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Abstract

The Exploratory Research Plan (ERP) is the document that describes the way validation activities will be prepared and executed. The purpose of this document is to be used as a guideline for the project when conducting validation activities. The validation activities described in here will validate the proposed PRIAM Solution, which is a data analytics and modelling toolset that supports a passenger-centric integration of IAM into multimodal regional transport networks across Europe. The PRIAM Solution will help understand passenger needs for regional travel, anticipate IAM adoption and use patterns, plan resilient IAM infrastructure networks that are seamlessly connected with other transport modes and optimise IAM service performance taking advantage of multimodal data sharing and passenger information systems.

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PRIAM

PLANNING REGIONAL-SCALE MULTIMODAL OPERATIONS FOR INNOVATIVE AIR MOBILITY SERVICES

PRIAM

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1 Executive summary

This Exploratory Research Plan (ERP) outlines the roadmap for advancing the PRIAM solution from pre-Technology Readiness Level 1 (pre-TRL1) to TRL1. The PRIAM Solution is an innovative data analytics and modelling toolset designed to enable the passenger-centric integration of Innovative Air Mobility (IAM) services into multimodal regional transport networks across Europe. PRIAM aims to support evidence-based planning and decision-making for IAM deployment by addressing key challenges such as infrastructure coordination, demand estimation, network optimisation, and impact assessment. The solution will serve as a strategic enabler to align IAM development with broader mobility goals, fostering more resilient, efficient, and sustainable transport systems.

To ensure a comprehensive and robust validation process, the validation of PRIAM is structured into six main Validation Exercises, each targeting a critical step in the research and innovation process:

1. **Validation of the problem definition and the impact assessment framework (TVAL.01.0):** This activity will validate the high-level requirements of the toolset and the impact assessment framework. It includes the validation with the External Experts Advisory Board (EEAB) and other external stakeholders through surveys, interviews, and a workshop.
2. **Validation of AI algorithms for estimating IAM adoption (TVAL.02.0).** This activity will validate the algorithms for identifying the human factors that explain IAM adoption by combining internal and external validation. Internal validation will focus on ensuring algorithm robustness and consistency, while external validation will be conducted through targeted engagement activities with stakeholders.
3. **Validation of algorithms for monitoring potential IAM demand (TVAL.03.0).** This activity will validate the algorithms estimating the potential demand for IAM services by combining internal and external validation. Internal validation will focus on ensuring algorithm robustness and consistency, while external validation will be conducted through targeted engagement activities with stakeholders.
4. **Validation of algorithms for estimating IAM captured and induced demand (TVAL.04.0).** This activity will validate the algorithms for modelling IAM demand by combining internal and external validation. Internal validation will focus on ensuring algorithm robustness and consistency, while external validation will be conducted through targeted engagement activities with stakeholders.
5. **Validation of algorithms for vertiport location optimisation (TVAL.05.0).** This activity will validate the tool for the optimisation of the IAM network by combining internal and external validation. Internal validation will focus on ensuring algorithm robustness and consistency, while external validation will be conducted through targeted engagement activities with stakeholders.
6. **Validation of algorithms for IAM and ground transport services optimisation (TVAL.06.0).** This activity will validate the algorithms for IAM coordination with other modes by combining internal and external validation. Internal validation will focus on ensuring algorithm robustness and consistency, while external validation will be conducted through targeted engagement activities with stakeholders.

By the end of this process, PRIAM will reach TRL1, delivering a well-conceptualised, data-driven toolset ready for further development. The outputs of this ERP will inform future research directions and lay the groundwork for a coordinated and integrated rollout of IAM across European regions.

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2 Introduction

2.1 Purpose of the document

This deliverable presents the Exploratory Research Plan (ERP) for PRIAM, outlining the roadmap to advance the proposed SESAR solution from pre-TRL1 to TRL1. PRIAM is a data analytics and modelling toolset designed to support the passenger-centric integration of IAM into multimodal regional transport networks across Europe.

The main objective of this document is to define the strategy for progressing from the conceptual pre-TRL1 stage to TRL1, marking an initial level of technological maturity and readiness for practical application. As IAM technologies are still at a very early stage, PRIAM aims to facilitate their development towards tangible, tested solutions.

The document details the methodologies planned for the development of the PRIAM framework, including a comprehensive set of validation exercises. These exercises are designed to assess both the overall approach and the specific data analytics tools employed, ensuring their applicability, robustness, and reliability throughout the project.

2.2 Intended readership

This document is intended for a diverse audience engaged in the development of regional IAM. It is particularly relevant to the SESAR3 Joint Undertaking and regional authorities, who can use its insights to guide strategic decisions and support IAM implementation. Potential end users such as drone operators, vertiport operators, and U-space service providers (USSPs) may benefit from the project's demand monitoring and planning tools, helping advance IAM solutions toward higher readiness levels. Policy makers and regulatory bodies can draw on PRIAM's findings to shape supportive legislation, while other SESAR projects may benefit from methodological synergies. The scientific community, especially those researching IAM and U-space, can leverage the results for further innovation.

2.3 Background

PRIAM builds on the research outputs of previous and ongoing R&I initiatives and will establish cross-fertilisation links with parallel SESAR 3 projects, with particular emphasis on passenger experience, multimodality and U-space research. The PRIAM Consortium includes partners from all ongoing SESAR multimodality projects (**MAIA**, **MultiModX, SIGN-AIR** and **Travel Wise**) and from many SESAR U-space initiatives (e.g., **MUSE, U-ELCOME, EUREKA, BURDI, SPATIO**, **USEPE, Metropolis 2** and **AI4Hydrop**).

The following table outlines the main links to other SESAR multimodality and U-space projects:

SESAR Project	Description and link to PRIAM	PRIAM partners involved
MultiModX	PRIAM will build upon the multimodal evaluation framework developed in MultiModX, extending it to IAM use cases. It will also leverage MultiModX's regional archetypes to upscale case study results for the European-level social cost-benefit analysis.	Nommon, ARC

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MAIA	The algorithms for modelling IAM demand and estimating the induced demand effects of IAM services will be developed using the demand modelling framework developed under the MAIA project. In PRIAM, the methodologies, insights, and modelling tools from MAIA will serve as the foundation for building the IAM induced demand models. These established components will be adapted and extended to suit the regional-scale IAM use cases addressed in PRIAM, ensuring methodological consistency and leveraging the proven capabilities of the MAIA framework.	Nommon (coordinator), TML
SIGN-AIR	PRIAM will consider the smart contract frameworks developed by SIGN-AIR as an enabling technology for the coordination mechanisms proposed by the multimodal optimisation models.	ENAC
TRANSIT	PRIAM will use and evolve TRANSIT's set of multimodal KPIs, data analysis methods and transport simulation tools for analysing IAM services.	Nommon (coordinator), ENAC
MODUS	PRIAM build on MODUS' passenger archetypes (to be updated within MultiModX) to segment IAM demand.	ENAC
X-TEAM D2D	X-TEAM D2D developed a concept of operations for the seamless integration of ATM into a transport intermodal network to enable the D2D connectivity, including UAM services. Its outputs will be incorporated to PRIAM's conceptual framework.	-
EUREKA	EUREKA develops complete arrival, departure and turnaround processes for vertiports. EUREKA solutions will inform the IAM and vertiport operation constraints to be considered in PRIAM.	ENAC, Deep Blue, Bluenest
MUSE	PRIAM will build on the KPIs and evaluation methods developed in MUSE for understanding the impact of UAM, and will adapt it to IAM regional use cases.	Nommon (coordinator)
ImAFUSA	PRIAM will consider the "Impact and capacity Assessment Framework for U-space Societal Acceptance" developed in ImAFUSA and will extend this framework to regional-scale IAM use cases	-
OperA	PRIAM will consider the operating conditions outlined by OperA in the definition of the addressed IAM services.	-
CORUS-XUAM	PRIAM will consider the most recent U-space ConOps from this project and its continuation when defining the service models and requisites for IAM operations.	-
EALU-AER	PRIAM will leverage the human factors and social acceptance research expected within the demonstration to inform its IAM adoption models.	Deep Blue

Table 1. Main links to other SESAR multimodality and U-space projects

Additionally, the dynamic analysis of population required to estimate IAM demand will be carried out using Nommon's Mobility Insights tool, which leverages Mobile Network Data (MND) for monitoring mobility patterns and travel behaviour. As part of PRIAM, this tool will be further enhanced to identify key characteristics relevant to assess the potential adoption of IAM services. This solution has been successfully applied and continuously improved in several previous SESAR ER projects such as **BigData4ATM**, **TRANSIT**, **IMHOTEP**, and **MultiModX**.

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Beyond the SESAR programme, the algorithm for optimal vertiport location developed in the **Engage Vertiport Location** project (coordinated by Nommon) will be reused and enhanced in PRIAM. This, together with the leading position of Deep Blue in **Engage 2**, will help PRIAM incorporate the most recent relevant research.

2.4 Structure of the document

The structure of the document is as follows:

- Chapter 1 presents the executive summary of the document.
- Chapter 2 serves as an introduction, providing general information about this exploratory research plan.
- Chapter 3 provides the context of the exploratory research plan, containing details such as the scope of the study.
- Chapter 4 outlines the approach taken for conducting exploratory research and lists PRIAM related validation exercises.
- Chapter 5 offers additional detailed information related to the validation exercises.

2.5 Glossary of terms

Term	Definition	Source of the definition
eVTOL	Vertical Take-off and Landing aircraft that uses electric power to hover, take-off and land. They can be manned or unmanned (piloted remotely or autonomously).	Mixed sources
Innovative Air Mobility (IAM)	Innovative Air Mobility (IAM) refers to the integration of new aerial transport solutions into regional and urban mobility systems. This includes the use of emerging technologies such as electric vertical take-off and landing (eVTOL) aircraft, drones, and other advanced air vehicles to provide on-demand, efficient, and sustainable air transport services. IAM is particularly focused on improving connectivity in underserved regions, reducing travel times, and complementing existing ground transport networks.	Mixed sources

Table 2. Glossary of terms

2.6 List of acronyms

Term	Definition
ATM	Air traffic management
DES	Digital European Sky
EEAB	External Experts Advisory Board
EXE	Exercise

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GA	Grant agreement
IAM	Innovative Air Mobility
KPA	Key performance area
KPI	Key performance indicator
MND	Mobile Network Data
PI	Performance indicator
SESAR	Single European sky ATM research
SESAR 3 JU	SESAR 3 Joint Undertaking
TRL	Technology Readiness Level
UAM	Urban Air Mobility
USSP	U-Space Service Provider

Table 3. List of acronyms

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3 Context of the exploratory research plan

3.1 Exploratory research plan context

The European transport policy aims to connect 90% of travellers within four hours using a multimodal strategy that includes high-speed rail and air travel ([8], [9]). While effective for inter-city connections and reducing emissions, this approach struggles to ensure accessibility in rural, mountainous, and insular areas due to high costs and environmental impacts ([10], [11], [12], [13]). Novel aircraft with electric, hybrid, or hydrogen propulsion and vertical take-off and landing capabilities are emerging as promising solutions for regional connectivity ([14], [15]). Initially framed under Urban Air Mobility (UAM), the concept is evolving into IAM to serve rural and suburban [16] potentially improving multimodal integration, resilience, and environmental performance ([17], [18]).

However, IAM still faces key uncertainties regarding integration with other transport modes, passenger acceptance, induced demand, and weather-related reliability ([19], [20], [21]). A multicriteria analysis is needed to address these complexities ([22], [23]). To enable a data-driven, regional-scale implementation of IAM in Europe, the PRIAM project has been launched to fill this gap.

PRIAM aims to define an overall methodology for planning regional-scale IAM services, aiming at optimising the overall transport network. **The PRIAM Solution is structured as an integrated framework composed of four interdependent components**, as presented in Figure 1.

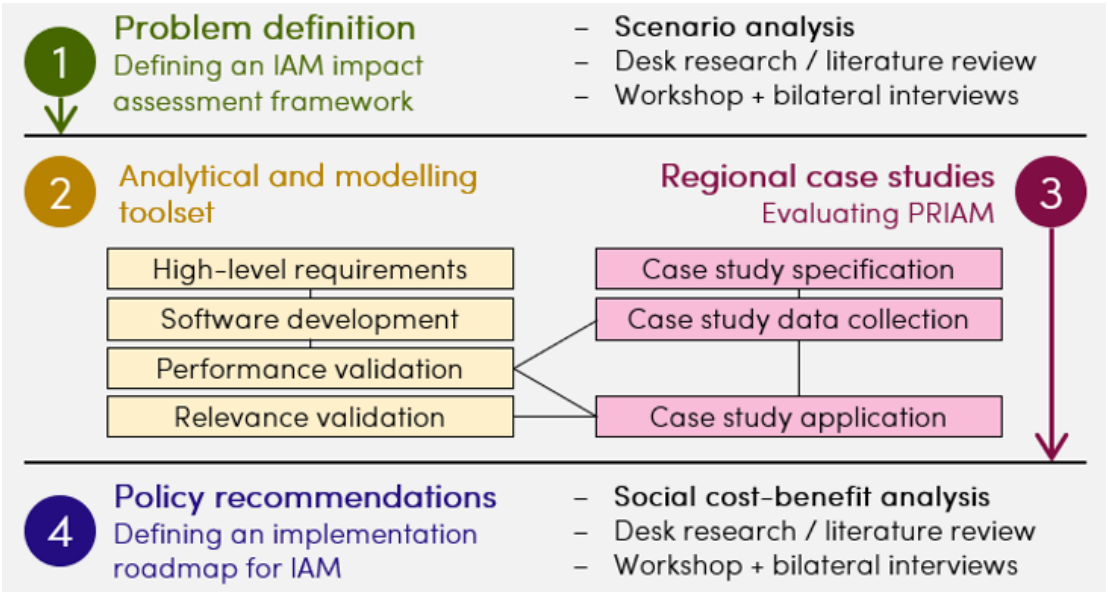

Figure 1. PRIAM framework

The components of the framework are as follows:

1. **Problem definition**. This component includes a comprehensive problem analysis, which will serve as the foundation for subsequent phases of the project. It will establish a set of **high-level requirements** that identify the key needs that IAM must address, while also guiding the technical design of the proposed solution to ensure alignment with SESAR performance objectives and regional mobility demands. It will also include the definition of an **impact**

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assessment framework to evaluate IAM services across key performance areas such as passenger experience, capacity, sustainability, and cost-efficiency.

2. **Analytical and modelling toolset.** It is composed of five elements, as presented in Figure 2.
   - **IAM adoption models.** AI-based techniques will be used to segment potential IAM users based on survey responses, supporting clustering and profiling of user groups to better understand acceptance drivers such as cultural and geographic factors.
   - **Potential demand monitoring tools.** Geolocation big data sources such as Mobile Network Data (MND) will be used to monitor current mobility patterns providing a better understanding of the passenger behaviour in regional areas.
   - **IAM demand models.** Advanced discrete choice models combining the outputs from the previous components (stated preference survey data and demand data derived from MND) will be used to estimate IAM modal share by estimating modal shifts to IAM and IAM induced demand.
   - **IAM network planning support tools.** A multicriteria evaluation method will support the robust planning of the vertiport network using demand model outputs from the previous component, but also considering other factors such as land use, weather, etc.
   - **IAM service optimisation tools.** Optimisation algorithms will be developed to synchronise IAM with ground transport modes, aiming to minimise transfer times and maximise service performance across integrated multimodal systems.

