SESAR Solution 02-08 SPR/INTEROP-OSED for V3 - Part IV - Human Performance Assessment Report

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EARTH

TRAFFIC OPTIMISATION ON SINGLE AND MULTIPLE RUNWAY AIRPORTS

Abstract

This document contains the Human Performance (HP) assessment report for the Solution 02-08 which consists of the HP assessment plan, the results of the HP activities conducted according to the HP assessment process, newly identified issues and the HP recommendations & requirements. It corresponds to the completion of the four steps of the Human Performance assessment process, namely: Step 1 – Understand the concept: Baseline, Solution and Assumptions, Step 2 – Understand the Human Performance Implications, Step 3 – Improve and Validate the concept and Step 4 – Collate findings & conclude on transition to next V-phase.

This document addresses the HP assessment report for three of the Concepts included in the Solution 02-08: Concept 1, Concept 3 and Concept 4.

Concept 2 does not require an HPAR, as it only brings a technical interface between Integrated Runway Sequence function and RMAN, which does not change anything in the operating mode for TWR Supervisor compared to the situation of using an RMAN not connected to an Integrated Runway Sequence function. The impact of using an RMAN on TWR Supervisor was already assessed in SESAR 1 in the frame of project 12.02.01 Runway Management Tools.

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1 Executive Summary

This document is the part IV of the Operational Services and Environment Definition (OSED) for SESAR Solution 02-08 for V3. It describes the result of the activities conducted to date according to the Human Performance assessment process to derive the Human Performance Report for the SESAR 02-08 Solution. It corresponds to the completion of the four steps of the Human Performance assessment process, namely: Step 1 – Understand the concept: Baseline, Solution and Assumptions, Step 2 – Understand the Human Performance Implications, Step 3 – Improve and Validate the concept and Step4 – Collate findings & conclude on transition to V3-phase.

The outputs of the steps are described and used to scope and identify the Human Performance activities that should be performed given the level of maturity of the concept at this stage of the project (V3).

In accordance with the HP Assessment Guidance process, and through consideration of project documentation, the following main HP objectives were addressed:

- Demonstrating ATCO acceptability of the proposed procedures when the Integrated Runway Sequence and ROCAT functions are used.

- Demonstrating the operational performance and maturity of the operational solution when the Integrated Runway Sequence and ROCAT functions and procedures are in use.

- Addressing potential evolution in ATCO workload.

- Addressing impact of the use of the Integrated Runway Sequence and of ROCAT in:
  - ATCOs individual and team situation awareness;
  - ATCOs job satisfaction and trust in the concept;
  - ATCOs skills.

- Addressing any HMI usability issues, in particular those related to the information presentation and integration in the CWP.

This document addresses the HP assessment report for three of the Concepts included in the Solution 02-08: Concept 1, Concept 3 and Concept 4. Concept 2 does not require an HPAR.

2 Introduction

2.1 Purpose of the document

The purpose of this document is to describe the results of the activities conducted according to the Human Performance (HP) assessment process [2] in order to derive the HP assessment report for Solution 02-08 including requirements and recommendations.

2.2 Intended readership

The intended audience for this document are the other team members of the SESAR Solution 02-08 under investigation, and those in the corresponding Solutions 01-02, 02-01 and 02-03.

HP practitioners at the level of the transversal areas and federating projects are also expected to have an interest in this document.

Other stakeholders that may be interested in this document are to be found among:

- Affected employee unions
- ANS providers
- Airport owners / providers
- Airspace users **Scope of the document**

This section describes the scope of the document identifying the broad context of the HP assessment and its results and drawing the line to other transversal areas assessments (e.g. Safety)

2.4 Human performance work schedule within the Solution

The Human Performance Assessment for the Solution 02-08 was conducted according to the HPAP (refer to [3]). However, the following deviations from the original plan are to be noted:

- EXE.02-08.V3.001 – ENAV RTS has been cancelled.
- HPAP considered the scope of the solution defined at the time the VALP was defined, i.e. addressing 3 concepts corresponding 3 different OI Steps (TS-0301, TS-0311 and AUO-0704), whereas in the meantime the 3rd Concept has been split into two and 2 CRs have been issued to replace AUO-0704 by AO-0337 and AO-0338.
- HPAR of Concept 3 is being delivered within this document and not in the HPAR of Solution 02-01 as stated in the HPAP.

