HUCAN Exploratory Research Plan

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Abstract

The HUCAN project addresses the legal and regulatory challenges of an ATM environment with higher levels of automation, addressing the need for new methodologies for validation and certification of AA. This document presents the exploratory research plan of the document, and in particular describes how the HUCAN Consortium will proceed to validate the suitability of the two outputs proposed, namely the holistic certification method and approach and the reliability of the Preliminary Guidelines for designing ATM-related systems based on higher levels of automation.

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Authoring & approval

Author(s) of the document

Organisation name	Date
Elisa Spiller | Deep Blue	16.02.2023
Paola Lanzi | Deep Blue	19.02.2023

Reviewed by

Organisation name	Date
Gabriella Gigante | CIRA	17.11.2023
Giuseppe Contissa | EUI	17.11.2023
Mohsan Jameel | DLR	17.11.2023
Edoardo Fornaciari | D-Flight	17.11.2023
Henk Hesselink | NLR	21.11.2023
Mariken Everdij | NLR	22.11.2023
Elisa Spiller | Deep Blue	23.11.2023
Paola Lanzi | Deep Blue	23.11.2023
Edoardo Fornaciari | D-Flight	27.02.2024
Mariken Everdij | NLR	28.02.2024

Approved for submission to the SESAR 3 JU by[1]

Organisation name	Date
Paola Lanzi | DBL	23.11.2023
Mariken Everdij | NLR	23.11.2023
Mohsan Jameel | DLR	23.11.2023
Gabriella Gigante | CIRA	23.11.2023
Edoardo Fornaciari | D-Flight	23.11.2023
Giuseppe Contissa | EUI	27.11.2023
Paola Lanzi | DBL	29.02.2024
Mariken Everdij | NLR	29.02.2024

[1] Representatives of all the beneficiaries involved in the project

Mohsan Jameel | DLR	29.02.2024
Gabriella Gigante | CIRA	29.02.2024
Edoardo Fornaciari | D-Flight	29.02.2024
Giuseppe Contissa | EUI	29.02.2024

Rejected by[2]

Organisation name	Date
Oznur Uygur | S3JU	22.12.2023

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[2] Representatives of the beneficiaries involved in the project

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HUCAN

HOLISTIC UNIFIED CERTIFICATION APPROACH FOR NOVEL SYSTEMS BASED ON ADVANCED AUTOMATION

HUCAN

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1 Executive summary

This document outlines the planned experimental approach, validation objectives and methods for the upcoming experiments and validation activities. It serves as an executive summary, summarising the key information from the Exploratory Research Plan (ERP).

The overall objective of HUCAN is to address three fundamental research questions:

- **Current shortcomings in certification**: What are the existing shortcomings and challenges in the certification of highly automated technologies in the aviation sector?
- **Design and safety criteria for certification testing**: What design and safety criteria should serve as benchmarks for the new certification tests, and how should they be applied given the specific characteristics of these technologies?
- **Methodological support for design and development**: What methodological measures can support the design and development phases of technologies and concepts to meet the identified requirements of the new certification scheme?

The validation activity, through consultation with an Expert Group (EG), aims to:

- **Verify the technical suitability**: Confirm the suitability of the identified technical requirements for the certification of high automation technologies.
- **Assess methodological consistency**: Validate the consistency of the certification methodology with previously identified gaps in the field.
- **Evaluate practical applicability**: Evaluate the practical applicability of the methodology.
- **Examine usability of preliminary design guidelines**: Evaluate the usability of preliminary design guidelines to facilitate the development of certifiable solutions according to the new methodology.

These objectives will be pursued through a workshop and two experiments. The workshop, integrated into the research innovative approaches to approval and certification process of automated and AI-based technology carried out of WP3, will serve an exploratory purpose, involving the entire SCG and complemented by the European Union Aviation Safety Agency (EASA) consultancy. On the other hand, the two experiments, respectively dedicated to the validation of the methodology (WP4) and the design support guidelines and toolkit (WP5), will use the EG to collect feedback on the application of the solutions to project use cases, thereby testing their suitability, coherence and practical applicability in real-world scenarios.

2 Introduction

2.1 Purpose of the document

According to the SESAR3 JU Project Handbook, the Experimental Research Plan aims to outline the plan for organising the exploratory research done in the project. In this framework, the HUCAN Exploratory Research Plan has the purpose to provide the validation approach and methodologies adopted by the project to assess the new certification method and approach and to ensure the reliability of the Preliminary Guidelines for designing ATM-related systems based on higher levels of automation produced in WP4 and in WP5. The document also introduces the project ethics policy and explains the criteria for voluntary participation adopted to contact the external research participants.

At the request of the Project Officer (PO) and in order to be consistent with the editorial guidelines for other S3JU funded projects, this document is structured according to the DES HE ERP Template 0.1 - Experimental Research Plan. However, in this deliverable, the acronym ERP stands for Exploratory Research Plan, as per the GA.

2.2 Intended readership

The primary intended audience of this report is the S3JU and HUCAN Consortium which will use it to plan the validation activities, assess the quality of the results produced and consolidate the outputs of the project. However, since this is a public document, the intended readership also includes the key stakeholders involved in the Consultation Group created by HUCAN and the overall aviation community interested in the document.

2.3 Background

The HUCAN project addresses the legal and regulatory challenges of an ATM environment with higher levels of automation. Coherently with the Strategic Research and Innovation Agenda (SRIA), which advocates the need for new methodologies for validation and certification of advanced automation (AA) that ensure transparency, legal aspects, robustness and stability under all conditions and take full consideration for a future ATM environment built on multiple Artificial Intelligence (AI) algorithms system of systems with a human-centric approach, the HUCAN project proposes a novel approach for certification and approval of new ATM-related airborne and ground systems embedding higher levels of automation, including those based on AI and Machine Learning (ML).

The proposed approach is intended to support both the approval/certification and the design phases of such technologies, developing to this end two interconnected products, which have been identified as the solutions produced by the project: (1) a new holistic and unified certification method for highly automated systems, whose main target users are EASA, national aviation authorities, qualified entities, and ANSPs, and (2) a set of suitable design guidelines and associated toolkit for streamlining the development of automation and AI-powered technologies, targeted to manufacturers.

For the design and development of such products, the project will review the most prominent trends and challenges in automation and AI research and applications regarding ATM systems, also analysing possible approaches developed in other socio-technical and safety-critical domains, and taking into

account all possible impacts of higher levels of automation, including those on ATCOs licence and training.

A parallel analysis of certification approaches, legal and regulatory features and critical issues of such technologies will be carried out. Case studies specifically focused on capacity on demand and dynamic airspace will feed and validate the theoretical research and the design of both the approval/certification approach and the guidelines for the design produced by the project.