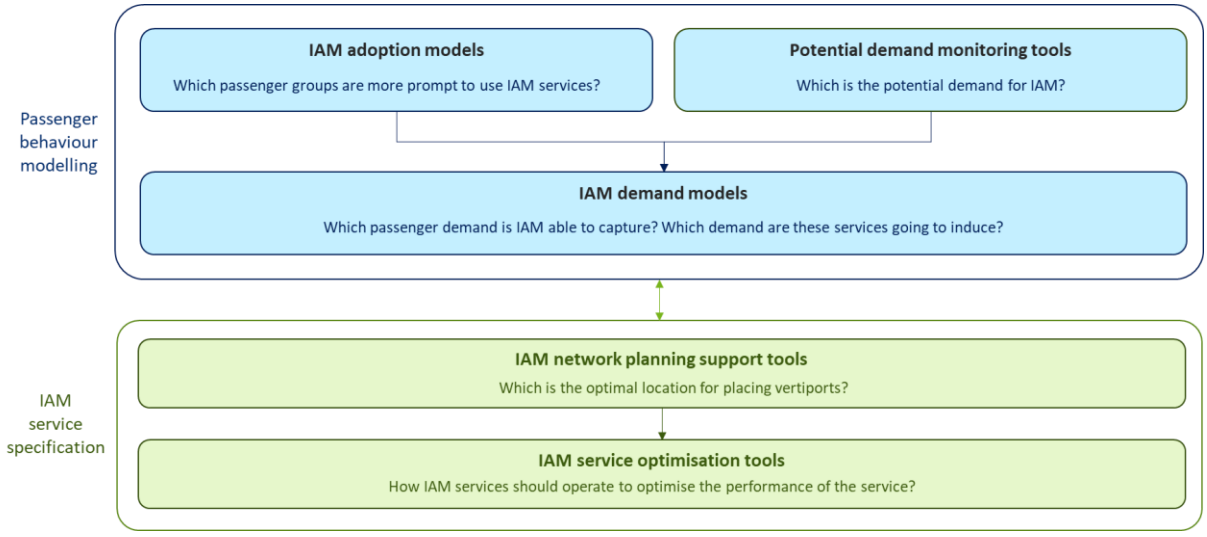

Figure 2. PRIAM Solution components

3. **Regional case studies.** This component includes the application of the PRIAM solution to a set of regional case studies across different European territories, aimed at providing real-world data and operational scenarios to test and validate the performance, flexibility, and relevance of the PRIAM tools, ensuring their applicability in diverse geographic and socio-economic contexts. Two case studies have been selected to validate the PRIAM Solution (see Figure 3):

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- The **Catalan Pyrenees**, representing a mountainous and sparsely populated area with limited transport infrastructure and significant seasonal tourism flows, making it an ideal setting to explore how IAM can enhance connectivity in complex terrains.
- The **Tenerife–La Gomera** connection, focusing on inter-island mobility within an insular territory, where current transport options are constrained by geography and travel time. This scenario allows the project to assess the potential of IAM services to improve accessibility between islands and within remote communities.



Figure 3. Graphical representation of the Catalan Pyrenees (left) and La Gomera-Tenerife (right) case studies

These regions were chosen for their distinctive mobility challenges and strategic relevance to regional IAM deployment. Together, these cases provide diverse and complementary conditions to evaluate the flexibility and impact of the PRIAM Solution

4. **Policy recommendations.** Drawing on the insights gained from the results derived from the case studies, this component will deliver an evidence-based policy recommendations and an implementation roadmap of regional-scale IAM services across Europe based on a social cost-benefit analysis.

This exploratory research plan focuses on designing a set of validation exercises aimed at assessing each component of the PRIAM Solution. These exercises will evaluate the validity of the assumptions considered within the problem definition phase, the technical feasibility of the proposed solution, the expected benefits it delivers, and the robustness of the implementation roadmap. The validation exercises defined for this purpose are further described in Section 4 and Section 5.

3.2 Scope

The validation exercises presented in this document aims at fulfilling the project's objectives listed below:

1. **Project Objective 1**: Define the problem PRIAM aims to address and develop an impact assessment framework for regional IAM services that evaluates how different IAM vehicular concepts and business models address regional connectivity challenges and passenger needs.

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2. **Project Objective 2**: Develop and validate a concept outline for PRIAM, consisting in a data analytics and modelling SESAR Solution for planning the integration of IAM infrastructure and services into regional multimodal transport networks.
3. **Project Objective 3**: Evaluate the capabilities of PRIAM through a set of case studies in European regions that show how the PRIAM Solution can help IAM regional-scale services improve passenger experience, capacity, environmental sustainability, and operational and cost efficiency.

To this end, six validation exercises have been defined, which are directly related to the project objectives: TVAL.01.0 contributes to Project Objective 1, while TVAL.02.0 to TVAL.06.0 contribute to Project Objectives 2 and 3, aiming at ensuring that all components of the solution described in Figure 2 are systematically and rigorously validated, with each validation exercise explicitly addressing a corresponding component of the solution.

Further details of the validation activities can be found in Section 5.

3.3 Key R&I needs

PRIAM's research primarily focuses on exploring how innovative IAM concepts and emerging aircraft technologies, such as electric Vertical Take-Off and Landing (eVTOL) vehicles, can improve regional mobility and address connectivity challenges in underserved areas. To achieve this, the project and its validation activities aim to generate valuable insights and advance knowledge in the following key research and innovation areas:

1. **Understanding regional connectivity gaps and passenger needs.** There is a need to identify regional mobility challenges and understanding how Integrated Air Mobility (IAM) can address them. This includes a deep analysis of different passenger profiles, travel needs, and expectations for regional-scale travel in Europe.
2. **Characterisation of IAM technologies and business models.** Research must consolidate emerging IAM vehicle concepts (such as VTOL and STOL), infrastructure types (like vertiports and regional airports), and business models (e.g., scheduled, on-demand) relevant to regional applications.
3. **Developing an impact assessment framework.** A key innovation need is the definition of an impact assessment framework, including the identification of Performance Indicators (PIs) across different dimensions: passenger experience, capacity, environmental sustainability, cost and operational efficiency.
4. **Developing advanced data analytics and modelling methods** for planning the regional IAM network and integrating it into the existing transport network**.** This includes the development of novel techniques in the following fields:
    - Developing AI methods the identify human factors influencing IAM adoption.
    - Developing data analytics methodologies for estimating the current mobility patterns and passenger behaviour form big geolocated data sources.
    - Developing modelling methodologies for estimating the modal shift to IAM modes and the IAM induced demand.

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- Developing a multicriteria evaluation method that optimise the most suitable vertiport location.
- Developing optimisation techniques that allow the multimodal coordination with ground transport modes.

5. **Socioeconomic evaluation and policy guidance.** There is a need to conduct social cost-benefit analyses to support evidence-based recommendations for IAM implementation. This also includes designing roadmaps for large-scale deployment and integration of IAM services in European regions.

This R&I needs led to the following research questions:

- What are the key mobility challenges affecting regional connectivity across different European territories?
- What are the expectations and preferences of regional travellers with regard to IAM services?
- How do different IAM vehicle types and operational models meet regional travel demands?
- Which PIs most effectively capture the impacts of IAM services across passenger experience, environmental sustainability, and cost-efficiency?
- What socio-demographic, psychological, and contextual factors influence the willingness to adopt IAM services? And, how can stated preference surveys be used to identify and quantify these adoption drivers?
- How can geolocated data sources such as mobile network data be used to estimate current mobility patterns and passenger behaviour?
- What are the potential induced demand and modal shift effects of regional IAM integration?
- What are the optimal strategies for integrating IAM infrastructure within regional multimodal transport systems?
- How can data sharing and information systems support IAM service coordination?
- How does the PRIAM Solution perform in varied regional contexts, and what improvements in mobility can it deliver?
- What are the social costs and benefits associated with deploying IAM services in different European scenarios?
- What policy measures and regulatory frameworks are needed to support the successful implementation of IAM services?

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3.4 Estimated performance contributions

The PRIAM solution is expected to bring relevant contributions to several Key Performance Areas (KPAs) defined in the DES programme. This expected performance contributions are highlighted in Table 4.

KPA	Contribution	Rationale
Environment	Reduction of CO_2 emissions through promotion of zero-emission IAM services	Modal shift from polluting modes to IAM aircrafts, enabled by clean propulsion technologies, offer the potential for reducing CO_2 emissions in regional mobility.
	Promotion of sustainable access to IAM infrastructure (e.g., vertiports)	Better placement of vertiports and services accessible by public and clean transport access to vertiports reduces local air pollution and supports integrated, sustainable mobility systems.
	Optimisation of noise levels and minimisation of the environmental impacts associated with IAM	Incorporating environmental factors (e.g., noise exposure maps, preservation of natural spaces) into network planning and service operations reduces the environmental footprint of IAM deployment.
Passenger experience	Improved accessibility and reduction of travel times to remote or sparsely populated regions	These regions lack efficient public transport options; IAM can provide a viable alternative and directly enable the EU goal of 4-hour D2D travel times.
	Improved travel experience through integration of IAM into multimodal transport networks	The PRIAM tool will support the coordination between IAM and ground transport modes thus enabling a seamless travel experience, reducing access and waiting times.
	Enhanced predictability and reliability of IAM journeys compared to traditional modes	IAM is expected to enhance predictability and reliability as it is expected to be less affected from congestion than ground transportation.
Capacity	Enhanced capacity across multimodal networks	IAM enables new links and resilience in cases of ground transport disruptions, improving overall regional transport capacity.
	Demand-aware planning and policy recommendations	PRIAM provides tools to balance user needs, expected demand and capacity constraints
Cost-efficiency	Reduction of infrastructure costs	PRIAM enables cost-efficient planning of IAM networks and services by addressing expected demand, vertiport siting, and multimodal coordination.
	Support for sustainable aviation business models	Evidence-based tools will enhance IAM service attractiveness and viability, fostering new IAM operators

Table 4. Estimated performance contributions

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3.5 Initial and exit maturity levels

Project/ Proposed SESAR solution(s) ID	Proposed SESAR solution(s) title	Initial maturity level	Exit maturity level	Reused validation material from past R&I Initiatives
Solution 0515	PRIAM - Planning Regional-Scale Multimodal Operations for Innovative Air Mobility Services	Pre-TRL1	TRL1	N/A

Table 5. Maturity levels table

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4 Exploratory research plan

4.1 Exploratory research plan approach

The Exploratory Research Plan has been designed to provide a thorough pathway to advance the proposed SESAR solution from pre-TRL1 to TRL1. To ensure a thorough and solid development process, the validation of PRIAM is organized into six main phases, each focusing on a key step in the research and innovation journey.

The first phase, focuses on defining the problem and developing the impact assessment framework (TVAL.01.0-PRIAM-0515-TRL1). This step lays the groundwork by identifying the main opportunities, challenges, and context for integrating IAM. It involves creating the high-level requirements and the impact assessment framework, based on both desk research and input from stakeholders.

The main technical components of the project will be validated individually in Exercises 2 to 6. Each tool will undergo internal validation by project members to ensure robustness and consistency of results, followed by external validation in a stakeholder workshop. The toolkit encompasses modelling the factors influencing IAM adoption, estimating both captured and induced demand, identifying optimal vertiport locations, and analysing the integration of IAM with ground transport. These case studies will demonstrate PRIAM's capacity to generate valuable insights for real-world IAM implementation.

By completing these phases, PRIAM will reach TRL1, delivering a well-designed, data-driven toolset prepared for further advancement. The outcomes of this Exploratory Research Plan will shape future research and support a coordinated, integrated rollout of IAM throughout European regions.

Considering the target maturity level of the solution (TRL-1), the planned experiments are sufficient to ensure validate the premised in the R&D needs outlined in Section 3.3. This milestone will be verified with the maturity self-assessment to be completed at the Maturity Gate. The set of questions that compose the self-assessment will help the project to monitor the achievement of the target maturity level.

Feedback from the intermediate review meeting will be analysed and, if it implies modification in the ERP, it will be incorporated in a new version of this deliverable, as well as feedback from other sources.

4.2 Stakeholders' expectations and involvement

Stakeholder	Involvement	Why it matters to the stakeholder
SESAR JU	Continuous assessment of the research conducted in PRIAM.	The developed methodology and results will fill some gaps on the roadmap towards the future implementation of regional-scale IAM services across Europe.

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Stakeholder	Involvement	Why it matters to the stakeholder
eVTOL aircraft operators	Provision of expert knowledge and assessment of the results related to eVTOLs operations.	The overall project methodology and results will generate valuable insights into potential travel demand. These findings will support eVTOL aircraft operators in establishing their services by informing decisions related to fleet requirements, market potential, operational constraints, and other key considerations.
eVTOL aircraft manufacturers	Provision of expert knowledge and assessment of the results related to eVTOL aircraft performance.	Understanding the impact of eVTOL characteristics—such as range, speed, and battery capacity—on regional service performance can help inform future design enhancements and guide the evolution of next-generation eVTOL technologies.
Vertiport operators	Provision of expert knowledge and assessment of the results related to vertiport location and eVTOL ground operations.	Improved understanding of the key factors influencing optimal vertiport placement based on estimated potential demand, as well as deeper insight into how different vertiport characteristics affect the distribution and allocation of that demand.
Regional authorities	Provision of expert knowledge and assessment of the results related to the potential integration of IAM service into the regional transport network.	Enhanced understanding of the potential demand of IAM services and the optimal location of the vertiports to maximise regional transport network performance can support regional authorities in planning, scheduling, and optimising public transportation.
Researchers and wider academic community	Academic insights, critical evaluation of the PRIAM assumptions, methodology, models and solution approach.	Researchers play a crucial role in validating the PRIAM framework, given the absence of ground-truth data from previous IAM implementations.
General public and wider society	Provision of public opinion and attitudes towards adoption of IAM services	Societal impacts, such as environmental or safety concerns, represent some of the key challenges to the adoption IAM services. Research initiatives like this one play a crucial role in addressing these issues and in laying the groundwork towards the future adoption of IAM services.

Table 6. Stakeholders' expectations and involvement

4.3 Validation objectives

The overall validation objective for PRIAM is to ensure the highest quality of research. We break down this overall goal into six specific validation objectives.

[OBJ]

Identifier	OBJ-0515-ERP-001
Objective	To validate the high-level requirements of the PRIAM tool and the impact assessment framework for the implementation of regional-scale IAM services in Europe. To this end, the project will analyse key regional connectivity challenges, passenger needs, and

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Identifier	OBJ-0515-ERP-001
	emerging vehicle concepts and business models, and will define relevant implementation scenarios. This analysis will lead to the derivation of high-level requirements for data analytics and modelling tools. Based on these insights, the project will design an impact assessment framework to evaluate IAM operations across passenger experience, social, environmental, and operational dimensions, aligned with SESAR performance management approaches and related projects (e.g., MUSE, TRANSIT, MultiModX).
Title	Problem definition and development of an impact assessment framework for regional IAM services
Category	<performance>, <acceptability>, <operational feasibility>
Key environment conditions	Nominal conditions, European regional scope
TRL	TRL1

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	0515

[OBJ Suc]

Identifier	Success Criterion
CRT-0515-TRL1-ERP-001.001	Identification of at least 5 challenges for regional connectivity across Europe.
CRT-0515-TRL1-ERP-001.002	Identification of at least 5 types of potential regional-scale IAM services.
CRT-0515-TRL1-ERP-001.003	Identification of at least 4 scenarios for regional-scale IAM operations in Europe.
CRT-0515-TRL1-ERP-001.004	Definition of a set of KPIs in at least 5 areas (passenger experience, capacity, environmental sustainability and operational and cost efficiency)
CRT-0515-TRL1-ERP-001.005	Identification of a set of high-level requirements for data analytics and modelling tools with implications for PRIAM developments.

Table 7. Validation objective OBJ-0515-ERP-001

[OBJ]

Identifier	OBJ-0515-ERP-002
Objective	To validate the algorithms for identifying the human factors that explain IAM adoption, based on Artificial Intelligence techniques that exploit survey data.
Title	Validation of AI algorithms for estimating IAM adoption levels
Category	<performance>, <acceptability>, <operational feasibility>, <technical feasibility>

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Identifier	OBJ-0515-ERP-002
Key environment conditions	Nominal conditions, European regional scope
TRL	TRL1

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	0515

[OBJ Suc]

Identifier	Success Criterion
CRT-0515-TRL1-ERP-002.001	The AI-based algorithms developed to identify human factors influencing IAM adoption have been validated through a combination of expert stakeholder reviews and quantitative methods, including cluster evaluation techniques and feature importance analysis, ensuring both their reliability and interpretability.

Table 8. Validation objective OBJ-0515-ERP-002

[OBJ]

Identifier	OBJ-0515-ERP-003
Objective	To validate algorithms for estimating the potential demand for regional-scale IAM services from the fusion of heterogeneous data sources, including geolocation data from personal mobile devices and mobility surveys.
Title	Validation of algorithms for monitoring potential IAM demand
Category	<performance>, <acceptability>, <operational feasibility>, <technical feasibility>
Key environment conditions	Nominal conditions, European regional scope
TRL	TRL1

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	0515

[OBJ Suc]

Identifier	Success Criterion
CRT-0515-TRL1-ERP-003.001	The mobility indicators derived from the algorithms for monitoring potential demand for IAM services through the fusion of MND and other data sources are consistent with the expected mobility behaviour. The achieved results have been validated through expert reviews conducted by external stakeholders as part of the project's planned engagement activities.

