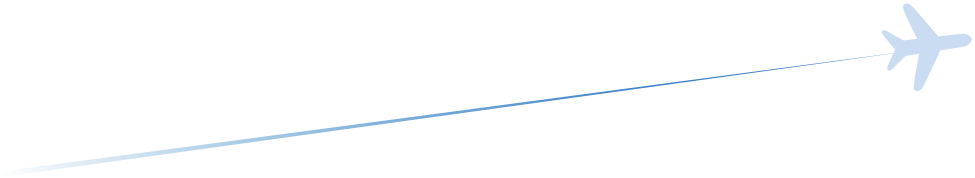

Preliminary Evaluation Results

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SAFELAND

SAFE LANDING THROUGH ENHANCED GROUND SUPPORT

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Abstract

SAFELAND is developing a future concept of operations, dealing with the single pilot incapacitation problem. The concept is developed with the contribution of different stakeholders and will be evaluated by internal and external experts.

This Deliverable presents **the results and analysis of a Preliminary Evaluation workshop with the SAFELAND Advisory Board (AB) members.** The activity was part of Task T3.2 Preliminary Evaluation, arranged and led by LFV with contributions from the SAFELAND consortium.

This document describes the framework and scope of the workshop. It also provides the readers with insight into the methodology used to retrieve the input from the Advisory Board members and how the results were analysed. Lastly, the readers of this document should gain an understanding of the workshop outcome and the general reception of the initial SAFELAND concepts from the different stakeholders involved.

Founding Members
EUROPEAN UNION EUROCONTROL

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1 Introduction[1]

1.1 Purpose and scope of this document

This Deliverable D3.2 *Preliminary Evaluation Results* reflects the output of task T3.2 *Preliminary Evaluation* and contains the objective results as well as analysis of the first workshop with the stakeholders of the Advisory Board (AB). The document will subsequently serve as an input to the revision process of the initial SAFELAND concept (described in D1.2 Initial concept [1]) in order to refine the final SAFELAND concept which will be presented in deliverable D1.4 *Final Concept* [2].

1.2 Structure of the document

This deliverable presents the framework, methodology, results and analysis of the Preliminary Evaluation workshop with the AB members. The document is structured as follows:

- Chapter **Error! Reference source not found.** (current one): Introduction of the purpose of the document and its structure
- Chapter 2: Explanation of the framework of the Preliminary Evaluation Workshop
- Chapter 3: Description of the methodology used to retrieve and analyse the inputs from the SAFELAND Advisory Board members
- Chapter **Error! Reference source not found.**: Results and Analysis
- Chapter 5: Summary and Conclusions
- Chapter 6: List of the references that were used within this deliverable

1.3 List of acronyms

Term	Definition
AB	Advisory Board
A/C	Aircraft
AI	Artificial Intelligence
AOCC	Airline Operation Control Centre
ATC	Air Traffic Control
ATCO	Air Traffic Controller
BRLOS	Beyond Radio Line Of Sight
BVLOS	Beyond Visual Line Of Sight
ConOps	Concept of Operations

[1] The opinions expressed herein reflect the author's view only. Under no circumstances shall the SESAR Joint Undertaking be responsible for any use that may be made of the information contained herein

CPDLC	Controller Pilot Data Link Communications
CS	Certification Specification
DAA	Detect And Avoid
DH	Decision Height
FHA	Functional Hazard Assessment
FMC	Flight Management Computer
FMS	Flight Management System
GS	Ground Station
GSO	Ground Station Operator (Remote Ground Pilot)
HF	Human Factors
IFR	Instrument Flight Rules
ILS	Instrument Landing System
NAS	National Airspace System
NIL	No Item Listed
OESD	Operational Event Sequence Diagram
PIC	Pilot In Command
RPA	Remotely Piloted Aircraft
RPAS	Remotely Piloted Aircraft System
RTCA	Radio Technical Commission for Aeronautics
SA	Situation Awareness
SJU	SESAR Joint Undertaking
SME	Subject Matter Expert
SMS	Safety Management System
SOCA-CAT	Social Organisation and Cooperation Analysis - Contextual Activity Template
SPO	Single Pilot Operations
TMA	Terminal Manoeuvring Area
UAS	Unmanned Aircraft System
VLOS	Visual Line Of Sight
WP	Work Package

Table 1. List of Acronyms

2 Workshop description

This section describes the overall target, structure and scope of the Preliminary Evaluation Workshop. It explains the different elements contained in the workshop and how they were used to collect expertise knowledge from the AB members attending to the workshop.

2.1 Objectives and scope

It is important to ensure an objective concept viewpoint and to embrace multifaceted inputs to the SAFELAND project in order to derive an innovative yet feasible concept that fits in the complex technical, procedural, regulatory and legal infrastructure of aviation. The SAFELAND concept will therefore undergo a refinement process utilizing external expertise inputs which is done by a Preliminary Evaluation Workshop. The SAFELAND consortium will gain valuable feedback in form of discussions, voting and comments from the AB members during the workshop. The feedback then undergoes a qualitative analysis and serves as complement input in the refinement process of the initial concept.

The objective of the workshop is to gather feedback from the SAFELAND Advisory Board members on three initial versions of the SAFELAND concept developed in Task T1.2 *Concept Development*. The feedback is used to support the refinement of the final version of the concept. Expert inputs are collected for each concept variant and used to evaluate relevant topics (e.g., acceptability, impact on workload) (cf. Table 2).

Objectives	Success criteria
To define a solution that is acceptable from the operational point of view	Positive feedback from the stakeholders of the AB on one of the proposed concept variants or, alternatively, suggestion of an alternative solution.
To define a solution that is safe	Positive feedback from the stakeholders of the AB on one of the proposed concept variants or, alternatively, suggestion of an alternative solution.
To define a solution that is acceptable from the expected impact on workload point of view	Positive feedback from the stakeholders of the AB on one of the proposed concept variants or, alternatively, suggestion of an alternative solution.
To define a solution that is economically acceptable	Positive feedback from the stakeholders of the AB on one of the proposed concept variants or, alternatively, suggestion of an alternative solution.
To define a solution that complies with regulations and laws	Positive feedback from the stakeholders of the AB on one of the proposed concept variants or, alternatively, suggestion of an alternative solution.

Table 2. Objectives and success criteria

More details are provided in D3.1 Evaluation plan [3].

2.2 Time schedule and agenda

The workshop was a one-day activity and held virtually using Webex. It consisted of three main parts (cf. Table 3), i) *introduction* providing the workshop participants (i.e. the SAFELAND Advisory Board), the workshop objectives and a brief introduction of the SAFELAND project, ii) *concept presentation part* where the initial SAFELAND concept with three different concept variants were presented to the participants and discussed. Feedback, comments and voting (using the Mentimeter tool) contributed by the AB were collected during this session, iii) *conclusion part* encouraging the participants to share final thoughts and provide justifications to their views.

Agenda

Time	Activity	Facilitator
09:00 – 09:15	Welcome and Opening	LFV
09:15 – 09:30	Workshop Overview	DBL
09:30 – 09:50	Three initial variants of a SAFELAND concept	DLR
09:50 – 10:00	***B R E A K***	
10:00 – 10:40	Discussion 1: Pilot Incapacitation phase	DLR
10:40 – 10:50	***B R E A K***	
10:50 – 12:00	Discussion 2: Handover phase	DLR
12:00 – 13:00	***L U N C H***	
13:00 – 14:10	Discussion 3: Airport Selection phase	LFV
14:10 – 14:20	***B R E A K***	
14:20 – 15:30	Discussion 4: Emergency descent and Landing phase	EMB
15:30 – 15:40	***B R E A K***	
15:40 – 16:00	Wrap-up of the discussions	DBL
16:00 – 16:30	Discussion 5: Location of the Ground Station	LFV
16:30	End of meeting	LFV

Table 3. Preliminary Evaluation Workshop Agenda

2.3 Participants

The AB consist of Subject Matter Experts (SME) within relevant and important fields related to aviation (cf. Table 4). They cover the following types of institutions:

- Industry
- Institutional bodies
- Air Navigation Service Providers
- Airlines
- Regulatory bodies
- Pilots' representative bodies

Twelve AB members participated to the workshop session, as representatives of the companies listed in Table **4**.

Advisory Board organizations/companies
Dassault Aviation
IAI
DGAC (French CAA)
MATS (Malta Air Traffic Services Ltd)
INCAS (National Institute for Aerospace Research "Elie Carafoli")
STASA
ENAC - Direttore Regolazione Personale e Operazioni Volo
Ministry of Infrastructure and Water Management
ENAV
Aeronautica militare
Ryanair

Table 4. Organizations/companies represented in the workshop

They also have different roles and areas of expertise, as summarised in figure 1.

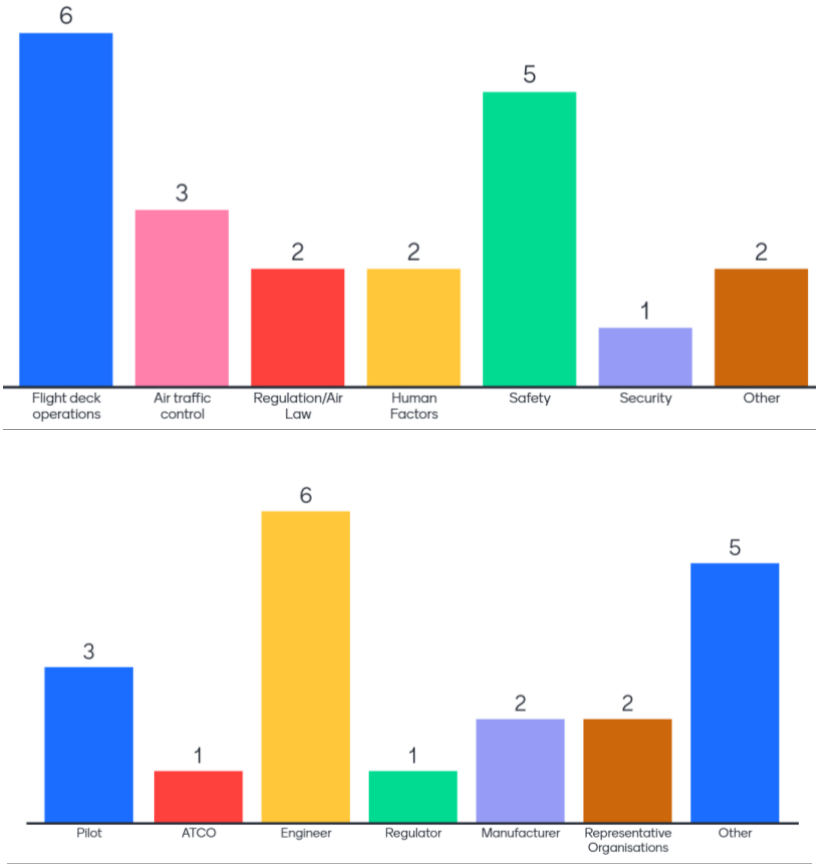

Figure 1. Workshop participant's expertise and background

A **briefing document** providing a short introduction of the initial SAFELAND concept was distributed to the Advisory Board prior to the workshop. The briefing document also explained the scope of the workshop and what to expect at the workshop. Lastly, it also explained the SAFELAND consortium expectation from the advisory board members and their roles in the concept development process.