Accordingly, HUCAN will draw from the results previously obtained in the following projects.

Table 1. Previous research projects of interest to HUCAN

Project	Subject/Relevance	Partner
ASCOS	The ASCOS (Aviation Safety and Certification of new Operations and Systems) project was financed by EC/FP7. It is especially relevant for changes which challenge existing approval approaches, either because of novel technologies or because they impact multiple approval domains.	NLR DBLUE
ALIAS and ALIAS II	The SESAR project ALIAS (Addressing Liability Impact of Automated Systems), and its follow-up ALIAS II allow the development of the Legal Case. The Legal Case is a methodological tool intended to support the integration of automated technologies into complex systems. More specifically, it is aimed at identifying and addressing liability issues in automated ATM systems, ensuring that these issues are clearly identified and dealt with at the right stage in the design, development, and deployment process.	EUI DBLUE
EvoATM	The SESAR project EvoATM studied the optimal allocation of elementary en-route middle airspace sectors in order to minimise the ATCO workload, without violating critical thresholds (safety separation), nor degrading in Capacity and considering possible constraints (such as technical problems, staffing issues, controller shifts). Its proof of concept is one of the case studies addressed by HUCAN.	CIRA
NUVASC 2021-2023	NUVASC 2021-2023 is a national project aimed to model AI algorithms to support the controller in decision making when applying final approach procedures (e.g., Point Merge System trombone routes). Using the Trombone procedure, aircraft join the final approach via a fixed path. Its proof of concept is one of the case studies of HUCAN.	CIRA
ARGOS	ARGOS is a MUAC project to safely handle increased traffic scenarios with the same number of ATCOs as today. The system can automatically issue the necessary operational clearances to safely handle basic traffic situations and aid the controller in handling complex traffic situations. DBLUE elaborated a report about the	DBLUE

	possible liability issues related to the implementation of this tool. The analysis applied the Legal Case methodology and highlighted relevant issues about innovative standardization policies regarding personnel training and performance and safety certification requirements.	
PJ34 AURA	SESAR2020 IR project PJ34 AURA provided requirements, processes and use cases for application of Dynamic Airspace reconfiguration and validated them. Certification aspects were not investigated by this project. This is the reason why there is a strong need to certificate and standardize this process also in perspective of AI application and support and management of dynamic airspace reconfiguration	D-Flight
Skill-UP	Skill-UP project developed an approach intended to lead and facilitate innovative processes within complex organizations, ensuring an adequate understanding of operators' skilling, up-skilling and re-skilling needs using new automated solutions. By means of the Skills Transformation Map methodology, Skill-UP approach allows a proactive mapping of automation-related critical scenarios, promptly identifying the actions and strategies that can facilitate management innovation and acceptability processes.	DBLUE

The research objectives of HUCAN are summarised in the following table.

Table 2.Research objectives and measurable outcomes

Research objective	Measurable outcomes
OBJ1 – Landscape of AA within the EU Digital Strategy for Mobility and ATM	**Advanced automation in aviation: current and future developments, opportunities, and challenges (D2.1)**
Description: Production of a comprehensive scientific review of the state of the art of AA within EU Digital Strategy for Mobility, in general, and aviation and ATM, more specifically.	
Target groups: EU and national representative regulatory authorities and policymakers, ANSPs; industrial stakeholders, producers, developers and manufacturers; S3JU research networks; academic community	
OBJ2 – Solid EU legal and regulatory framework on certification in aviation and ATM	**Certification methods and automation: benefits, issues and challenges (D3.1)**
Description: Production of a comprehensive legislative and regulatory review on certification in aviation and ATM, with a specific focus on AA technologies, including AI-powered solutions. User-based understanding of expectations and concerns about the efficacy of current and prospective certification programs for these solutions	

Target groups: EU and national representative regulatory authorities and policymakers, ANSPs; industrial stakeholders, producers, developers and manufacturers; S3JU research networks; academic community	
OBJ3 – Novel methods and procedures of certification of highly automated systems	**Holistic approach to approval and certification of automated systems (D4.4)**
Description: Elaboration of a holistic certification method for highly automated systems in ATM (including AI-powered ones), encompassing all the elements affected by the systems' operativity, and thus including the technical aspects as well as legal and regulatory requirements and safety provisions	
Target groups: EU and national representative regulatory authorities and policymakers, and ANSPs; S3JU research networks; academic community	
OBJ4 – Specific guidelines and toolkit for AA-based ATM systems design	**Preliminary guidelines for advanced automation systems design and toolkit for application (D5.2)**
Description: Production of a set of suitable guidelines and associated toolkit for the development of automation and AI technologies, to streamline the certification/approval thereof	
Target groups: EU and national ANSPs; industrial stakeholders, producers, developers and manufacturers; S3JU research networks; academic community	

2.4 Structure of the document

This document is structured in 6 sections, according to the following scheme:

- **Executive Summary**, providing an overview of the core contents of the deliverable.
- **Introduction**, reporting the essential information for the fair navigation of the document and the background of the project.
- **Context of the exploratory research plan**, where the readers find the experimental research context, the scope of the validation activities, the relevant R&I needs, estimated performance contributions and the entry and exit maturity levels for the purposes of HUCAN.
- **Experimental plan**
- **Validation exercises**
- **References.**

2.5 Glossary of terms

Table 3. Glossary of terms

Term	Definition	Source of the definition
Advanced Automation	It refers to the use of a system that, under certain conditions, operates without direct human intervention.	ISO/IEC 22989:2022(en), 3.1.7
Air Traffic	All aircraft in flight or operating on the manoeuvring area of an aerodrome.	ICAO Annex 11 - ATS
Artificial Intelligence	Technology that can, for a given set of human-defined objectives, generate outputs such as content, predictions, recommendations, or decisions influencing the environments they interact with.	EASA AI Roadmap 2.0
Air Traffic Management	The dynamic, integrated management of air traffic and airspace including air traffic services, airspace management and air traffic flow management - safely, economically and sufficiently - through the provision of facilities and seamless services in collaboration with all parties and involving airborne and ground-based functions.	ICAO Doc 4444 - ATM
Certification	any form of recognition in accordance with this Regulation, based on an appropriate assessment, that a legal or natural person, product, part, non-installed equipment, equipment to control unmanned aircraft remotely, aerodrome, safety-related aerodrome equipment, ATM/ANS system, ATM/ANS constituent or flight simulation training device complies with the applicable requirements of this Regulation and of the delegated and implementing acts adopted on the basis thereof, through the issuance of a certificate attesting such compliance	Regulation (EU) n. 2018/1139 Article 3(9)
ATM/ANS	air traffic management and air navigation services and covers all of the following: the air traffic management functions and services as defined in point (10) of Article 2 of Regulation (EC) No 549/2004; the air navigation services as defined in point (4) of Article 2 of that Regulation,	Regulation (EU) n. 2018/1139 Article 3(5)