This report addresses the HPAR of Concept 1, Concept 3 and Concept 4 of the Solution 02-08. No HP assessment is required for Concept 2.

This report is based on the results obtained in the frame of the different HP activities conducted during the V3 phase, and namely during the following V3 validation exercises:

- EXE.02-08.V3.002 - LFV-COOPANS RTS (Concept 1)
- EXE.02-08.V3.003 - SKYGUIDE RTS (Concept 1)

- EXE.02-08.V3.004 – PANSA RTS (Concept 4)

- EXE.02-08.V3.005 – EUROCONTROL RTS (Concept 3)

It is to be noted that no HP Log has been maintained for Concept 1 or Concept 4: HP practitioners of PJ02-08 Concept 1 and Concept 4 prefer to work directly with the HPAP and HAPR documents in order to reduce workload and avoid potential errors linked to the split of information among different documents and forms.

2.5 Structure of the document

This document is structured as follows:

- **Section 1** provides an executive summary of the document.
- **Section 2** (this section) introduces the document.
- **Section 3** provides a short overview of the Human Performance assessment process.
- **Section 4** presents the activities performed and the findings obtained from the Human Performance assessment steps conducted and completed to date.
- **Section 5** lists the documents referenced in this document.

2.6 Acronyms and Terminology

Term	Description
Human Factors (HF)	HF is used to denote aspects that influence a human's capability to accomplish tasks and meet job requirements. These can be external to the human (e.g. light & noise conditions at the work place) or internal (e.g. fatigue). In this way, "Human Factors" can be considered as *focussing on the variables that determine Human Performance*.
Human Performance (HP)	HP is used to denote the human capability to successfully accomplish tasks and meet job requirements. In this way, "Human Performance" can be considered *as focussing on the observable result of human activity in a work context*. Human Performance is a function of Human Factors (see above). It also depends on aspects related to Recruitment, Training, Competence, and Staffing (RTCS) as well as Social Factors and Change Management.
HP activity	An HP activity is an evidence-gathering activity carried out as part of Step 3 of the HP assessment process. An HP activity can relate to, among others, task analyses, cognitive walkthroughs, and experimental studies.
HP argument	An HP argument is an HP claim that needs to be proven through the HP Assessment Process.
HP assessment	An HP assessment is the documented result of applying the HP assessment process to the SESAR Solution-level. HP assessments provide the input for the HP case.
HP assessment process	The HP assessment process is the process by which HP aspects related to the proposed changes in SESAR are identified and addressed. The development of this process constitutes the scope of Project 16.04.01. It covers the conduct of HP assessments on the Solution-level as well as the HP case building over larger clusters of Solutions.
HP benefit	An HP benefit relates to those aspects of the proposed ATM concept that are

	likely to have a positive impact on human performance.
HP case	An HP case is the documented result of combining HP assessments from Solutions into larger clusters (SESAR Projects, deployment packages) in SESAR.
HP issue	An HP issue relates to those aspects in the ATM concept that need to be resolved before the proposed change can deliver the intended positive effects on Human Performance.
HP impact	An HP impact relates to the effect of the proposed solution on the human operator. Impacts can be positive (i.e. leading to an increase in Human Performance) or negative (leading to a decrease in Human Performance).
HP recommendations	HP recommendations propose means for mitigating HP issues related to a specific operational or technical change. HF recommendations are proposals that require additional analysis (i.e. refinement and validation). Once this additional analysis is performed, HF recommendations may be transformed into HF requirements.
HP requirements	HP requirements are statements that specify required characteristics of a solution from an HF point of view. HP requirements should be integrated into the DOD, OSED, SPR, or specifications. HF requirements can be seen as the stable result of the HF contribution to the Solution, leading to a redefinition of the operational concept or the specification of the technical solution.