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Table 9. Validation objective OBJ-0515-ERP-003

[OBJ]

Identifier	OBJ-0515-ERP-004
Objective	To validate the algorithms for modelling the induced demand effects and modal shifts derived from regional-scale IAM services under different territorial settings, competing transport modes and operational configurations.
Title	Validation of algorithms for estimating IAM captured and induced demand
Category	<performance>, <acceptability>, <operational feasibility>, <technical feasibility>
Key environment conditions	Nominal conditions, European regional scope
TRL	TRL1

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	0515

[OBJ Suc]

Identifier	Success Criterion
CRT-0515-TRL1-ERP-004.001	The discrete choice and induced demand models are calibrated using the survey data to ensure they accurately reflect observed and potential travel behaviors. Model validation is carried out through established statistical tests for discrete choice modelling, including the likelihood ratio test, McFadden's R-squared, adjusted R-squared, and significance of estimated parameters. Predictive performance is further assessed using hold-out validation or cross-validation techniques where applicable. Models are deemed successful if they demonstrate statistical significance, robustness of estimated coefficients, and goodness-of-fit values consistent with standards in travel behavior research. Additionally, the plausibility of induced and switching demand estimates is checked against external benchmarks and expert stakeholder review, ensuring that the models are representative of the real population and suitable for policy and planning applications.

Table 10. Validation objective OBJ-0515-ERP-004

[OBJ]

Identifier	OBJ-0515-ERP-005
Objective	To validate the algorithms for performing a multicriteria evaluation of the integration of IAM infrastructure networks into multimodal transport systems.
Title	Validation of algorithms for vertiport location optimisation
Category	<performance>, <acceptability>, <operational feasibility>, <technical feasibility>

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Identifier	OBJ-0515-ERP-005
Key environment conditions	Nominal conditions, European regional scope
TRL	TRL1

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	0515

[OBJ Suc]

Identifier	Success Criterion
CRT-0515-TRL1-ERP-005.001	The results of the multicriteria evaluation methods for the optimisation of IAM infrastructure networks are consistent with the expected behaviour. The achieved results have been validated through expert reviews conducted by external stakeholders as part of the project's planned engagement activities.

Table 11. Validation objective OBJ-0515-ERP-005

[OBJ]

Identifier	OBJ-0515-ERP-006
Objective	To validate the algorithms for optimising the coordination of IAM services with other modes.
Title	Validation of algorithms for IAM and ground transport services optimisation
Category	<performance>, <acceptability>, <operational feasibility>, <technical feasibility>
Key environment conditions	Nominal conditions, European regional scope
TRL	TRL1

[OBJ Trace]

Relationship	Linked Element Type	Identifier
<COVERS>	<SESAR Solution>	0515

[OBJ Suc]

Identifier	Success Criterion
CRT-0515-TRL1-ERP-006.001	The optimisation algorithms for IAM service coordination with other modes are assessed in terms of computational efficiency, robustness under varying operational conditions, and scalability within a European regional scope. Validation has been carried out through simulation-based testing, ensuring that the results are aligned with operational feasibility, technical feasibility, and performance requirements.

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	Additionally, the results have been validated through expert reviews conducted by external stakeholders as part of the project's planned engagement activities.

Table 12. Validation objective OBJ-0515-ERP-006

4.4 Validation assumptions

The table below summarises the assumptions considered by the project for the experiments to be performed and that are applicable to all the validation exercises. Each exercise may detail additional assumptions in Section 5, e.g., a specific concept of operations followed in the case studies.

Category	ID	Title	Description	Justification	Impact Assessment
Technological advancements in IAM	AS-01	Vehicle propulsion	Electric, hybrid, and/or hydrogen propulsion systems will mature and become viable for short-haul and long-haul IAM.	Current advances on propulsion systems are on track for this	Delay on the development of this technology could affect the proposed timeline (2035 & 2050)
	AS-02	Certification of eVTOLs	Development and certification of novel aircraft types with short or vertical take-off and landing capabilities (STOL, VTOL) suitable for regional passenger transport will be achieved by 2035.	Several companies are already in the process of certification	Delay or difficulties in the completion of the certification process could affect the proposed timeline (2035 & 2050)
	AS-03	IAM operations	Development of reliable sensor technology will enable IAM operations in diverse environmental conditions, including night-time and adverse weather.	Technology advancement points in this direction	Delay on the development of this technology could affect the proposed timeline (2035 & 2050)
	AS-04	Battery and charging	Enhancements in battery range, charging time, and safety will support viable regional IAM operations by 2035, with further advancements by 2050. Battery swapping may emerge as an alternative solution.	Battery performance is an active area of research and is improving year by year	Delay on the development of this technology could affect the proposed timeline (2035 & 2050)

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Category	ID	Title	Description	Justification	Impact Assessment
	AS-05	Automation of eVTOLs	Advanced automation technologies enabling autonomous eVTOL operations will be available by 2050, contingent on regulatory approval and robust safety features.	Both the desk research and the interview performed assured us that this timeline is realistic	Delay on the development of this technology could affect the proposed timeline (2035 & 2050)
Development of supporting infrastructure and services	AS-06	Vertiport availability	Establishment of vertiports in regional areas, potentially upgrading existing infrastructure like heliports, by 2035. This includes the development of vertiport design and management tools.	Both the desk research and the interview performed assured us that this timeline is realistic	Lagging development of vertiport technologies poses a risk to meeting the proposed milestones set for 2035 and 2050.
	AS-07	U-space	U-space will be implemented by 2035 when the first passenger drone operations take place.	The successful implementation of U-space services, integrated with existing ATM, is crucial for managing IAM operations, particularly in very low-level airspace.	Delay on the implementation of U-Space could affect the proposed timeline (2035 & 2050)
	AS-08	Data availability	Establishment of data spaces and AI tools to support IAM decision-making, including demand prediction, network planning, and service optimisation.	This assumption aligns with the desk research and the latest SESAR master plan	The unavailability of the data required by the PRIAM solution could affect the implementation of the solution in specific cases.
	AS-09	Data sharing	Evolution of data sharing and passenger information systems to facilitate seamless integration of IAM with other transport modes.	This assumption aligns with the desk research and the latest SESAR master plan	Delay on the development of this technology or unwillingness to the different actors to share data could difficult the integration between modes of transport in the future.

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Category	ID	Title	Description	Justification	Impact Assessment
Economic and business viability	AS-10	Business models	Development of business models for regional IAM services that balance operating costs with fares and potential subsidies, achieving competitive pricing compared to existing transportation methods.	This assumption aligns with the desk research and the interviews	The lack of viable and effective business models could significantly hinder the deployment of IAM services.
	AS-11	IAM recognition	The aviation sector will recognise IAM's potential to create sustainable value, offering new business opportunities for airlines and infrastructure providers.	This is needed for IAM integration in airports	The lack of recognition of IAM's potential could limit industry engagement, leading to reduced investment and delayed deployment of services.
Societal acceptance	AS-12	Societal acceptance	Societal acceptance of IAM services will grow as passengers gain confidence in the safety and reliability of new technologies. Factors like accessibility and connectivity are expected to positively influence acceptance.	This assumption aligns with the desk research and the stakeholder interviews	Social reluctancy to IAM may result in a reduced demand.
Regulatory framework	AS-13	Regulatory framework	Regulatory frameworks will evolve to enable safe and efficient IAM operations, covering aspects like vehicle certification, airspace management (including U-space), and vertiport standards.	This assumption is necessary to ensure eVTOLs can operate	Delay on the establishment of a regulatory framework could affect the proposed timeline (2035 & 2050)
Multimodal integration	AS-14	IAM coordination with traditional modes	There is willingness between the relevant stakeholders to enable effective integration of novel IAM services with existing ground transport modes within regional multimodal transport networks, leveraging mechanisms such as data sharing.	This assumption aligns with the desk research and the stakeholder interviews	A lack of interest in intermodal coordination would hinder the seamless integration of IAM services into regional transport networks.

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Category	ID	Title	Description	Justification	Impact Assessment
PRIAM toolset	AS-15	Data availability	Data required for the proper work of the PRIAM solution (demand data to provide the current mobility patterns in the region of study, and IAM adoption surveys to model the level of adoption of these services) will be in place for the implementation of the solution in different contexts.	Demand data is widely used in Europe to analyse mobility patterns. If MND is not available, travel surveys, commonly conducted across European countries, can serve as an alternative. In the absence of IAM adoption surveys, they can be conducted or estimated using heuristic approaches.	The unavailability of this data can limit the application of the solution to other geographical contexts.
	AS-16	Data quality	The quality of the data is sufficient to ensure that the outputs of the PRIAM solution are reliable.	Quality of data can be good enough to accurately represent the current mobility patterns and the IAM adoption trends.	Bad quality data can lead to non-reliable results.
	AS-17	Data representati-veness	The data sample is representative of the behaviour of the total population, and is sufficient to ensure that the outputs of the PRIAM solution are reliable.	Data should be representative, ensuring that all the passenger segments are equally represented.	Non-representative data can lead to biases and to achieving non-reliable results.

Table 13. Validation assumptions overview

4.5 Validation exercises list

[EXE]

Identifier	TVAL.01.0-PRIAM-0515-TRL1
Title	Validation of the problem definition and the impact assessment framework
Description	The objective of this validation exercise is to address the validation objective OBJ-0515-ERP-001. This exercise will validate the high-level requirements derived from the identified challenges related to regional connectivity across Europe, assess the relevance of potential regional-scale IAM service types and operational scenarios, and evaluate the applicability of the impact assessment framework developed within the project. The validation will be carried out through expert judgement provided by the EEAB and other external stakeholders, as part of the project's planned stakeholder engagement activities.

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KPA/TA addressed	<Environment>, <Demand>, <Capacity>, <Cost Efficiency>, <Operational Efficiency>, <Passenger experience>
Addressed expected performance contribution(s)	N/A
Maturity level	<TRL1>
Use cases	N/A
Validation technique	<Expert Group>
Validation platform	N/A
Validation location	1st PRIAM Stakeholder Workshop, Airport Regions Council (ARC) facilities, Brussels, Belgium
Start date	01/01/2025
End date	30/04/2025
Validation coordinator	Deep Blue
Status	<completed>
Dependencies	TVAL.02.0-PRIAM-0515-TRL1 TVAL.03.0-PRIAM-0515-TRL1 TVAL.04.0-PRIAM-0515-TRL1 TVAL.05.0-PRIAM-0515-TRL1 TVAL.06.0-PRIAM-0515-TRL1

[EXE Trace]

Linked Element Type	TVAL.01.0-PRIAM-0515-TRL1
<SESAR Solution>	0515
<Project>	PRIAM
<Sub-Operating Environment>	N/A
<Validation Objective>	OBJ-0515-ERP-001

Table 14. Validation exercise TVAL.01.0-PRIAM-0515-TRL1

[EXE]

Identifier	TVAL.02.0-PRIAM-0515-TRL1
Title	Validation of the algorithms for developing new AI-based methods for identifying human factors behind IAM adoption.
Description	This validation exercise addresses the validation objective OBJ-0515-ERP-002. It focuses on validating the AI techniques used for identifying human factors that affect IAM adoption, and clustering passengers into groups according to what extent are they more or less favourable and inclined to become IAM users in the future.

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	The validation will be conducted by analysing the clustering results and ensuring its consistency. This process will involve several complementary steps. First, the number of clusters will be determined using the Elbow method, followed by the application of the Silhouette method to assess whether the clusters generated and selected are adequately separated and meet acceptable minimal values. Feature selection and importance will then be examined through Random Forest models, which will help measure the reduction in residual errors from the cluster centroids and assess the level of convergence of features across clustering, regression trees, and logistic or multiple regression models. In addition to these quantitative approaches, validation will also draw on expert judgement from external stakeholders, incorporated as part of the project's planned stakeholder engagement activities.
KPA/TA addressed	<Environment>, <Demand>, <Capacity>, <Cost Efficiency>, <Operational Efficiency>, <Passenger experience>
Addressed expected performance contribution(s)	These algorithms help understand the human factors that affect the level of acceptance and adoption of IAM services.
Maturity level	<TRL1>
Use cases	N/A
Validation technique	<Analytical Modelling> and <Expert Group>
Validation platform	N/A
Validation location	2nd PRIAM Workshop Location (TBD)
Start date	01/09/2025
End date	31/12/2025
Validation coordinator	HAIKAI
Status	<In progress>
Dependencies	TVAL.01.0-PRIAM-0515-TRL1 TVAL.03.0-PRIAM-0515-TRL1 TVAL.04.0-PRIAM-0515-TRL1 TVAL.05.0-PRIAM-0515-TRL1 TVAL.06.0-PRIAM-0515-TRL1

[EXE Trace]

Linked Element Type	TVAL.02.0-PRIAM-0515-TRL1
<SESAR Solution>	0515
<Project>	PRIAM
<Sub-Operating Environment>	N/A
<Validation Objective>	OBJ-0515-ERP-002

Table 15. Validation exercise TVAL.02.0-PRIAM-0515-TRL1

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[EXE]

Identifier	TVAL.03.0-PRIAM-0515-TRL1
Title	Validation of the algorithms for developing new methods of monitoring potential demand for IAM services.
Description	This validation exercise addresses the validation objective OBJ-0515-ERP-003. It focuses on validating the algorithms for estimating the potential demand for regional-scale IAM services from the fusion of heterogeneous data sources, including geolocation data from personal mobile devices and mobility surveys. The validation will be carried out by deeply analysing a set of mobility indicators to assess its consistency with the expected passenger behaviour, as well as through expert judgement from external stakeholders, as part of the planned stakeholder engagement activities.
KPA/TA addressed	<Environment>, <Demand>, <Capacity>, <Cost Efficiency>, <Operational Efficiency>, <Passenger experience>
Addressed expected performance contribution(s)	These algorithms provide an accurate view of the current passenger behaviour and mobility patterns within the area of study. This provides an initial idea of the potential demand of the IAM services, and allows the application of discrete choice models to estimate IAM adoption.
Maturity level	<TRL1>
Use cases	N/A
Validation technique	<Analytical Modelling> and <Expert Group>
Validation platform	N/A
Validation location	2nd PRIAM Workshop Location (TBD)
Start date	01/10/2025
End date	30/05/2026
Validation coordinator	Nommon
Status	<Pending>
Dependencies	TVAL.01.0-PRIAM-0515-TRL1 TVAL.02.0-PRIAM-0515-TRL1 TVAL.04.0-PRIAM-0515-TRL1 TVAL.05.0-PRIAM-0515-TRL1 TVAL.06.0-PRIAM-0515-TRL1

[EXE Trace]

Linked Element Type	TVAL.03.0-PRIAM-0515-TRL1
<SESAR Solution>	0515
<Project>	PRIAM
<Sub-Operating Environment>	N/A
<Validation Objective>	OBJ-0515-ERP-003

Table 16. Validation exercise TVAL.03.0-PRIAM-0515-TRL1

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[EXE]

Identifier	TVAL.04.0-PRIAM-0515-TRL1
Title	Validation of the methodology for developing new models for predicting IAM demand, including induction and modal shift effects.
Description	This validation exercise addresses the validation objective OBJ-0515-ERP-004. It focuses on validating the discrete choice and induced demand models aimed at estimating the IAM captured and induced demand. The validation will be carried out by extracting a set of validation tests and metrics, such as the likelihood ratio test and McFadden's R-squared, to evaluate the model's performance and its capability to precisely replicate observed travel behaviour. Additionally, expert judgement validation will be carried out from external stakeholders, as part of the planned stakeholder engagement activities.
KPA/TA addressed	<Environment>, <Demand>, <Capacity>, <Cost Efficiency>, <Operational Efficiency>, <Passenger experience>
Addressed expected performance contribution(s)	These algorithms help understand the influence of new modes on regional mobility.
Maturity level	<TRL1>
Use cases	N/A
Validation technique	<Analytical Modelling> and <Expert Group>
Validation platform	N/A
Validation location	2nd PRIAM Workshop Location (TBD)
Start date	01/10/2025
End date	30/05/2026
Validation coordinator	TML
Status	<Pending>
Dependencies	TVAL.01.0-PRIAM-0515-TRL1 TVAL.02.0-PRIAM-0515-TRL1 TVAL.03.0-PRIAM-0515-TRL1 TVAL.05.0-PRIAM-0515-TRL1 TVAL.06.0-PRIAM-0515-TRL1

[EXE Trace]

Linked Element Type	TVAL.04.0-PRIAM-0515-TRL1
<SESAR Solution>	0515
<Project>	PRIAM
<Sub-Operating Environment>	N/A
<Validation Objective>	OBJ-0515-ERP-004