	including the network management functions and services referred to in Article 6 of Regulation (EC) No 551/2004, as well as services which augment signals emitted by satellites of core constellations of GNSS for the purpose of air navigation; flight procedures design; and services consisting in the origination and processing of data and the formatting and delivering of data to general air traffic for the purpose of air navigation	
ATM/ANS System	the aggregation of airborne and ground-based constituents, as well as space-based equipment, that provides support for air navigation services for all phases of flight	Regulation (EU) n. 2018/1139 Article 3(7)
Unmanned Aircraft	any aircraft operating or designed to operate autonomously or to be piloted remotely without a pilot on board	Regulation (EU) n. 2018/1139 Article 3(30) Regulation (EU) n. 2019/945, Article 3(1)
Unmanned Aircraft System	an unmanned aircraft and the equipment to control it remotely	Regulation (EU) n. 2019/945, Article 3(3) Regulation (EU) n. 2019/947, Article 2(1)
Dynamic Airspace Reconfiguration	Temporary modification of the U-space airspace in order to accommodate short-term changes in manned traffic demand, by adjusting the geographical limits of that U-space airspace	Regulation (EU) n. 2021/664, Article 2(6)

2.6 List of acronyms

Table 4. List of acronyms

Term	Definition
AA	Advanced Automation
AI	Artificial Intelligence
ANS	Air Navigation System
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management

CDR	Conflict Detection Resolution
D	Deliverable
DA	Digital Assistant
DAR	Dynamic Airspace Reconfiguration
DMP	Data Management Plan
EASA	European Union Aviation Safety Agency
EC	European Commission
EG	Experts Group
E-OCVM	European Operational Concept Validation Methodology
ERP	Exploratory Research Plan
EU	European Union
EUROCAE	European Organisation for Civil Aviation Equipment
GA	Grant Agreement
HP	Human Performance
HUCAN	Holistic Unified Certification Approach for Novel systems based on advanced automation
ICAO	International Civil Aviation Organisation
KPA	Key Performance Area
KPI	Key Performance Indicator
L&T	Law and Technology
M	Month
ML	Machine Learning
N/A	Not Applicable
OBJ	Objective

PMP	Project Management Plan
PO	Project Officer
R&I	Research & Innovation
RTCA	Radio Technical Commission for Aeronautics
S3JU	SESAR 3 Joint Undertaking
SCG	Stakeholders Consultation Group
SESAR	Single European Sky ATM Research
SHS	Safety, Human Factors, and Security
SOL	Solution
SRIA	Strategic Research and innovation Agenda
SSH	Social Sciences and Humanities
T	Task
TBD	To Be Defined
TMA	Terminal Manoeuvring Area
TRL	Technology Readiness Level
UAS	Unmanned Aerial System
UC	Use Case
U-space	Urban airspace
WP	Work Package

3 Context of the experimental research plan

3.1 Exploratory research plan context

As anticipated in the D1.7 – Project Management Plan, the strategic objective of HUCAN is to develop a novel approach for the certification and approval of innovative ATM-related airborne and ground systems based on human-centric AA, including those based on AI-powered solutions.

The HUCAN project differs from other initiatives funded under the same flagship. Rather than introducing a novel technical solution, the HUCAN research approach capitalises on well-established use cases and uses proposed scenarios to formulate and evaluate a new comprehensive certification methodology for Advanced Automated (AA) solutions and a set of associated preliminary guidelines for AA systems design and the toolkit for their application.

HUCAN adopts an innovative interdisciplinary research approach, integrating social sciences and humanities to promote human-centred design of tools. The consortium emphasises user involvement, aiming to design technologies that are more acceptable and trustworthy, thus improving the user experience. Regular discussions and collaboration with users will be facilitated throughout the research design and process.

To achieve its main research objectives, HUCAN will pursue three structured lines of activity. The first line will analyse the state of the art and challenges related to automated/AI systems and their certification. The second line will focus on the development of a novel holistic certification approach and design guidelines. The third line will validate the products above by means of their application to selected case studies.

As a result, the specific objectives of the project, the theoretical nature of the solutions proposed and the emphasis on improving certification processes for AA systems require a tailor-made approach to experimentation and testing, which differs from standard methodologies.

In line with this, HUCAN will apply standard law and technology (L&T) research methodologies, taking into account legal theory, and comparative public and policy perspectives. Standard social science and humanities (SSH) methods such as interviews, focus groups and questionnaires will be used to gather continuous feedback from end-users.

Against this background, the work will be structured in 7 steps:

(1) analysis of the case studies, exploring how the level of automation and the specific characteristics of the systems being investigated may have an impact on approval and certification aspects,
(2) evaluation of the suitability of the multiple new approaches to approval and certification investigated within the project,
(3) elaboration of performance-based requirements for AA,
(4) development of a new holistic approach for approval/certification of AA,
(5) testing of the new method on the case studies previously selected, and draft a validation report, and improve the approach using validation results,

(6) development of preliminary guidelines for advanced automation systems design and toolkit for guidelines application, and
(7) testing of the guidelines and the related to tool to the selected use cases and the consequent consolidation based on the results of the validation activity.

Four case studies will be used to feed the design and evaluation of the method. They are representative of a spectrum of highly automated systems, characterised by different operational purposes and impacts, different reference scenarios (*i.e.,* middle airspace, TMA, U-space) and types of algorithms (*i.e.,* deterministic, ML, reinforcement learning).

In this context, it is crucial to emphasise that achieving the expected level of maturity in HUCAN will rely primarily on desk research and expert consultation. The emphasis will be on leveraging the wealth of knowledge and insight from desk studies and seeking guidance from the experts involved, including through the Stakeholder Consultation Group established within the project.

The focus on human-centred automation is key in this framework, as it implies the need for a holistic approach to certification that together with technical reliability takes into consideration also other aspects of the system, such as its impact on human performance and operations (including human-system teaming and training and skills requirements), and at the societal, value-based and ethical level. In addition, the proposed certification approach is intended to be unified, meaning that it is aimed to be able to take into account and fit the wide range of deterministic and non-deterministic algorithms available and the automation of tasks and procedures according to different levels of software automation and autonomy.

The novel approach will support both the approval/certification process and the design phase of highly automated technologies, proposing to this end the development of two interconnected and tangible products: a new holistic and unified certification method for systems based on AA, and a set of suitable guidelines and associated toolkit for streamlining the development of highly automated and AI-based technologies.

