progress tool from ULTIMO project (extension of EASI-AV©), wants to address validation challenges and assess societal impact effectively, such as reduced congestion costs and social costs. The tool calculates the total cost of mobility, excluding personal cars, and adapts to site-specific costs and benefits based on factors such as the size of shuttles, fleet numbers, and kilometres travelled. Regarding economic considerations, ULTIMO aims to refine assumptions, including dynamic pricing models, to improve accuracy, and demand and charging models will be analyzed, addressing issues such as free transport services and willingness to pay, with a specific look at cases like Luxembourg public transport (PT).

Additionally, it wants to improve the quality-of-service metrics, such as waiting times, which are evaluated dynamically, considering the willingness to wait and the appropriate fleet size, and incorporate Life Cycle Analysis and Infrastructure costs (not currently considered) to enhance the tool's capabilities to provide a more comprehensive analysis.

Regarding scalability, the ULTIMO tool project values to assess the feasibility of scaling up operations. It is possible to carry out a study on social acceptability to identify determinants that influence user behaviour change, and the willingness to pay will be factored into CBA, TCO, and BM, focusing on encouraging more people to use public transportation instead of private cars, that is addressed in WP16.

[5] https://h2020-avenue.eu/

7.2 Economic analysis

While the tool offers various services, including fleet dimensioning, total cost of ownership (CAPEX and OPEX) comparison to a baseline vehicle, and calculation of local external costs for communities where shuttles are deployed, this section primarily focuses on fleet dimensioning for the service. Our emphasis lies in scalability, particularly in terms of increasing the number of vehicles.

Before calculating investments and operating costs, determining the necessary fleet size of shuttles is essential for the service's proper functioning. The EASI-AV© analysis aims to provide fleet dimensioning for both fixed-route and on-demand services, offering calculations via supply-push (unknown service demand) or demand-pull (known public transport demand).

A. Fixed-Route Fleet Dimensioning (Option 1)

- **Approach**: Uses traditional fleet size calculations.
- **Parameters**: Includes route length, average operational speed, layover time, shuttle capacity, battery autonomy, and charging time.
- **Calculation**: Simple algorithms integrate these parameters to propose an optimum fleet size.
- **Validation**: Both supply-push and demand-pull calculation options for fixed-route have been tested and validated.

B. On-Demand Fleet Dimensioning (Option 2)

- **Approach**: Requires more complex algorithms.
- **Parameters**: Considers passenger waiting time and maximum distance between requester and vehicle at request time.
- **Status**: Algorithms are currently being developed and tested, with results to be presented in the next deliverable.

C. Service 1: Demand-Pull Calculation

- **Purpose**: Used when mobility demand in the service area is known.
- **Scenarios**:
  1. **Scenario 1**: Precise data on passengers per hour during peak and off-peak hours.
  2. **Scenario 2**: Estimated percentage of passengers during peak and off-peak hours.
  3. **Scenario 3**: No precise or estimated passenger data.
- **Objective**: Provides a flexible, modular tool based on transport demand and data availability.

D. Service 2: Supply-Push Calculation

- **Purpose**: Used when public transport demand is unknown, or the service is a new offering.
- **Data Entry**: General parameters are needed for both demand-pull and supply-push calculations. Specific data entry options are highlighted in yellow (demand-pull) and green (supply-push) in the spreadsheet based on Luxembourg's Pfaffenthal pilot site (fixed route).

EASI-AV© offers fleet dimensioning tools tailored for fixed-route and on-demand services, with the former validated and the latter under development. These tools can adapt to varying levels of data availability to optimize shuttle fleet sizes and reduce costs. EASI-AV© is designed to assist policymakers, regions, PTOs, and other interested stakeholders in implementing automated shuttle services, such as at private corporate sites or university/hospital campuses.

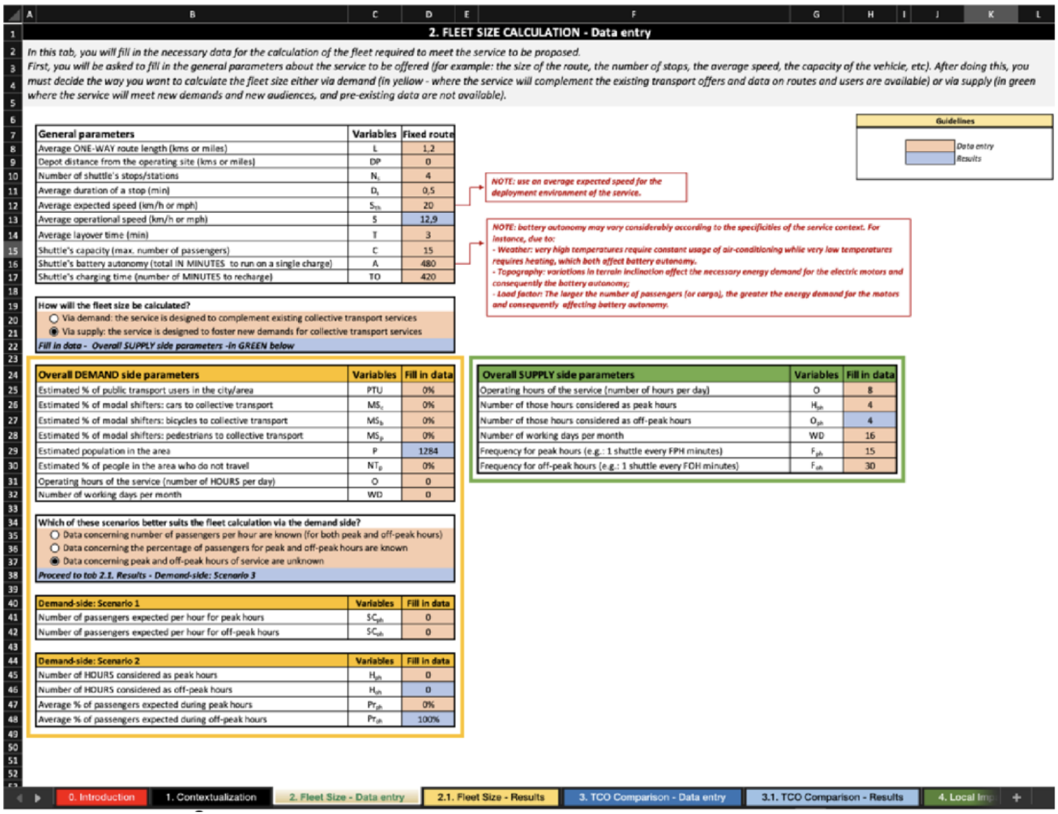


Figure 25: EASI-AV© fleet size calculation **(AVENUE, 2021)**.

Once all elements for the fleet size calculation data entry are completed, results will be automatically displayed on the next tab of the EASI-AV© tool (2.1. Fleet Size – Results). The results are colour-coded by service options: yellow for demand-pull and green for supply-push. Besides the total fleet size estimation, other relevant data and KPIs are displayed:

- Estimated frequency of service (both peak and off-peak hours)
- Fleet size for both peak and off-peak hours
- Estimated number of daily users (both peak and off-peak hours)
- Estimated maximum kilometres to be completed by the shuttle (daily, monthly, and yearly), aiding in estimating maintenance and energy consumption costs

7.3 Validation with Real-World sites

The EASI-AV© tool provides critical insights into fleet dimensioning, total cost of ownership, and local external costs, aiding in the economic assessment of automated vehicle services. The tool's analysis emphasizes fleet size optimization, cost management, and service scalability. Validation with real-world data from various pilot sites confirms the tool's reliability and practical applicability.

Considering the current limitation of data availability/access to the pilot sites (e.g., passenger waiting time, battery autonomy, charging time etc.), this section includes a practical example of the use of the tool described in [17] of the pilot site Pfaffenthal in Luxembourg (Fixed-route and Supply push).

Using data from the Pfaffenthal pilot site, EASI-AV© estimated a total fleet size of two shuttles, matching the actual number used by Sales-Lentz in their trials. This consistency indicates the tool's reliability. The tool was also validated with data from other testing sites, including Groupama Stadium in Lyon (KEOLIS), Nordhavn in Copenhagen (Holo), and Ormøya in Oslo (Holo), yielding the same fleet size as the actual number of shuttles used in these AVENUE testing sites.