Table 17. Validation exercise TVAL.04.0-PRIAM-0515-TRL1

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[EXE]

Identifier	TVAL.05.0-PRIAM-0515-TRL1
Title	Validation of the novel multicriteria evaluation methods for IAM infrastructure network optimisation.
Description	This validation exercise addresses the validation objective OBJ-0515-ERP-005. It focuses on validating the multicriteria evaluation method for the optimal integration of IAM infrastructure in multimodal transport networks The validation will be carried out by ensuring the model results are consistent the expected behaviour. The outcomes of the vertiport site optimisation model will be evaluated and the identified locations will be assessed to ensure that they are consistent, reasonable, and aligned with the model's intended objectives. Additionally, a validation based on expert judgement will be conducted from external stakeholders, as part of the planned stakeholder engagement activities.
KPA/TA addressed	<Environment>, <Demand>, <Capacity>, <Cost Efficiency>, <Operational Efficiency>, <Passenger experience>
Addressed expected performance contribution(s)	• Improved passenger experience through the reduction of travel times to regional areas and enhanced connectivity. • Reduced environmental impact due to the use of new clean modes (e.g., eVTOLs) • Maximisation of IAM passenger demand through the optimisation of the vertiport location and the IAM service characteristics
Maturity level	<TRL1>
Use cases	N/A
Validation technique	<Analytical Modelling> and <Expert Group>
Validation platform	N/A
Validation location	2nd PRIAM Workshop Location (TBD)
Start date	01/10/2025
End date	30/05/2026
Validation coordinator	Nommon
Status	<Pending>
Dependencies	TVAL.01.0-PRIAM-0515-TRL1 TVAL.02.0-PRIAM-0515-TRL1 TVAL.03.0-PRIAM-0515-TRL1 TVAL.04.0-PRIAM-0515-TRL1 TVAL.06.0-PRIAM-0515-TRL1

[EXE Trace]

Linked Element Type	TVAL.05.0-PRIAM-0515-TRL1
<SESAR Solution>	0515

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<Project>	PRIAM
<Sub-Operating Environment>	N/A
<Validation Objective>	OBJ-0515-ERP-005

Table 18. Validation exercise TVAL.05.0-PRIAM-0515-TRL1

[EXE]

Identifier	TVAL.06.0-PRIAM-0515-TRL1
Title	Validation of the algorithms for developing new models for optimising IAM service coordination with other modes.
Description	This validation exercise addresses the validation objective OBJ-0515-ERP-006. It focuses on validating the optimisation techniques developed for coordinating IAM services with other modes. The exercise will assess the algorithms' ability to enhance multimodal integration, improve passenger demand satisfaction, and ensure that IAM services complement rather than compete with ground transport options. Specific attention will be given to evaluating computational efficiency, robustness under varying operational conditions, and scalability within a European regional scope. Validation will be carried out through simulation-based testing, ensuring that the results are aligned with operational feasibility, technical feasibility, and performance requirements. Additionally, external validation from external stakeholders will be carried out as part of the planned stakeholder engagement activities.
KPA/TA addressed	N/A
Addressed expected performance contribution(s)	• Improved passenger experience through the reduction of travel times due to higher coordination between modes. • Maximisation of IAM passenger demand through the optimisation of the coordination between modes.
Maturity level	<TRL1>
Use cases	N/A
Validation technique	<Analytical Modelling> and <Expert Group>
Validation platform	N/A
Validation location	2nd PRIAM Workshop Location (TBD)
Start date	01/10/2025
End date	30/05/2026
Validation coordinator	ENAC
Status	<Pending>
Dependencies	TVAL.01.0-PRIAM-0515-TRL1 TVAL.02.0-PRIAM-0515-TRL1 TVAL.03.0-PRIAM-0515-TRL1 TVAL.04.0-PRIAM-0515-TRL1 TVAL.05.0-PRIAM-0515-TRL1

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[EXE Trace]

Linked Element Type	TVAL.06.0-PRIAM-0515-TRL1
<SESAR Solution>	0515
<Project>	PRIAM
<Sub-Operating Environment>	N/A
<Validation Objective>	OBJ-0515-ERP-006

Table 19. Validation exercise TVAL.06.0-PRIAM-0515-TRL1

4.6 Validation exercises planning

Figure 4 presents the planning of the validation exercises proposed within the project, along with the project Gantt Chart.

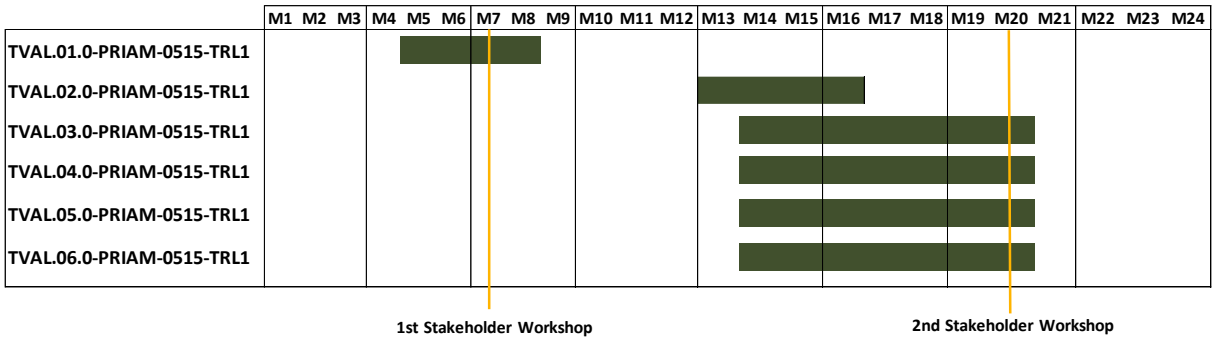

Figure 4. Validation exercises planning

TVAL.01.0-PRIAM-0515-TRL1 is primarily linked to the tasks under *WP2 Definition of IAM Scenarios and Impact Assessment Framework*. This validation exercise will run for four months, from January 2025 (Month 5) to April 2025 (Month 8). During this period, the exercise will focus on validating the key benefits and challenges associated with IAM, the IAM needs and the preliminary version of the impact assessment framework, identified from the initial desk research. This validation process will include a combination of bilateral interviews with relevant members of the Advisory Board, culminating in the 1st PRIAM Stakeholder Workshop in March 2025 (Month 7) where the final outcomes of the process will be validated.

TVAL.02.0-PRIAM-0515-TRL1 will run for 4 months, from September 2025 (Month 13) to December 2026 (Month 16). During this period, the exercise will focus on the validation of the AI methods for identifying human factors behind IAM adoption, and the clustering of passengers with similar behaviour. The results will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around May 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

TVAL.03.0-PRIAM-0515-TRL1 will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). During this period, the exercise will focus on the validation of the algorithms for the potential IAM demand monitoring based on the use of geolocation big data sources. The results will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around

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April 2025 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

TVAL.04.0-PRIAM-0515-TRL1 will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). During this period, the exercise will focus on the validation of the discrete choice models aimed at estimating the IAM captured and induced demand. The results will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around May 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

TVAL.05.0-PRIAM-0515-TRL1 will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). During this period, the exercise will focus on the validation of the IAM network planning support tools. The results will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around April 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

TVAL.06.0-PRIAM-0515-TRL1 will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). During this period, the exercise will focus on the validation of the IAM service optimisation tools based on AI methods. The results will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around April 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

Although the length of the validation exercises may seem too extensive in some cases, this is explained by the overlap between the internal validation of the solution's technical components (TVAL.02.0-PRIAM-0515-TRL1 to TVAL.06.0-PRIAM-0515-TRL1) with the development phases. The internal validation of the algorithms follows an inherently iterative process, progressing in parallel with their development. This iterative approach is a critical step to ensure continuous improvement and to guarantee that the final product achieves the required quality standards.

4.7 Deviations with respect to the SESAR 3 JU project handbook

There is no deviation based on SESAR 3 JU project handbook.

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5 Validation exercises

5.1 Validation exercise #01 plan

5.1.1 Validation exercise description and scope

This exercise will validate the high-level requirements derived from the identified challenges related to regional connectivity across Europe, assess the relevance of potential regional-scale IAM service types and operational scenarios, and evaluate the applicability of the impact assessment framework developed within the project. Validation will be carried out through a combination of interviews with members of the Advisory Board and the 1st PRIAM Stakeholder Workshop, held in March 2025 with the participation of the EEAB and other relevant stakeholders. The validation phase will run for four months, from January 2025 (Month 5) to April 2025 (Month 8). Deep Blue will lead this activity, with contributions from the other project partners across specific tasks.

5.1.2 Stakeholder's expectations and benefit mechanisms addressed by the exercise

Stakeholder	Involvement	Why it matters to the stakeholder
SESAR JU	Bilateral monthly meetings and presentations, and 1st PRIAM Stakeholder Workshop	The SESAR 3 JU will be informed about the advancement of Validation Exercise #01, so that it can verify that it progresses according to the work plan. This will also help identify synergies and establish links with other SESAR initiatives.
eVTOL aircraft operators	Interviews and 1st PRIAM Stakeholder Workshop	eVTOL operators will provide expert knowledge and assessment of the results related to the expected operation of future eVTOLs.
eVTOL aircraft manufacturers	Interviews and 1st PRIAM Stakeholder Workshop	eVTOL manufacturers will provide expert knowledge and assessment of the results related to expected eVTOL aircraft performance.
Vertiport operators	Interviews and 1st PRIAM Stakeholder Workshop	Vertiport operators will provide expert knowledge and assessment of the results related to assumptions about vertiport location and eVTOL ground operations.
Regional authorities	Interviews and 1st PRIAM Stakeholder Workshop	Specific regional authorities related to the specific case studies performed in PRIAM will provide expert knowledge related to the potential integration of IAM service into the regional transport network.
Researchers and wider academic community	Interviews and 1st PRIAM Stakeholder Workshop	Researchers and the scientific community will provide academic insights, critical evaluation of the PRIAM assumptions.

Table 20. Stakeholders' expectations

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5.1.3 Validation objectives

SESAR solution validation objective	Exercise validation objective	SESAR solution success criteria	Exercise success criteria	Coverage of SESAR solution validation objective in exercise #01
Problem definition and development of an impact assessment framework for regional IAM services (OBJ-0515-ERP-001)	To define the problem that PRIAM aims to address and to develop an impact assessment framework for the implementation of regional-scale IAM services in Europe. To this end, the project will analyse key regional connectivity challenges, passenger needs, and emerging vehicle concepts and business models, and will define relevant implementation scenarios. This analysis will lead to the derivation of high-level requirements for data analytics and modelling tools. Based on these insights, the project will design an impact assessment framework to evaluate IAM operations across passenger experience, social, environmental, and operational dimensions, aligned with SESAR performance management approaches and related projects (e.g., MUSE, TRANSIT, MultiModX).	CRT-0515-TRL1-ERP-001.001	Identification of at least 5 challenges for regional connectivity across Europe.	Fully covered
		CRT-0515-TRL1-ERP-001.002	Identification of at least 5 types of potential regional-scale IAM services.	Fully covered
		CRT-0515-TRL1-ERP-001.003	Identification of at least 4 scenarios for regional-scale IAM operations in Europe.	Fully covered
		CRT-0515-TRL1-ERP-001.004	Definition of a set of KPIs in at least 5 areas (passenger experience, capacity, environmental sustainability and operational and cost efficiency)	Fully covered
		CRT-0515-TRL1-ERP-001.005	Identification of a set of high-level requirements for data analytics and modelling tools with implications for PRIAM developments.	Fully covered

Table 21. Validation objectives addressed in validation exercise #01

5.1.4 Validation scenarios

5.1.4.1 Reference scenario(s)

N/A

5.1.4.2 Solution scenario(s)

N/A

5.1.5 Exercise validation assumptions

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No additional assumptions are identified beyond those specified in Section 0.

5.1.6 Limitations and impact on the level of significance

The limitations and the potential impact on the level of significance of the results that may be obtained are connected to the techniques that will be used for this validation exercise. While expert validation sessions can be effective for validating results, generating new ideas and fostering creativity, they have some limitations:

- **Social and group dynamics**. Discussions may be dominated by outspoken individuals or shaped by group conformity, leading to the suppression of diverse perspectives.
- **Limited diversity of perspectives due to homogeneous groups**. If the group members share similar backgrounds, experiences, or perspectives, the range of ideas may be constrained.
- **Lack of expertise**. A lack of specific knowledge within the group can result in incomplete or less insightful feedback.
- **Time constraints**. Tight schedules may force rushed contributions and limit deep reflection, reducing the overall quality of ideas
- **Cognitive biases**. Participants may fixate on familiar or initial ideas, hindering creative thinking and exploration of novel alternatives.

Despite these limitations, many of these issues can be mitigated by incorporating best practices, such as providing clear guidelines, encouraging a diverse group composition, and using methods for fostering discussion such as performing group dynamics, surveys, etc.

5.1.7 Validation exercise platform / tool and validation technique

5.1.7.1 Validation exercise platform / tool characteristics

Validation Exercise #01 involves two main activities. First, conducting a set of bilateral interviews to gather external experts' feedback. And second, the organisation of a structured workshop (1st PRIAM Stakeholder Workshop) which will bring together a panel of stakeholders to engage in brainstorming sessions and targeted discussions. The workshop will be designed to encourage interaction and collaborative thinking, allowing participants to share feedback through a series of facilitated exercises.

The main tools to be used in Validation Exercise #01 consist of:

- Semi-structured interviews that will be used during bilateral interviews to collect expert opinions in a consistent and comparable format, ensuring a robust basis for analysis.
- Workshop materials. A variety of materials that will support the interactive sessions during the stakeholder workshop. These may include:
    - Presentations and visual briefings
    - Graphical representations of IAM scenarios and concepts
    - Interactive tools such as live polling (i.e., Mentimeter) and digital collaboration platforms (i.e., Miro)
    - Additional surveys or short questionnaires to capture participant feedback in real-time

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Together, these tools and methods will ensure a comprehensive and well-rounded validation process that supports PRIAM's research objectives.

5.1.7.2 Validation exercise technique

As mentioned in the previous section, the technique chosen to perform this validation exercise includes a set of expert judgment activities. These activities encompass a set of bilateral interviews to gather external experts' feedback, and the organization of the 1st PRIAM Stakeholder Workshop which will bring together a panel of stakeholders to engage in brainstorming sessions and targeted discussions. Suitability of the selected techniques can be justified as follows.

- Interviews with stakeholders are a highly suitable technique providing valuable insights and fostering effective communication. Interviews allow for in-depth exploration and understanding of stakeholder perspectives, concerns, and expectations.
- The workshop will be designed to encourage interaction and collaborative thinking, allowing participants to share feedback through a series of facilitated exercises that may include:
    - Interactive sessions that will encourages participants to think broadly and generate a wide range of ideas without immediate judgment. This fosters divergent thinking, allowing for the exploration of unconventional and creative performance indicators and measurement mechanisms.
    - Survey questionnaires, a widely used and suitable technique for efficiently collecting data from a large number of respondents simultaneously. Respondents will complete survey questionnaires, during the workshop followed-up by brainstorming sessions. This technique allows quieter participants to provide their feedback in situations when some experts may dominate the discussion during the brainstorming sessions.

5.1.8 Data collection and analysis

5.1.8.1 Data and data collection methods

For this validation exercise, the following datasets have been used:

- Existing literature on the state-of-the-art on IAM vehicular concepts, business models, challenges and benefits. This includes scientific papers, business reports, press news and articles, etc. Qualitative feedback from stakeholders involved in real-world deployments (e.g. insular use cases) may be used to validate assumptions and ensure contextual alignment of the impact assessment framework
- Experts' feedback gathered through bilateral interviews and the 1st PRIAM Stakeholder Workshop.

Most of the data acquired during this phase of the project will be qualitative, although quantitative data regarding the Performance Framework will be gathered.

5.1.8.2 Analysis methods

To capture the latest developments in IAM, a state-of-the-art literature review will be conducted using systematic desk research methods. This will involve identifying, selecting, and critically analysing

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relevant academic literature to extract key trends, technological advancements, and policy insights. The review will follow a structured protocol to ensure comprehensiveness and reproducibility.

Feedback gathered from external experts will be analysed using appropriate techniques depending on the nature of the data collected:

- Quantitative data from structured questionnaires will be subjected to descriptive statistical analysis to identify aggregate trends and common patterns.
- Qualitative data from open-ended responses or group discussions will be analysed through thematic analysis, enabling the identification of recurring themes, expert concerns, and novel insights. All responses will be anonymised and reported in an aggregated form to ensure confidentiality and objectivity.