These two products are the SESAR solutions produced by the project. To meet the strategic objective of the project and produce the two solutions above, four objectives were set. The following table presents the list of the objectives of the project, showing also their link with the solutions produced by the project and with the WPs and the deliverables that directly contribute to their achievement. The information included in the table is coherent with the Grant Agreement (GA) Annex 1.

Table 5. HUCAN research plan

Scope	Objective	SESAR solution	WP	Deliverable
A novel approach for the certification and approval of new ATM-related airborne and ground systems embedding human-centric AA,	OBJ.1 Landscape of AA within the EU Digital Strategy for Mobility and ATM	SOL.1 Holistic certification approach and method for novel ATM-related systems based on	WP2	D2.1 Advanced automation in aviation

including those based on AI-powered solutions	OBJ.2 Solid EU legal and regulatory framework on certification in aviation and ATM	higher levels of automation	WP3	D3.1 Certification methods and automation: benefits, issues and challenges
				D3.2 Innovative approaches to approval and certification
	OBJ.3 Novel methods and procedures of certification of highly automated systems		WP4	D4.1 Case studies introduction: level of automation analysis and certification issues
				D4.2 Performance based requirements for advanced automation
				D4.3 Validation Report
				D4.4 Holistic approach to approval and certification of automated systems
	OBJ.4 Specific guidelines and toolkit for AA-based ATM systems design	SOL.2 Preliminary Guidelines to design ATM-related systems based on higher levels of automation	WP5	D5.1 Guidelines Validation report
				D5.2 Preliminary guidelines for advanced

				automation systems design and toolkit for guidelines application

3.2 Scope

The HUCAN validation scope focuses on OBJ3 and 4, with the aim of validating two key outcomes: the novel certification methodology and guidelines, and the design support toolkit. The project's characteristics and expected results differ from conventional SESAR projects. The goal is not to verify a technical proof of concept, but rather to assess the novelty, regulatory and normative coherence, functional suitability and operational usability of the new certification methodology and design support guidelines and the related toolkit in practical scenarios.

Considering these factors, the Expert Group (EG) is the most effective tool available to validate these outcomes. By gathering qualitative data such as opinions, comments, and suggestions, the EG enables an impartial and objective evaluation of the work's quality.

Accordingly, the validation activity aims to:

- Verify the suitability of the identified technical requirements for the certification of high automation technologies.
- Assess the coherence of the certification methodology with previously identified gaps in the field.
- Evaluate the practical applicability of the methodology.
- Evaluate the usability of the preliminary design guidelines to facilitate the development of solutions ready for certification according to the new methodology.

As explained later, these objectives will be pursued through a workshop and two experiments. The workshop, integrated in the certification activities of WP3, has an exploratory value, involving the whole SCG and complemented by EASA consultancy. The two experiments, dedicated to the validation of the methodology (WP4) and of the design support guidelines and the related toolkit (WP5), use the EG to collect feedback on the application of the solutions to project use cases, thereby testing their suitability, coherence and practical applicability in real-world scenarios.

3.3 Key R&I needs

The certification of AA technologies, including those supported by AI, is a widely discussed topic in various sectors. The main characteristics of these technologies are their degree of autonomy and adaptability, which varies according to the different applications and contexts. In the aeronautical sector, EASA has provided important guidance on the verification of the trustworthiness of AI by publishing a set of expected means of compliance dedicated to this family of technologies. However, the issue remains largely unexplored. Open questions on certification go beyond AI as a stand-alone technology but aim to encompass all solutions leading to advanced levels of automation. In addition, research must include the impact of automation on the operations and processes that are intended to benefit from it.

A holistic approach, as proposed by HUCAN, suggests addressing these certification issues in a multidisciplinary approach, addressing technical, safety, human performance, skills and ethical-legal aspects within a unified framework.

Accordingly, in line with the objectives outlined in the GA, this document shapes the research approach around three core questions:

- What are the current shortcomings and challenges in the certification of highly automated technologies in the aviation sector?
- What design and safety criteria should serve as benchmarks for the new certification tests and how should they be administered based on the specific characteristics of these technologies?
- What methodological measures can support the design and development phases of technologies and concepts to meet the identified requirements of the new certification scheme?

3.4 Estimated performance contributions

HUCAN has the potential to have a significant impact on the ATM sector and to contribute to AI regulatory research. The scale and far-reaching impact of the project, particularly in the ATM sector, which currently lacks consolidated certification programmes, underlines its importance. With regulations prioritising performance, the project aims to provide clarity by developing guidelines aligned with licensing and certification requirements. This will include holistic certification methodologies that address the challenges of AA.

The importance of the project is further highlighted by the evolving landscape in both EU and non-EU countries, where early pilot programmes for AI-based solutions are underway. HUCAN's approach addresses the limitations of the traditional certification model, particularly when dealing with non-deterministic systems. The project is in line with emerging legislation such as the EU AI Act, and its findings could influence the development of regulatory frameworks for AI in aviation and ATM.

The dual benefit of HUCAN lies in the direct benefit to the aviation and ATM sectors through design guidelines and holistic certification methodologies, and the indirect benefit to the broader AI research field. The separate approach for aviation and ATM, justified by safety-critical environments, can pave the way for safe and trustworthy development in less problematic contexts and contribute to the consistent evolution of legal and regulatory frameworks.

Against this background, the table below provides an overview of the activities carried out within the project and the related KPAs and KPIs.

Table 6. Estimated performance contributions

Solution Title	Solution Definition	Qualitative Performance Expectation	KPA/KPI
Certification method	Holistic certification approach and method for novel ATM related systems based on higher levels of automation	Transferability of the method and application (as well as further validation) in other	SAF SEC HP

		SESAR ER and IR projects, with mutual benefits	
Toolkit for guidelines application	Toolkit to support the application of the guidelines to develop highly automated systems consistently with the certification approach above	Transferability of the method and application (as well as further validation) in other SESAR ER and IR projects, with mutual benefits	SAF SEC HP

3.5 Initial and exit maturity levels

Table 7. 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
HUCAN	Certification method	TRL0/1	TRL2/3	ASCOS ALIAS and ALIAS II EvoATM NUVASC 2021-2023 ARGOS PJ34 AURA Skill-UP
HUCAN	Toolkit for guidelines application	TRL0/1	TRL2/3	ASCOS ALIAS and ALIAS II EvoATM NUVASC 2021-2023 ARGOS PJ34 AURA Skill-UP

4 Experimental plan

4.1 Experimental plan approach

The strategy of the experimental plan to progress from the initial to the exit maturity level in the new certification approach is systematic and gradual. In HUCAN, it is important to emphasise that due to the specific nature of the solutions proposed, the achievement of the expected maturity level relies primarily on desk research and expert consultation.