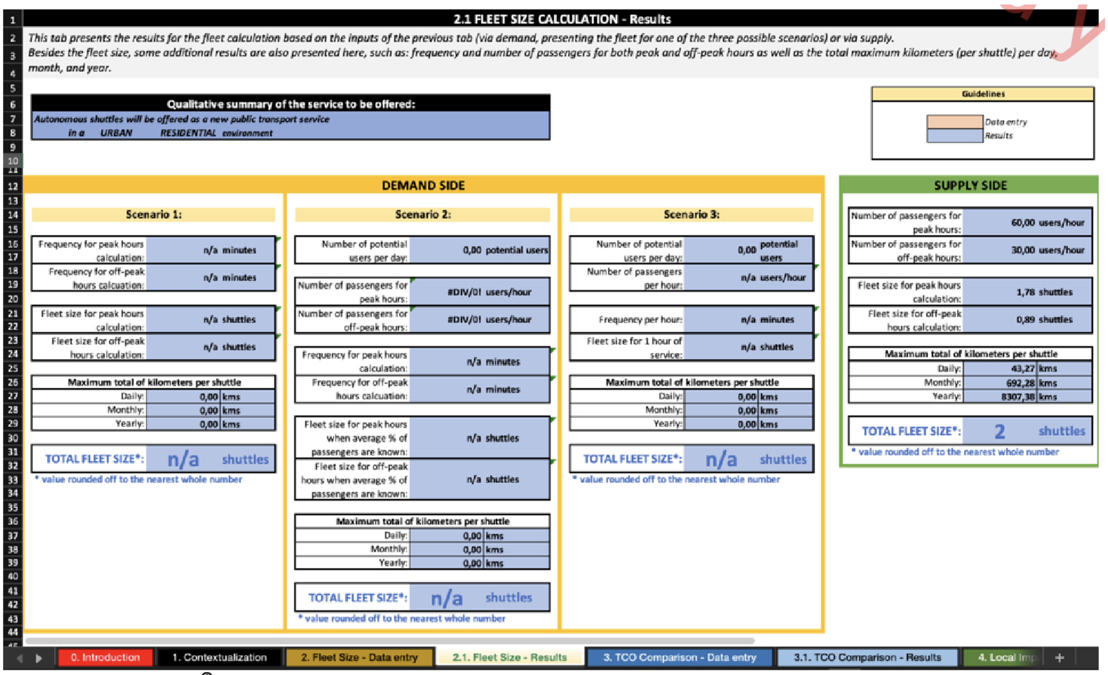


Figure 26: EASI-AV© fleet size calculation results of Pfaffenthal in Luxembourg **[17]**.

This tool and its extension (work-in-progress tool ULTIMO) can be utilised in the current ongoing pilots especially to calculate the fleet size in projects of scalation, service costs, simulate revenue sources, and determine the net present value of AV public transport services, making it a valuable resource for stakeholders interested in assessing the economic impact of AV deployments.

As it was mentioned before, the demand for the services (number of passengers) is a key factor in the escalation of the operations[6]. This feature influences cost, revenue, efficiency, scalability, and external factors. Optimizing the demand and the user's willingness to pay is key to realizing the full economic potential of AV deployments.

During the project period, various pilot sites were operational, each with distinct passenger volumes and operational timelines. The following analysis includes the historical demand of passengers on the sites (that plan to scale or have scaled their operations) based on the monthly reports provided in SHOW until April 2024 (please note that this does not equal with the final numbers of passengers for the pilot sites).

[6] This demand profile can be used as a base for A13.6: Overall impact assessment and cross-pilot comparisons (see GA), for the analysis of future scenarios of demand adoption.

Frankfurt accommodated 3051 passengers from November 2022 to October 2023 (see Figure 27). While Monheim served 32069 passengers from May 2022 to December 2023 (see Figure 28):

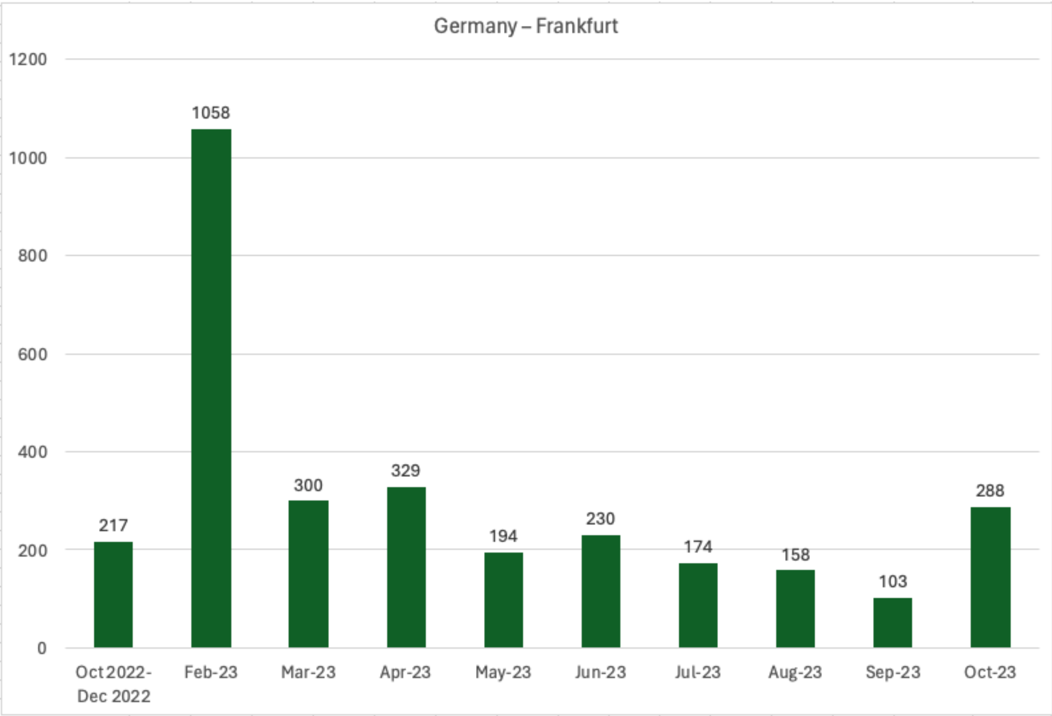


Figure 27: Number of passengers in Germany – Frankfurt based on monthly reports.

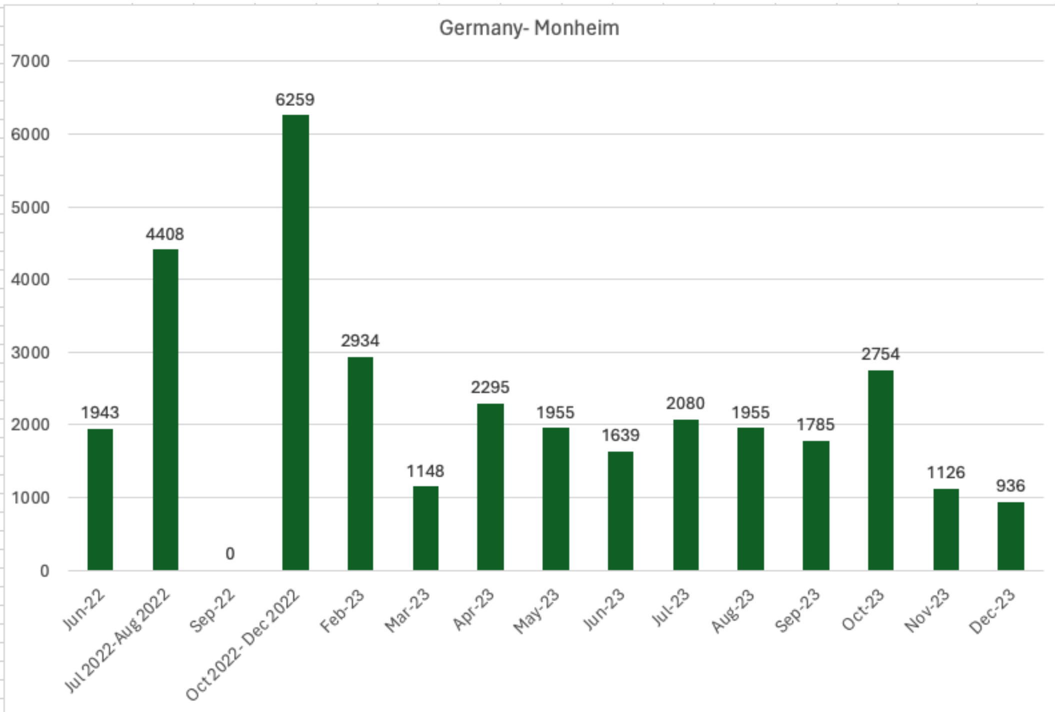


Figure 28: Number of passengers in Germany- Monheim based on monthly reports.