The findings from the 1st PRIAM Stakeholder Workshop will be synthesised in a dedicated report (D3.2 Exploratory Research Report – Interim). This synthesis will involve interpretative analysis, combining insights from literature and expert feedback to assess their relevance in light of the project's research questions and objectives. The report will be structured to clearly communicate conclusions, identify gaps, and support evidence-based recommendations for subsequent phases of PRIAM.

5.1.9 Exercise planning and management

5.1.9.1 Activities

Validation exercise #01 (TVAL.01.0-PRIAM-0515-TRL1) is comprised by two main activities:

- **Bilateral interviews with external experts**. A set of interviews will be conducted with members of the EEAB aiming at receiving feedback from the initial desk research and identifying potential gaps in the literature. Interviews are a highly suitable technique providing valuable insights and fostering effective communication, allowing an in-depth exploration and understanding of stakeholder perspectives, concerns, and expectations.
- **Stakeholder Workshop.** Once the feedback from the interviews is collected, a more mature version of the IAM challenges, benefits, IAM needs and the impact assessment framework will be consolidated. The results will be presented in the 1st PRIAM Stakeholder workshop, aiming at collecting feedback from a wider set of stakeholders. The workshop will be designed to encourage interaction and collaborative thinking, allowing participants to share feedback through a series of facilitated exercises that may include interactive sessions and survey questionnaires, as stated in Section 5.1.7.2.

5.1.9.2 Roles and responsibilities in the exercise

Validation Exercise #01 (TVAL.01.0-PRIAM-0515-TRL1) will be led by Deep Blue, as they will coordinate both the desk research and the stakeholder involvement process. Within these activities, Deep Blue will review the documents related to IAM vehicular concepts and business models, and then will conduct part of the interviews and develop the IAM implementation scenarios. Nommon will support Deep Blue, taking care of the literature review related to passenger needs and connectivity challenges in the regional context and conducting part of the interview.

Nommon will also develop the impact assessment framework, harnessing the outputs of the stakeholder involvement process.

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TML and ENAC will support the tasks with their expertise in accessibility challenges, data sharing and coordination between modes, and ATM performance. Bluenest, ARC and AdC will closely follow Validation Exercise #01 (e.g., by adding references to the desk research, participating in interviews, etc.) to make sure that the vision of IAM companies, regional airports and authorities is considered in the conceptual framework of the project.

5.1.9.3 Time planning

Validation exercise #01 will run for four months, from January 2025 (Month 5) to April 2025 (Month 8). During this period, the exercise will focus on validating the key benefits and challenges associated with IAM, the IAM needs and the preliminary version of the impact assessment framework, identified from the initial desk research. The process will combine bilateral interviews with selected members of the Advisory Board, conducted in January (Month 5) and February (Month 6), to gather targeted expert feedback. The insights obtained will be used to consolidate a more refined version of the results, which will subsequently be presented at the 1st PRIAM Stakeholder Workshop in March 2025 (Month 7), where the final outcomes of the validation process will be assessed. In the concluding month, April 2025 (Month 8), all feedback will be systematically integrated into the final version of the results.

5.1.9.4 Identified risks and mitigation actions

Risks	Impact (1-low, 2-medium, 3-high)	Likelihood (1-low, 2-medium, 3-high)	Criticality (calculated based on likelihood x impact)	Mitigation actions
Lack of interest from stakeholders and/or low attendance of project events	Medium	Low	2	Stakeholder involvement will be proactively searched since the beginning of the project.
Inability to collect sufficient data	High	Low	3	If certain stakeholders are not involved in the planned workshop, additional bilateral interviews will be proposed to gather specific missing information.
Some aircraft manufacturers involved in the project are facing financial instability, which may result in unavailability or withdrawal of their representatives from the EEAB, leading to a loss of valuable insights and sectoral expertise	Low	Medium	2	The project will ensure that representatives from several different manufacturers are invited, reducing dependency on a limited number of companies and maintaining a balanced and diverse set of perspectives. Measures will be taken to secure the commitment of participants even in cases where their companies are facing financial difficulties. This will be done by maintaining close communication with the experts, and highlighting the value of their individual contribution to the project beyond their company's financial situation.

Table 22. Exercise #01 risks and mitigation actions

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5.2 Validation exercise #02 plan

5.2.1 Validation exercise description and scope

This validation exercise will focus on the validation of the AI methods for identifying human factors behind IAM adoption, and the clustering of passengers with similar behaviour. The results will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around May 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

The validation exercise will run for 4 months, from September 2025 (Month 13) to December 2026 (Month 16). Haikai will lead this activity, with contributions from the other project partners across specific tasks.

5.2.2 Stakeholder's expectations and benefit mechanisms addressed by the exercise

Stakeholder	Involvement	Why it matters to the stakeholder
SESAR JU	Bilateral monthly meetings, and 2nd PRIAM Stakeholder Workshop	The SESAR 3 JU will be informed about the advancement of Validation Exercise #02, so that it can verify that it progresses according to the work plan. This will also help identify synergies and establish links with other SESAR initiatives.
eVTOL aircraft operators	2nd PRIAM Stakeholder Workshop and bilateral meetings	eVTOL operators will assess and validate the results from the application of the PRIAM solution to the case studies, relative to the future operation of eVTOLs. Additionally, the results achieved in PRIAM are interesting for eVTOL operators as PRIAM will provide valuable insights into potential travel demand. These findings will support eVTOL aircraft operators in establishing their services by informing decisions related to fleet requirements, market potential, operational constraints, and other key considerations.
eVTOL aircraft manufacturers	2nd PRIAM Stakeholder Workshop and bilateral meetings	eVTOL manufacturers will assess and validate the results from the application of the PRIAM solution to the case studies, relative to the future performance of eVTOLs. Additionally, the results achieved in PRIAM are interesting for eVTOL manufacturers as PRIAM will provide better understanding of the impact of eVTOL characteristics (e.g., range, speed, or battery capacity) on regional service performance can help inform future design enhancements and guide the evolution of next-generation eVTOL technologies.
Vertiport operators	2nd PRIAM Stakeholder Workshop and	Vertiport operators will assess and validate the results from the application of the PRIAM solution to the case studies, relative to the vertiport site location.

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Stakeholder	Involvement	Why it matters to the stakeholder
	bilateral meetings	Additionally, the results achieved in PRIAM are interesting for vertiport operators as PRIAM will provide improved understanding of the key factors influencing optimal vertiport placement based on estimated potential demand, as well as deeper insight into how different vertiport characteristics affect the distribution and allocation of that demand.
Regional authorities	2nd PRIAM Stakeholder Workshop and bilateral meetings	Specific regional authorities related to the case studies will assess and validate the results from the application of the PRIAM solution to the case studies, relative to the potential integration of IAM service into the regional transport network. Additionally, the results achieved in PRIAM are interesting for the regional authorities as PRIAM will provide an enhanced understanding of the potential demand of IAM services and the optimal location of the vertiports to maximise regional transport network performance can support regional authorities in planning, scheduling, and optimising public transportation.
Researchers and wider academic community	2nd PRIAM Stakeholder Workshop and bilateral meetings	Researchers and the scientific community will assess and validate the results from the application of the PRIAM solution to the case studies, from an academic perspective, providing academic insights and a critical evaluation of the PRIAM methodologies and results. Additionally, the results achieved in PRIAM are interesting for the scientific community as PRIAM will serve as base for future research in the field.

Table 23. Validation exercise #02: Stakeholders' expectations

5.2.3 Validation objectives

SESAR solution validation objective	Exercise validation objective	SESAR solution success criteria	Exercise success criteria	Coverage of SESAR solution validation objective in exercise #02
Validation of AI algorithms for estimating IAM adoption levels (OBJ-0515-ERP-002)	To validate the algorithms for identifying the human factors that explain IAM adoption, based on Artificial Intelligence techniques that exploit survey data.	CRT-0515-TRL1-ERP-002.001	The AI-based algorithms developed to identify human factors influencing IAM adoption have been validated through a combination of expert stakeholder reviews and quantitative methods, including cluster evaluation techniques and feature importance analysis, ensuring both their reliability and interpretability.	Fully covered

Table 24. Validation objectives addressed in validation exercise #02

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5.2.4 Validation scenarios

5.2.4.1 Reference scenario(s)

N/A

5.2.4.2 Solution scenario(s)

N/A

5.2.5 Exercise validation assumptions

No additional assumptions are identified beyond those specified in Section 4.4.

5.2.6 Limitations and impact on the level of significance

The limitations and the potential impact on the significance of the results in Validation Exercise #02 are closely linked to the nature of the techniques applied. This validation exercise primarily involves modelling future IAM services in regional areas, using a combination of data analytics and modelling tools based on multiple data sources.

The results will undergo two key validation steps:

- **Internal validation**, which will consist of checking the consistency and robustness of the outputs produced by the models.
- **External expert validation**, during which a group of experts will assess the results to provide feedback, identify potential methodological gaps, and highlight modelling errors.

While this approach offers a solid foundation for assessing the potential of IAM services, it also presents several limitations that may influence the significance and reliability of the results:

- **Data availability**. The effectiveness of the proposed modelling approach heavily relies on access to diverse and comprehensive datasets. Data availability may vary significantly across regions, potentially limiting the geographical applicability of the solution.
- **Data quality aspects**. The accuracy and reliability of the modelling outputs are directly dependent on the quality of the input data. Any biases, inconsistencies, or inaccuracies in the data will be reflected in the results. Therefore, high-quality, validated datasets are crucial for generating meaningful insights.
- **Modelling assumptions.** Given the early stage of IAM development, a number of assumptions have been made to enable the modelling process. These assumptions may not fully reflect real-world conditions, and deviations between assumed and actual scenarios could impact the validity of the results.
- **Expert validation activities**: Although expert validation is essential for evaluating the plausibility of findings and enriching the analysis, it is subject to limitations:
    - **Social and group dynamics**. Discussions may be dominated by outspoken individuals or shaped by group conformity, leading to the suppression of diverse perspectives.

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- **Limited diversity of perspectives due to homogeneous groups**. If the group members share similar backgrounds, experiences, or perspectives, the range of ideas may be constrained.
- **Lack of expertise**. A lack of specific knowledge within the group can result in incomplete or less insightful feedback.
- **Time constraints**. Tight schedules may force rushed contributions and limit deep reflection, reducing the overall quality of ideas
- **Cognitive biases**. Participants may fixate on familiar or initial ideas, hindering creative thinking and exploration of novel alternatives.

To address these limitations, several best practices will be adopted, such as conducting thorough data quality assessments to verify the reliability and completeness of datasets, cross-checking key modelling assumptions with a wide range of external experts, ensuring a diverse expert panel and providing clear validation guidelines during expert sessions and using structured tools to foster balanced discussions, such as group dynamics, interactive surveys, and moderated brainstorming.

These mitigation measures will strengthen the robustness of Validation Exercise #02 enhancing the credibility of the results and ensuring that identified insights are as meaningful and representative as possible.

5.2.7 Validation exercise platform / tool and validation technique

5.2.7.1 Validation exercise platform / tool characteristics

Not applicable

5.2.7.2 Validation exercise technique

The validation process will involve two key steps:

- **Internal validation,** which entails assessing the consistency and robustness of the model outputs. A major challenge in this step is the experimental nature of the project and the early stage of IAM concepts, which result in a lack of real-world data for direct comparison. Consequently, the evaluation will rely on a qualitative assessment of the consistency of the results, supplemented by comparisons with existing data sources where available.
- **External expert validation,** during which a panel of experts will review the results to provide feedback, identify methodological gaps, and highlight potential modelling errors. This validation will take place during the 2nd PRIAM Stakeholder Workshop, which will convene a diverse group of stakeholders for brainstorming sessions and focused discussions.

The workshop will be designed to promote interaction and collaborative thinking, allowing participants to contribute feedback through a series of structured activities, including:

- Interactive sessions that encourage participants to think creatively and generate a broad range of ideas without immediate judgment. These sessions aim to foster divergent thinking and explore innovative performance indicators and evaluation mechanisms.
- Survey questionnaires, a widely used and effective method for collecting input from many participants simultaneously. These will be administered during the workshop and followed by

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brainstorming sessions. This approach allows quieter participants to express their views, particularly in cases where more vocal experts may dominate open discussions.

If necessary, additional validation activities may be conducted during the course of the validation exercise. These could include bilateral meetings with Advisory Board members or other external experts, as well as the organisation of supplementary workshops or webinars.

5.2.8 Data collection and analysis

5.2.8.1 Data and data collection methods

The data required for this validation exercise includes data for the proper work of the solution, which are presented in Table 25, as well as data used for validation purposes.

Dataset	Description	Source
Stated preference surveys	Surveys designed to capture the intention of population to adopt and readiness to use IAM services once available. The Survey also assesses those IAM Service characteristics and features (e.g., security, safety, connectivity levels) available for the future users	Own creation

Table 25. TVAL.02.0-PRIAM-0515-TRL1 required datasets

For validation purposes, the most important data source is experts' feedback. Their feedback will be recorded by means of bilateral meetings, questionnaires, the 2nd PRIAM Stakeholder Workshop and other potential events.

5.2.8.2 Analysis methods

The data analysis tools and methods developed to validate the developed models will be detailed in the deliverable D4.2 – PRIAM ERR - Final version.

Experts feedback will be analysed following a systematic approach: distribution of answers and average answers in ranked questions, identification of common ideas and frequency of responses and judgment of the most relevant issues identified in order to incorporate the feedback into the solution, when possible, or identifying future research lines.

5.2.9 Exercise planning and management

5.2.9.1 Activities

This validation exercise will encompass two main activities:

- **An internal validation** focused on assessing the accuracy of the clustering algorithms developed. For that purpose, diverse accuracy metrics will be implemented ranging from the adequacy levels of the number of clusters selected with the Elbow method to the Silhouette method applied to verify the relative error distribution for various cluster solutions proposed. Also, the study of the residual sum of squared deviations around the clusters shall be verified with the use of Random Forest feature importance selection. Along with these methods, the model results will be compared by running regression trees and logistic functions (or multiple regressions) models to verify convergence towards the clustering methods outcomes.

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- **An external expert validation** during which a panel of experts will review the results to provide feedback, identify methodological gaps, and highlight potential modelling errors. This validation will take place during the 2nd PRIAM Stakeholder Workshop, which will convene a diverse group of stakeholders for brainstorming sessions and focused discussions.

5.2.9.2 Roles and responsibilities in the exercise

HAIKAI will be in charge of validating the AI-based algorithms for IAM adoption modelling with the support of Nommon and TML, if required.

5.2.9.3 Time planning

The validation exercise will run for 4 months, from September 2025 (Month 13) to December 2025 (Month 16). Additionally, the outcomes will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around May 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

5.2.9.4 Identified risks and mitigation actions

Risks	Impact (1-low, 2-medium, 3-high)	Likelihood (1-low, 2-medium, 3-high)	Criticality (calculated based on likelihood x impact)	Mitigation actions
Inability to collect sufficient data	High	Low	3	Online surveys for collecting data on passenger adoption and use factors for IAM will be developed in the context of the case studies and the questionnaires will be disseminated with support of local stakeholders such as AdC.
Delays in software implementation due to the difficulties to enable interaction between the different components	High	Medium	6	Continuous interaction between different tasks within WP3 to develop and validate requirements for input and output files agreed by all modellers. Implementation of state-of-the-art software quality management methods and tools to ensure a robust management of the whole software life cycle
Excessive complexity of the models and/or their implementation in the case studies	Medium	Medium	4	Models will be designed with a focus on essential functionality, minimising unnecessary intricacies. Simple modelling approaches will be identified for each task as alternative pragmatic methods to make preliminary assessments.

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Limited performance of models	Medium	Medium	4	The active involvement of end-users will provide valuable insights into critical performance thresholds for diverse models and offer scope adjustments to enhance accuracy.
Lack of interest from stakeholders and/or low attendance of project events	Medium	Low	2	Stakeholder involvement will be proactively searched since the beginning of the project.

Table 26. Exercise #02 risks and mitigation actions

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5.3 Validation exercise #03 plan

5.3.1 Validation exercise description and scope

This validation exercise will focus on the validation of the algorithms for the potential IAM demand monitoring based on the use of geolocation big data sources. The results of the validation exercise will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around April 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

The validation exercise will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). Nommon will lead this activity, with contributions from the other project partners across specific tasks.