2.4 Assumptions

Assumptions to be considered during the Preliminary Evaluation Workshop were communicated in a briefing document sent out to the AB prior to the workshop. The list of assumptions was developed and presented in a deliverable of WP1 (D1.2 SAFELAND Initial Concept [1]), and it is shown in the assumption bullet points below.

Assumptions:

- Nominal flight conditions apart from single pilot incapacitation.
- Presence of a ground station that would at least monitor aircraft system and pilot health throughout the flight, operated by a human operator, the Ground Station Operator (GSO). Further, in order to have (financial) advantages compared to dual piloted operations, one GSO is assumed to be monitoring several aircraft at the same time. In an emergency event of one aircraft, the remaining (healthy) aircraft would be transferred to another ground station

operator giving the GSO the opportunity to solely concentrate on the aircraft in need of assistance. The GSO would thus become a dedicated remote pilot for this aircraft.

- The single pilot aircraft is equipped with more sophisticated automation than a current CS-25 certified aircraft (e.g. onboard pilot health monitoring system, reliable and sufficient data link to other actors without latency). Onboard automation is able to refuse/reject instructions issued by any human operator from ground if they are outside the performance limits of the aircraft, hence not compliant with aircraft capabilities. In addition, the landing airport supports ILS CAT IIIc approaches, which are currently not operational.
- Presence of an onboard pilot health monitoring system capable of detecting an incapacitation and automatically informing relevant actors. After the pilot incapacitation is detected (and verified), the emergency procedure would be to land the aircraft as soon as possible in order to not put aircraft, pilot and passenger safety at risk.
- The workshop focused solely on total pilot incapacitation.
- To give a frame to the discussion, we assume a 2-3 hours flight en-route over Europe in which the pilot incapacitation occurs during cruise. The rationale for this assumption was that due to its accumulated duration compared to the departure and landing phases, the cruise phase is the most probable phase in flight for a pilot incapacitation to occur.

In addition, the AB members were asked to come with a futuristic mind-set as SAFELAND is an exploratory research project.

3 Methodology

3.1 Input from Preliminary initial Concepts

Before the workshop, the SAFELAND consortium developed an initial concept (as presented in D1.2 [1]) that serves the basis and background material for the workshop. The initial concept is comprised of three concept variants associated with three different focuses, i.e. Automation focused, Ground Station focused and ATC focused. The strategy is to refine the initial concept by performing evaluation and analysis, and identifying weaknesses, strengths, key features as well as necessary changes, remove, add or combine elements of the three different concept variants into a final concept.

3.2 Phase specific analysis

This section describes the phase specific sessions related to each concept (i.e., Automation, Ground Station, ATC focused concepts). To simplify the discussion, the three concept variants have been presented phase by phase; in other words, for each phase a description was provide about how the different variants were handling pilot incapacitation.

3.2.1 Operational Event Sequence Diagrams (OESD)

All three concepts identify four main flight phases:

- Pilot incapacitation phase,
- Handover phase,
- Airport selection phase and
- Emergency descent and Landing phase.

Each of the flight phases are described by an operational event sequence diagram (OESD) that displays the operational and communication flow. Each concept variant is described in each flight phase, (cf. Figures 2-7).

During the workshop, a SAFELAND consortium member presented and explained the OESDs for the AB members. Questions and clarifications were also possible during these presentations.

The presentations shown during the workshop are provided in the following figures.

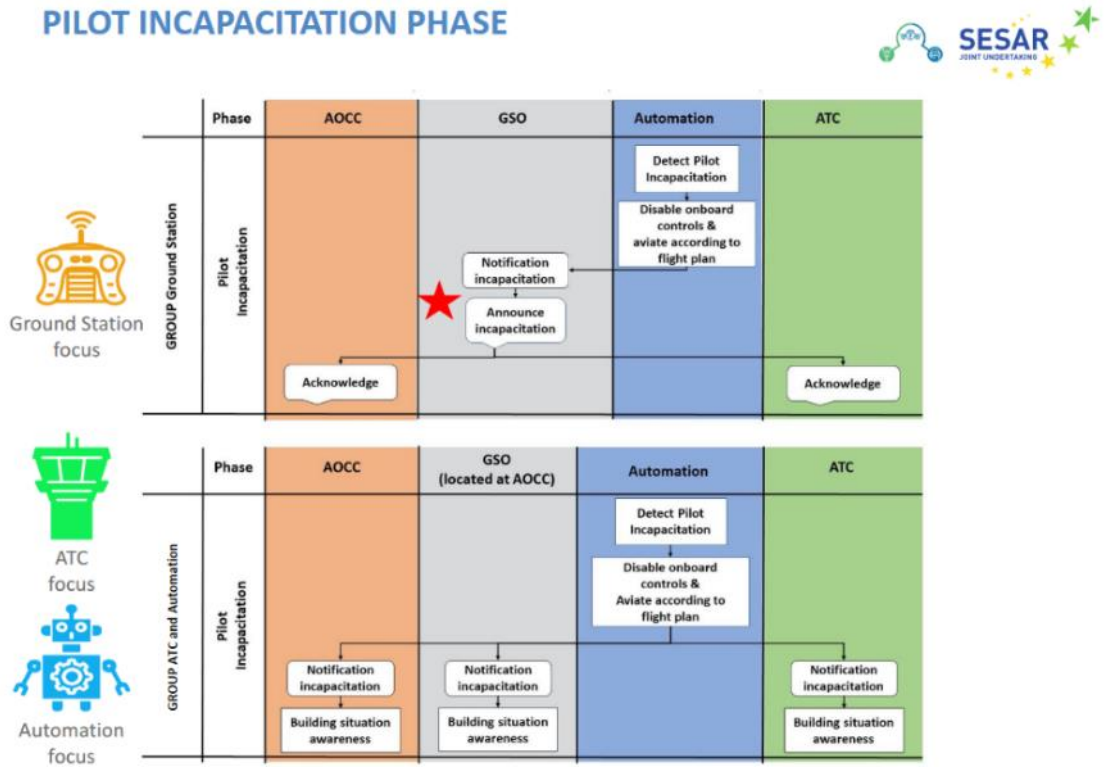

Figure 2. Pilot Incapacitation Phase

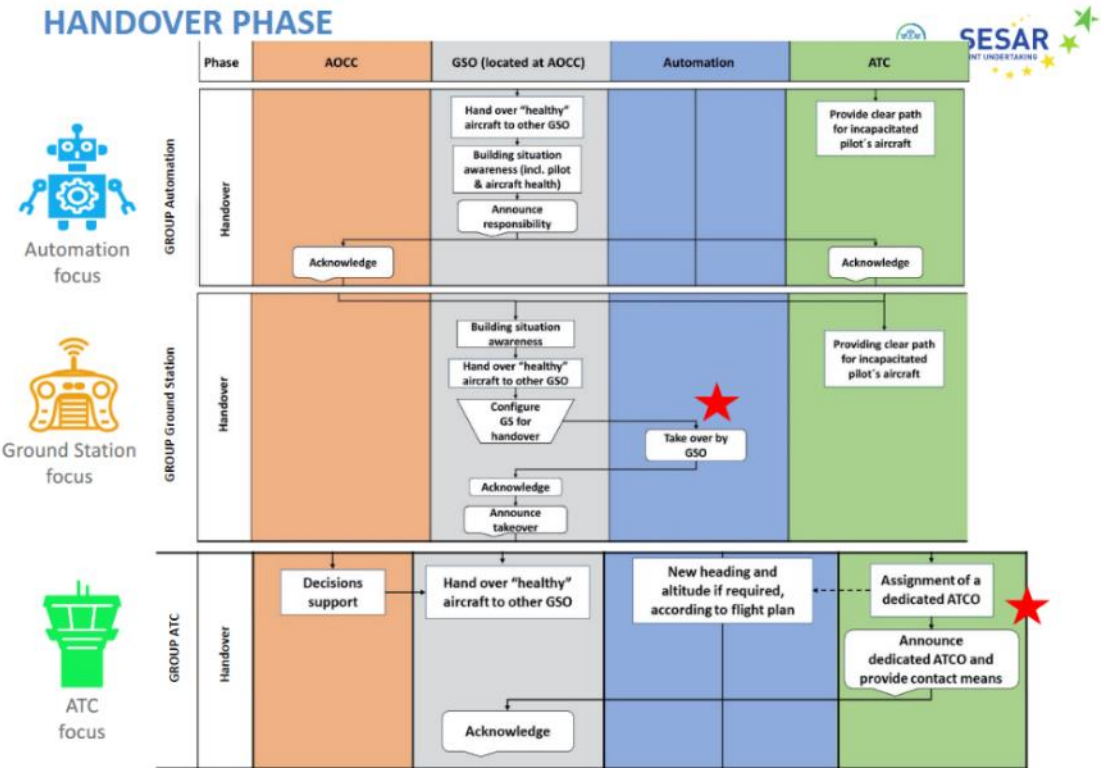

Figure 3. Handover Phase

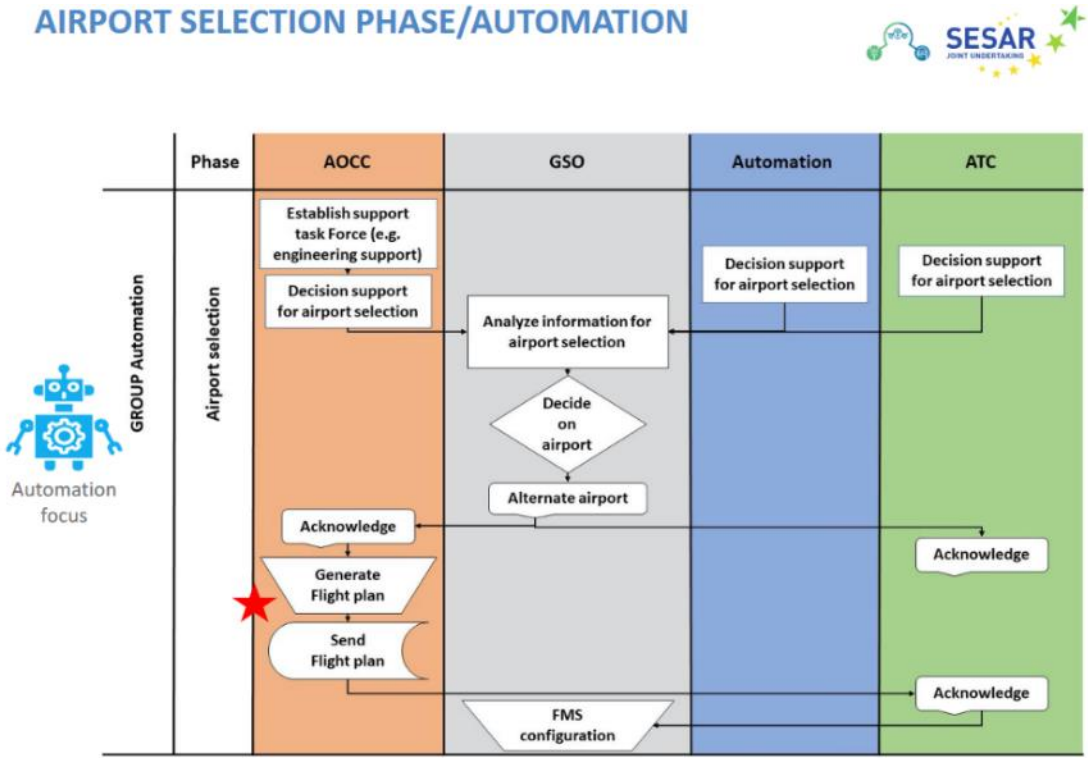

Figure 4. Airport Selection Phase (Concept – Automation)