Table 1: Acronyms and terminology

3 The Human Performance Assessment Process: Objective and Approach

The purpose of the HP assessment process described in detail in [2] is to ensure that HP aspects related to SESAR technical and operational developments are systematically identified and managed.

The SESAR HP assessment process uses an 'argument' and 'evidence' approach. A HP argument is a 'HP claim that needs to be proven'. The aim of the HP assessment is to provide the necessary 'evidence' to show that the HP arguments impacted have been considered and satisfied by the HP assessment process. This includes the identification of HP requirements and recommendations to support the design and development of the concept.

The HP assessment process is a four-step process that provides an overview of these four steps with the tasks to be carried out and the two main outputs (i.e. HP plan and HP assessment report In addition, a HP Log is maintained throughout the lifecycle of the Solution in which all the data/ information obtained from all HP activities conducted as part of the HP assessment is documented. This HP Log is a living document and is updated and / or added to as the Solution progresses.

Figure 1: Steps of the HP assessment process

4 Human Performance Assessment

4.1 Step 1 Understand the ATM concept

4.1.1 Description of reference scenario

This HPAR addresses three of the four concepts included in Solution 02-08:

- **Concept 1:** Optimised integration of arrival and departure traffic flows with the use of a trajectory based Integrated Runway Sequence (TS-0301). This concept applies namely to execution phase and addresses mainly TWR and TMA ATCOs.

- **Concept 3:** Increased Runway Throughput based on local ROT characterization (ROCAT) (AO-0337).

- **Concept 4:** Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338).

More details are provided in the Solution 02-08 OSED for V3 (refer to [1]).

4.1.1.1 Description of reference scenario for Concept 1

For the Solution 02-08 Concept 1, the reference scenario considered is the current situation where AMAN and DMAN provide support to the ATCOs separately.

The procedures used are the following:

- The **Tower Runway Controller** uses the arrival and departure sequences calculated by the AMAN and DMAN as support in order to maximise runway throughput. The integration of both sequences and the use of the runway occupancy time per flight is done in the ATCOs head and not shared via HMI with the other stakeholders.

- The **Tower Ground Controller** manages the traffic taking into account the arrival and departure sequences calculated by the AMAN and DMAN. The Tower Ground Controller mostly manages the departure sequence calculated by the DMAN taking into account the arrival sequence calculated by the AMAN.

- The **Apron Controller** manages the traffic in order to permit the Tower Ground Controller to manage the departure sequence calculated by the DMAN.

- The **Executive TMA controller** manages the traffic taking into account the arrival and departure sequences calculated by the AMAN and DMAN. The Executive TMA controller mostly manages the arrival sequence calculated by the AMAN taking into account the departure sequence calculated by the DMAN.

- The **Sequence Manager** manages the arrival sequence by planning, setting and adjusting runway landing rates according to changes, by monitoring the arrival sequence and by introducing on it the necessary manual changes when required.

In this situation, consistency between tools and operating methods are only maintained by coordination between TWR Supervisor and TMA and TWR ATCOs.

4.1.1.2 Description of reference scenario for Concept 3

For the Solution 02-08 Concept 3, the reference scenario considered is the current situation where the approach controller applies the required wake vortex separation scheme on the final approach with no tool.

Radar separation standards for arrivals and departures include MRS which prevents aircraft collision and WT separation which is intended to protect aircraft from adverse WTEs. In current day operations WT separations are defined between categories of aircraft which are grouped based on their MTOW. Examples of WT category schemes include ICAO, RECAT-EU 6 category and UK 6 category. When no WT separation is applicable then MRS is applied. This is typically 3NM although can be 2.5NM under certain conditions. Radar separations in current operations are defined in distance for arrival aircraft.