The emphasis is on leveraging the knowledge and insights from desk studies and seeking guidance from experts, including the Stakeholder Consultation Group established within the project. The plan includes a high-level summary of the planned consultations, demonstrating their direct relevance to addressing research and innovation (R&I) needs. As the project covers low Technology Readiness Levels (TRLs), specifically from TRL0 to TRL2/3, the approach includes a concise summary of key validation objectives per TRL. Milestones are strategically integrated to update the Exploratory Research Plan (ERP) after successful completion of a TRL, allowing dynamic refinement of objectives and activities for subsequent levels.

Throughout the process, interdependencies and relationships between exercises are highlighted to ensure a coherent and interrelated approach. Based on the results obtained in D4.3 - Validation Report; D4.4 - Holistic Approach to Approval and Certification of Automated Systems; and D5.1 - Guidelines Validation Report, the project places a strong emphasis on incorporating feedback from various sources, including content integration, project activities and exercises from previous lifecycle phases. This iterative feedback mechanism facilitates continuous improvement and adaptation of the experimentation plan based on lessons learned and issues identified at previous maturity gates.

4.2 Stakeholders' expectations and involvement

4.2.1 Stakeholder Consultation Group

In line with the project objectives and the SESAR Strategic Research and Innovation Agenda (SRIA) objectives, HUCAN has established a unique Stakeholder Consultation Group. This group includes projects associated with the Capacity on Demand and Dynamic Airspace Flagships as well as the Civil/Military Interoperability and Coordination Flagship. These projects consider that they have issues or interests related to the topics covered by HUCAN. This initiative aims to gain insights from the research experiences of other consortia, focusing on the challenges and concerns related to uncertainties in the certification of highly automated technologies. The aim is to facilitate the development and validation of solutions that are consistent, relevant and ready for use.

The HUCAN project plans to organise a series of workshops in conjunction with the Stakeholder Consultation Group (SCG), which aim to be a fundamental aspect of stakeholder engagement. The workshops will act as interactive platforms that enable stakeholders to engage directly with the project's progress, offering them an immersive chance to comprehend, evaluate, and endorse the research findings. The workshops have been designed to provide an all-inclusive depiction of the project's integration into the wider ATM framework, as well as a practical encounter with the project's outputs.

Their aim is twofold: firstly, to facilitate transparent communication about the HUCAN project's advancements; secondly, to offer a forum for gathering priceless feedback that will direct benefit prospective research and development. These meetings aim to facilitate a participatory setting in which stakeholders can express their requirements and expectations, guaranteeing that the project stays in line with the actual needs of the ATM sector.

In light of the above, the following table presents the stakeholders involved, the role they will play and the value of their contribution to HUCAN.

Table 8. Stakeholders' expectations and involvement

Stakeholder	Involvement	Why it matters to the stakeholder
Producers and manufacturers	Expert group	They can offer genuine insights into the concerns and issues of operators who deal with the certification of AA technology in real-world contexts on a daily basis.
ANSPs	Expert group	They can provide specific needs and requirements for certification of ATM systems, especially for AA technology.
Public authorities and policy makers	Expert group	They can provide directives and guidelines for the concrete improvement of HUCAN solutions, in line with the ongoing legal and regulatory initiatives for the certification of AA and AI.
SESAR 3 JU Community	Expert group	They can bring relevant insights on the problems encountered in the SESAR-funded research projects, on certification issues and design guidelines, on the development and validation of concepts and solutions at different stages of maturity.

4.2.2 Possible ethical issues

According to the European Commission (EC) note on Roles and Functions of Ethics Advisors/Ethics Advisory Groups in EC-funded Projects (EC, 2023), the EU Ethics appraisal process considers 'ethics' as including questions of legal and regulatory compliance as well as questions on moral principles, fundamental rights and values, and how these apply to research activities. It is part of a process of 'governance', that aims to ensure the protection of the rights and interests of all those affected by research and related activities, respect for fundamental EU values and human rights, and that EU funded research is not misused.

The HUCAN project was subject to the EC ethical review and this assessment provided relevant insights about the ethical risks associated with the proposed research and innovation activities. Although the focus of the project is on highly automated systems, including those AI-powered, the project does not foresee that AI-based activities will be carried out and will not design and develop AI-based tools. Instead, as reported in the GA, ethical issues could apply to participation of external groups, as the

HUCAN project foresees interviews about the use cases; workshops involving the Stakeholder Consultation Group participants and other identified stakeholders and validation activities involving end users and other identified stakeholders.

Based on these considerations and according to the EC Guidelines for Identifying serious and complex ethics issues in EU-funded research (EC, 2021) and the EC Ethical Self-Assessment Checklist (EC, 2021), the ethical issues associated to the project are mainly related to voluntary participation of external individuals to research activities and the processing of their personal data.

In this regard, it was agreed that the identified/recruited participants will be adults (no vulnerable adults) and selected on a voluntary basis. Participants will be identified and allocated in a timely manner. As the participants will be experts in the technologies being investigated in the use cases, their identification will be based on their involvement in the projects identified as relevant and their recruitment will be upon direct invitation. To ensure that participants are aware of the purpose of the specific research activity in which they are involved and of their rights, they will be given a project specific information sheet and informed consent form to be signed prior to the activity.

Moreover, in accordance with D1.1., personal data of the participants collected by the Consortium will be limited to their name, affiliation and email address. Such information will be collected by means of the above-mentioned consent form. With the respect of the 'data minimisation' principle, all processed data will be limited to that relevant to the project. All the data collected will be managed in an anonymised and aggregated way. They will be stored in the project dedicated repository, with restricted access to just the personnel involved in the project. Processing of personal data may include collection (digital audio, digital video caption, etc.); recording; organisation, structuring and storage (cloud, LAN or WAN servers); retrieval and consultation; disclosure by transmission, dissemination or otherwise making available (share, exchange, transfer); restriction, erasure or destruction.

The participants will be provided with information on procedures "that will be followed, concerning collection, change and removal of data.

4.2.3 Ethical principles for voluntary participation in research activities

4.2.3.1 Voluntary participation

Following the general principles of ethical research, all the participatory research activities will be strictly limited to volunteers.

4.2.3.2 Informed consent

For the sake of transparency and accountability, the Consortium will obtain the free and fully informed consent of the research participants. The free and informed consent of each of the participants is required before conducting interviews and accessing personal data records. The purpose of informed consent is to allow individuals to make a voluntary informed decision about whether to participate in the research based on knowledge of its goals, procedures and outcomes. No volunteers who are minors and with reduced autonomy or vulnerability will be involved.