5.3.2 Stakeholder's expectations and benefit mechanisms addressed by the exercise

Stakeholder	Involvement	Why it matters to the stakeholder
SESAR JU	Bilateral monthly meetings and 2nd PRIAM Stakeholder Workshop	The SESAR 3 JU will be informed about the advancement of Validation Exercise #03, so that it can verify that it progresses according to the work plan. This will also help identify synergies and establish links with other SESAR initiatives.
eVTOL aircraft operators	2nd PRIAM Stakeholder Workshop and bilateral meetings	eVTOL operators will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the future operation of eVTOLs. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to eVTOL operators about key factors that can affect the suitable operation of IAM.
eVTOL aircraft manufacturers	2nd PRIAM Stakeholder Workshop and bilateral meetings	eVTOL manufacturers will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the future performance of eVTOLs. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to eVTOL manufacturers regarding key eVTOL characteristics (e.g., range, speed, or battery capacity) on regional service performance that can help inform future design enhancements and guide the evolution of next-generation eVTOL technologies.
Vertiport operators	2nd PRIAM Stakeholder Workshop and bilateral meetings	Vertiport operators will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the vertiport operations. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to vertiport operators such as improved understanding of the key factors influencing

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Stakeholder	Involvement	Why it matters to the stakeholder
		optimal vertiport placement and potential tendencies in Europe in this regard.
Regional authorities	2nd PRIAM Stakeholder Workshop and bilateral meetings	Specific regional authorities related to the case studies will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the potential integration of IAM services into the regional transport network. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed within PRIAM will offer valuable insights for vertiport operators, enhancing their understanding of the key factors influencing optimal vertiport placement and shedding light on emerging trends and potential implementation pathways across Europe. This knowledge will support strategic planning and investment decisions, ensuring alignment with future demand patterns and regulatory development.
Researchers and wider academic community	2nd PRIAM Stakeholder Workshop and bilateral meetings	Researchers and the scientific community will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe from an academic perspective, providing academic insights and a critical evaluation of the PRIAM outcomes. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed within PRIAM will offer valuable insights for the scientific community as PRIAM will serve as base for future research in this field.

Table 27. Validation exercise #03: Stakeholders' expectations

5.3.3 Validation objectives

SESAR solution validation objective	Exercise validation objective	SESAR solution success criteria	Exercise success criteria	Coverage of SESAR solution validation objective in exercise #03
Validation of algorithms for monitoring potential IAM demand (OBJ-0515-ERP-003)	To validate algorithms for estimating the potential demand for regional-scale IAM services from the fusion of heterogeneous data sources, including geolocation data from personal mobile devices and mobility surveys.	CRT-0515-TRL1-ERP-003.001	The mobility indicators derived from the algorithms for monitoring potential demand for IAM services through the fusion of MND and other data sources are consistent with the expected mobility behaviour. The achieved results have been validated through expert reviews conducted by external stakeholders as part of the project's planned engagement activities.	Fully covered

Table 28. Validation objectives addressed in validation exercise #03

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5.3.4 Validation scenarios

5.3.4.1 Reference scenario(s)

N/A

5.3.4.2 Solution scenario(s)

N/A

5.3.5 Exercise validation assumptions

No additional assumptions are identified beyond those specified in Section 4.4.

5.3.6 Limitations and impact on the level of significance

The limitations and the potential impact on the significance of the results in Validation Exercise #03 are closely linked to the nature of the techniques applied. This validation exercise primarily involves modelling future IAM services in regional areas, using a combination of data analytics and modelling tools based on multiple data sources.

The results will undergo two key validation steps:

- **Internal validation**, which will consist of checking the consistency and robustness of the outputs produced by the models.
- **External expert validation**, during which a group of experts will assess the results to provide feedback, identify potential methodological gaps, and highlight modelling errors.

While this approach offers a solid foundation for assessing the potential of IAM services, it also presents several limitations that may influence the significance and reliability of the results:

- **Data availability**. The effectiveness of the proposed modelling approach heavily relies on access to diverse and comprehensive datasets. Data availability may vary significantly across regions, potentially limiting the geographical applicability of the solution.
- **Data quality aspects**. The accuracy and reliability of the modelling outputs are directly dependent on the quality of the input data. Any biases, inconsistencies, or inaccuracies in the data will be reflected in the results. Therefore, high-quality, validated datasets are crucial for generating meaningful insights.
- **Modelling assumptions.** Given the early stage of IAM development, a number of assumptions have been made to enable the modelling process. These assumptions may not fully reflect real-world conditions, and deviations between assumed and actual scenarios could impact the validity of the results.
- **Expert validation activities**: Although expert validation is essential for evaluating the plausibility of findings and enriching the analysis, it is subject to limitations:
    - **Social and group dynamics**. Discussions may be dominated by outspoken individuals or shaped by group conformity, leading to the suppression of diverse perspectives.

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- **Limited diversity of perspectives due to homogeneous groups**. If the group members share similar backgrounds, experiences, or perspectives, the range of ideas may be constrained.
- **Lack of expertise**. A lack of specific knowledge within the group can result in incomplete or less insightful feedback.
- **Time constraints**. Tight schedules may force rushed contributions and limit deep reflection, reducing the overall quality of ideas
- **Cognitive biases**. Participants may fixate on familiar or initial ideas, hindering creative thinking and exploration of novel alternatives.

To address these limitations, several best practices will be adopted, such as conducting thorough data quality assessments to verify the reliability and completeness of datasets, cross-checking key modelling assumptions with a wide range of external experts, ensuring a diverse expert panel and providing clear validation guidelines during expert sessions and using structured tools to foster balanced discussions, such as group dynamics, interactive surveys, and moderated brainstorming.

These mitigation measures will strengthen the robustness of Validation Exercise #03 enhancing the credibility of the results and ensuring that identified insights are as meaningful and representative as possible.

5.3.7 Validation exercise platform / tool and validation technique

5.3.7.1 Validation exercise platform / tool characteristics

Not applicable

5.3.7.2 Validation exercise technique

The validation process will involve two key steps:

- **Internal validation,** which entails assessing the consistency and robustness of the model outputs. This validation will focus on ensuring that mobility indicators derived from the algorithms for monitoring potential demand for IAM services through the fusion of MND and other data sources are consistent with the expected mobility patterns and passenger behaviour.
- **External expert validation,** during which a panel of experts will review the results to provide feedback, identify methodological gaps, and highlight potential modelling errors. This validation will take place during the 2nd PRIAM Stakeholder Workshop, which will convene a diverse group of stakeholders for brainstorming sessions and focused discussions.

The workshop will be designed to promote interaction and collaborative thinking, allowing participants to contribute feedback through a series of structured activities, including:

- Interactive sessions that encourage participants to think creatively and generate a broad range of ideas without immediate judgment. These sessions aim to foster divergent thinking and explore innovative performance indicators and evaluation mechanisms.
- Survey questionnaires, a widely used and effective method for collecting input from many participants simultaneously. These will be administered during the workshop and followed by

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brainstorming sessions. This approach allows quieter participants to express their views, particularly in cases where more vocal experts may dominate open discussions.

If necessary, additional validation activities may be conducted during the course of the validation exercise. These could include bilateral meetings with Advisory Board members or other external experts, as well as the organisation of supplementary workshops or webinars.

5.3.8 Data collection and analysis

5.3.8.1 Data and data collection methods

The data required for this validation exercise includes data for the proper work of the solution, which are presented in Table 29, as well as data used for validation purposes.

Dataset	Description	Source
Mobile network data	Anonymised mobile phone records which contain an encrypted Id of the user, the sequence of geolocated antennas to which the user is connected, and the timestamp of each register. Age-gender information is sometimes available.	Through an agreement between Nommon and Orange Spain
Land use	Data that describes how different areas of land are being used by humans, such as for agriculture, housing, industry, or recreation.	Spanish Land Use Information System (SIOSE): https://www.siose.es/presentacion
Transport supply	Road and public transport networks and public transport services in the case study regions	OpenStreetMaps and Spanish NAP: (https://nap.transportes.gob.es/)
Census data	Sociodemographic information of population from census data (age, gender, income)	National Statistics Institute (INE): https://www.ine.es/

Table 29. TVAL.03.0-PRIAM-0515-TRL1 required datasets

For validation purposes, the most important data source is experts' feedback. Their feedback will be recorded by means of bilateral meetings, questionnaires, the 2nd PRIAM Stakeholder Workshop and other potential events.

5.3.8.2 Analysis methods

The data analysis tools and methods developed to validate the developed algorithms will be detailed in the deliverable D4.2 – PRIAM ERR - Final version.

Experts feedback will be analysed following a systematic approach: distribution of answers and average answers in ranked questions, identification of common ideas and frequency of responses and judgment of the most relevant issues identified in order to incorporate the feedback into the solution, when possible, or identifying future research lines.

5.3.9 Exercise planning and management

5.3.9.1 Activities

This validation exercise will encompass two main activities:

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- **An internal validation** focused on assessing the consistency and robustness of the results. This activity will ensure that mobility indicators derived from the algorithms for monitoring potential demand for IAM services through the fusion of MND and other data sources are consistent with the expected mobility patterns and passenger behaviour.
- **An external expert validation** during which a panel of experts will review the results to provide feedback, identify methodological gaps, and highlight potential modelling errors. This validation will take place during the 2nd PRIAM Stakeholder Workshop, which will convene a diverse group of stakeholders for brainstorming sessions and focused discussions.

5.3.9.2 Roles and responsibilities in the exercise

Nommon will be in charge of validating the algorithms for estimating the potential demand for regional-scale IAM services from the fusion of heterogeneous data sources.

5.3.9.3 Time planning

Validation exercise #03 will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). During this period, the exercise will focus on the validation of the algorithms for the potential IAM demand monitoring based on the use of geolocation big data sources.

The results will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around April 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

5.3.9.4 Identified risks and mitigation actions

Risks	Impact (1-low, 2-medium, 3-high)	Likelihood (1-low, 2-medium, 3-high)	Criticality (calculated based on likelihood x impact)	Mitigation actions
Inability to collect sufficient data	High	Low	3	The agreement with Orange Spain facilitates the access to mobile network data. Transport supply data is available through NAP portals in Europe.
Delays in software implementation due to the difficulties to enable interaction between the different components	High	Medium	6	Continuous interaction between different tasks within WP3 to develop and validate requirements for input and output files agreed by all modellers. Implementation of state-of-the-art software quality management methods and tools to ensure a robust management of the whole software life cycle
Excessive complexity of the models and/or their	Medium	Medium	4	Models will be designed with a focus on essential functionality, minimising unnecessary intricacies.

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implementation in the case studies				Simple modelling approaches will be identified for each task as alternative pragmatic methods to make preliminary assessments.
Limited performance of models	Medium	Medium	4	The active involvement of end-users will provide valuable insights into critical performance thresholds for diverse models and offer scope adjustments to enhance accuracy.
Lack of interest from stakeholders and/or low attendance of project events	Medium	Low	2	Stakeholder involvement will be proactively searched since the beginning of the project.

Table 30. Exercise #03 risks and mitigation actions

5.4 Validation exercise #04 plan

5.4.1 Validation exercise description and scope

This validation exercise will focus on the validation of the algorithms for modelling the induced demand effects and modal shifts derived from regional-scale IAM services under different territorial settings, competing transport modes and operational configurations. The results of the validation exercise will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around April 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

The validation exercise will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). TML will lead this activity, with contributions from the other project partners across specific tasks.

5.4.2 Stakeholder's expectations and benefit mechanisms addressed by the exercise

Stakeholder	Involvement	Why it matters to the stakeholder
SESAR JU	Bilateral monthly meetings and 2nd PRIAM Stakeholder Workshop	The SESAR 3 JU will be informed about the advancement of Validation Exercise #04, so that it can verify that it progresses according to the work plan. This will also help identify synergies and establish links with other SESAR initiatives.
eVTOL aircraft operators	2nd PRIAM Stakeholder Workshop and bilateral meetings	eVTOL operators will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the future operation of eVTOLs. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to eVTOL operators about key factors that can affect the suitable operation of IAM.

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Stakeholder	Involvement	Why it matters to the stakeholder
eVTOL aircraft manufacturers	2nd PRIAM Stakeholder Workshop and bilateral meetings	eVTOL manufacturers will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the future performance of eVTOLs. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to eVTOL manufacturers regarding key eVTOL characteristics (e.g., range, speed, or battery capacity) on regional service performance that can help inform future design enhancements and guide the evolution of next-generation eVTOL technologies.
Vertiport operators	2nd PRIAM Stakeholder Workshop and bilateral meetings	Vertiport operators will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the vertiport operations. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to vertiport operators such as improved understanding of the key factors influencing optimal vertiport placement and potential tendencies in Europe in this regard.
Regional authorities	2nd PRIAM Stakeholder Workshop and bilateral meetings	Specific regional authorities related to the case studies will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the potential integration of IAM services into the regional transport network. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed within PRIAM will offer valuable insights for vertiport operators, enhancing their understanding of the key factors influencing optimal vertiport placement and shedding light on emerging trends and potential implementation pathways across Europe. This knowledge will support strategic planning and investment decisions, ensuring alignment with future demand patterns and regulatory development.
Researchers and wider academic community	2nd PRIAM Stakeholder Workshop and bilateral meetings	Researchers and the scientific community will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe from an academic perspective, providing academic insights and a critical evaluation of the PRIAM outcomes. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed within PRIAM will offer valuable insights for the scientific community as PRIAM will serve as base for future research in this field.

Table 31. Validation exercise #04: Stakeholders' expectations

5.4.3 Validation objectives

SESAR solution validation objective	Exercise validation objective	SESAR solution	Exercise success criteria	Coverage of SESAR solution

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		success criteria		validation objective in exercise #04
Validation of algorithms for estimating IAM captured and induced demand (OBJ-0515-ERP-004)	To validate the algorithms for modelling the induced demand effects and modal shifts derived from regional-scale IAM services under different territorial settings, competing transport modes and operational configurations.	CRT-0515-TRL1-ERP-004.001	The discrete choice model accurately represents observed travel behaviour. Appropriate tests for discrete choice models, such as the likelihood ratio test and McFadden's R-squared, are used to evaluate the model's performance and its capability to precisely replicate observed choices. The achieved results have been validated through expert reviews conducted by external stakeholders as part of the project's planned engagement activities.	Fully covered

Table 32. Validation objectives addressed in validation exercise #04

5.4.4 Validation scenarios

5.4.4.1 Reference scenario(s)

The baseline scenario will represent the current mobility patterns and passenger behaviours within the geographical scope defined by the case studies in the Catalan Pyrenees and the Canary Islands. It will serve as a reference point for evaluating the demand impact of IAM services. This baseline scenario relies on the estimation of current demand derived from MND, complemented by the results of stated preference surveys that capture present travel behaviour, including mode choice and trip characteristics. Together, these elements provide a robust foundation for calibrating the demand models and establishing a reliable point of reference.

The primary objective of the baseline scenario is to enable a meaningful comparison with the future solution scenarios, in which IAM services are introduced. By contrasting these scenarios, the analysis will assess the impact of IAM on passengers and the broader multimodal transport network.

5.4.4.2 Solution scenario(s)

The solution scenarios represent future conditions in which the proposed IAM network and services will be deployed.

In this regard, both IAM captured demand (from existing transport modes) and induced demand (new trips generated by IAM availability) will be estimated through advanced demand forecasting techniques. These estimations will be supported by mobility data and behavioural assumptions derived from the survey, which explored stated preferences under potential future scenarios.

5.4.5 Exercise validation assumptions

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No additional assumptions are identified beyond those specified in Section 4.4.

5.4.6 Limitations and impact on the level of significance

The limitations and the potential impact on the significance of the results in Validation Exercise #04 are closely linked to the nature of the techniques applied. This validation exercise primarily involves modelling future IAM services in regional areas, using a combination of data analytics and modelling tools based on multiple data sources.

The results will undergo two key validation steps:

- **Internal validation**, which will consist of checking the consistency and robustness of the outputs produced by the models.
- **External expert validation**, during which a group of experts will assess the results to provide feedback, identify potential methodological gaps, and highlight modelling errors.