Radar separation is applied by observing the headings, distances, and speeds, between consecutive aircraft. The Final Approach Controller knows the locally applied wake turbulence radar separation table (i.e. ICAO or RECAT-EU). From the respective aircraft wake turbulence categories from the flight strips, or from the target labels of the lead and follower aircraft, the Controller establishes the wake turbulence radar separation required between the respective aircraft pairs.

The final Approach ATCO has to determine what spacing to apply on the final approach between each aircraft pair depending on the wake vortex category of the lead and the follower aircraft - the spacing applied by the final approach not only depends on the separation required to be delivered safely at the separation delivery point / runway threshold but also extra buffer to account for the compression that occurs between aircraft pairs in the last 4-5NM of the final approach from the DF. The compression depends on the aircraft type of the lead and the follower aircraft and also the head wind. The final approach ATCO does not consider ROT when determining applying the required separation/spacing on the final approach to apply before handing over to TWR RWY ATCO.

In current operations the spacings / separations are applied with no controller tool support, except distance markers on the final approach displayed on the CWP HMI.

The separation distance limits are determined by the ATCO by the use of scales on the radar map and through the observation of catch-up from the separation distance progression observed between the follower aircraft and the lead aircraft. In case of possible infringement, the ATCO will first use speed instructions, and then use vectoring, or order a go-around. Inside of 4NM (from the DF) from the runway threshold no speed instructions are advised.

The ROCAT concept (solution 02-08 Concept 3) will have particular benefits where ROT is one of the major factors that constrains arrival runway throughput capacity, such as in the Zurich approach and airport environment where MRS is set at 3NM in all conditions due to ROT constraints.

More details are provided in the Solution 02-08 OSED for V3 (refer to [1]) with regards to the reference scenario.

4.1.1.3 Description of reference scenario for Concept 4

For the Solution 02-08 Concept4, the reference scenario is the current situation where the Tower Runway controller, who is responsible for safe and efficient operations for arriving and departing aircrafts, performs standard, day-to-day operations. For arriving aircraft, the Controller is responsible for monitoring of final approach and landing unless runway is cleared from the arrival. As a part of an ATCO training, the controllers are taught the aircraft performances, including standard deceleration or required landing distances per aircraft categories. When performing the controller's tasks for arrivals, and as a part of his routine, controller may suggest, upon her/his best knowledge and experience, preferred runway exit.

Controller is performing standard TWR ATCO tasks using the standard CWP available in the platform.

On the cockpit side, Pilot is expected to adjust to the preferred exit, however due to operational reasons crew might be unable to fulfil the ATCO's instruction. When Crew is unable to adjust to the instruction, Pilot in charge advises ATCO on incapability. Gaining her/his experience in the operations, Tower Runway Controller is more precise with adjustment of the preferred exit upon different aircraft type. This allows to issue to the crew an instruction that best fits both the operational need and the current aircraft performance. In very rare number of situations the crew is unable to fulfil the request – then controller is being informed or is observing the aircraft missing the preferred exit.

To be noted that in terms of traffic load, the reference scenario considers that flights are separated by 4.75NM, which is much more intense than usual for the tested environment (i.e. Gdańsk).

4.1.2 Description of solution scenario

More details are provided in the Solution 02-08 OSED for V3 (refer to [1]).

4.1.2.1 Description of solution scenario for Concept 1

For the Solution 02-08 Concept 1, the solution scenario considered is the situation where an Integrated Runway Sequence function establishes an integrated arrival and departure sequence by providing accurate TTOTs and TLDTs, including dynamic balancing of arrivals and departures to optimise runway throughput. ATCOs follow this sequence. There is always a possibility to make manual adjustments, but the integration of arrival and departure sequences will be mostly automated.

The following procedures are used:

- **Approach controllers**
  will have to respect the integrated sequence for arrival traffic and follow spacing advisories between arrivals to accommodate departing flights.