Considering the previous conditions, the procedure for volunteers adheres to the conditions below:

- Every volunteer has the right to remain anonymous.
- Every volunteer has their data protected as stated in the applicable data protection legislation.
- All data released by the volunteers participating in the project research activities brings a duty of confidentiality.
- Every volunteer has the right to know who will benefit from his/her participation in the research activity and, if they wish, to receive information of any potential commercial exploitation of the research that involves their participation.
- Participants are informed in their own language about the purpose of the research, the vehicles for the dissemination of the results and people, organisations and stakeholders involved in the research, and about data treatment and handling.
- Volunteers willing to be informed on the results of the research are timely updated with the outcomes of the study.
- Volunteers are informed of the appropriate insurance cover that is in place, if applicable.
- It is clearly explained to the volunteers that they can withdraw from the project at any time.
- Data are collected in a way that the researchers do not impose any of their own bias on the data itself.
- Fair involvement, equal opportunities and equal treatment among people with different socio-cultural backgrounds (e.g., gender, nationality, religion, age, etc.) is guaranteed.

4.2.3.3 Informed consent form

Considering the above, all research participants will receive a written consent form about the research and about the implications of their participation, the methods, the timeframe and the environment in which their data will be studied. The individuals have a contact point in case they need to receive additional information regarding their participation. The participants are informed about the opt-out procedure.

The information sheets, accompanying the informed consent form, are written in a language and terms fully understandable to the participant. The sheets describe the aims, methods and implications of the research, the nature of the participation and any benefits, risks or discomfort that might be involved. The information sheet explicitly states that participation is voluntary and that anyone has the right to refuse to participate and to withdraw their participation, samples or data at any time — without any consequences. Only when the research participant has fully understood the information sheet and has given consent without any pressure having been put on them, then consent will be considered valid.

For the sake of conciseness, the informed consent to voluntary participation and the consent to the processing of personal data are collected in a unique document. The two expressions of consent are separate, although substantially complementary. The template is available in Appendix A of D1.1. The conditions and the measures adopted for the protection of personal data are further detailed in that document.

4.3 Validation objectives

Table 9. HUCAN validation objectives

Research objective	SESAR solution	Validation objective(s)
OBJ.1 Landscape of AA within the EU Digital Strategy for Mobility and ATM	SOL.1 Holistic certification approach and method for novel ATM-related systems based on higher levels of automation	Assess the applicability and effectiveness of the methodology within the aviation domain to address unique challenges and requirements specific to this sector. Ensure that the methodology aligns with the various stages of concept development as per the E-OCVM framework, addressing each stage of concept evolution appropriately. Evaluate the usability of the methodology during concept validation, ensuring its effectiveness and practicality in different stages of the validation process for aviation concepts.
OBJ.2 Solid EU legal and regulatory framework on certification in aviation and ATM		
OBJ.3 Novel methods and procedures of certification of highly automated systems		
OBJ.4 Specific guidelines and toolkit for AA-based ATM systems design	SOL.2 Preliminary Guidelines to design ATM-related systems based on higher levels of automation	Assess the methodology's correspondence with the recommendations and advancements outlined in the SESAR Automation in ATM Report and the EASA AI Roadmap. Verify that the methodology is in sync with the evolving technologies and automation strategies as per the guidance provided by SESAR and EASA

4.4 Validation assumptions

In light of the project's specificities, this requirement does not apply to HUCAN.

4.5 Validation exercises list

Table 10. Exercise SOL.1#

Identifier	TVAL.01.0[HUCAN]-[SOL.1]-TRL1
Title	Validation of the certification test suggested by the new methodology
Description	The tests will be executed on each UC. The objective of the validation is to verify whether the applications of each UC meet the standards and technical requirements identified by the test. Tests will be conducted to simulate real conditions in R&I and R&D processes. They may include safety, performance, interoperability, and other critical aspects.
KPA/TA addressed	Safety
Addressed expected performance contribution(s)	Assess the feasibility of the test according to the identified requirements. Refine the list of the requirements included by the test. Validate the certification methodology. Assess the usability of the methodology in practice.
Maturity level	
Use cases	UC1; UC2; UC3; UC4
Validation technique	Expert group
Validation platform	N/A
Validation location	TBD
Start date	M18
End date	M21
Validation coordinator	DBL

Status	<in progress>
Dependencies	N/A

Table 11. Exercise SOL.1# Trace

Linked Element Type	TVAL.01.0
<SESAR Solution>	TVAL.01.0
<Project>	HUCAN
<Sub-Operating Environment>	N/A
<Validation Objective>	1, 2, 3

Table 12. Exercise SOL.2#

Identifier	TVAL.02.0[HUCAN]-[SOL.2]-TRL1
Title	Validation of the guidelines and toolkit developed by HUCAN
Description	The guidelines (and the toolkit) will be tested on each UC. The objective of the validation is to verify whether the use of the guidelines (and the toolkit) might provide ready-to-use insights to the design process of the solutions presented by the UC, orienting the development to future-proof compliance. Tests will be conducted to simulate real conditions in R&I and R&D processes. They may include the KPIs considered by EASA for the current certification methods and the AMCs provided in the deliverables of EASA AI Roadmap.
KPA/TA addressed	Safety
Addressed expected performance contribution(s)	Assess the usability of the methodology in practice. Refine the contents of the guidelines (and the toolkit) according to their expertise and experience Validate the guidelines
Maturity level	
Use cases	UC1; UC2; UC3; UC4

Validation technique	Expert group
Validation platform	N/A
Validation location	TBD
Start date	M18
End date	M21
Validation coordinator	DBL
Status	<in progress>
Dependencies	N/A

Table 13. Exercise SOL.2# Trace

Linked Element Type	TVAL.02.0
<SESAR Solution>	TVAL.02.0
<Project>	HUCAN
<Sub-Operating Environment>	N/A
<Validation Objective>	4

4.6 Validation exercises planning

As part of WP4 and WP5 activities, the validation exercise will be held between M18 (February, 2025) and M21 (May, 2025).

4.7 Deviations with respect to the SESAR 3 JU project handbook

In line with the project objectives and research methodology as outlined in the proposal and approved in the GA, the Consortium has worked with the Project Officer to proceed as described above. This approach, while deviating from the validation strategies conventionally adopted for concepts and technical solutions, has been mutually agreed.

5 Validation exercises

5.1 Validation exercises within HUCAN

Due to the nature of the project, traditional exercises are not feasible. However, validation activities will still be conducted as described below.