Carinthia's Pörtschach site (6518 passengers) initially completed Demo 1 from May to November 2022, reconvening in July 2023 but ending abruptly on 9 August due to a parking incident, and resumed operations from 22 April to 17 May 2024 (see **Figure 29**)

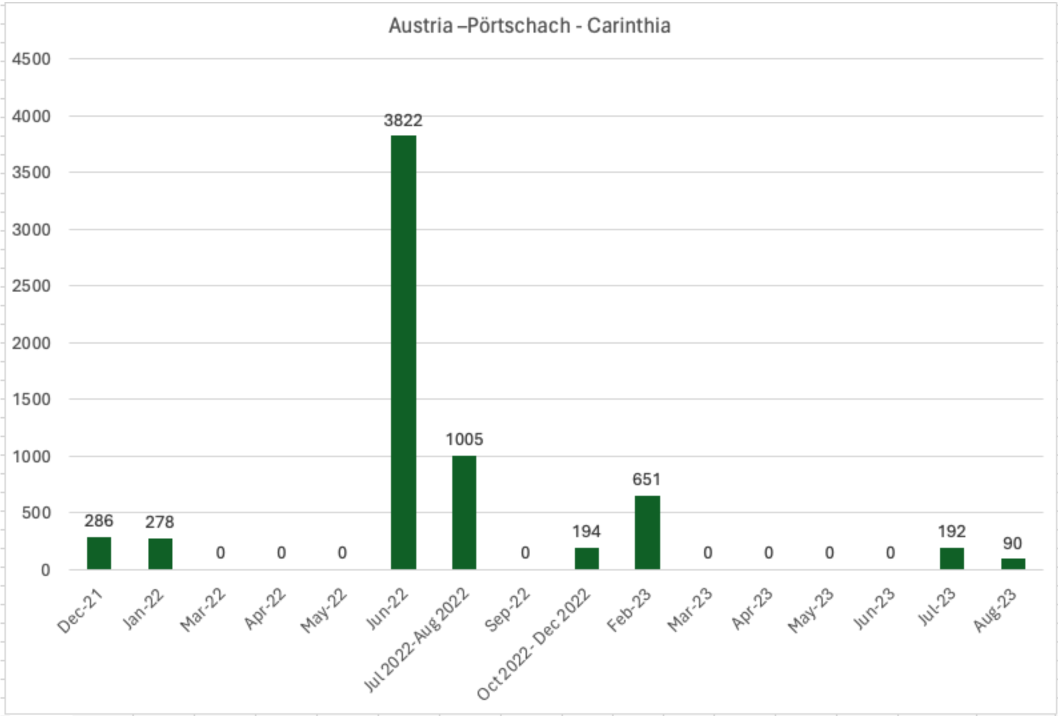


Figure 29: Number of passengers in Austria –Pörtschach – Carinthia based on monthly reports.

Tampere saw phased operations: Phase 1 from January to March 2022, Phase 2 from May to June 2022, Phase 3 from December 2022 to June 2023, and Phase 4 from July 2023 to December 2023 in Tampere/Hervanta, and November 2023 to April 2024 in Tampere/Lintuhytti, continuing in April 2024 (see **Figure 30**). Additionally, operations took place in Lahti from September to December 2023, while Kuopio and Lempäälä, outside Tampere, were slated to commence operations soon.

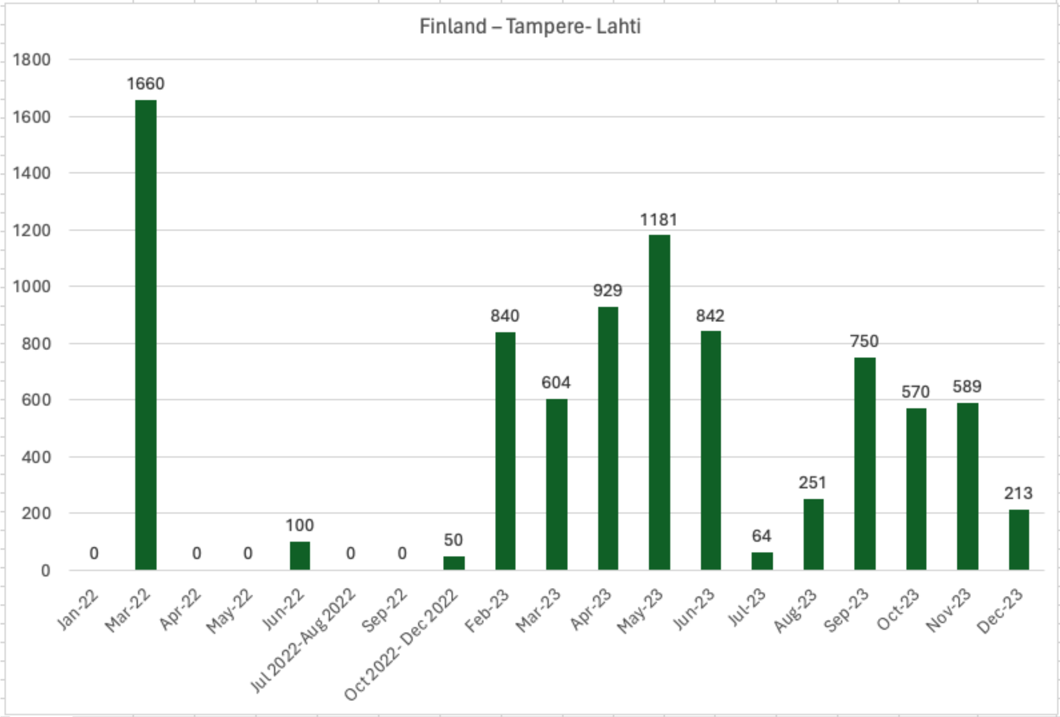


Figure 30: Number of passengers in Finland – Tampere- Lahti based on monthly reports.

Furthermore, the graph of passengers of the sites that are analysing the opportunities/exploring alternatives of scaling but face challenges to materialize include Les Mureaux (1084 passengers), Linköping (17683 passengers), Graz (520 passengers), Trikala (5532 passengers), and Brno (37129 passengers) can be found in **Appendix II.**

8 Conclusions

Scalability of operations

The scalability of automated shuttle services is influenced by a myriad of factors, including technological, regulatory, economic, and social dimensions. Addressing these challenges through strategic planning, stakeholder engagement, and robust economic assessments is essential for successful scaling. Continued efforts to optimize demand, enhance technology, and secure economic sustainability will be key to realizing the full potential of AV deployments in public transportation.

As further analyses that were out of the scope of this deliverable, it is recommended for future initiatives after SHOW to broaden the evaluation of city-level scalability by comparing the performance of each business model based on the defined KPIs and documenting the simulation results and their implications for city planning (for all the sites) and transport policies to provide recommendations for optimizing the implementation of the business models to achieve the best outcomes. Furthermore, it is recommended to implement the use of economic impact tools (e.g., EASI-AV©) to provide a comprehensive roadmap for policymakers, regions, and stakeholders to navigate the complexities of scaling automated shuttle services effectively.

Economic viability

The results from the scenarios of the EASI-AV© model provide valuable insights for policymakers in shaping strategies for the deployment of automated vehicles (AVs). It is also expected that Sustainable Urban Mobility Plans (SUMP) serve as a robust framework to guide the implementation of AV technology.

Additionally, the progress made in the economic assessment tool EASI-AV© is highlighted, including the incorporation of an on-demand fleet size calculation option and the development of a beta version of the web application. This tool allows stakeholders to calculate service costs, simulate revenue sources, and determine the net present value of AV public transport services, making it a valuable resource for stakeholders interested in assessing the economic impact of AV deployments.

Overall, these efforts highlight significant advancements in the scientific understanding of AV technology. By emphasizing the importance of considering economic viability, both public and private sectors are encouraged to address limitations and foster the growth of AV services compared to traditional transportation methods.

Transferability

The transferability of AV BMs is a multifaceted challenge influenced by political, economic, social, technological, legal, and environmental factors. By addressing these factors through strategic planning, stakeholder engagement, and robust analysis frameworks, the SHOW project can successfully replicate and adapt its AV models across diverse settings. The insights from PESTLE (D2.4), SWOT, and Porter's Five Forces analyses provide a roadmap for navigating the complexities of transferability, ensuring the broader diffusion of AV innovations, and contributing to economic development and societal progress. Continued efforts to optimize regulatory compliance, public acceptance, technological readiness, and economic sustainability will be key to realizing the full potential of AV deployments globally.

These conclusions are in line with the results of other projects such as ARCADE, in its analysis conducted in the first year of the project, several key conditions for the successful deployment of new CAD services, including cost Reduction, interoperability and Integration, Safety Specifications, and network Integration. It was also highlighted that Large-scale pilots should be prioritized to address these conditions and facilitate the successful deployment of new mobility services.

The SWOT analysis underscored the strengths, weaknesses, opportunities, and threats associated with transferring AV BMs: (i) Strengths: Successful integration of SMEs, startups, and PTOs without undermining existing operations, and prioritization of innovative approaches; (ii) Weaknesses: High initial investments and technological limitations can hinder transferability; (iii) Opportunities: Expanding into new markets, leveraging technological advancements, and forming strategic partnerships present significant growth potential; (iv)Threats: Regulatory hurdles, public resistance, and competition from established transport modes pose challenges to transferability.