While this approach offers a solid foundation for assessing the potential of IAM services, it also presents several limitations that may influence the significance and reliability of the results:

- **Data availability**. The effectiveness of the proposed modelling approach heavily relies on access to diverse and comprehensive datasets. Data availability may vary significantly across regions, potentially limiting the geographical applicability of the solution.
- **Data quality aspects**. The accuracy and reliability of the modelling outputs are directly dependent on the quality of the input data. Any biases, inconsistencies, or inaccuracies in the data will be reflected in the results. Therefore, high-quality, validated datasets are crucial for generating meaningful insights.
- **Modelling assumptions.** Given the early stage of IAM development, a number of assumptions have been made to enable the modelling process. These assumptions may not fully reflect real-world conditions, and deviations between assumed and actual scenarios could impact the validity of the results.
- **Expert validation activities**: Although expert validation is essential for evaluating the plausibility of findings and enriching the analysis, it is subject to limitations:
    - **Social and group dynamics**. Discussions may be dominated by outspoken individuals or shaped by group conformity, leading to the suppression of diverse perspectives.
    - **Limited diversity of perspectives due to homogeneous groups**. If the group members share similar backgrounds, experiences, or perspectives, the range of ideas may be constrained.
    - **Lack of expertise**. A lack of specific knowledge within the group can result in incomplete or less insightful feedback.
    - **Time constraints**. Tight schedules may force rushed contributions and limit deep reflection, reducing the overall quality of ideas
    - **Cognitive biases**. Participants may fixate on familiar or initial ideas, hindering creative thinking and exploration of novel alternatives.

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To address these limitations, several best practices will be adopted, such as conducting thorough data quality assessments to verify the reliability and completeness of datasets, cross-checking key modelling assumptions with a wide range of external experts, ensuring a diverse expert panel and providing clear validation guidelines during expert sessions and using structured tools to foster balanced discussions, such as group dynamics, interactive surveys, and moderated brainstorming.

These mitigation measures will strengthen the robustness of Validation Exercise #04 enhancing the credibility of the results and ensuring that identified insights are as meaningful and representative as possible.

5.4.7 Validation exercise platform / tool and validation technique

5.4.7.1 Validation exercise platform / tool characteristics

Not applicable

5.4.7.2 Validation exercise technique

The validation process will involve two key steps:

- **Internal validation,** which entails assessing the consistency and robustness of the model outputs. This validation will focus on ensuring that mobility indicators derived from the algorithms for monitoring potential demand for IAM services through the fusion of MND and other data sources are consistent with the expected mobility patterns and passenger behaviour.
- **External expert validation,** during which a panel of experts will review the results to provide feedback, identify methodological gaps, and highlight potential modelling errors. This validation will take place during the 2nd PRIAM Stakeholder Workshop, which will convene a diverse group of stakeholders for brainstorming sessions and focused discussions.

The workshop will be designed to promote interaction and collaborative thinking, allowing participants to contribute feedback through a series of structured activities, including:

- Interactive sessions that encourage participants to think creatively and generate a broad range of ideas without immediate judgment. These sessions aim to foster divergent thinking and explore innovative performance indicators and evaluation mechanisms.
- Survey questionnaires, a widely used and effective method for collecting input from many participants simultaneously. These will be administered during the workshop and followed by brainstorming sessions. This approach allows quieter participants to express their views, particularly in cases where more vocal experts may dominate open discussions.

If necessary, additional validation activities may be conducted during the course of the validation exercise. These could include bilateral meetings with Advisory Board members or other external experts, as well as the organisation of supplementary workshops or webinars.

5.4.8 Data collection and analysis

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5.4.8.1 Data and data collection methods

The data required for this validation exercise includes data for the proper work of the solution, which are presented in Table 29, as well as data used for validation purposes.

Dataset	Description	Source
Demand data	IAM estimated demand data derived from the fusion of MND and other heterogeneous data, and the application of discrete choice models. This is the output of Validation Exercise #03	Own creation (output of Validation Exercise #03)
Stated preference surveys	Surveys designed to capture the intention of population to adopt and use IAM	Own creation

Table 33. TVAL.04.0-PRIAM-0515-TRL1 required datasets

For validation purposes, the most important data source is experts' feedback. Their feedback will be recorded by means of bilateral meetings, questionnaires, the 2nd PRIAM Stakeholder Workshop and other potential events.

5.4.8.2 Analysis methods

The data analysis tools and methods developed to validate the developed algorithms will be detailed in the deliverable D4.2 – PRIAM ERR - Final version.

Experts feedback will be analysed following a systematic approach: distribution of answers and average answers in ranked questions, identification of common ideas and frequency of responses and judgment of the most relevant issues identified in order to incorporate the feedback into the solution, when possible, or identifying future research lines.

5.4.9 Exercise planning and management

5.4.9.1 Activities

This validation exercise will encompass two main activities:

- **An internal validation** focused on assessing the consistency and robustness of the discrete choice model developed. The validation will be carried out by extracting a set of validation tests and metrics, such as the likelihood ratio test and McFadden's R-squared, to evaluate the model's performance and its capability to precisely replicate observed travel behaviour.
- **An external expert validation** during which a panel of experts will review the results to provide feedback, identify methodological gaps, and highlight potential modelling errors. This validation will take place during the 2nd PRIAM Stakeholder Workshop, which will convene a diverse group of stakeholders for brainstorming sessions and focused discussions.

5.4.9.2 Roles and responsibilities in the exercise

TML will be in charge of validating the algorithms for modelling the induced demand effects and modal shifts derived from regional-scale IAM services, with the support of Nommon.

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5.4.9.3 Time planning

Validation exercise #04 will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). During this period, the exercise will focus on the validation of the algorithms for modelling the induced demand effects and modal shifts derived from regional-scale IAM services.

The results will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around April 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

5.4.9.4 Identified risks and mitigation actions

Risks	Impact (1-low, 2-medium, 3-high)	Likelihood (1-low, 2-medium, 3-high)	Criticality (calculated based on likelihood x impact)	Mitigation actions
Inability to collect sufficient data	High	Low	3	The agreement with Orange Spain facilitates the access to mobile network data. Transport supply data is available through NAP portals in Europe.
Delays in software implementation due to the difficulties to enable interaction between the different components	High	Medium	6	Continuous interaction between different tasks within WP3 to develop and validate requirements for input and output files agreed by all modellers. Implementation of state-of-the-art software quality management methods and tools to ensure a robust management of the whole software life cycle
Excessive complexity of the models and/or their implementation in the case studies	Medium	Medium	4	Models will be designed with a focus on essential functionality, minimising unnecessary intricacies. Simple modelling approaches will be identified for each task as alternative pragmatic methods to make preliminary assessments.
Limited performance of models	Medium	Medium	4	The active involvement of end-users will provide valuable insights into critical performance thresholds for diverse models and offer scope adjustments to enhance accuracy.
Lack of interest from stakeholders and/or low attendance of project events	Medium	Low	2	Stakeholder involvement will be proactively searched since the beginning of the project.
Some aircraft manufacturers	Low	Medium	2	The project will ensure that representatives from several different manufacturers are

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involved in the project are facing financial instability, which may result in unavailability or withdrawal of their representatives from the EEAB, leading to a loss of valuable insights and sectoral expertise				invited, reducing dependency on a limited number of companies and maintaining a balanced and diverse set of perspectives. Measures will be taken to secure the commitment of participants even in cases where their companies are facing financial difficulties. This will be done by maintaining close communication with the experts, and highlighting the value of their individual contribution to the project beyond their company's financial situation.

Table 34. Exercise #04 risks and mitigation actions

5.5 Validation exercise #05 plan

5.5.1 Validation exercise description and scope

This validation exercise will focus on the validation of the algorithms for performing a multicriteria evaluation of the integration of IAM infrastructure networks into multimodal transport systems. The results of the validation exercise will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around April 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

The validation exercise will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). Nommon will lead this activity, with contributions from the other project partners across specific tasks.

5.5.2 Stakeholder's expectations and benefit mechanisms addressed by the exercise

Stakeholder	Involvement	Why it matters to the stakeholder
SESAR JU	Bilateral monthly meetings and 2nd PRIAM Stakeholder Workshop	The SESAR 3 JU will be informed about the advancement of Validation Exercise #05, so that it can verify that it progresses according to the work plan. This will also help identify synergies and establish links with other SESAR initiatives.
eVTOL aircraft operators	2nd PRIAM Stakeholder Workshop and bilateral meetings	eVTOL operators will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the future operation of eVTOLs. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to eVTOL operators about key factors that can affect the suitable operation of IAM.

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Stakeholder	Involvement	Why it matters to the stakeholder
eVTOL aircraft manufacturers	2nd PRIAM Stakeholder Workshop and bilateral meetings	eVTOL manufacturers will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the future performance of eVTOLs. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to eVTOL manufacturers regarding key eVTOL characteristics (e.g., range, speed, or battery capacity) on regional service performance that can help inform future design enhancements and guide the evolution of next-generation eVTOL technologies.
Vertiport operators	2nd PRIAM Stakeholder Workshop and bilateral meetings	Vertiport operators will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the vertiport operations. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to vertiport operators such as improved understanding of the key factors influencing optimal vertiport placement and potential tendencies in Europe in this regard.
Regional authorities	2nd PRIAM Stakeholder Workshop and bilateral meetings	Specific regional authorities related to the case studies will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the potential integration of IAM services into the regional transport network. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed within PRIAM will offer valuable insights for vertiport operators, enhancing their understanding of the key factors influencing optimal vertiport placement and shedding light on emerging trends and potential implementation pathways across Europe. This knowledge will support strategic planning and investment decisions, ensuring alignment with future demand patterns and regulatory development.
Researchers and wider academic community	2nd PRIAM Stakeholder Workshop and bilateral meetings	Researchers and the scientific community will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe from an academic perspective, providing academic insights and a critical evaluation of the PRIAM outcomes. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed within PRIAM will offer valuable insights for the scientific community as PRIAM will serve as base for future research in this field.

Table 35. Validation exercise #05: Stakeholders' expectations

5.5.3 Validation objectives

SESAR solution validation objective	Exercise validation objective	SESAR solution	Exercise success criteria	Coverage of SESAR solution

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		success criteria		validation objective in exercise #05
Validation of algorithms for vertiport location optimisation (OBJ-0515-ERP-005)	To validate the algorithms for performing a multicriteria evaluation of the integration of IAM infrastructure networks into multimodal transport systems.	CRT-0515-TRL1-ERP-005.001	The results of the multicriteria evaluation methods for the optimisation of IAM infrastructure networks are consistent with the expected behaviour. The achieved results have been validated through expert reviews conducted by external stakeholders as part of the project's planned engagement activities.	Fully covered

Table 36. Validation objectives addressed in validation exercise #05

5.5.4 Validation scenarios

5.5.4.1 Reference scenario(s)

The baseline scenario will represent the current mobility patterns and passenger behaviours within the geographical scope defined by the case studies in the Catalan Pyrenees and the Canary Islands. It will serve as a reference point for evaluating the demand impact of IAM services.

The primary objective of the baseline scenario is to enable a meaningful comparison with the future solution scenarios, in which IAM services are introduced. By contrasting these scenarios, the analysis will assess the impact of IAM on passengers and the broader multimodal transport network.

5.5.4.2 Solution scenario(s)

The solution scenarios represent potential future conditions under which the proposed IAM network and services will be deployed. These scenarios will include the optimal locations of the IAM network, identified through the multicriteria evaluation model. This framework enables a comparison between the current transport network and an enhanced network incorporating IAM services, thereby facilitating the analysis of their overall impact.

5.5.5 Exercise validation assumptions

No additional assumptions are identified beyond those specified in Section 4.4.

5.5.6 Limitations and impact on the level of significance

The limitations and the potential impact on the significance of the results in Validation Exercise #05 are closely linked to the nature of the techniques applied. This validation exercise primarily involves modelling future IAM services in regional areas, using a combination of data analytics and modelling tools based on multiple data sources.

The results will undergo two key validation steps:

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- **Internal validation**, which will consist of checking the consistency and robustness of the outputs produced by the models.
- **External expert validation**, during which a group of experts will assess the results to provide feedback, identify potential methodological gaps, and highlight modelling errors.

While this approach offers a solid foundation for assessing the potential of IAM services, it also presents several limitations that may influence the significance and reliability of the results:

- **Data availability**. The effectiveness of the proposed modelling approach heavily relies on access to diverse and comprehensive datasets. Data availability may vary significantly across regions, potentially limiting the geographical applicability of the solution.
- **Data quality aspects**. The accuracy and reliability of the modelling outputs are directly dependent on the quality of the input data. Any biases, inconsistencies, or inaccuracies in the data will be reflected in the results. Therefore, high-quality, validated datasets are crucial for generating meaningful insights.
- **Modelling assumptions.** Given the early stage of IAM development, a number of assumptions have been made to enable the modelling process. These assumptions may not fully reflect real-world conditions, and deviations between assumed and actual scenarios could impact the validity of the results.
- **Expert validation activities**: Although expert validation is essential for evaluating the plausibility of findings and enriching the analysis, it is subject to limitations:
    - **Social and group dynamics**. Discussions may be dominated by outspoken individuals or shaped by group conformity, leading to the suppression of diverse perspectives.
    - **Limited diversity of perspectives due to homogeneous groups**. If the group members share similar backgrounds, experiences, or perspectives, the range of ideas may be constrained.
    - **Lack of expertise**. A lack of specific knowledge within the group can result in incomplete or less insightful feedback.
    - **Time constraints**. Tight schedules may force rushed contributions and limit deep reflection, reducing the overall quality of ideas
    - **Cognitive biases**. Participants may fixate on familiar or initial ideas, hindering creative thinking and exploration of novel alternatives.

To address these limitations, several best practices will be adopted, such as conducting thorough data quality assessments to verify the reliability and completeness of datasets, cross-checking key modelling assumptions with a wide range of external experts, ensuring a diverse expert panel and providing clear validation guidelines during expert sessions and using structured tools to foster balanced discussions, such as group dynamics, interactive surveys, and moderated brainstorming.

These mitigation measures will strengthen the robustness of Validation Exercise #05 enhancing the credibility of the results and ensuring that identified insights are as meaningful and representative as possible.

5.5.7 Validation exercise platform / tool and validation technique

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5.5.7.1 Validation exercise platform / tool characteristics

Not applicable

5.5.7.2 Validation exercise technique

The validation process will involve two key steps:

- **Internal validation,** which entails assessing the consistency and robustness of the model outputs. This validation will focus on ensuring that mobility indicators derived from the algorithms for monitoring potential demand for IAM services through the fusion of MND and other data sources are consistent with the expected mobility patterns and passenger behaviour.
- **External expert validation,** during which a panel of experts will review the results to provide feedback, identify methodological gaps, and highlight potential modelling errors. This validation will take place during the 2nd PRIAM Stakeholder Workshop, which will convene a diverse group of stakeholders for brainstorming sessions and focused discussions.

The workshop will be designed to promote interaction and collaborative thinking, allowing participants to contribute feedback through a series of structured activities, including:

- Interactive sessions that encourage participants to think creatively and generate a broad range of ideas without immediate judgment. These sessions aim to foster divergent thinking and explore innovative performance indicators and evaluation mechanisms.
- Survey questionnaires, a widely used and effective method for collecting input from many participants simultaneously. These will be administered during the workshop and followed by brainstorming sessions. This approach allows quieter participants to express their views, particularly in cases where more vocal experts may dominate open discussions.

If necessary, additional validation activities may be conducted during the course of the validation exercise. These could include bilateral meetings with Advisory Board members or other external experts, as well as the organisation of supplementary workshops or webinars.

5.5.8 Data collection and analysis

5.5.8.1 Data and data collection methods

The data required for this validation exercise includes data for the proper work of the solution, which are presented in Table 29, as well as data used for validation purposes.

Dataset	Description	Source
Demand data	IAM estimated demand data derived from the fusion of MND and other heterogeneous data, and the application of discrete choice models. This is the output of Validation Exercise #04	Own creation (output of Validation Exercise #04)
Land use	Data that describes how different areas of land are being used by humans, such as for agriculture, housing, industry, or recreation.	Spanish Land Use Information System (SIOSE): https://www.siose.es/presentacion

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Dataset	Description	Source
Land cost	Data that describes the cost of the land.	https://www.mivau.gob.es/el-ministerio/observatorios-y-estadisticas/estadisticas/precios-suelo-urbano
Weather data	Historical data on relevant weather variables for IAM operation from the case study regions.	Spanish Meteorological Agency (AEMET): https://www.aemet.es/en/portada
Airspace restrictions	Data that describes the airspace restriction locations.	https://www.seguridadaerea.gob.es/es/ambitos/servidumbres-aeronauticas/mapa-de-ssaa
Protected natural areas	Data with the location of the natural protected spaces.	https://www.miteco.gob.es/es/biodiversidad/servicios/banco-datos-naturaleza/informacion-disponible/enp_descargas.html

Table 37. TVAL.05.0-PRIAM-0515-TRL1 required datasets

For validation purposes, the most important data source is experts' feedback. Their feedback will be recorded by means of bilateral meetings, questionnaires, the 2nd PRIAM Stakeholder Workshop and other potential events.