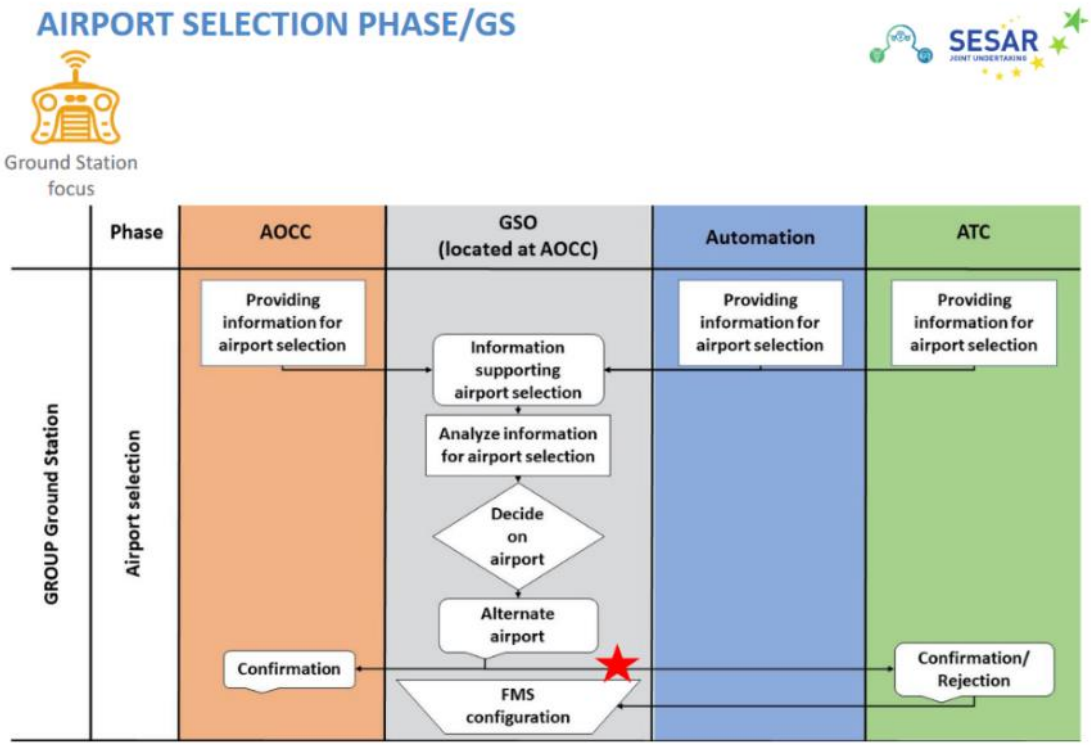

Figure 5. Airport Selection Phase (Concept – Ground Station)

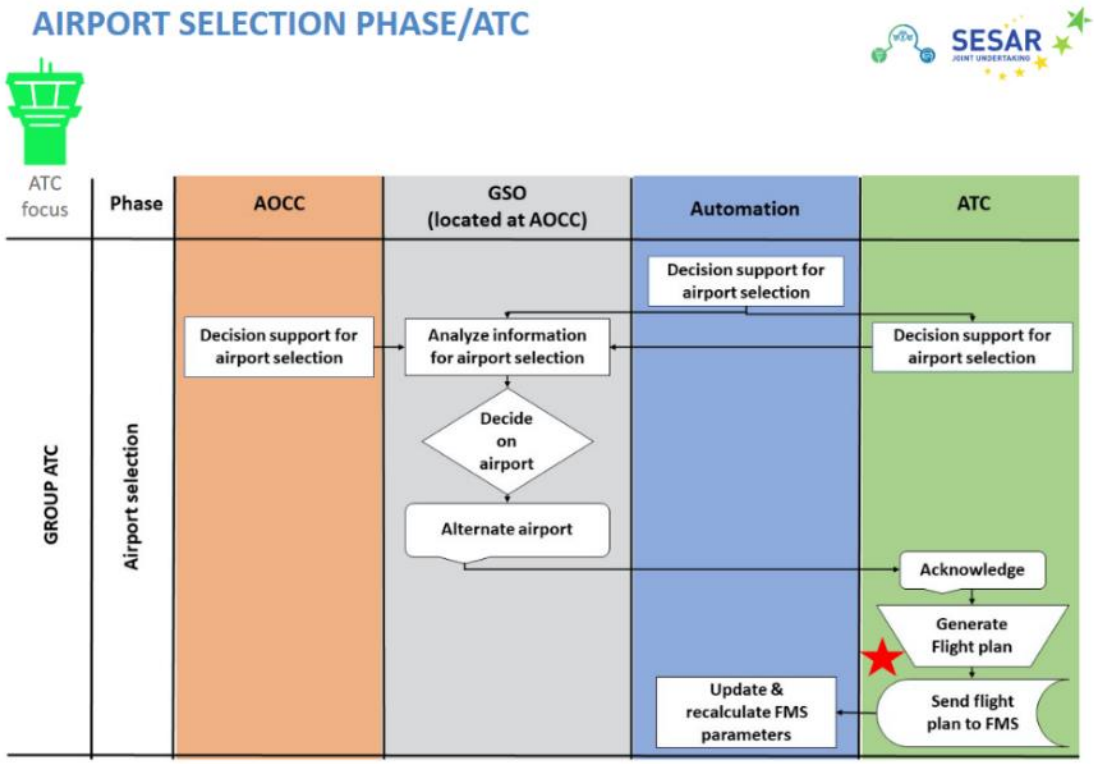

Figure 6. Airport Selection Phase (Concept – ATC)

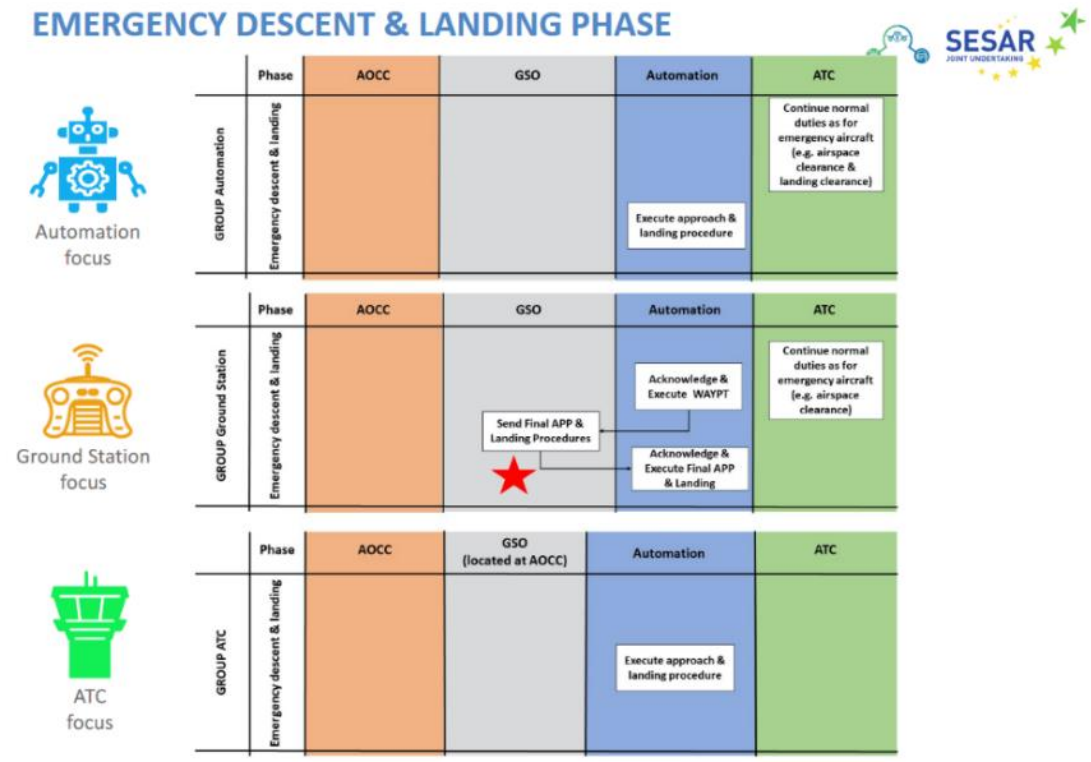

Figure 7. Emergency Decent & Landing Phase

3.2.2 Mentimeter

To make the most from the limited time available and facilitate feedback collection, an online pooling tool has been used.

Mentimeter is an interactive online tool used in this workshop to collect inputs provided by the AB. Voting and written comments related to the different phases of the concepts were collected from AB members using this tool. Mentimeter sessions were performed after each phase of each concept. Therefore, the results were presented in real time during the workshop and the participants were able to see and discuss the results. An example view of a Mentimeter session is shown in figures 8-10.