In general, based on Porter's Five Forces analysis the automated vehicle industry is characterized by high barriers to entry, moderate to high supplier power, moderate buyer power, a significant threat from substitutes, and intense rivalry. Success in this industry will depend on technological innovation, strategic partnerships, regulatory navigation, and the ability to differentiate in a competitive market. The listed projects show a wide range of efforts in the development and adoption of CCAV. However, significant work remains, particularly in developing BM, ensuring service robustness, and addressing social inclusion. Future initiatives after SHOW must address these gaps, focusing on large fleets in urban environments, real-life conditions, and stakeholder collaboration in urban transport.

References

[1] Techopedia, "Scalability," 2017. [Online]. Available: https://www.techopedia.com/definition/9269/scalability.

[2] Chesbrough, H., , Vanhaverbeke, W. and West, J., Open Innovation: Researching a New Paradigm, Oxford University Press, 2006.

[3] F. Hofmann, "Business Model Scalability: Internal vs External.," 2019. [Online]. Available: https://bmilab.com/blog/2019/1/10/business-model-scalability-internal-vs-external#:~:text=Internal%20scalability%20describes%20how%20capable,customer%20base%20and%20increase.

[4] Simoudis, E., "Requirements for Growing and Scaling Autonomous Mobility," 2019. [Online]. Available: https://synapsepartners.co/six-requirements-for-growing-and-scaling-autonomous-mobility/..

[5] UITP, "Policy brief: AV a potential game changer for urban mobility," 2017.

[6] Hardvard Business Review, 2008. [Online]. Available: https://hbr.org/2008/01/the-five-competitive-forces-that-shape-strategy.

[7] P. Gratton, Investopedia, 2024. [Online]. Available: https://www.investopedia.com/terms/p/porter.asp.

[8] J. Worschech, "Benchmarking of existing business / operating models & best practices - D2.1," European Union's Horizon 2020 research and innovation programme, , 2020.

[9] J. Worschech, "Proposed business / operating models & mapping to UCs and Pilot sites », , SHOW - 2021.," European Union's Horizon 2020 research and innovation programme, 2021.

[10] SHOW D2.2, "D2.2: Proposed business / operating models & mapping to UCs and Pilot sites," 2020.

[11] SHOW D2.4, "Final validated business/ operating models," 2024.

[12] KPMG, "utonomous Vehicles Readiness Index (AVRI)," 2020.

[13] SHOW, "D16.1: Market Analysis," 2021.

[14] Connected automated driving, "Thematic Areas," 2024. [Online]. Available: https://www.connectedautomateddriving.eu/thematic-areas/.

[15] SHOW, "Pilot results based simulations for impact assessment," 2021.

[16] AVENUE, "D8.6 Economic Impact Assessment," 2021.

[17] AVENUE, "D8.4 Second Iteration Economic impact," 2021.

Appendix I

SHOW WP2, Interview BM, Societal impact, SUMP

Date and time of call:	
Interviewee(s) case	
Role of the interviewee (PTO, city)	
SHOW partners	

1 Business Models (30 min)

1	*Confirm Business model - Depending on the pilot site*
2	*How does the main stakeholders (City, PTO, Tiers, etc.) define that a **Pilot** has been successful? Which are the objectives? How are they evaluated?* ○ *Relate to the 5 Goals*
- **O1: Accessibility, Equity and Community vitality** - **O2: Economic** - **O3: Environment (noise, emissions, congestion, etc.)** - **O4: Business ecosystem and development** - **O5: Technology and safety**	
3	*How does the PTO/city define what has been a successful **business model**? Any consideration regarding this? (Note the difference with the previous question: Pilot vs Business model)*
- **O1: Accessibility, Equity and Community vitality (Social)** - **O2: Economic** - Cost too high to have a business case - **O3: Environment (noise, emissions, congestion, etc.)** - **O4: Business ecosystem and development** - **O5: Technology and safety**	
4	How mature are the current services?
Social (to increase attractivity, accessibility, equity, etc.) - *Indicative questions:* ○ *What are the main benefits for active population and users with special needs?* *Not specifically addressed, it had a ramp,* ○ *How much are these services integrated into the existing transport system?* ○ *Were the services attractive to the local community?* **Economic** - *Indicative questions:* ○ *What were the main economic challenges?*	

BAX & COMPANY
VALUE FROM SCIENCE AND TECHNOLOGY

1 / 5

Expensive development. Pilot run thanks to the project, otherwise not possible.
- *Could you rate the economic performance regarding OPEX and CAPEX? (1 = affordable, 5 = expensive)*

Environmental
- *Indicative questions:*
  - *Did the service contribute to private car usage reduction? The increase of public transport use?*
  - *Any insights regarding emissions and noise pollution?*

Development of the Business ecosystem
- *Indicative questions:*
  - *Did the project allow to integrate a diversity of stakeholders? Were they interested; how did they contribute?*

Technology and safety
- *Indicative questions:*
  - *Maturity of the technology? (supervision, detection robustness, etc.)? safety operator mandatory*
  - *Rate the experimentation regarding safety and accidentology (number of accidents reduced)?*
  - *Other Features (Real-time information for users)? real time operations on the website*

5	What are the biggest challenges for a seamless service operation and customer acceptance?

Social (to increase attractivity, accessibility, equity, etc.):

Economic

Environmental

Technology

Legal aspects

Political:

6	What will have to change in the future? to make it operational and economically successful?
7	*Are there plans to **transfer the use cases** to other parts of the city? Have citizens requested the **expansion of the service** to other parts of the city? Similar parts (in terms of configuration/environment) or different ones? Is there any plan to **increase the number of vehicles**? In the same area or a different one?*
8	*Which **collaborations** are required to **scale-up** the business? Who would be expected to be the **main investor** for the development of this business? Which **service characteristics** would be needed to have to consider investing? The investment would be **directed** at tech startups,*

BAX & COMPANY/
VALUE FROM SCIENCE AND TECHNOLOGY

2 / 5

	*PT providers, cities (including **subsidies** or infrastructure), others? What could be the **willingness to pay** from users for the service?* Affordability?
9	*What is the expected effect of **fleet increase** on investments, costs & revenues? Improvement of infrastructure?*

2 Societal Impact KPIs (30min)

1	*Percentage of jobs that have a high probability of being replaced by computer automation within the next two decades* ○ How many job positions have been reduced in the last 5 years due to automation? ○ How many do you expect to reduce in the coming 10 years?
2	*Number of jobs created by the implementation of computer automation, and other systems (sensors, cameras etc) used in autonomous vehicles within the next two decades* ○ How many **new** job positions have been created in the last 5 years due to automation? ○ How many new jobs do you expect to create in the coming 10 years?
3	***Public space:** Has public space been affected by the implementation of autonomous shuttles? Sidewalks? Short-term vs long-term forecast?*
4	***Users**: Has the implementation of the pilot affected the type of users? Increased/reduced (particular type) users? Affected accessibility?*
5	***Jobs**: Others. What response did you experience from the workers and drivers? Are they willing to change activities? Are you providing benefits other than training to change?*

SUMP (30min)

- Current state of SUMP on CCAV

1	Can you share the local SUMP of your city here (official link):
2	Does your local administration consider CCAM innovation as part of their local climate plans/SUMPs?
	Yes *No* *Don't know*
3	If yes; how do you expect CCAM to contribute to achieve the climate objectives? (Can select several)
	- Ensure all citizens are offered transport options that enable access to key destinations and services. - Improve safety and security. - Reduce air and noise pollution, greenhouse gas emissions and energy consumption. - Improve the efficiency and cost-effectiveness of the transportation of persons and goods. - Contribute to enhancing the attractiveness and quality of the urban environment and urban design for the benefits of citizens, the economy and society as a whole
4	*Is there any regional or national legislation on CCAM?*
	-

- Needs from the site to integrate CCAV in the SUMP

1	What type of obstacles have you encountered in implementing the pilot in your city? (Regarding **SUMP** or city **regulations**)
2	Is there a policy or a regulation currently stopping the pilot from **scaling up**?
3	Does the city government have the **will to implement** the necessary policies to scale up CCAM deployment (implement bigger operations, bigger region…)?