The document has been compiled with adherence to the standard format, providing relevant information systematically according to the purposes of this deliverable.

5.1.1 Validation exercises description and scope

Validation activities will begin at M18, with a focus on the work carried out in WP4 and WP5. These activities will be led by consortium partners, building on the results of literature research and engagement efforts in WP2 and WP3. The primary goal is to address opportunities and challenges identified in the development and implementation of AA technologies in aviation, as highlighted in T2.3 and an associated internal workshop.

Insights from the workshop with the SCG in T3.2 will be considered. The focus will be on exploring benefits, challenges, and issues related to certifying non-deterministic systems based on AI and ML. These considerations will be incorporated into WP5 to design a new, comprehensive certification approach for systems using AA. The task will evaluate innovative certification approaches based on criteria such as safety, cost-benefit, throughput time, stimulation of innovation, required expertise, bureaucracy, means of compliance definition, divergence from current requirements, human factor involvement, delegation of responsibility, and feasibility.

In addition, this task will establish connections with standardisation bodies working on AI/ML in aviation, such as ICAO, EUROCAE/RTCA, with the support of the Stakeholder Consultation Group. This will ensure alignment with the latest developments in the field and coherence between outputs in subsequent WPs and the overall framework. EASA is expected to contribute to both WP3.1 and WP3.2 by providing a comprehensive overview of current certification methods and regulations. This will consider the work conducted and the approach adopted for defining the EASA AI Roadmap.

The main validation objectives include:

- Identification of certification issues emerging in the project use cases, particularly focusing on the level of automation and operational impact of ATM-related systems.
- Identification of performance-based requirements for the new certification method, demonstrating the safety of automation during normal, impaired operation, and recovery phases of service provision.
- Application of the new certification method to selected use cases.
- Verification of the suitability of the new methodology to address or mitigate identified certification issues.
- Production of preliminary guidelines for AA systems design and a toolkit for application.
- Application of the guidelines and use of the toolkit in selected use cases.
- Verification of the suitability of the new methodology to address or mitigate issues identified in the state-of-the-art survey (comparative analysis).

Validation techniques used involve multidisciplinary analysis of use cases and creating corresponding concepts following the E-OCVM approach. This includes analysing certification systems using techniques specific to the principle-based approach and regulatory comparison. The new methodology and guidelines will be applied in simulations, using the toolkit. This will be done through use cases with an incremental approach based on feedback.

A standardized validation platform will not be used due to the project's characteristics. The TRLs are 2/3.

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

Table 14. Stakeholders' expectations

Stakeholder	Involvement	Why it matters to the stakeholder
Producers and manufacturers	Expert group	They can assess whether the methodology and guidelines developed within HUCAN are consistent with their organisational and technical operational needs and suggest the appropriate adjustments if necessary.
ANSPs	Expert group	They can provide valuable insights into the consistency of the new certification methodology with the current ones, and the practicality of the one proposed by HUCAN. In addition, they can provide a crucial perspective on all aspects related to HP and upskilling in practice.
Public authorities and policy makers	Expert group	They can assess and align the results obtained by the HUCAN project in light of current directives and guidelines and the ongoing legal and regulatory initiatives about certification of AA and AI-based systems.
SESAR 3 JU Community	Expert group	They can bring expert opinions gained in the SESAR-funded research projects, on certification issues and design guidelines, on the development and validation of concepts and solutions at different stages of maturity.

5.1.3 Validation objectives

Table 15. Validation objectives addressed in validation exercises SOL.1# and SOL.2#

SESAR solution validation objective	SESAR solution success criteria	Coverage and comments on the coverage of SESAR solution validation objective in exercises SOL.1# and SOL.2#	Exercise validation objective	Exercise success criteria
N/A	N/A	N/A	Assess the applicability and effectiveness of the methodology within the aviation domain to address unique challenges and requirements specific to this sector.	The methodology is applicable to the UCs and is able to address the pending certification issues experienced while using currently available methods.
N/A	N/A	N/A	Ensure that the methodology aligns with the various stages of concept development as per the E-OCVM framework, addressing each stage of concept evolution appropriately.	The methodology is aligned with the various stages of concept development as outlined in the E-OCVM framework.
N/A	N/A	N/A	Evaluate the usability of the methodology during concept validation, ensuring its effectiveness and	The methodology can be used during concept validation, and the design guidelines and

			practicality in different stages of the validation process for aviation concepts.	toolkit provide valid support throughout the development process.

5.1.4 Validation scenarios

Within the scope of HUCAN, the validation scenarios correspond to those depicted in the selected use cases for the project. More specifically, the validation activities will focus on the situations described in the table below.

Table 16. Validation scenarios

Use case	Purpose	Objectives
Dynamic airspace sectoring	Improvement of middle airspace utilisation obtained by means of dynamic optimisation of the airspace sector reconfiguration	Dynamically define and apply the best allocation of elementary sectors for: • ATCOs workload optimization • Capacity optimization • Flow management optimization
AI-powered digital assistant (DA) in TMA	Optimisation of the application of advanced continuous descent operations in TMA, by means of a DA for Spacing, Scheduling and Conflict Detection and Resolution (CDR)	Provide an AI-powered DA to support ATCOs to effectively manage inbound traffic and ensure continuous descent operations, with benefits for: • Safety in terms of ICAO longitudinal/lateral separations • Runway capacity maximization • Fuel consumption minimization • Environmental impact minimization • Pilot and ATCO workload optimization
Dynamic Airspace Reconfiguration Procedure for U space	Dynamic U-space volumes definition and information exchanges between ATM and U Space	Dynamically support ATCOs in activating/deactivating U-Space volumes to UAS traffic for management of priority operations, emergencies, of manned aviation in U-Space, with benefits in: • Optimization of U-Space as well as controlled airspace

		• Increase of safety levels • ATCO workload reduction
Dynamic allocation of traffic between ATCO and system	Improvement of upper airspace utilisation by means of allocation dynamic of traffic between the ATCO and ARGOS[3]	Dynamically support the ATCOs in managing the traffic in the sector, by means of issuing operational clearances to safely handle basic traffic situations and aid controllers in handling complex traffic situations. ARGOS has 3 modes of use. Two of them will be taken into account in HUCAN concerning respectively the autonomous management of the traffic by ARGOS in specific circumstances and the hybrid management of the traffic between the ATCO and the ARGOS system (dynamic allocation of traffic)

5.1.4.1 Reference scenario(s)

In light of the project's specificities, this requirement does not apply to HUCAN.

5.1.4.2 Solution scenario(s)

In light of the project's specificities, this requirement does not apply to HUCAN.