5.5.8.2 Analysis methods

The data analysis tools and methods developed to validate the developed algorithms will be detailed in the deliverable D4.2 – PRIAM ERR - Final version.

Experts feedback will be analysed following a systematic approach: distribution of answers and average answers in ranked questions, identification of common ideas and frequency of responses and judgment of the most relevant issues identified in order to incorporate the feedback into the solution, when possible, or identifying future research lines.

5.5.9 Exercise planning and management

5.5.9.1 Activities

This validation exercise will encompass two main activities:

- **An internal validation** focused on assessing the consistency and robustness of the results. Since no external data is available for comparison, due to the novelty of the solution, the outcomes of the vertiport site optimisation model will be evaluated against the expected behaviour. The identified locations will be assessed to ensure that they are consistent, reasonable, and aligned with the model's intended objectives.
- **An external expert validation** during which a panel of experts will review the results to provide feedback, identify methodological gaps, and highlight potential modelling errors. This validation will take place during the 2nd PRIAM Stakeholder Workshop, which will convene a diverse group of stakeholders for brainstorming sessions and focused discussions.

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5.5.9.2 Roles and responsibilities in the exercise

Nommon will be in charge of validating the multicriteria evaluation tool for the optimisation of the integration of IAM infrastructure networks into multimodal transport systems.

5.5.9.3 Time planning

Validation exercise #05 will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). During this period, the exercise will focus on the validation of the multicriteria evaluation tool for IAM network optimisation.

The results will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around April 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

5.5.9.4 Identified risks and mitigation actions

Risks	Impact (1-low, 2-medium, 3-high)	Likelihood (1-low, 2-medium, 3-high)	Criticality (calculated based on likelihood x impact)	Mitigation actions
Inability to collect sufficient data	High	Low	3	The agreement with Orange Spain facilitates the access to mobile network data. Transport supply data is available through NAP portals in Europe.
Delays in software implementation due to the difficulties to enable interaction between the different components	High	Medium	6	Continuous interaction between different tasks within WP3 to develop and validate requirements for input and output files agreed by all modellers. Implementation of state-of-the-art software quality management methods and tools to ensure a robust management of the whole software life cycle
Excessive complexity of the models and/or their implementation in the case studies	Medium	Medium	4	Models will be designed with a focus on essential functionality, minimising unnecessary intricacies. Simple modelling approaches will be identified for each task as alternative pragmatic methods to make preliminary assessments.
Limited performance of models	Medium	Medium	4	The active involvement of end-users will provide valuable insights into critical performance thresholds for diverse models and offer scope adjustments to enhance accuracy.
Lack of interest from stakeholders and/or	Medium	Low	2	Stakeholder involvement will be proactively searched since the beginning of the project.

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Some aircraft manufacturers involved in the project are facing financial instability, which may result in unavailability or withdrawal of their representatives from the EEAB, leading to a loss of valuable insights and sectoral expertise	Low	Medium	2	The project will ensure that representatives from several different manufacturers are invited, reducing dependency on a limited number of companies and maintaining a balanced and diverse set of perspectives. Measures will be taken to secure the commitment of participants even in cases where their companies are facing financial difficulties. This will be done by maintaining close communication with the experts, and highlighting the value of their individual contribution to the project beyond their company's financial situation.

Table 38. Exercise #05 risks and mitigation actions

5.6 Validation exercise #06 plan

5.6.1 Validation exercise description and scope

This validation exercise will focus on the validation of the algorithms for IAM and ground transport services optimisation. The results of the validation exercise will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around April 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

The validation exercise will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). ENAC will lead this activity, with contributions from the other project partners across specific tasks.

5.6.2 Stakeholder's expectations and benefit mechanisms addressed by the exercise

Stakeholder	Involvement	Why it matters to the stakeholder
SESAR JU	Bilateral monthly meetings and 2nd PRIAM Stakeholder Workshop	The SESAR 3 JU will be informed about the advancement of Validation Exercise #06, so that it can verify that it progresses according to the work plan. This will also help identify synergies and establish links with other SESAR initiatives.
eVTOL aircraft operators	2nd PRIAM Stakeholder Workshop and bilateral meetings	eVTOL operators will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the future operation of eVTOLs. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to eVTOL

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Stakeholder	Involvement	Why it matters to the stakeholder
		operators about key factors that can affect the suitable operation of IAM.
eVTOL aircraft manufacturers	2nd PRIAM Stakeholder Workshop and bilateral meetings	eVTOL manufacturers will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the future performance of eVTOLs. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to eVTOL manufacturers regarding key eVTOL characteristics (e.g., range, speed, or battery capacity) on regional service performance that can help inform future design enhancements and guide the evolution of next-generation eVTOL technologies.
Vertiport operators	2nd PRIAM Stakeholder Workshop and bilateral meetings	Vertiport operators will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the vertiport operations. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed in PRIAM will provide valuable insights to vertiport operators such as improved understanding of the key factors influencing optimal vertiport placement and potential tendencies in Europe in this regard.
Regional authorities	2nd PRIAM Stakeholder Workshop and bilateral meetings	Specific regional authorities related to the case studies will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe, from the perspective of the potential integration of IAM services into the regional transport network. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed within PRIAM will offer valuable insights for vertiport operators, enhancing their understanding of the key factors influencing optimal vertiport placement and shedding light on emerging trends and potential implementation pathways across Europe. This knowledge will support strategic planning and investment decisions, ensuring alignment with future demand patterns and regulatory development.
Researchers and wider academic community	2nd PRIAM Stakeholder Workshop and bilateral meetings	Researchers and the scientific community will assess and validate the cost-benefit analysis and the roadmap for the implementation of IAM services in Europe from an academic perspective, providing academic insights and a critical evaluation of the PRIAM outcomes. Additionally, the cost-benefit analysis and the IAM implementation roadmap developed within PRIAM will offer valuable insights for the scientific community as PRIAM will serve as base for future research in this field.

Table 39. Validation exercise #06: Stakeholders' expectations

5.6.3 Validation objectives

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SESAR solution validation objective	Exercise validation objective	SESAR solution success criteria	Exercise success criteria	Coverage of SESAR solution validation objective in exercise #06
Validation of algorithms for IAM and ground transport services optimisation (OBJ-0515-ERP-006)	To validate the algorithms for optimising the coordination of IAM services with other modes.	CRT-0515-TRL1-ERP-006.001	The optimisation algorithms for IAM service coordination with other modes are assessed in terms of computational efficiency, robustness under varying operational conditions, and scalability within a European regional scope. Validation has been carried out through simulation-based testing, ensuring that the results are aligned with operational feasibility, technical feasibility, and performance requirements. Additionally, the results have been validated through expert reviews conducted by external stakeholders as part of the project's planned engagement activities.	Fully covered

Table 40. Validation objectives addressed in validation exercise #06

5.6.4 Validation scenarios

5.6.4.1 Reference scenario(s)

The baseline scenario will represent the situation previous to the coordination between IAM and ground transport modes in the context of the case studies, the Catalan Pyrenees and the Canary Islands. It will serve as a reference point for evaluating the impact of the coordination methods developed.

The primary objective of the baseline scenario is to enable a meaningful comparison with the future solution scenarios, in which coordination between IAM and ground transport services is in place. By contrasting these scenarios, the analysis will assess the impact of IAM on passengers and the broader multimodal transport network.

5.6.4.2 Solution scenario(s)

The solution scenarios represent potential future conditions under which coordination processes between IAM and ground transport services are in place. This framework enables a comparison between the scenarios with and without the deployment of the developed coordination solutions, thereby facilitating the analysis of their overall impact.

5.6.5 Exercise validation assumptions

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No additional assumptions are identified beyond those specified in Section 4.4.

5.6.6 Limitations and impact on the level of significance

The limitations and the potential impact on the significance of the results in Validation Exercise #06 are closely linked to the nature of the techniques applied. This validation exercise primarily involves modelling future IAM services in regional areas, using a combination of data analytics and modelling tools based on multiple data sources.

The results will undergo two key validation steps:

- **Internal validation**, which will consist of checking the consistency and robustness of the outputs produced by the models.
- **External expert validation**, during which a group of experts will assess the results to provide feedback, identify potential methodological gaps, and highlight modelling errors.

While this approach offers a solid foundation for assessing the potential of IAM services, it also presents several limitations that may influence the significance and reliability of the results:

- **Data availability**. The effectiveness of the proposed modelling approach heavily relies on access to diverse and comprehensive datasets. Data availability may vary significantly across regions, potentially limiting the geographical applicability of the solution.
- **Data quality aspects**. The accuracy and reliability of the modelling outputs are directly dependent on the quality of the input data. Any biases, inconsistencies, or inaccuracies in the data will be reflected in the results. Therefore, high-quality, validated datasets are crucial for generating meaningful insights.
- **Modelling assumptions.** Given the early stage of IAM development, a number of assumptions have been made to enable the modelling process. These assumptions may not fully reflect real-world conditions, and deviations between assumed and actual scenarios could impact the validity of the results.
- **Expert validation activities**: Although expert validation is essential for evaluating the plausibility of findings and enriching the analysis, it is subject to limitations:
    - **Social and group dynamics**. Discussions may be dominated by outspoken individuals or shaped by group conformity, leading to the suppression of diverse perspectives.
    - **Limited diversity of perspectives due to homogeneous groups**. If the group members share similar backgrounds, experiences, or perspectives, the range of ideas may be constrained.
    - **Lack of expertise**. A lack of specific knowledge within the group can result in incomplete or less insightful feedback.
    - **Time constraints**. Tight schedules may force rushed contributions and limit deep reflection, reducing the overall quality of ideas
    - **Cognitive biases**. Participants may fixate on familiar or initial ideas, hindering creative thinking and exploration of novel alternatives.

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To address these limitations, several best practices will be adopted, such as conducting thorough data quality assessments to verify the reliability and completeness of datasets, cross-checking key modelling assumptions with a wide range of external experts, ensuring a diverse expert panel and providing clear validation guidelines during expert sessions and using structured tools to foster balanced discussions, such as group dynamics, interactive surveys, and moderated brainstorming.

These mitigation measures will strengthen the robustness of Validation Exercise #06 enhancing the credibility of the results and ensuring that identified insights are as meaningful and representative as possible.

5.6.7 Validation exercise platform / tool and validation technique

5.6.7.1 Validation exercise platform / tool characteristics

Not applicable

5.6.7.2 Validation exercise technique

The validation process will involve two key steps:

- **Internal validation,** which entails assessing the consistency and robustness of the model outputs. This validation will focus on ensuring that mobility indicators derived from the algorithms for monitoring potential demand for IAM services through the fusion of MND and other data sources are consistent with the expected mobility patterns and passenger behaviour.
- **External expert validation,** during which a panel of experts will review the results to provide feedback, identify methodological gaps, and highlight potential modelling errors. This validation will take place during the 2nd PRIAM Stakeholder Workshop, which will convene a diverse group of stakeholders for brainstorming sessions and focused discussions.

The workshop will be designed to promote interaction and collaborative thinking, allowing participants to contribute feedback through a series of structured activities, including:

- Interactive sessions that encourage participants to think creatively and generate a broad range of ideas without immediate judgment. These sessions aim to foster divergent thinking and explore innovative performance indicators and evaluation mechanisms.
- Survey questionnaires, a widely used and effective method for collecting input from many participants simultaneously. These will be administered during the workshop and followed by brainstorming sessions. This approach allows quieter participants to express their views, particularly in cases where more vocal experts may dominate open discussions.

If necessary, additional validation activities may be conducted during the course of the validation exercise. These could include bilateral meetings with Advisory Board members or other external experts, as well as the organisation of supplementary workshops or webinars.

5.6.8 Data collection and analysis

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5.6.8.1 Data and data collection methods

The data required for this validation exercise includes data for the proper work of the solution, which are presented in Table 29, as well as data used for validation purposes.

Dataset	Description	Source
Demand data	Estimated demand data per transport mode derived from the fusion of MND and other heterogeneous data, and the application of discrete choice models. This is the output of Validation Exercise #05	Own creation (output of Validation Exercise #05)
Transport supply	Road and public transport networks and public transport services in the case study regions	OpenStreetMaps and Spanish NAP: (https://nap.transportes.gob.es/)

Table 41. TVAL.06.0-PRIAM-0515-TRL1 required datasets

For validation purposes, the most important data source is experts' feedback. Their feedback will be recorded by means of bilateral meetings, questionnaires, the 2nd PRIAM Stakeholder Workshop and other potential events.

5.6.8.2 Analysis methods

The data analysis tools and methods developed to validate the developed algorithms will be detailed in the deliverable D4.2 – PRIAM ERR - Final version.

Experts feedback will be analysed following a systematic approach: distribution of answers and average answers in ranked questions, identification of common ideas and frequency of responses and judgment of the most relevant issues identified in order to incorporate the feedback into the solution, when possible, or identifying future research lines.

5.6.9 Exercise planning and management

5.6.9.1 Activities

This validation exercise will encompass two main activities:

- **An internal validation** focused on assessing the algorithms' ability to enhance multimodal integration, improve passenger demand satisfaction, and ensure that IAM services complement rather than directly compete with ground transport options. Specific attention will be given to evaluating computational efficiency under varying operational conditions, and scalability within a European regional scope. Validation will be carried out through simulation-based testing, ensuring that the results are aligned with operational feasibility, technical feasibility, and performance requirements.
- **An external expert validation** during which a panel of experts will review the results to provide feedback, identify methodological gaps, and highlight potential modelling errors. This validation will take place during the 2nd PRIAM Stakeholder Workshop, which will convene a diverse group of stakeholders for brainstorming sessions and focused discussions.

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5.6.9.2 Roles and responsibilities in the exercise

ENAC will be in charge of validating the optimisation methods for coordination between IAM and ground transport modes, with the support of the rest of the partners.

5.6.9.3 Time planning

Validation exercise #06 will run for 8 months, from October 2025 (Month 14) to April 2026 (Month 20). During this period, the exercise will focus on the validation of the optimisation algorithms for IAM and ground transport modes coordination.

The results will be assessed during the 2nd PRIAM Stakeholder Workshop, which is expected to be conducted around May 2026 (Month 20), although additional validation activities (e.g., bilateral meetings with AB members or other external experts) could also be conducted if required.

5.6.9.4 Identified risks and mitigation actions

Risks	Impact (1-low, 2-medium, 3-high)	Likelihood (1-low, 2-medium, 3-high)	Criticality (calculated based on likelihood x impact)	Mitigation actions
Inability to collect sufficient data	High	Low	3	The agreement with Orange Spain facilitates the access to mobile network data. Transport supply data is available through NAP portals in Europe.
Delays in software implementation due to the difficulties to enable interaction between the different components	High	Medium	6	Continuous interaction between different tasks within WP3 to develop and validate requirements for input and output files agreed by all modellers. Implementation of state-of-the-art software quality management methods and tools to ensure a robust management of the whole software life cycle
Excessive complexity of the models and/or their implementation in the case studies	Medium	Medium	4	Models will be designed with a focus on essential functionality, minimising unnecessary intricacies. Simple modelling approaches will be identified for each task as alternative pragmatic methods to make preliminary assessments.
Limited performance of models	Medium	Medium	4	The active involvement of end-users will provide valuable insights into critical performance thresholds for diverse models and offer scope adjustments to enhance accuracy.
Lack of interest from stakeholders and/or	Medium	Low	2	Stakeholder involvement will be proactively searched since the beginning of the project.

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Table 42. Exercise #06 risks and mitigation actions

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6 References

6.1 Applicable documents

This ERP complies with the requirements set out in the following documents:

Content integration

[1] Content Integration - Executive Overview, 16/02/2023, 00.01

Content development

[2] SESAR operational concept document 2023, 14/07/2023, 02.00.00

Performance management

[3] PJ19 D4.4 – 874473 DES Performance Framework, 29/06/2023, 01.00

Validation

[4] DES HE requirements and validation / demonstration guidelines, 15/09/2023, 03.00

Project and programme management

[5] 101167262 PRIAM Grant Agreement, 25/06/2024

[6] SESAR 3 JU Project Handbook – Programme Execution Framework, 11/04/2022, 01.00

[7] SESAR 3 DES Solutions slides, 31/10/2023, 01.00

6.2 Reference documents

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