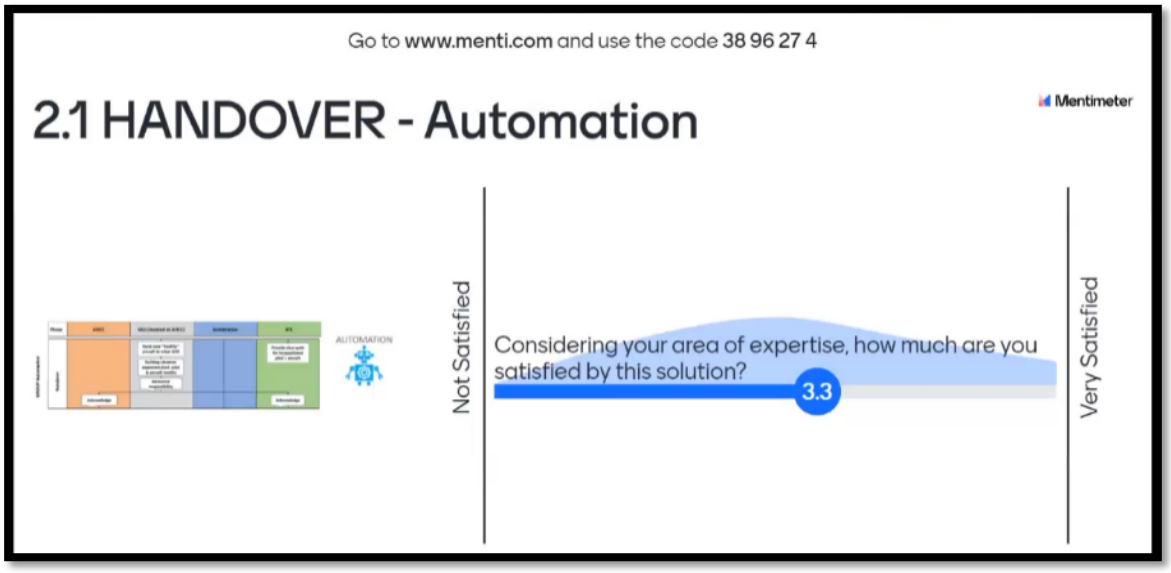

Figure 8. Voting in Mentimeter, overall score (Handover phase – Concept Automation)

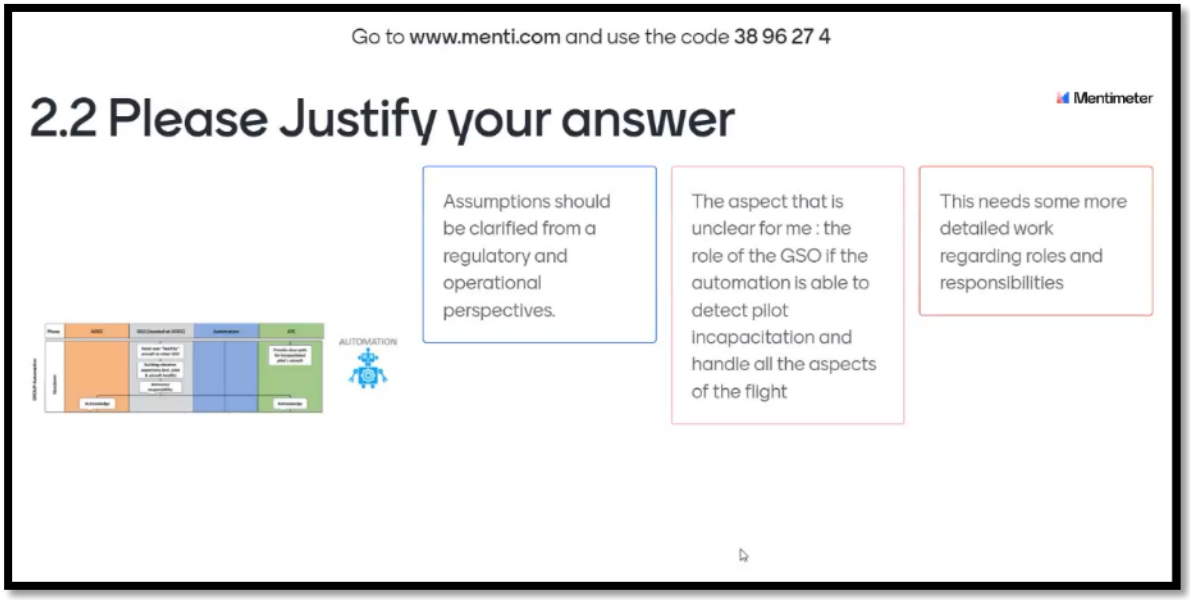

Figure 9. Comment section in Mentimeter (Handover phase – Concept Automation)

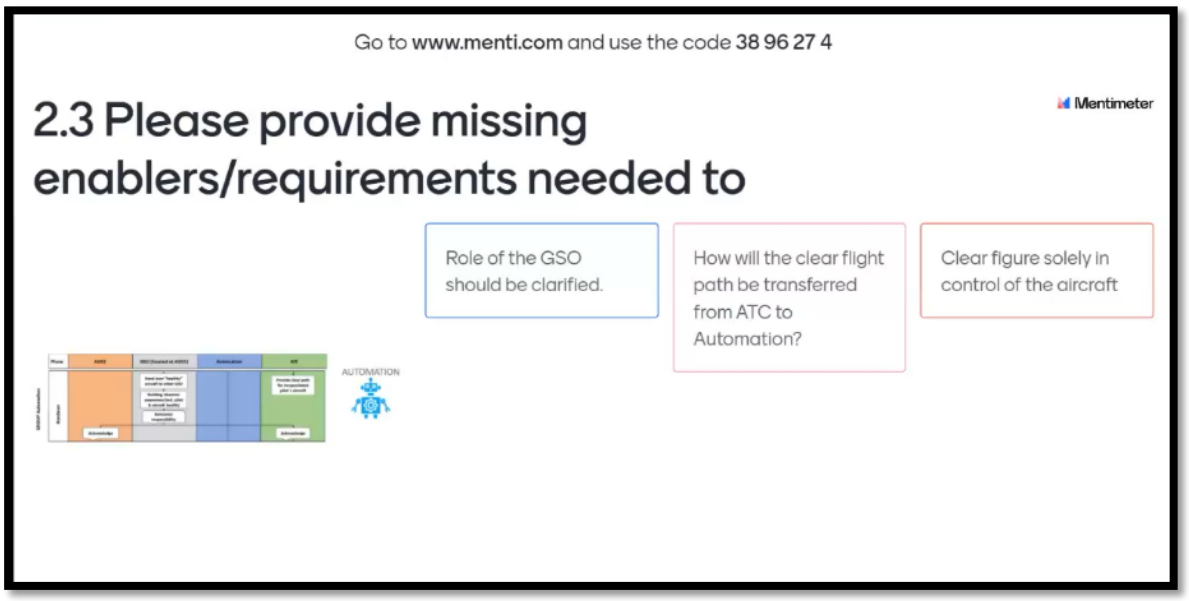

Figure 10. Comment section in Mentimeter (Handover phase – Concept Automation)

3.2.3 Discussion session

A verbal discussion took place after each phase in connection with the Mentimeter sessions. The motivation was to capture any ambiguities and to give the AB a chance to share thoughts and opinions, as well as commenting others feedback. This is an essential step to ensure high quality feedback and to gain details that the written comments perhaps did not capture.

3.3 Location of ground station

The concept consists of different concept variants (Automation, Ground Station and ATC). The similarity between them is that they all utilise a ground station that serves certain function before, during and after pilot incapacitation. The aspects of the location of the ground station were considered by a dedicated session during the workshop where the AB members could provide the SAFELAND consortium with comments and inputs in the same manner as in the flight-phase sessions. An overview table was presented to the AB as discussion basis, (cf. Table 5).

LOCATION OF THE GROUND STATION

Location	Pros	Cons
AOCC	• Fast and efficient provision of airline/aircraft expert personnel • Airport selection • Faster decision making • Airline specific procedures • Liability remains with the airline as is today • GS at AOCC becomes legal responsible over a/c	• New infrastructure in place for communication between ATC and GS • Cyber-Security • Smaller airlines difficulties to provide GS at AOCC • Latency
Other options • ATC • Airport • GS for multiple airlines	Efficient communication (ATC/GS), Cyber-Security Latency issues, line of sight remote landing Easier for smaller airlines	Liability, communication (GS/AOCC) Economical, communication Cyber-Security, Latency

Table 5. Discussion basis for the Location of the Ground Station.

3.4 AB workshop Results Analysis

The Preliminary Evaluation Workshop results analysis was performed by combining workshop inputs in form of voting, written and verbal feedback from the AB. The feedback was structured by dividing it into different categories, (cf. Table 6). The categorised feedback and main conclusions are presented in the Result & Analysis section (cf. chapter 4).

No	Input category
1	Safety aspects
2	Security aspects
3	Human Performance aspects
4	Legal and Regulatory aspects
5	Technical feasibility aspects
6	Operational aspects

Table 6. Input category

4 Results & Analysis

This section presents the results from the Preliminary Evaluation Workshop.

The results are divided into four flight phases, i.e. Pilot Incapacitation phase, Handover phase, Airport Selection phase, Emergency descent & Landing phase, related to each concept variant. It also presents the feedback on the location of the ground station.

In the subsections “Mentimeter result” (cf. subsection 4.1.1, 4.2.1 and 4.3.1), the Mentimeter voting is presented (cf. Table 7-9) and in the subsections “Feedback Analysis” (cf. subsections 4.1.2, 4.2.2 and 4.3.2), comments from the advisory board are clustered, analysed and presented in related tables.

Every input is coded with the following structure:

The first set of character/characters denotes the Concept (Automation, Ground Station or ATC), described below:

A = Automation concept
GS = Ground Station concept
ATC = ATC concept

The Location of the Ground Station have the following set of characters:
GSL = Ground Station Location

The second set denotes the category, described below:

S = Safety aspect
SE = Security aspect
HP = Human Performance
L = Legal and Regulatory
T = technical feasibility
O = Operational aspect

The third set denotes the type, described below:

C = Cons
P = Pros
R = Recommendation
OQ = Open Questions

Lastly an identity number is added at the end. An example of an ID code for an Open Question comment under the automation concept in the safety category would be: ASOQ1

Main conclusions are presented in section 5 (Conclusions).

The raw comments from the Advisory Board can be found in appendix A.

4.1 Concept – Automation

In this section, the input results from the Automation Concept are presented.

4.1.1 Mentimeter result

Mentimeter results from the four different phases for the **Automation Concept** are presented below in table 7. Mentimeter question: ***Considering your area of expertise, how much are you satisfied by this solution?*** (Higher score means higher level of satisfaction). Due to a low statistical number of votes, the score presented in the table is only view as an indication of opinion from the AB.

Phases	AUTOMATION
PILOT INCAPACITATION	3,1
HANDOVER	3,2
AIRPORT SELECTION	2,5
DESCENT & LANDING	2,9
	2,9
	out of 5

Table 7. Mentimeter voting results for the Automation Concept. Top of the table: average scores for the different phases (Scale 1-5). Bottom of the table: average score for the concept in bold.