5.1.5 Exercise validation assumptions

In light of the project's specificities, this requirement does not apply to HUCAN.

5.1.6 Limitations and impact on the level of significance

In light of the project's specificities, this requirement does not apply to HUCAN.

5.1.7 Validation exercise platform / tool and validation technique

5.1.7.1 Validation exercise platform / tool characteristics

In light of the project's specificities, this requirement does not apply to HUCAN.

[3] ARGOS (ATC Real Groundbreaking Operational System) is a proprietary tool designed and developed by EUROCONTROL Maastricht Upper Area Control (MUAC).

5.1.7.2 Validation exercise technique

In light of the project's specificities, this requirement does not apply to HUCAN.

5.1.8 Data collection and analysis

5.1.8.1 Data and data collection methods

Validation activities for the project will primarily involve collecting qualitative data in the form of opinions, inputs, and feedback, either in standardised or open formats. Strictly statistical tests are not planned, but it will be possible to evaluate the data both quantitatively and qualitatively in terms of recurrence, concordance and discordance. Two iterations of validation activities are planned, one within the scope of WP4 and the other within WP5. The two sets of activities are interdependent and must be carried out sequentially.

Currently, it is not possible to standardise data quality due to the inherent nature of the information that needs to be collected. Information regarding the operational scope of stakeholders involved, the roles and responsibilities of individuals participating in the validation activities, expectations regarding the methodology, and the nature and quality of responses, including comparative aspects, may be collected. Validation activities are funded by the project. Results may be documented, also through graphical representations and photographs, but the nature and standardisation of the content cannot be estimated at this time.

Periodical updates of the Data Management Plan (DMP) will provide additional information on the nature and quality of collected data, as well as the methods used for collection and processing.

5.1.8.2 Analysis methods

As outlined in the validation exercise descriptions, the adopted validation technique is that of the EG. It is worth noting that the EG is not a validation activity as such. Instead, it aims to provide concept clarification, requirements development or elaboration activities.

The primary role of the EG will be to address inquiries from exercise leaders seeking clarification on specific subjects. The EG serves as a reservoir of knowledge throughout the project, available for exercise leaders to draw upon as needed.

The data treatment within the HUCAN project involves a comprehensive approach to gathering the multiple contributions provided by the Consortium partner the EG, the SCG. This expertise is meticulously captured through a combination of methodologies, including questionnaires, as scenario-based simulations, tabletop exercises, and EG sessions and recorded discussions. These techniques are strategically employed to ensure a thorough and nuanced understanding of the regulatory and applicative issues related to the current certification process and the new solutions produced within HUCAN.

In the context of the WP4 and WP5 Validation Activities, the gathered data is instrumental in assessing the efficacy, reliability, and alignment of HUCAN certification methodology and the related guidelines with predefined standards and requirements, as well with the expectations of the stakeholders usually involved in these procedures.

Accordingly, the treatment of data extends to the validation workshops conducted within the project. These workshops employ diverse methodologies such as scenario-based simulations, tabletop

exercises, and EG sessions. Scenario-based simulations provide a practical assessment of proposed solutions in simulated real-world conditions. Tabletop exercises facilitate collaborative discussions and problem-solving in a controlled environment. EG sessions play a crucial role in seeking clarifications and leveraging a collective pool of knowledge.

More specifically, the qualitative data will be processed with the following methodologies:

- **Content analysis**: this method involves identifying and analysing recurring themes in textual or visual data. It can be done through open coding (identifying categories without preconceptions) or thematic coding (assigning data to predefined categories).
- **Discourse analysis**: this method focuses on analysing language and communication patterns in the data. It may involve keyword analysis, tone assessment, or the study of discourse structure.
- **Process analysis**: this approach focuses on exploring and understanding the meanings that individuals or groups attach to a particular experience. It involves a detailed description of a process as perceived by the participants.
- **Qualitative network analysis**: this approach examines relationships between units of analysis, such as individuals or organisations, and visualises them through network diagrams. This method can help to understand social dynamics and interrelationships.
- **Frame analysis**: this method focuses on identifying conceptual patterns or frames of interpretation through which people understand a particular phenomenon.

5.1.9 Exercise planning and management

5.1.9.1 Activities

Workshops will be the main format used, both internal to the consortium and open to the participation of the interested members of the Stakeholder Consultation Group (SCG).

5.1.9.2 Roles and responsibilities in the exercise

The WP leaders, in collaboration with the partners involved in validation activities, will plan, organize, and manage these activities following the guidelines established by the GA. The project coordinator, as per the PMP, is responsible for ensuring the smooth progress of various phases and is available for collaboration if consulted.

5.1.9.3 Time planning

The table below reports the relevant project milestones for validation purposes and the corresponding means of verification.

Table 17. Time planning and milestones

No	Milestone name	WP	Lead	Means of verification	Due date
1	Stakeholder Consultation Group created	WP6	DBLUE	Letters of acceptance received	M3

2	Preliminary version of the certification method available for validation	WP4	NLR	Start of validation activities	M18
3	Preliminary version of the guidelines for AA systems design and of the toolkit for guidelines application available for validation	WP5	CIRA	Start of validation activities	M18
5	Exit maturity gate	WP1	DBLUE	Minutes of the meeting	M24

5.1.9.4 Identified risks and mitigation actions

Table 18. 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 and impact)	Mitigation actions
Lack of technical expertise within the consortium	3	1	2	The consortium partners are organisations of renowned expertise, and the involved professionals have been specifically selected based on their technical competencies relevant to the specific goals of the project.
Lack of technical expertise within the group of experts	3	1	2	The participants in the expert group have been selected based on their specific expertise in the aviation sector and the relevance of their current activities to the validation objectives of the project.
Validation objectives inadequately designed	3	2	2,5	The validation objectives have been defined consistently with the statements in the GA, and their formulation was collectively determined within the consortium and agreed upon with the Project Officer (PO).
Inadequate design of the validation activities	3	2	2,5	The validation activities have been defined in accordance with the validation objectives, and the adopted methodologies have been selected for their relevance and

				appropriateness to the project's goals. All methodological choices have been collaboratively determined within the consortium and agreed upon with the Project Officer (PO).
Management failures in performing validation	3	1	2	The validation activities have been planned in accordance with the agreements outlined in the GA and their content is in line with the expertise, resources and means available to the consortium. The partners involved in the latter have gained experience in similar activities in other research projects, ensuring professionalism in the management of each activity.
Lack of involvement of the EG	2	1	1,5	Members of the Stakeholder Consultation Group have already shown a keen interest in the content of the project, particularly the practical implications of the results for their current and future research activities. This indicates an intention to participate actively.

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