- Other questions (SUMP)

1	How and to what extent is your organisation involved in decision-making processes linked to transport & CCAM?
2	*Which stakeholders do you think should be involved in the planning/inclusion of CCAM in SUMPs (you can tick as many as you think)?*
City PTA	

BAX & COMPANY/
VALUE FROM SCIENCE AND TECHNOLOGY

4 / 5

Regional/National government EU Public Transport operators Private Transport operators Citizens, CCAM users Citizens, not CCAM users (PT) Researchers, academic community CCAM industry manufacturers Others:	
3	*In which form have the previous groups been involved during the planning process of your pilot?*

Other questions

1	
2	

BAX & COMPANY/

5 / 5

Appendix II

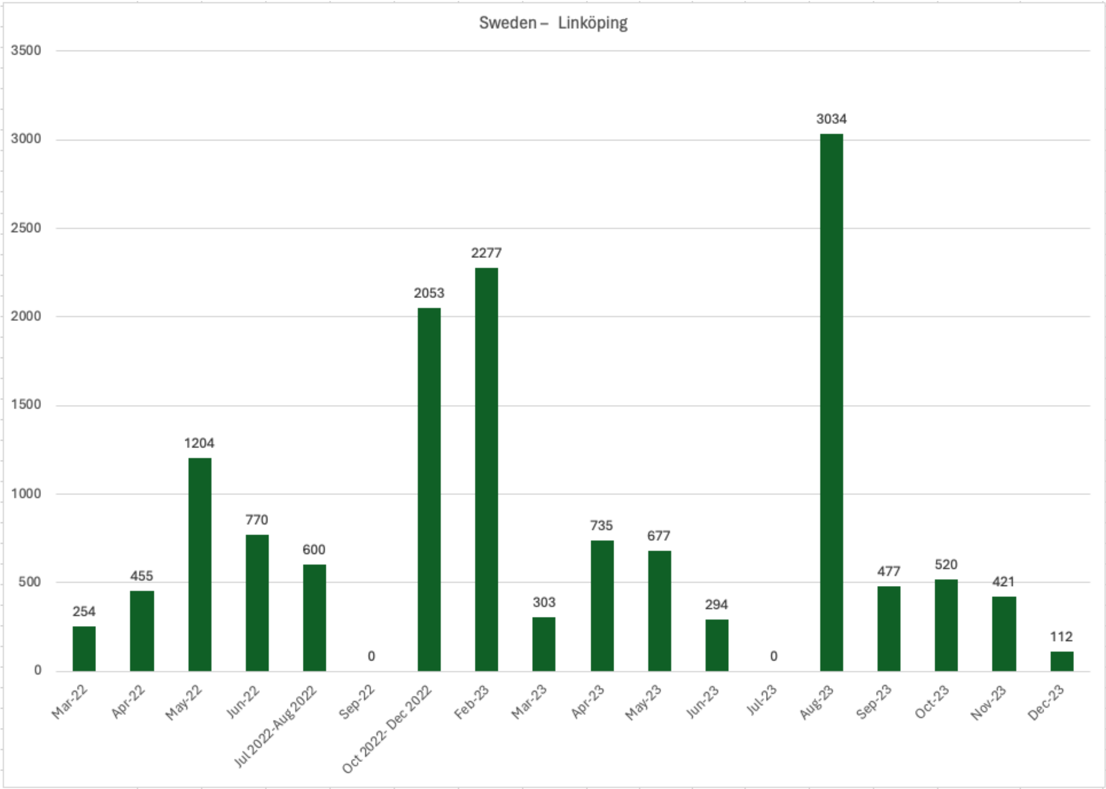


Figure 31: Number of passengers in Sweden – Linköping based on monthly reports.

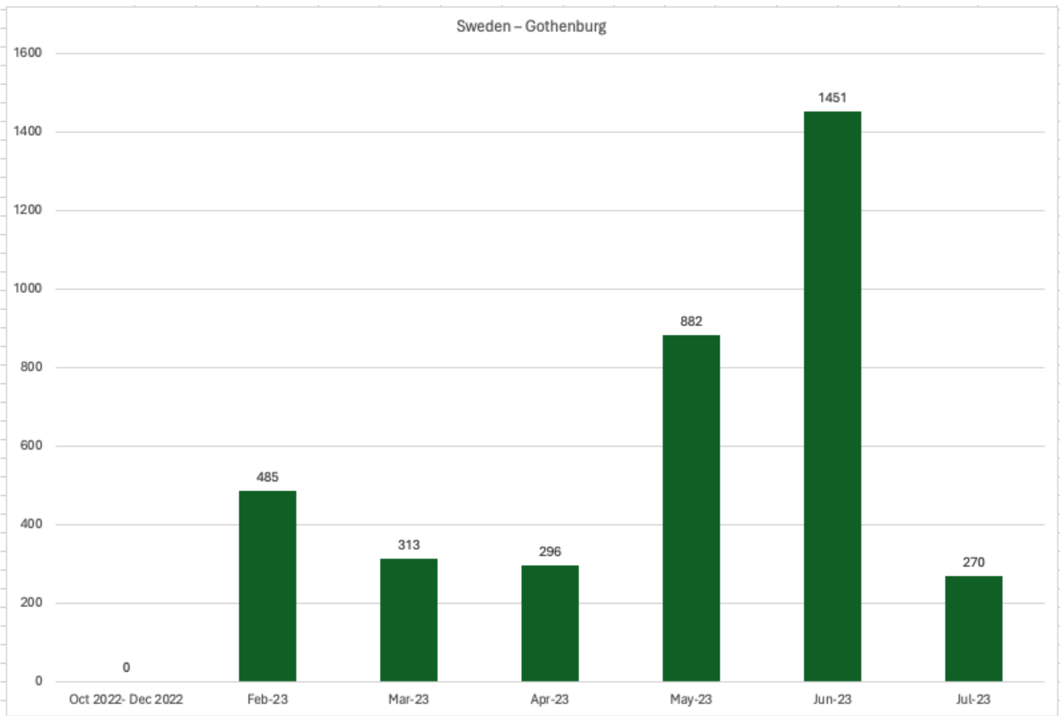


Figure 32: Number of passengers in Sweden – Gothenburg based on monthly reports.

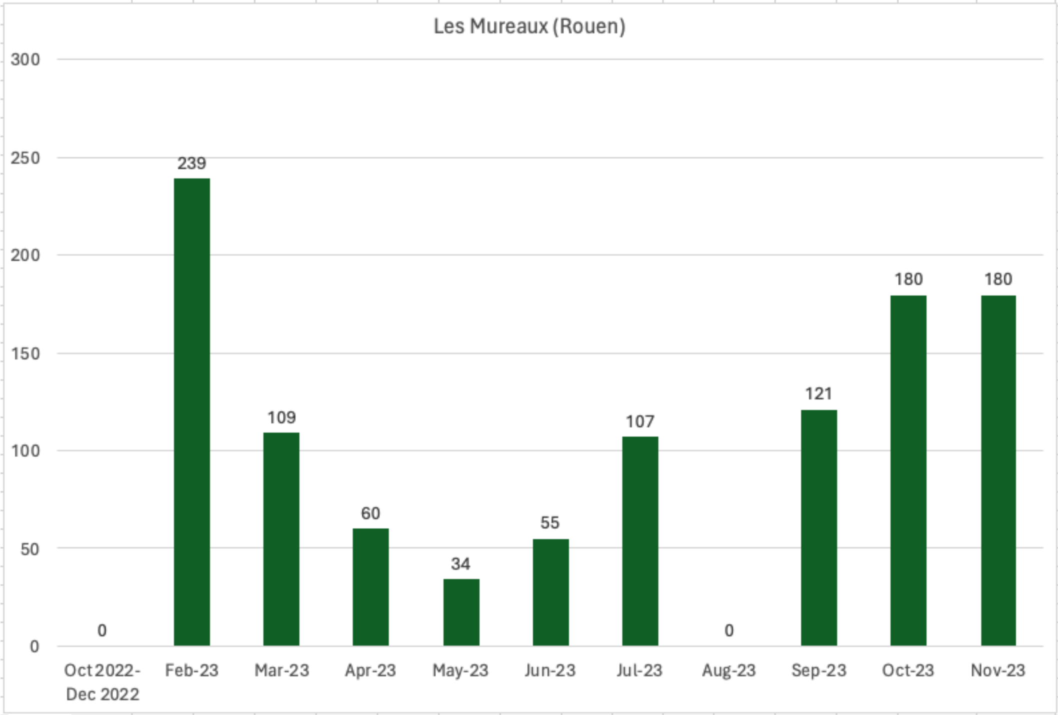


Figure 33: Number of passengers in Les Mureaux (Rouen) based on monthly reports.