- **Clearance Delivery Controller**
  will provide start-up approval based on TSAT (considering that TSAT is a predefined window of e.g. - 2/+3 minutes) provided by the Integrated RWY Sequence. TSAT calculation will be based on TOBT and accurate estimated taxi times provided by routing and planning service.

- **Ground Controller (including Apron Manager)**

will provide push-back approval in line with TSAT window (- 2/+3 minutes TBD). Taxi-out clearance is arranged to meet the proposed departure sequence, updated in line with TTOTs as closely as practical. Handle deviations and possible updates based on remaining taxi-out time with update of departure sequence. Propose the use of runway intersections according to local procedures.

- **Tower Runway Controller**
  will verify that the runway is clear and that the aircraft will meet arrival/departure separation requirements. He/she has to respect and follow the departure sequence and TTOTs as closely as practical. In coordination with Flight Crew use runway intersections according to local procedures to maintain runway throughput.

- **Sequence Manager**
  will manage the integrated arrival/departure runway sequence by planning, setting and adjusting runway landing and departure rates according to changes, by monitoring the runway integrated sequence and by introducing on it the necessary manual changes when required.

4.1.2.2 Description of solution scenario for Concept 3

The solution scenario for Concept 3 used ROCAT based on the static definition of ROT per aircraft type. The application of ROCAT based on the static definition of ROT per aircraft type is only feasible with a controller support tool. It is proposed that ROCAT is applied with the ORD tool developed in PJ02-01 (AO-0328).

The ORD tool consists of Target Distance Indicators which provide an indication of the required spacing/separation minima per aircraft pair (Final Target Distance (FTD) indicator) on the final approach down to the runway threshold, together with an indication of the compression due to aircraft decelerating for landing (the Initial Target Distance (ITD) indicator).

The Target Distance Indicators takes into consideration operational constraints such as the Wake Turbulence Separation (WT), Minimum Radar Separation (MRS) and Runway Occupancy Time (ROT) for each aircraft pair. As ROT is taken into consideration in the ORD tool then MRS on the final approach can be reduced up to 2.0NM MRS if required. Thus for those airports where runway throughput is constrained by ROT, capacity gains can be obtained.

In the final approach, position on the ITD is permanently displayed. The FTD will automatically appear if the ITD is infringed (or in the case of little or no compression when the aircraft is 0.3NM from the FTD). However, the ORD can be implemented with just the FTD. In this case the final Approach ATCO has to add on a buffer to account for the compression that will occur in the last 4NM after the DF.

When working with the ORD tool, the task of the final controller is to ensure the aircraft are either on or behind their respective ITD (or if FTD behind the FTD with added buffer to account for the compression) by a specific point on the final approach (e.g. in the case of the ECTL ORD tool this point is at 8NM from the runway threshold) with a speed of 160knots prior to handing over the aircraft to the tower controller, to ensure the required separation / spacing is achieved at the runway threshold. (Note - the point at which a certain speed has to be achieved on the final approach and the actual speed to be achieved are parameters within the ORD tool that can be adjusted).

4.1.2.3 Description of solution scenario for Concept 4

The solution scenarios take the setup of the reference scenarios and add capability to present the predicted ROT and/or preferred runway exit. The predicted ROT presented in the appropriate field of the flight progress strip will show the Tower Runway Controller the predicted time that the aircraft will spend on the runway. The ROT prediction mechanism will consider current weather data, aircraft performance during the final approach and the runway condition as the factors influencing the ROT. The ROT will be calculated 5 minutes prior to ETA.

At the same time, the system will calculate the preferred runway exit supporting the controller with computed data. System will present the exit taxiway designator on the flight strip, informing the tower runway controller, that this is the first available exit. Controller however may assign different taxiway to leave the runway, depending on his requirements.

4.1.3 Consolidated list of assumptions

Assumptions are listed in the section 4.4 of the VALP Part I document (see [1]).