4.1.2 Feedback Analysis

Comments from the advisory board regarding the Automation Concept are presented in tables below

4.1.2.1 Safety

4.1.2.1.1 Cons

ID	Issue	Affected phases
ASC1	**Reliance on automation and response to automation failure.**	All

4.1.2.1.2 Recommendations

ID	Recommendation	Affected phases
ASR1	**Sufficient level of detail to carry out a proper safety assessment for the concept.**	All

4.1.2.2 Security

4.1.2.2.1 Cons

ID	Issue	Affected phases
ASEC1	**The present policy of keeping the cockpit secure from the inside would require to be changed to enable cabin crew to access and help the pilot if required.**	Pilot Incapacitation

4.1.2.2.2 Recommendations

ID	Recommendation	Affected phases
ASER1	**Safety cyber security requirements.**	Pilot automation

4.1.2.3 Human Performance

4.1.2.3.1 Cons

ID	Issue	Affected phases
AHPC1	**Level of dependence to automation vs human capabilities.**	All
AHPC2	**Management of information required for effective decision making.**	Airport Selection

4.1.2.3.2 Recommendations

ID	Recommendation	Affected phases
AHPR1	**Definition of exact roles and function for each party involved to avoid confusion.**	All
AHPR2	**Assurance of coherent Situational Awareness build up during Handover Phase.**	Pilot incapacitation, Handover
AHPR3	**Develop tools to improve strategic decision making.**	Airport Selection

4.1.2.3.3 Open questions

ID	Question	Affected phases
AHPOQ1	**To improve GSO situational awareness, should he be provided with video feed over the aircraft position/cockpit?**	All

4.1.2.4 Legal & Regulatory

4.1.2.4.1 Pros

ID	Aspect	Affected phases
ALP1	**Responsibilities are clearer with this scenario**	Handover

4.1.2.4.2 Recommendations

ID	Recommendation	Affected phases

ALR1	**The concept is clear but requires more evaluation of roles and responsibilities.**	All
ALR2	**Need to look on works done on R&D of the European community R&D regarding alternative airports and decisions**	Airport selection
ALR3	**It is required a high clarity about who is in control of the aircraft. Moreover, the liable actor/s must be specified considering that the operator (airline) would never accept the liability related to the actions of someone that is not an employee of the airline itself.**	All
ALR4	**Legal framework for GSO shall be addressed in more details.**	All
ALR5	**The automation will be responsible for notification to all participants.**	Pilot Incapacitation, Handover
ALR6	**The distribution of the liabilities and responsibilities of the different actors shall be made very clear (e.g. between aircraft operator and automation provider or aircraft operator and ANSP).**	All
ALR7	**The remote pilot becomes the new pilot-in-command with the associated roles and responsibilities.**	All
ALR8	**Assumptions should be clarified from a regulatory perspective.**	All
ALR9	**ICAO RPAS Manual should be considered.**	All

4.1.2.4.3 Open questions

ID	Question	Affected phases
ALOQ1	**How can the future legal changes be anticipated?**	All
ALOQ2	**Who is responsible in this scenario? Who is checking the automation? How are information shared?**	Pilot Incapacitation

4.1.2.5 Technical feasibility

4.1.2.5.1 Cons

ID	Issue	Affected phases
ATC1	**Difficulty of the datalink availability if the selection of the destination airport is performed by the remote pilot in the ground station.**	Airport selection
ATC2	**Backup and Takeover assurance**	All

4.1.2.5.2 Pros

ID	Aspect	Affected phases
ATP1	**Technologies already present**	Handover

4.1.2.5.3 Recommendations

ID	Recommendation	Affected phases

ATR1	**Performance of C2 link**	All
ATR2	**Decision upon technology needed: SAT control link (to be used over the world for BRLOS) or GCS with radio link (radius of 200km of coverage)**	All
ATR3	**Definition of required Level of automation.**	Descending&Landing
ATR4	**Automation should be really reliable.**	All
ATR5	**Intervention from the ground to update the automated system**	Descent and Landing

4.1.2.5.4 Open questions

ID	Question	Affected phases
ATOQ1	**Automation of system with limited or full authority?**	All
ATOQ2	**More information regarding technical requirements for data sharing and exchange and expected recovering scenario.**	All

4.1.2.6 Operational aspects

4.1.2.6.1 Cons

ID	Issue	Affected phases
AOC1	**Apart from cyber related issues, a remote pilot has to be available on a 24-hour basis possibly doing nothing during this time awaiting an emergency involving an incapacitated pilot. Maybe operators would find this expensive to maintain.**	GS Location
AOC2	**Need to clarify what is done by the remote pilot.**	Pilot Incapacitation
AOC3	**ATC and Automation don't know company policies. Therefore, they might take a different decision compared to what an airline should take. On the other side, if the AOCC should take role in this part, the communication will require time**	All
AOC4	**Some sort of intervention from the ground would still be required**	Descent and Landing
AOC5	**Showing the GSO line empty is a little bit misleading. In fact, the remote pilot has the duty to detect if something goes wrong and take the appropriate action.**	Pilot Incapacitation

4.1.2.6.2 Pros

ID	Aspect	Affected phases
AOP1	**As long as all necessary and required information regarding a pilot-incapacitated aircraft has been shared with ATCOs, s/he will be able to handle this emergency situation.**	Pilot Incapacitation

AOP2	**Automation could identify the incapacitation- trigger the ground pilot that take in control the aircraft and share with pilot on ground all the info and data useful to fly and land the A/C.**	Handover

4.1.2.6.3 Recommendations

ID	Recommendation	Affected phases
AOR1	**The project must clearly define roles, responsibilities and functions of GSO and ATCOs.**	All
AOR2	**There should be clear scenario with kind of templates to provide emergency support.**	Airport Selection
AOR3	**Remote pilot role (monitoring etc.) shall be clearly defined**	Descent and Landing
AOR4	**The role of the GSO should be detailed in this concept as everything seems to rely on automation.**	Pilot Incapacitation
AOR5	**Requirements for adequate airports pre-identification. Faster communications between the parties.**	Airport Selection
AOR6	**Responsibilities of each party need more clarification**	Handover
AOR7	**The network of suitable airports should already be organized for this scenario.**	Airport Selection
AOR8	**Details of available airports along the route of flight should be immediately available to the remote pilot**	Airport Selection
AOR9	**Strategic preparation done in pre-flight and only tactical decisions during airport selection phase.**	Airport Selection

4.1.2.6.4 Open questions

ID	Question	Affected phases
AOOQ1	**How will the clear flight path be transferred from ATC to Automation?**	Handover
AOOQ2	**Role of GSO is not clear**	Handover
AOOQ3	**Interaction between remote control station and cabin crew onboard**	Pilot Incapacitation
AOOQ4	**What would be the implications and next steps?**	Pilot Incapacitation

4.1.3 Automation focused concept result summary

The Automation concept has been overall judged positively and numerous inputs have been received in each of the highlighted areas.

Safety:

The main concern for safety is the level of reliability of the automation. The automation needs to be capable of coping with datalink failures and maintain required safety levels in all conditions. This

requirement will be considered when proposing the new systems we are expecting will be needed to support the SAFELAND solution (D3.4).

Moreover, procedures need to be established to account for the possibility of automation failure. This will be considered in the generation of the final concept.

The level of details regarding the concept needs to be increased to allow for a complete safety assessment. This will be done in WP3 (Safety Assessment).

Security:

A complete cybersecurity assessment needs to be carried out for this concept, given the important role of automation based on remote connection. This will be done in WP3 (Cyber security assessment analysis)

An additional issue to be considered is the management of the cockpit door as the incapacitation occurs. Most companies at the moment have a “closed cockpit policy”, whereby entrance to the flight deck is granted only under specific security rules. This aspect needs to be considered for the application of the concept, in case cabin crew intervention will be included.

Human Performance:

The main problematic is the level of dependence of this concept from automation: too much high automation may reduce SA of the human actors involved. This is of course an issue common to the introduction of higher levels of automation in general. For the descent and landing phase, there is confusion concerning the role of GSO in regard to his/her intervention capabilities and monitoring requirements. Concerning this, the possibility of placing video cameras to provide the GSO with visual feedback should be considered.

Another important aspect is represented by the management of the airport selection phase, during which a fundamental requirement is the establishment of efficient decision-making supporting tools for the GSO to enhance his/her situational awareness. Focus is to be given on clearly defining roles of each team member. To be detailed in the Final Concept.

Legal and Regulatory:

The overall concept does not present too many difficulties concerning the applicable legal framework, since references can be made to the existent technical regulations applicable to automation in aviation (mainly focused on “manned” aircraft).

Taking into consideration in any case an RPA may be used for its implementation, there is the requirement to clearly define the figure of the PIC, identified in the GSO, highlighting his role, capabilities, and responsibilities.

Technical:

Datalink performance and reliability is the main technical aspect to be considered to assure the concept implementation. Some of the technologies are already present and frequently utilized by the militaries. This is for sure a requirement for the new systems needed for the SAFELAND solution implementation.

Another aspect to be considered concerns the level of advancement of the on-board automation, which may present a technological challenge expanding the time frame of the concept implementation; this point in particular depends on the chosen level of autonomy for the automation. The type of needed on-board automation needs to be better defined in the final concept.

Operational:

The level of automation needed for the concept potentially renders it an efficient solution. However, roles and responsibility, as well as capabilities of intervention and monitoring from the GSO, needs to be clearly defined.

The overall functioning of the system will depend on the way data are shared between each team member and the automation. In this regard there is the need to support decision making capabilities of the GSO, providing him/her with detailed briefings concerning the flight, and a pre-identification of possible solutions, to aid his/her strategic decision making (ex: pre-identification of adequate alternates at flight planning stage.)

For what concerns ATC, provisions need to be made concerning traffic separation to allow smooth management of the situation.

Finally, as high levels of automations are involved, complacency problems for the GSO need to be considered as, for most of the duty time, he may have very low level of workload, rapidly increasing during an emergency.

4.2 Concept– Ground Station

In this section the input results from the Ground Station Concept are presented.

4.2.1 Mentimeter result

Mentimeter results from the four different phases for the Ground Station **Concept** are presented below in table. Mentimeter question: ***Considering your area of expertise, how much are you satisfied by this solution?*** (Higher score means higher level of satisfaction). Due to a low statistical number of votes, the score presented in the table is only view as an indication of opinion from the AB.

Phases	GS
PILOT INCAPACITATION	3,5
HANDOVER	3,1
AIRPORT SELECTION	3,4
DESCENT & LANDING	2,7
	3,2
	out of 5

Table 8. Mentimeter voting results for the Ground Station Concept. Top of the table: average scores for the different phases (Scale 1-5). Bottom of the table: average score for the concept in bold.

4.2.2 Feedback Analysis

Comments from the advisory board regarding the Ground Station Concept are presented in tables below.