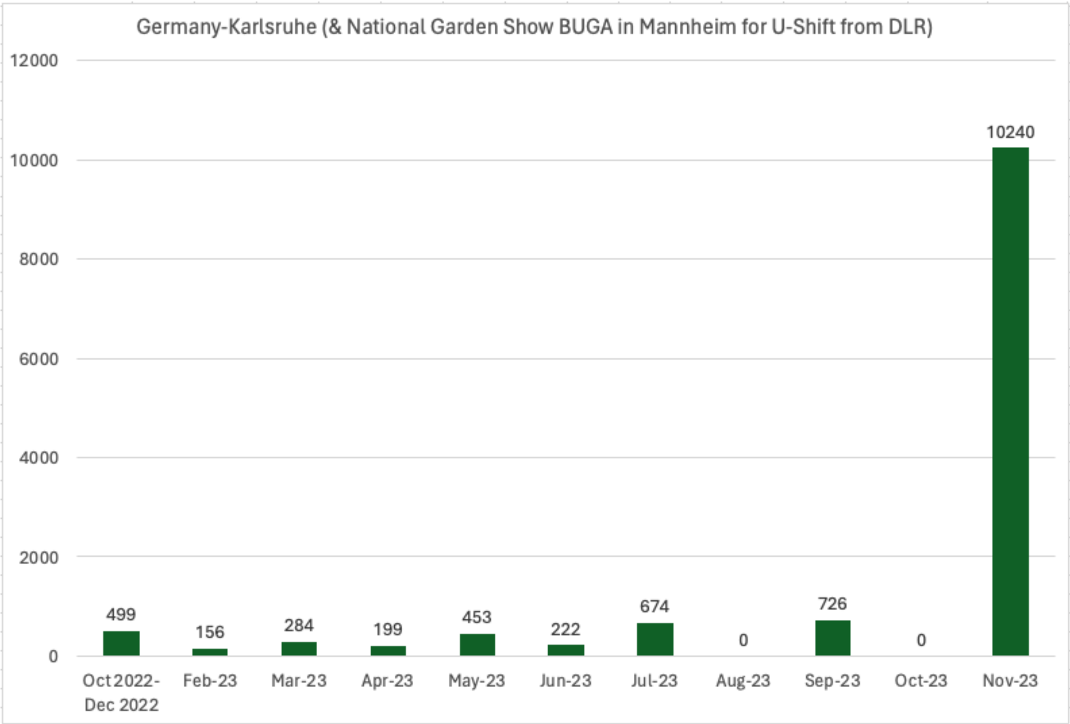


Figure 34: Number of passengers in Germany-Karlsruhe (& National Garden Show BUGA in Mannheim for U-Shift from DLR) based on monthly reports.

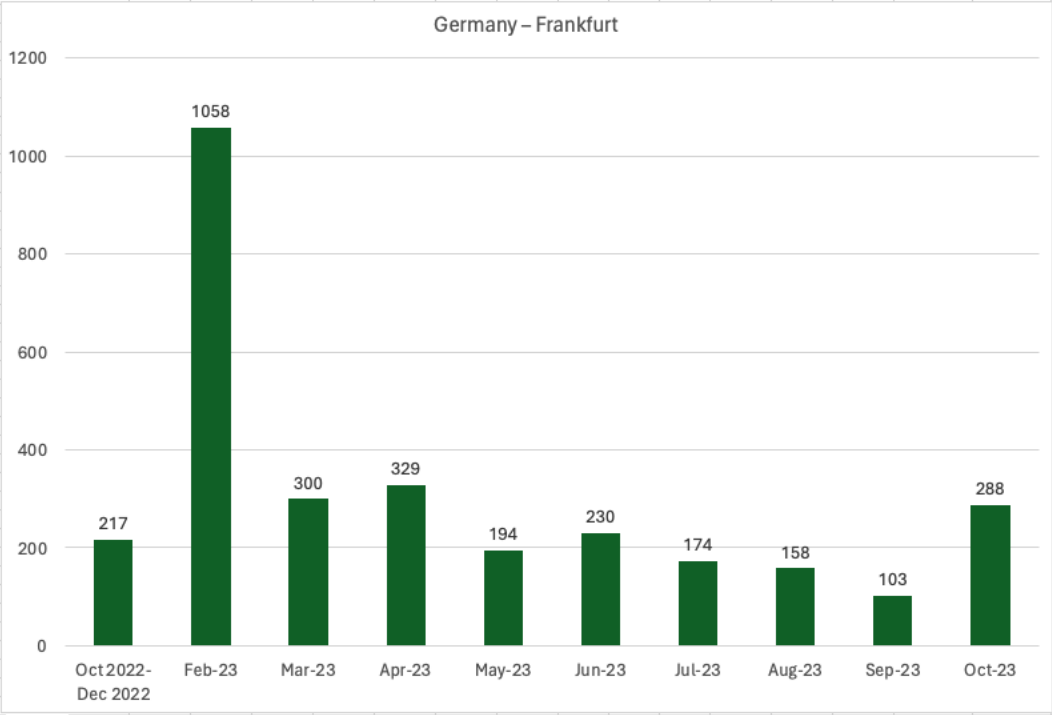


Figure 35: Number of passengers in Germany – Frankfurt based on monthly reports.

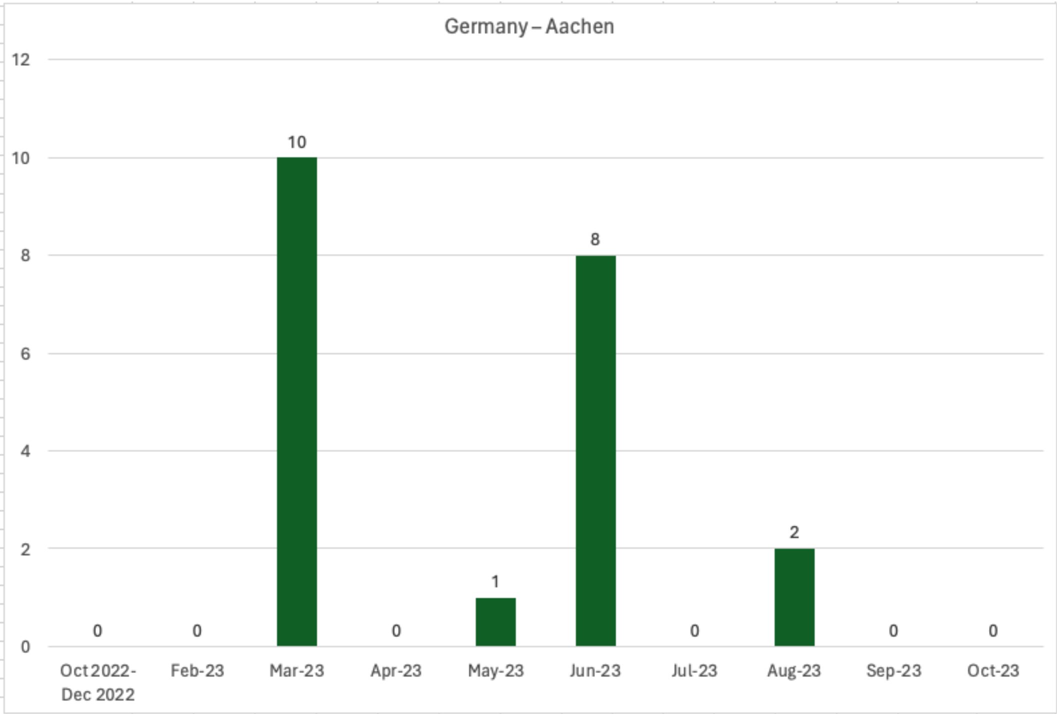


Figure 36: Number of passengers in Germany – Aachen based on monthly reports.

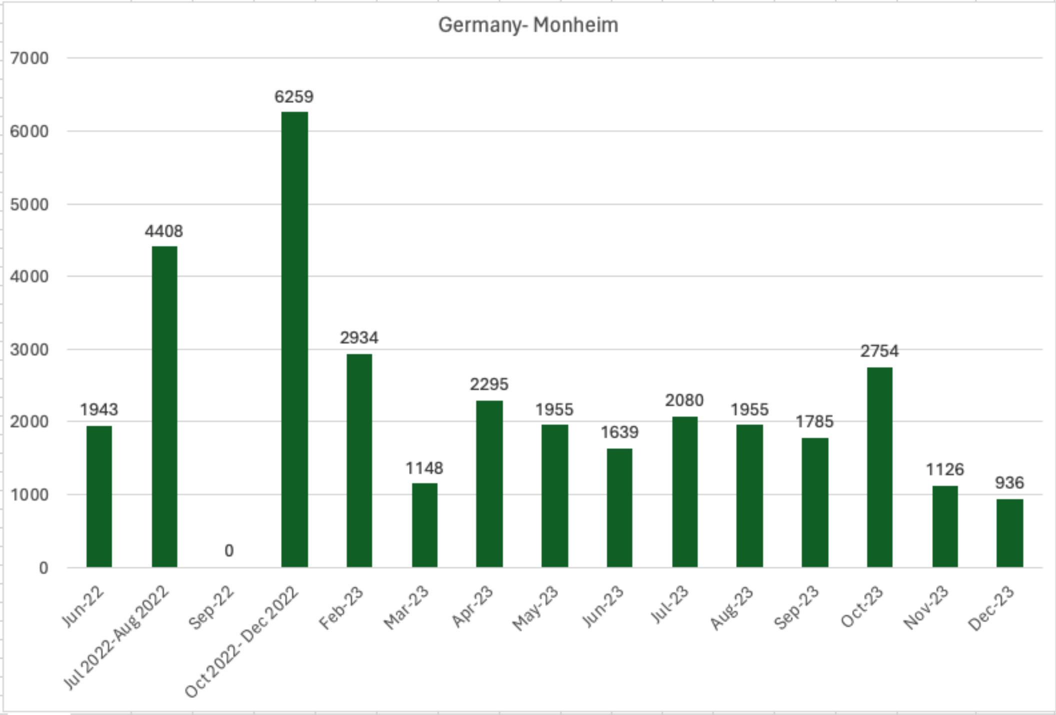


Figure 37: Number of passengers in Germany- Monheim based on monthly reports.