4.1.4 List of related SESAR Solutions to be considered in the HP assessment

Solution 02-08 is somehow related to Solution 01-02 (which addresses integration of arrival and departure flows **at TMA**). The HP activities of this solution should be monitored and coordination with the HP practitioners needs to be ensured but there is no dependency between both solutions.

On the other hand, HP assessment of the Concept 3 is done together with the HP assessment of Solution 02-01.

4.1.5 Identification of the nature of the change

This section describes the main HP-related impacts of the changes resulting from the introduction of the Integrated Runway Sequence concept in terms of who will be impacted and how, and identifies the impacted HF work areas on which to focus the HP assessments.

4.1.5.1 Identification of the nature of the change for Concept 1

For Concept 1 (Optimised integration of arrival and departure traffic flows with the use of a trajectory based Integrated Runway Sequence):

HP argument branch	Change & affected actors
1. ROLES & RESPONSIBILITIES Left column	
1.1 ROLES & RESPONSIBILITIES	Roles and responsibilities of the concerned actors (ATCOs) with regards to providing Air Traffic Services will not change.
	Only the sequencing of arrival and departure aircraft will be supported by the Integrated Runway

	Sequence function which will provide sequence propositions to the controllers who will try to apply them as close as possible.
1.2 OPERATING METHODS	The concept involves a change in operating method (new procedures).
	Procedures will be defined to follow what is proposed, to verify whether what is asked is carried out, to make adaptation and correction in case of deviation.
	The controllers will have to be attentive to changes made by the system in the proposed sequence when some events on a flow of traffic will create constraints on another flow (e.g. aircraft stuck on the ground not getting to the holding point).
1.3 TASKS	There will be new tasks to perform such as informing the system when the controller (Approach, Runway or Ground) cannot apply what is asked, or makes something else for optimisation purpose. The tasks linked to manipulation on the new tools will also be new.
	The **Approach Supervisor** and **Airport Tower Supervisor** will have to verify whether the assumptions made on the traffic are carried out. They will have to be more reactive in case it proves impossible to comply with the sequence due to adverse conditions (strong wind, storm phenomena…). Active monitoring will be necessary.
	The **Tower Ground Controller** has to comply as much as possible with the expected sequence from the off block to the take-off (TSAT and TTOT) for respecting the runway sequence for departure flights according to the Integrated Runway Sequence function proposals. He/She might need to update the sequence (e.g. to exchange two departing aircraft places within the same TSAT span).
	The **Tower Runway Controller** performs his/her tasks according to the information provided by the Integrated Runway Sequence (departures sequencing, take-off clearance, departures integration in the arrival sequence in mixed-mode operations). If possible, the Runway controller fine tunes the sequence for throughput improvement,

	and if necessary, adjusts the sequence for safety. If the integrated runway sequence is well made, the Runway controller will see the spacing created between arrivals and will make the departures leave without problem. However if the sequence is not quite well made, it will be more complicated (e.g. when there is a spacing of 2,5 minutes instead of 3 minutes to make two departures leave, what to do: slowing down the second arrival or make two departures leave or accelerate in order not to lose too much time if only one aircraft leaves). The Integrated Runway Sequence function should support the controller in that case. The **Approach Executive Controller** performs his/her tasks establishing the sequence provided by the Integrated Runway Sequence function proposals with the required separations. The **En-Route Controller** has to follow the Target Metering Times and arrival sequence (order and time), depending of the Integrated Runway Sequence horizon. No impact compared to the baseline scenario is expected on the **flight crew**. The presentation of the integrated runway sequence should allow the controllers to have a better and shared awareness of the traffic situation and constraints. This should have a positive impact on their level of confidence in the tool and its requests. The integrated runway sequence becomes a common target to reach for all the controllers, where if a flow is given priority (e.g. priority to departures in order to free the parking stands in case there is a special need), it is done in total transparency (i.e. information provided).
2. HUMAN & SYSTEM	
2.1 ALLOCATION OF TASKS (HUMAN & SYSTEM)	The allocation of tasks between the human actors and the technical system should change as the Tower Controllers should follow the integrated arrival and departure sequence calculated by the Integrated Runway Sequence and not only use it as an advisory. The system decides on the sequence and the controllers have to apply it as close as possible.