4.2.2.1 Safety

4.2.2.1.1 Cons

ID	Issue	Affected phases
GSSC1	**Reliance on automation and response to automation failure.**	All
GSSC2	**Delegate responsibilities to third party, which are not actively involved, is not the best way to deal with situation**	All

4.2.2.1.2 Recommendations

ID	Recommendation	Affected phases
GSSR1	**Backup system in case of automation failures.**	All
GSSR2	**Backup system in case of Datalink failure.**	All

4.2.2.2 Human Performance

4.2.2.2.1 Cons

ID	Issue	Affected phases
GSHPC1	**Training requirements for the GSO, which should have a pilot training and be also qualified to act as new pilot in command.**	All
GSHPC2	**GSO arousal levels and possible startle effect.**	Handover, Airport Selection
GSHPC3	**Decision making process may be too much complicate.**	Airport Selection

4.2.2.2.2 Pros

ID	Aspect	Affected phases
GSHPP1	**Logic sequence of events.**	Airport Selection
GSHPP2	**One trained person taking the decision based on information gathered from different parties. S/he become the PIC and therefore partly responsible for the reminder of the flight. Quicker communication available and execution of the selected option.**	Airport Selection

4.2.2.2.3 Recommendations

ID	Recommendation	Affected phases
GSHPR1	**Allow easy and complete sharing of information between party members.**	Airport Selection
GSHPR2	**Definition of exact roles and function for each party involved to avoid confusion.**	All
GSHPR3	**Detailed determination of GSO roles and functions**	Descent and Landing
GSHPR4	**Comprehensive and reliable technical information with regards to incapacity reason.**	Pilot Incapacitation
GSHPR5	**Quick and concrete sharing of information is paramount to avoid time wasting and misunderstanding**	Airport Selection
GSHPR6	**Training program for ATC and remote pilot, development of a system quick enough to elaborate tactical decision base about NOTAM, airport and aircraft performances, to be use as an assistance**	All
GSHPR7	**GSO training and requirements for that new role may also be considered**	All
GSHPR8	**The complete duty of the remote pilot has to be detailed as in the two other concepts.**	Descent and Landing

4.2.2.2.4 Open questions

ID	Question	Affected phases
GSHPOQ1	**What would happen in case of disagreement between party members during the airport selection phase?**	Airport Selection
GSHPOQ2	**What method should be employed to ensure the GSO obtains the required level of situational awareness to act correctly in this situation?**	Airport selection

4.2.2.3 Legal & Regulatory

4.2.2.3.1 Cons

ID	Issue	Affected phases
GSLC1	**Detect and Avoid is still a technological lock in Class G and Class E.**	All

4.2.2.3.2 Pros

ID	Aspect	Affected phases
GSLP1	**The situation is very similar to what the ICAO RPAS Panel is working, so international regulations will be available in a few years. It will be addressed in future EU regulation.**	Pilot Incapacitation
GSLP2	**The situation shows a lot of similarities with the RPAS work at ICAO, so it is possible to build on the experience gained with the ICAO work. Issues such as handover procedures and airworthiness are already addressed there.**	Handover

GSLP3	**Remotely Piloted Aircraft system (RPAS) Concept of OperationS (CONOPS) for International IFR operations (icao.int) and Microsoft Word - Doc.10019.1st Edition.alltext.en.docx (skybrary.aero) could be input for the concept. Therefore, there are some regulatory starting points for the proposed solution.**	Handover
GSLP4	**Remote pilots are already addressed by the current European regulation (i.e. Commission Implementing Regulation (EU) 2019/947) even if not yet for "certified" UAS carrying passengers. The relevant regulation should arrive in a few years.**	Handover

4.2.2.3.3 Recommendations

ID	Recommendation	Affected phases
GSLR1	**Clarifications on the real meaning of the process in terms of legal responsibility and technical authority are required.**	Handover
GSLR2	**A case study should be implemented. Then, it would be possible to consider the lessons learned.**	All
GSLR3	**Protocols and regulations about the work of the remote pilot shall be considered.**	All
GSLR4	**Regulations for SPO and automation use. Legal definitions of responsibilities**	Pilot Incapacitation
GSLR5	**There has to be a very strict protocol with limited options.**	Airport Selection
GSLR6	**As the aircraft would virtually become an RPA, relevant procedures for RPA operations within controlled airspace have to be defined for every airspace the aircraft will be flying through.**	All
GSLR7	**Law advice about responsibility and insurance coverage Airline interaction and discussion about the all subject**	Handover

4.2.2.3.4 Open questions

ID	Question	Affected phases
GSLOQ1	**Are all the airports expected to be able to allow RPAS aerodrome operations (landing, take-off,)?**	Airport Selection

4.2.2.4 Technical feasibility

4.2.2.4.1 Cons

ID	Issue	Affected phases
GSTC1	**Loss of Datalink connection**	All

4.2.2.4.2 Pros

ID	Aspect	Affected phases

GSTP1	**Remote pilot control (or GSO) is already used by military. Part of the technology already exists**	All

4.2.2.4.3 Recommendations

ID	Recommendation	Affected phases
GSTR1	**FHA**	Pilot incapacitation
GSTR2	**Define GS location**	Handover
GSTR3	**Type of connection (BRLOS, BVLOS) needed**	All
GSTR4	**Consult: "Minimum Aviation Systems Performance Standard for Remote Pilot Stations supporting IFR operations into non-segregated airspace"**	All
GSTR5	**Reliable C2 link**	All
GSTR6	**Automation system able to disable on board controls of an airliner needs a very high level of reliability and will have to be acceptable to the public.**	Pilot Incapacitation
GSTR7	**Level of Automation support in the aircraft.**	All
GSTR8	**In such an unusual situation control from the ground at least until the final phase of the flight in conjunction with automation for landing would be desirable**	Descent and Landing
GSTR9	**On board camera could help to provide situational awareness to the remote pilot**	Descent and Landing

4.2.2.5 Operational aspects

4.2.2.5.1 Cons

ID	Issue	Affected phases
GSOC1	**Cross Border Area (CBA) seems to be very hard to be produced**	Pilot incapacitation
GSOC2	**Manoeuvre of an RPAS in controlled airspace (contingency, latency, etc.)**	All
GSOC3	**Need to rethink announcing the incapacitation in parallel instead of after automation taking over. in general the concept is missing few areas that need to be addressed such as Emergency declare**	Pilot incapacitation
GSOC4	**Delegate responsibilities to third party, which are not actively involved, is not the best way to deal with situation**	Pilot Incapacitation

4.2.2.5.2 Pros

ID	Aspect	Affected phases
GSOP1	**Possibility of immediately maintain flight path safety during a situation (remote but possible) of incapacity**.	Pilot incapacitation

GSOP2	**It is quite clear that a procedure where a GSO with a qualified remote pilot maintains direct contact with an ATCO would be similar to current RPAS operations set up.**	All
GSOP3	**There is a final check when the aircraft is in the vicinity of the landing airport. If communications with the aircraft are lost, this would give time to the ATCO to make sure that the airport can accept the aircraft.**	Descent and Landing
GSOP4	**The interactions between the ATCO and the aircraft could be very simple and also automated.**	Descent and Landing
GSOP5	**The GSO can be a pilot who know procedures of the airline, performances of the aircraft and create a decision based on his knowledge and company inputs. Also, from responsibility point of view, he can share part of the responsibility for the outcome.**	All
GOP6	**The automatic take over by automation guarantees 'the safety'**	Pilot Incapacitation

4.2.2.5.3 Recommendations

ID	Recommendation	Affected phases
GSOR1	**Contingency procedures in case of fault in change control from air/to ground need to be defined**	Handover
GSOR2	**Pilot incapacitation is recognized and treated as an emergency situation. Therefore, ATCOs should have proper trainings to handle this particular situation.**	Pilot Incapacitation
GSOR3	**Once pilot incapacitation has occurred, ATCOs should realize that the aircraft is being flown remotely and that certain type of separation provision must be applied in order to maintain a safe separation from other aircraft.**	Pilot Incapacitation
GSOR4	**Need to rethink announcing the incapacitation in parallel instead of after automation taking over.**	Pilot Incapacitation
GSOR5	**Proper training for all members involved (costs?)**	Pilot Incapacitation
GSOR6	**To train a competent remote control operator is complex, he/she have to embrace high level of situation awareness, decisions makings, this usually takes years, and is not for everyone, you can be a good pilot but not a good captain, you need both in this instance.**	All
GSOR7	**The remote pilot is required to have all flight plan information and airports available along the route which could be used for the diversion.**	Airport Selection
GSOR8	**Need to clarify what is done by the remote pilot.**	Descent and Landing

4.2.2.5.4 Open questions

ID	Question	Affected phases

GSOOQ1	**Is there a ground station per airline? Or per flying area? Is there a GSO per aircraft model? Or a generic pilot?**	All
GSOOQ2	**What if the automation for takeover fails?**	Pilot Incapacitation
GSOOQ3	**Training requirements for both the GSO and single pilot. Requirements also for checking. Intercommunication between the aircraft and GSO.**	Pilot Incapacitation
GSOOQ4	**Role of the GSO should be clarified.**	Handover
GSOOQ5	**Provide details on what can be done before the flight (strategic) and what needs to be done during flight (tactical).**	Airport Selection
GSOOQ6	**If the role of the GS is replacing the pilot (incapacitated) than it means that he will have to directly fly the airplane. Should a more autonomous concept be instead considered?**	Descent and Landing
GSOOQ7	**I could not see in the concept how many GS will be required? Is one centre with remote other GS or in each airport? or area?**	Descent and Landing

4.2.3 GS focused concept results summary

The GSO focused concept overall received the highest appraisal levels.

Safety:

A problematic is the concept dependence from automation, posing potential problems in case of automation failure. This issue will be addressed in WP3 (Safety Assessment).

A back up system and procedures should be established both accounting for this and also for the possibility of datalink failure.

Human Performance:

The sequence of events and overall concept flow is regarded as logical and efficient, however some points need to be cleared. The role and responsibilities of the GSO needs to be detailed; as he/she is going to be the new PIC of the aircraft, it is paramount that he/she has received the required training to act as the new “captain” of the aircraft. Additionally, the GSO needs to retain the required level of authority over the aircraft flight path.

A critical aspect is the maintaining of good levels of SA for the GSO. The GSO SA will strictly depend on the quality of information he/she will have at his/her disposal (latency effects should also be taken into consideration, as well as the possibility of installing cameras for video feed).

Since multiple members are involved in the different phases, provision for internal coordination and avoidance of communication issue needs to be detailed, in particular for the phase of airport selection.

Finally, the question of automation complacency needs to be accounted for: as the GSO levels of workload may dramatically increase during the emergency situation, in comparison to routine duties, he/she may suffer from startle effect.

Legal and Regulatory:

The GSO concept benefits from the similarity with RPAS operational concepts. Both ICAO and EU published several guidelines on this matter, which can be used for support, even if not many binding rules are currently issued for "certified" UAS operations. The main requirement is the clear definition of GSO role and responsibilities, to assess the related Operator liability.

Another point which needs clarification concerns the diversion airport requirements. On this aspect, it is relevant to clarify if the aircraft should be "certified" to land only in special airports and if the diversion airports may be planned in the strategic phase (scheduling the flight).

Technical:

Many technical questions raised. The levels of automation and its sophistication should be clearly detailed to allow the clear definition of requirements and a safety analysis to be carried out.

Many technologies are already available in this field, in particular the one used by militaries, however their aspects need to be adapted and revised for SAFELAND purposes.

An open problematic remains the kind of datalink connection required (LOS, BRLOS, BVLOS etc).

Operational:

From an operational point of view many questions need to be solved, however the concept can greatly benefit from RPA operational experience.