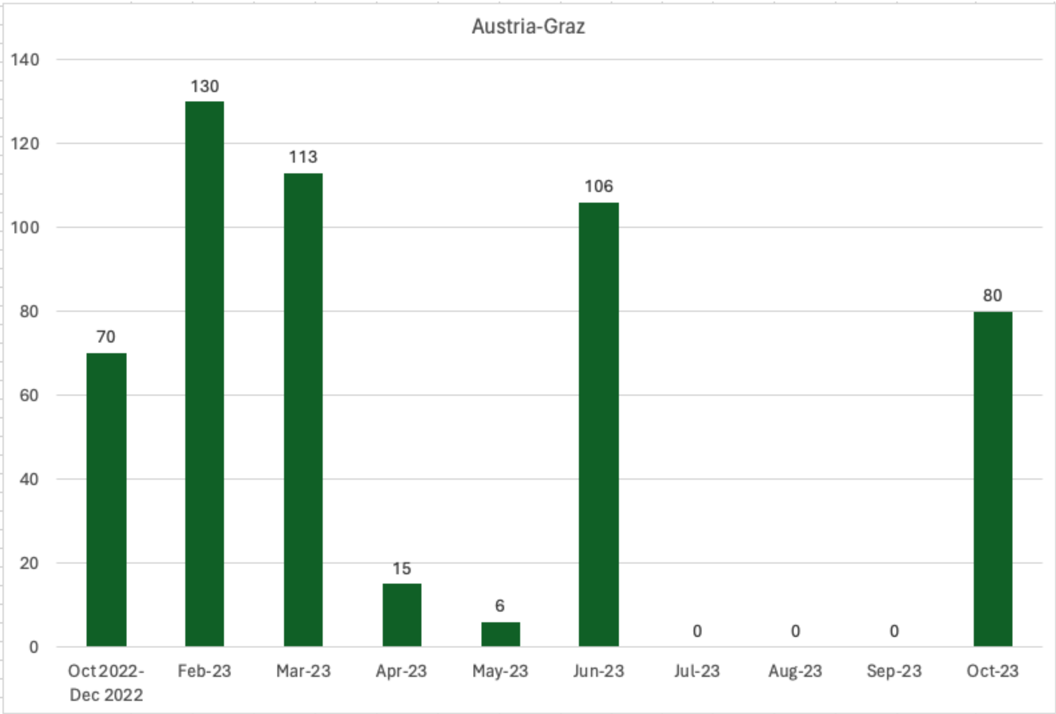


Figure 38: Number of passengers in Austria-Graz based on monthly reports.

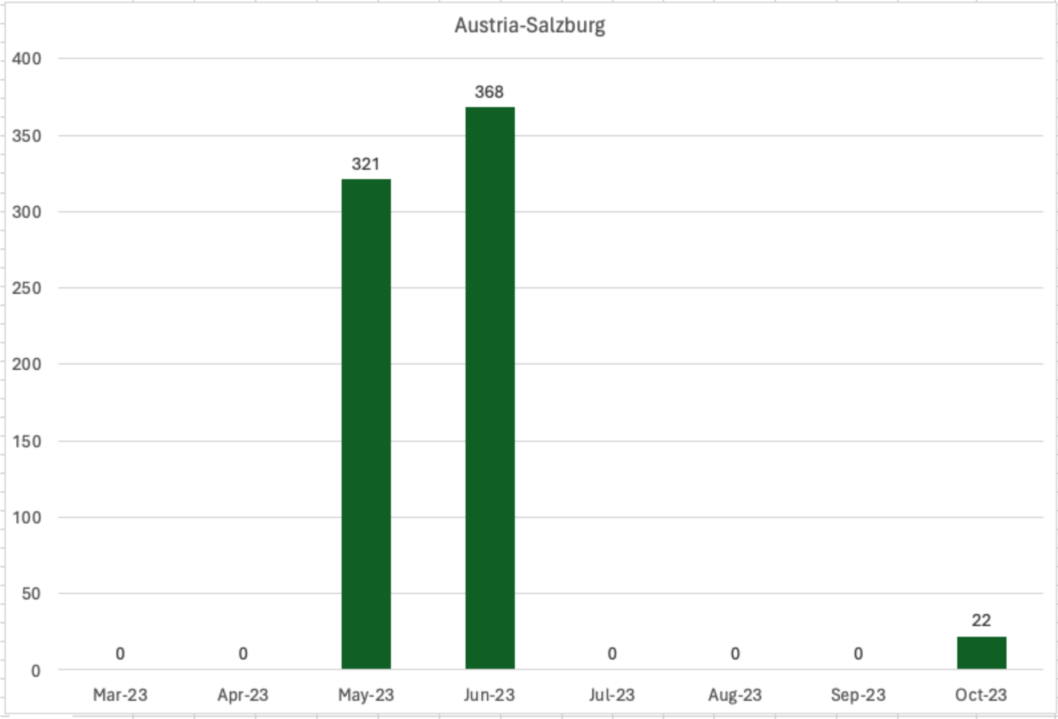


Figure 39: Number of passengers in Austria-Salzburg based on monthly reports.

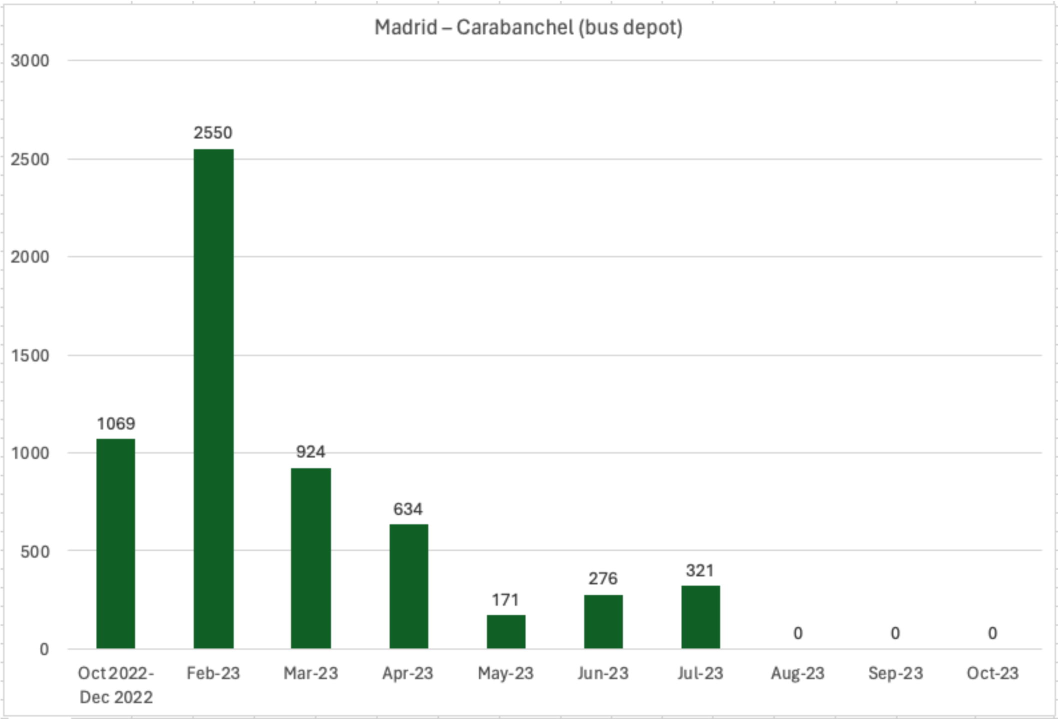


Figure 40: Number of passengers in Madrid – Carabanchel (bus depot) based on monthly reports.