It is suggested that announcement of incapacitation should be given as it happens, during the phase in which automation takes over, not after.

The GSO should be identified as a remote pilot, and therefore a detailed description of GSO training requirements should be provided, together with the clear identification of GSO role and possibilities of intervention/monitoring over the flight path. In this regard, there is the need to decide whether a single or multiple GSO will manage the flight, and during which phases (D.1.4).

Additionally, should the GSO directly control of the aircraft, or more autonomous solutions be implemented? In particular for the landing phase, a decision should be made concerning GSO position. Should he/she be at the landing airport to allow minimal latency through LOS connection? The solution to this question will depend upon automation capabilities and technological solutions available.

Finally, another concern is GSO flexibility: will he/she be type rated for a single aircraft (maybe not practical/economical convenient), or be able to operate a number of different airplanes, thanks to a greater cockpit conformity?

4.3 Concept– ATC

In this section the input results from the ATC Concept are presented.

4.3.1 Mentimeter result

Mentimeter results from the four different phases for the **ATC Concept** is presented below in table. Mentimeter question: ***Considering your area of expertise, how much are you satisfied by this solution?*** (Higher score means higher level of satisfaction). Due to a low statistical number of votes, the score presented in the table is only view as an indication of opinion from the AB.

Phases	ATC
PILOT INCAPACITATION	3,1
HANDOVER	1,7
AIRPORT SELECTION	1,6
DESCENT & LANDING	1,9
	2,1
	out of 5

Table 9. Mentimeter voting results for the ATC Concept. Top of the table: average scores for the different phases (Scale 1-5). Bottom of the table: average score for the concept in bold.

4.3.2 Feedback Analysis

Comments from the advisory board regarding the ATC Concept is presented in tables below

4.3.2.1 Safety

4.3.2.1.1 Cons

ID	Issue	Affected phases
ATCSC1	**Reliance on automation and response to automation failure.**	All

4.3.2.1.2 Recommendations

ID	Recommendation	Affected phases
ATCSR1	**Backup system in case of Datalink failure.**	All
ATCSR2	**Safety cyber security requirements**	All
ATCSR3	**Must implement a system designed to inform cabin crew about the situation.**	Handover

4.3.2.1.3 Open questions

ID	Question	Affected phases
ATCSOQ1	**How the level of incapacitation is determined and how addressed to the right person involved?**	Pilot Incapacitation

4.3.2.2 Security

4.3.2.2.1 Recommendations

ID	Recommendation	Affected phases
ATCSER1	**Interaction between remote control station and cabin crew onboard**	Pilot Incapacitation
ATCSER2	**Cyber security analysis**	All

4.3.2.2.2 Open questions

ID	Question	Affected phases
ATCSEOQ1	**The present policy of keeping the cockpit secure from the inside would require to be changed to enable cabin crew to access and help the pilot if required**	Pilot Incapacitation

4.3.2.3 Human Performance

4.3.2.3.1 Cons

ID	Issue	Affected phases
ATCHPC1	**Level of dependence to automation vs human capabilities.**	All
ATCHPC2	**Complexity of the relation between the different members involved in the situation.**	Airport Selection, Descent and Landing
ATCHPC3	**Level of complexity, human not adequately kept in the loop with the situation and assigned a role not coherent with background and expertise.**	Descent and Landing
ATCHPC4	**Role of the GSO in this situation is not clear.**	Pilot Incapacitation

4.3.2.3.2 Recommendations

ID	Recommendation	Affected phases
ATCHPR1	**Clear determination of ATC roles and functions during the decision-making process.**	Airport Selection
ATCHPR2	**The role of the GSO should be precise in this concept as every thing seems rely on automation.**	Pilot Incapacitation
ATCHPR3	**We need clear definition of roles and responsibilities, including technical resources involved.**	Handover

4.3.2.4 Legal & Regulatory

4.3.2.4.1 Cons

ID	Issue	Affected phases
ATCLC1	**Most complex scenario. It adds new concept to ATC role, but many things remain unclear.**	Airport Selection
ATCLC2	**Unclear roles of the parties. Unclear responsibilities**	Handover

4.3.2.4.2 Recommendations

ID	Recommendation	Affected phases
ATCLR1	**The automation will be responsible for notification to all participants.**	Pilot Incapacitation
ATCLR2	**The distribution of the liabilities and responsibilities of the different actors shall be made very clear (e.g. between aircraft operator and automation provider or aircraft operator and ANSP).**	Pilot Incapacitation
ATCLR3	**Roles and responsibilities should be clarified during the strategic phase (rulemaking activities).**	Handover

4.3.2.4.3 Open questions

ID	Question	Affected phases
ATCLOQ1	**Who is taking the decision? And how? ATC does not know company policies**	Handover
ATCLOQ2	**It seems to be the most difficult solution in terms of responsibility. For example who will be in charge that the aircraft can fly the commanded trajectory : the ATCO or the remote pilot?**	Handover

4.3.2.5 Technical feasibility

4.3.2.5.1 Cons

ID	Issue	Affected phases
ATCTC1	**Timeframe is missing.**	Handover

4.3.2.5.2 Recommendations

ID	Recommendation	Affected phases
ATCTR1	**Requirements related the performance of C2 link**	Pilot incapacitation
ATCTR2	**SAT control link (to be used over the world for BRLOS) or GCS with radio LOS link (radius of 200km of coverage)**	Pilot incapacitation
ATCTR3	**CNS requirements**	Handover
ATCTR4	**Automation should be really reliable. Therefore, a lot of automation is required on board compared to what already exist.**	Pilot Incapacitation

ATCTR5	**The ability to fly a trajectory relies on true performance and handling qualities which relies on aircraft technical status.**	Handover
ATCTR6	**Backup requirements.**	All

4.3.2.5.3 Open questions

ID	Question	Affected phases
ATCTOQ1	**More information regarding technical requirements for data sharing and exchange and expected recovering scenario.**	All
ATCTOQ2	**Consider in case that if the handover occurs during a cross border operation there is a need of transfer control from an ATC to another**	Handover
ATCTOQ3	**Specific ATC phraseology aspects need to be considered**	Handover

4.3.2.6 Operational aspects

4.3.2.6.1 Cons

ID	Issue	Affected phases
ATCOC1	**To train an ATCO to become a remote pilot would not be financially viable because the role of ATCO and remote pilot are completely different and separated, i.e. an ATCO is to provide separation between aircraft but a remote pilot is to remotely fly aircraft.**	All
ATCOC2	**There are several issues that need to be addressed before an ATCO can become a remote pilot.**	All
ATCOC3	**Although ATCOs' role and responsibility are to support an aircraft in emergency, the 'aviate' function of the flight should not be within its remit.**	All
ATCOC4	**Apart from cyber related issues, a remote pilot has to be available on a 24 hour basis possibly doing nothing during this time awaiting an emergency involving an incapacitated pilot. Maybe operators would find this expensive to maintain.**	All
ATCOC5	**It is not practical to foresee that airports of ATC could have remote pilots qualified for each type of airplanes.**	Descent and Landing
ATCOC6	**Too complex scenario. What it the use of GSO in this case? If the situation would be assigned to a specific ATCO, then it would become a kind of GSO**	Handover

4.3.2.6.2 Pros

ID	Aspect	Affected phases

ATCOP1	**As long as all necessary and required information regarding a pilot-incapacitated aircraft has been shared with ATCOs, s/he will be able to handle this emergency situation.**	Pilot Incapacitation

4.3.2.6.3 Recommendations

ID	Recommendation	Affected phases
ATCOR1	**For this concept variant to be doable, a training for ATCOs is required.**	Handover
ATCOR2	**There are so much requirements such as defining responsibilities and licensing of an ATCO as a remote pilot. This concept variant is not viable given that a GS with a remote pilot set up already exists.**	Handover
ATCOR3	**The responsibilities to safely land a pilot-incapacitated aircraft should be divided between the aircraft operator and the ANSP/ATCO.**	All
ATCOR4	**It is clear that the project needs to re-define the ATC if it chooses this solution.**	Airport Selection
ATCOR5	**A better understanding of the roles of ATC is required.**	Airport Selection
ATCOR6	**This concept has to be completed and better defined. ATCOs might have specific roles and could execute some commands in specific situations such as when an aircraft is in communication loss situation.**	Descent and Landing
ATCOR7	**A pro might be that a GSO is not required. On the other side, ATC should be well trained and provided with some ground controller.**	Pilot Incapacitation
ATCOR8	**ATC role and responsibilities to be clarified. Operational procedures to be defined.**	Descent and Landing
ATCOR9	**the ATCO assigned should be the one of the active ATC sector. Landing of remote aircraft will be managed as an emergency landing**	Handover

4.3.2.6.4 Open questions

ID	Question	Affected phases
ATCOOQ1	**Can an ATCO be a remote pilot as well?**	Handover
ATCOOQ2	**Should ATCOs take on responsibility to execute aircraft functions, i.e. descent, landing and taxiing commands?**	Descent and Landing

4.3.3 ATC focused concept result summary

The ATC concept was regarded as the least effective solution by the AB members.

Safety:

The level of dependence of this concept to automation may create problems in case of system failures. To carry out a more in depth analysis a higher level of detail should be provided concerning concept aspects.

Overall back-up systems should be implemented, also covering the possibility of communication failures between ATCO and GSO.

Cybersecurity requirements also need to be addressed. This will be done in WP3 (Security Assessment).

Security:

Provision should be made to address the problematic of communication between ATCO/GSO/Cabin crews, in particular for what concern flight deck door policy.

Additionally, cybersecurity risks may be increased, given the requirement for two lines of control (GSO and ATCO).

Human Performance:

Multiple human performance issues have been identified for this concept. High automation levels may result in complacency problems and, most importantly, need an assessment of human capacity in case of system failure.

Of great concern is the distribution of roles/responsibilities/functions between all team members. The concept create confusion upon this matter, in particular in regard to the relation between ATCO and GSO in controlling the aircraft and deciding on its flight path.

Legal and Regulatory:

From a regulatory aspect, the situation is very complex, due to different and very specific roles and responsibilities regarding each party. The figure of the PIC cannot be clearly identified, and this may cause liability issues. This will be further analysed in the *Final concept legal, regulatory and economy aspects analysis* (see D3.1 [3] for details).

Additionally, ATCO responsibilities should be completely re-modulated, allowing for their new role in the system, and this will require the complete redefinition of ATC related regulations. For this reason, this concept is regarded as the most complex from a regulatory and legal point of view.

Technical:

Main technical issues with this concept relates to the required level of automation and datalink reliability. In particular the need for VLOS or BVLOS connection should be established, as well as backup solutions in case of failure.

Operational:

The concept presents several unresolved issues relating to in particular to the figure of the ATCO and GSO. It is confused the role each of the party member will have (including different ATCO), and many doubts are raised concerning the feasibility of transforming an ATCO into a sort of remote operator for an aircraft, as ATCO training and responsibilities are very different from the one of pilots.