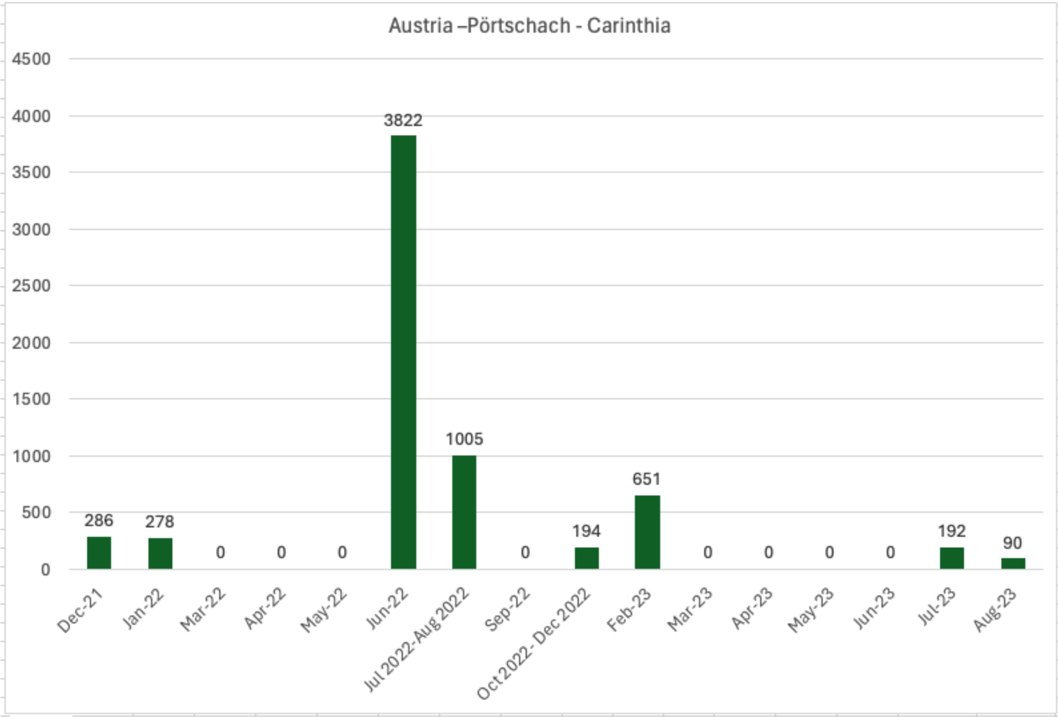


Figure 41: Number of passengers in Austria –Pörtschach – Carinthia based on monthly reports.

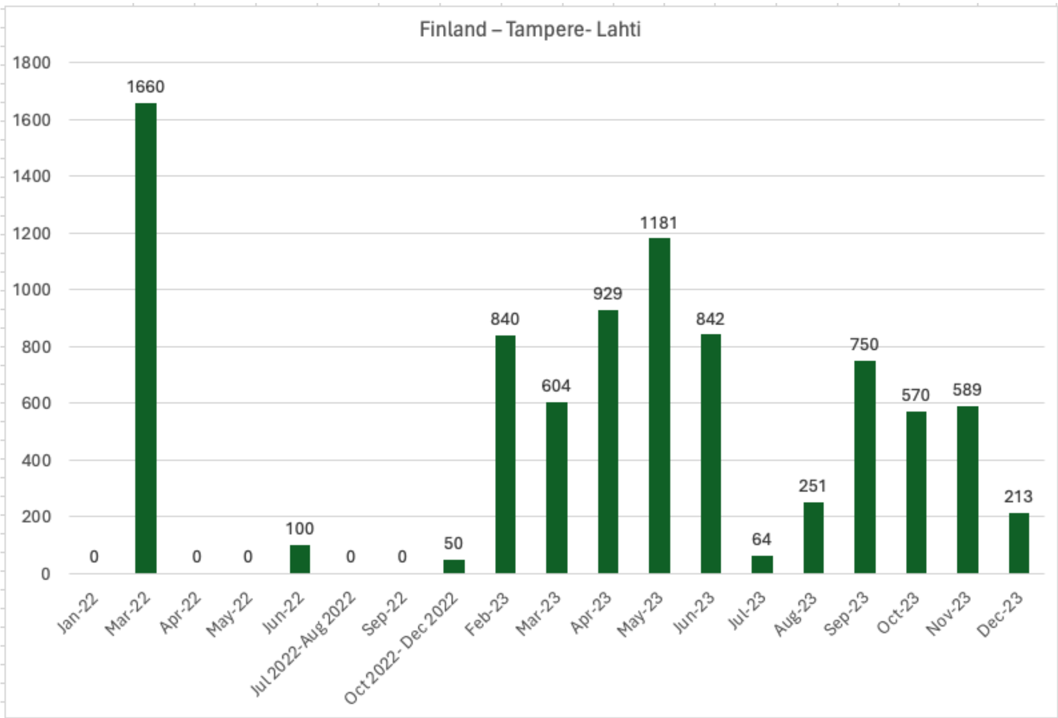


Figure 42: Number of passengers in Finland – Tampere- Lahti based on monthly reports.

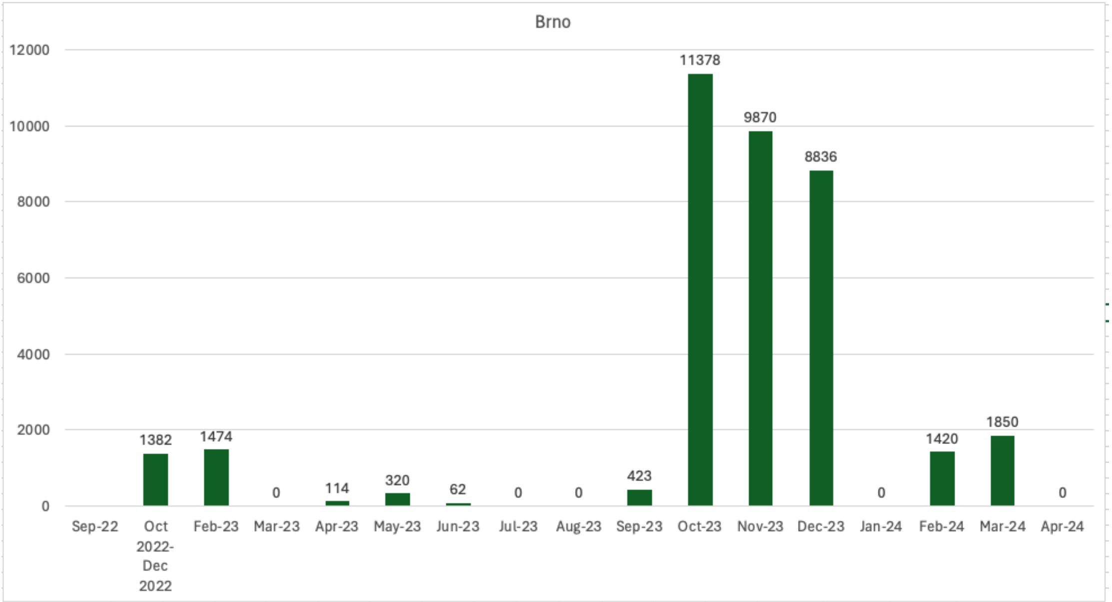


Figure 43: Number of passengers in Brno based on monthly reports.

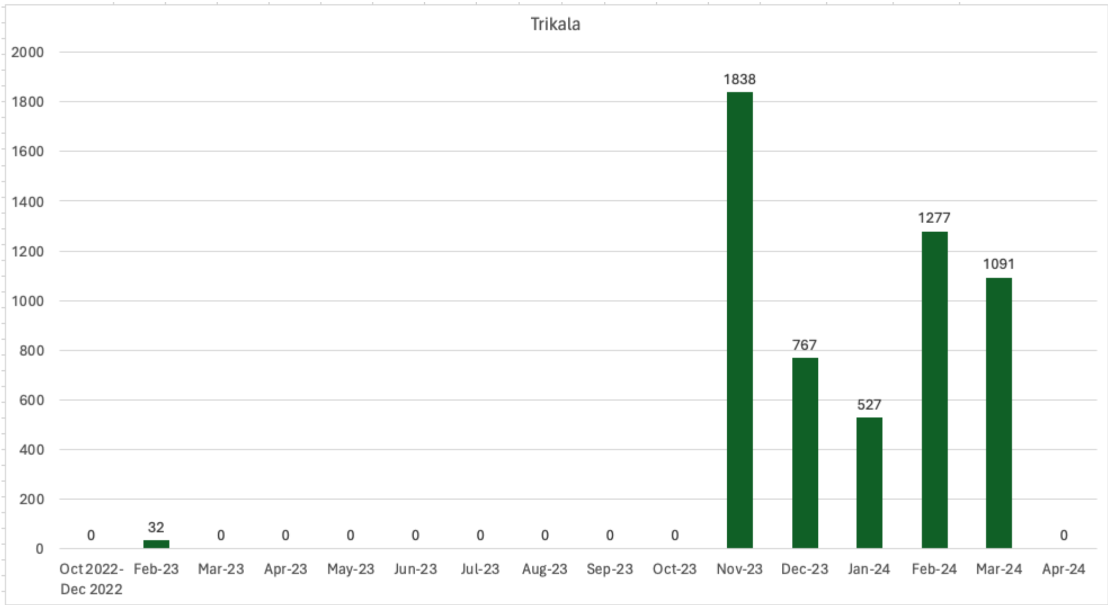


Figure 44: Number of passengers in Trikala based on monthly reports.