Additionally, it is unclear which level of automation would be required to allow this concept to be implemented.

Finally, the main problematic resides in the possible confusion that may arise between responsibilities of ATCO/GSO in the most delicate phases of flight, such as airport selection phase and landing.

The concept does not clearly answer to the question: Who is the PIC after pilot incapacitation?

4.4 Ground Station Location

4.4.1 Mentimeter result

Mentimeter results for the **Ground Station Location** are presented below in table. Mentimeter question: ***Considering your area of expertise, how much are you satisfied by this solution?*** (Higher score means higher level of satisfaction). Due to a low statistical number of votes, the score presented in the table is only view as an indication of opinion from the AB.

Ground Location at AOCC
5
3
4
2
4
3,6
out of 5

Table 10. Mentimeter voting result for the location of the ground station, scale 1-5. Average score in bold text.

4.4.2 Feedback Analysis

Comments from the advisory board regarding the location of the ground station are presented in tables below.

4.4.2.1 Cons

ID	Issue	Relation
GSLC1	**Cyber security would be the biggest issues, but also security in general, as there are no security checks within the AOCC.**	Security
GSLC2	**Apart from cyber related issues, a remote pilot has to be available on a 24 hour basis possibly doing nothing during this time awaiting an emergency involving an incapacitated pilot. Maybe operators would find this expensive to maintain.**	Security/Operational/Cost
GSLC3	**It is not practical to foresee that airports of ATC could have remote pilots qualified for each type of airplanes.**	Other options/Cost

4.4.2.2 Pros

ID	Aspect	Relation
GSLP1	**This is the best scenario most probably. Ideally one GSO per aircraft type.**	General

4.4.3 Result summary for GS location

The positioning of the GSO at the AOCC of the company has been positively regarded as the best solution for the SAFELAND concept. Few comments have been raised.

Both cyber security and security issues need to be addressed. This will be done in WP3 (Safety Assessment). Currently AOCC are not completely security restricted areas, or at least are not strictly surveyed as airport facilities; the positioning of the GSO at AOCC will therefore means that security level will need to be increased.

Another corner point for deciding GSO location is represented by the requirements for LOS connection, and the technological challenge of guaranteeing the required levels of latency in control and communication without being forced to place the GSO at the airport of landing.

Finally, an important question that need to be tackled concerns the possibility for the GSO to operate on multiple types of aircraft). Depending on the level of performance/cockpit/operational conformity, the GSO may be allowed to operate on multiple types of aircraft, while this may be convenient from an economical point of view, it may increase the difficulty of his/her job, in particular during emergency situations.

5 Conclusions

5.1 Foreword

The feedback gained from the Preliminary Evaluation Workshop has been very valuable in order to understand the external experts' reception of the concept as a whole, collecting constructive feedback that will be used to identify the need for adjustments and improvement to derive the final concept.

The conclusion on the feedback does not only consider the written comments from the AB. It also takes into account the verbal discussion the consortium had with the AB during the workshop, and the Mentimeter sessions. However, due to a statistical low number of AB members the Mentimeter voting is not seen as a proof of a trend, instead is only used as an indication of the reception of the different concept variants.

5.2 General feedback

5.2.1 Safety

- Levels of automation: It is needed a good balance between automation and other elements. The system needs backup solutions in order to be fail-safe.
- Roles and responsibilities are not sufficiently clarified
- Decision making complexity, especially with third parties' involvement
- Communication technologies, latency, resilience, cyber-attacks
- Training and experience of the flight crew.
- Flight Crew procedures: Defining the flight crew role in an emergency pilot incapacitation incident. One option could be that flight attendants should be able to access cockpit area. Training and experience of the flight crew

5.2.2 Security

- Risk of cyber-attacks
- GSO located at the AOCC, there are today limited security checks within the AOCC

5.2.3 Human Performance

A good balance between automation and human actors is important to ensure sufficient situational awareness. Ground station will only be economical defensible if it can serve many airborne aircraft simultaneously and, therefore, will the handover phase may be prone to confusions and communication errors in the process of gaining the situation awareness of the situation.

Today we cannot assign the legal responsibility of the aircraft to automation and therefore the human actor needs to be kept in the loop taking over the responsible from the incapacitated pilot. The automation-human actor allocation needs special attention to make sure they serve in the areas they are best suited for.

In the SAFELAND concept the human actor is an essential element and is thought to provide the needed flexibility in an emergency.

5.2.4 Legal & Regulatory

The advisory board generally commented that no automation can be assigned the outmost responsibility of decision making and control of the aircraft. This confirms the SAFELAND project strategy to keep this at human level. However, automation should be responsible for carrying out specific tasks i.e. taking over the aircraft controls in the exact moment of pilot incapacitation. This is the most time efficient procedure before the GSO can establish situational awareness and take over the control.

5.2.5 Technical Feasibility

The main feedback for the technical aspects is presented in some bullet points:

- Data-link: The technical infrastructure needs to be dealt with in greater details. Resilience, continuity and latency and cyber-security are some of the important factors to consider
- Enhanced automation with, perhaps AI solution
- Communication aspects between different actors

5.2.6 Operational Aspects

The operational aspects will cover a broad area and share some part from the human performance and technical aspects. At this stage the concept maturity does not bring sufficient clarity in detail regarding new operating procedures, roles and responsibilities. It does not either reflect in detail how this will be mixed with the elements of automation. The project needs to consider on how to practically operate a ground station at the AOCC.

- How many aircraft should one operator be responsible for?
- How does a typical shift look like? Assumption must mean that Pilot incapacitation is a rare event, occasion and therefore the ground operator needs to be able to do other less critical task while being ready at all times for an emergency.
- What new procedures for the Flight Crew will be needed?

5.3 Feedback - Similarities/differences for the Concept variants

The concept was divided into three different concept variants (Automation, Ground Station and ATC). Some differences and similarities have been identified in this diversity.

The automation concept possesses many common elements of Ground Station and ATC concepts. AB feedback indicates that the liability must remain within the airline itself and a human actor needs to take over the pilot role of responsibility. However, tasks need to be optimally distributed in what it is best suited for. Fail-safe system needs to be accounted for and a more detailed description of the interaction of the different elements is needed.

The Ground Station focus inherently share many of the automation elements, however, the role of the automation is lower and the ground operator is seen to take more active control over the aircraft.

Again, the advisory board agrees with the idea of the liability staying within the airline and the ground operator taking the role of the on-board pilot. Comments from the advisory presents some risk of confusion, misunderstandings and difficulties regarding the building up of SA for the ground operator during the incapacitation and handover phases. Communication latency is also seen as a risk due possible data-link limitations.

The ATC focus is the area that differs the most. ATCO being actively more or less controlling the aircraft poses many problems. This new role of the ATCO implies training, expertise and division of work tasks in an event of incapacitation. ATCO need aircraft and airline specific knowledge which will may be render the concept unfeasible to realize. The roles and responsibilities of the on-board pilot will shift to the ATCO that currently have a complete different set of responsibilities. More complex communication between AOCC and ATC will most probably be a result.

5.4 Final concept selection

For each alternative concept, a list of Pros&Cons, requirements for the final concept and open questions (some out of the scope of the project but relevant in general) have been gathered from the SAFELAND board of experts, with different competencies and backgrounds.

Regarding function allocations, according to the results, it is clear that the GSO and Automation focused concepts have been regarded as the two most promising alternatives for SAFELAND. This choice has been motivated by the perceived feasibility and operational logic of these two solutions.

In particular the GSO concept, by clearly identifying the GSO as the new PIC of the aircraft, provides a smooth transition from SP to RPAS-like operations, representing a solution for many regulatory and operational issues.

On the other side, the ATCO focused proposal has collected the most negative results. This was due to the confusion generated by the concept concerning roles and responsibilities of each actor, as well as of the doubts raised concerning the possibility of assigning additional duties to ATCO for the control of the emergency aircraft.

Taking into consideration these results, the project will focus with D1.4 [2] on defining the final concept for SAFELAND, which is expected to be characterized as a blend of the Automation and GSO concepts aspects, consequently discarding the specific operational configuration of the ATCO focused solution.

Regarding the location of the ground station, the choice proposed by the project (GS within AOCC) has been well received by the AB members, from all the considered points of view.

5.5 Recommendations for concept definition

Recommendation	Open questions
Clear definition of roles and responsibilities for each team member.	How many GSOs will be required to handle the emergency?
Define the GSO as the new PIC of the flight following pilot incapacitation.	What kind of monitoring & intervention capabilities and authority the GSO should have over the aircraft? Does GSO need video feed from the aircraft?

	Should the GSO directly control the aircraft or more autonomous solutions be implemented? What are the training requirements for the GSO? Will there be one GSO per type of aircraft, or will a GSO be allowed to operate on multiple aircraft types?
Identify Back-up systems in case of automation failure.	How reliable should the automation be?
Identify Back-up systems to account for loss of datalink connection.	What kind of protocols should be established in case of communication failure?
Address cyber-security and safety issues.	What protocols can be established to manage problems of cyber-security due to remote connection? Should the AOCC be re-organized in terms of safety and security if the GSO will be based there? Can complacency and too much dependence on automation be a problem?
Support Decision Making with dedicated tools for the GSO: • **Flight planning stage** • **In flight support and information feed**	Should the GSO receive a complete briefing over the emergency flight? Can adequate airports be established in case of incapacitation already at flight planning stage? How can startle effect and workload levels for GSO be controlled? How can decision making be coordinated between team members, to guarantee high levels of SA?
Revise handover phase.	Should parties be informed immediately of the incapacitation or after automation takes over? What information should ATCO have regarding the emergency flight? How to deal with cockpit security requirements and cabin crews to provide support to incapacitated pilot?
Establish the level of automation required.	What time frame can we expect for the creation of required automation? How much automated should the aircraft be? Depending on considered function, should automation have limited or full authority?
Establish the performance requirements of Datalink connection.	Is VLOS, BRLOS or BVLOS connection required? During which phase? Will the GSO be required to be at the in VLOS with the landing airport?
Establish procedures for traffic collision avoidance.	How can traffic collision be coordinated between ATCO/GSO and on-board automation?

Investigate existing regulations on RPAS.	What requirements are dictated by existing regulations on the matter?

Table 11. Recommendations for Concept definition and open questions

5.6 Next steps

The final SAFELAND concept will be described in D1.4 [2]. A simulation platform will be set up in WP2 so to test the concept in a Human in the loop simulation with the involvement of relevant stakeholders (WP3). In the meantime, additional analysis will be performed on the final concept (i.e. Safety and Security assessment, Legal and regulatory assessment).

6 References

[1] SAFELAND Project (2020). SAFELAND Initial Concept. SAFELAND D1.2.

[2] SAFELAND Project (2020). SAFELAND Final Concept. SAFELAND D1.4.

[3] SAFELAND Project (2021). SAFELAND Evaluation Plan. SAFELAND D3.1.

Appendix A

A.1 Menitimeter sessions results

AB-WS.xlsx