2.2 PERFORMANCE OF TECHNICAL SYSTEM	The Integrated Runway Sequence provides the controller with an integrated arrival/departure sequence based on a dynamic balancing of arrival and departures.
2.3 HUMAN – MACHINE INTERFACE	The information of the integrated sequence calculated by the Integrated Runway Sequence function will be presented to the controller on a new HMI. For a more homogenous representation of the situation, the Integrated Runway Sequence information could be displayed on an existing HMI (i.e. ground radar, air radar) or in a separate one but ensuring consistency with the other displays. Depending on the control working position configuration only arrival or departure sequence might be shown to the controller, with different settings.
3. TEAMS & COMMUNICATION	
3.1 TEAM COMPOSITION	No changes in the composition of teams are foreseen.
3.2 ALLOCATION OF TASKS	No changes to the allocation of tasks between ATCOs are foreseen.
3.3 COMMUNICATION	Changes in communication needs are foreseen. Real time feedback will have to be exchanged, notably if a controller cannot implement what is asked (e.g. an aircraft at a holding point not ready to take-off, adverse meteorological conditions, etc.). The runway sequence calculated by the Integrated Runway Sequence will be shared by different controllers, which can facilitate the communication around a shared traffic sequence picture. No impact on communication between ATCOs and flight crew is expected. No changes to the phraseology are foreseen. No changes in communication means are foreseen.
4. HP RELATED TRANSITION FACTORS	
4.1 ACCEPTANCE & JOB SATISFACTION	The expected improved predictability and efficiency will have an effect on flexibility. The Tower Controllers should follow as close as possible the

	integrated arrival and departure sequence calculated by the Integrated Runway Sequence function. However, if a lack of sufficient flexibility or a lack of improvement on their efficiency is experienced, it might not be acceptable to the controllers.
	Tower Controller workload should evolve.
	In terms of ATCO situational awareness, it should be increased due to ready times and sequence number being displayed.
4.2 COMPETENCE REQUIREMENTS	No changes on competence requirements are currently foreseen.
	The personnel using these new operating methods and systems shall receive the necessary training.
4.3 STAFFING REQUIREMENTS & STAFFING LEVELS	No changes to staffing requirements & staffing levels are currently foreseen.
4.4 Recruitment and selection process	No changes identified.
4.5 Training	Training (theoretical and simulator) on the new integrated runway sequence functionality and working methods should be provided, as for any new function impacting procedures.

Table 2: Description of the change for Solution 02-08 Concept 1

4.1.5.2 Identification of the nature of the change for Concept 3

HP argument branch	Change & affected actors
1. ROLES & RESPONSIBILITIES Left column	
1.1 ROLES & RESPONSIBILITIES	The roles and responsibilities of the APP and TWR ATCOs or SUPs (APP, TWR) will not change significantly under ROCAT. The technicians and system engineers will be responsible for monitoring and maintaining the health of the tools implemented to support ROCAT with ORD operations.
1.2 OPERATING METHODS	As MRS is reduced to 2.5NM or 2NM (depending on the environment) in certain airport environments ROT may then become the constraining factor that has to be applied and respected on the final approach to ensure the safe separation/spacing of aircraft. The ROCAT rules will provide reductions in separations / spacing in certain approach

environment for certain MRS pairs compared to current operations therefore the runway throughput, and hence the number of aircraft handled per hour by the FIN APP and TWR ATCOs, is expected to increase. It will not be possible for ATCOs to memorise all potential ROTs required for different aircraft, so it is anticipated that the ATCOs will need a support tool to be able to determine the required spacing between each aircraft pair on the final approach. The ROCAT support tool is currently proposed to be the same as for the WDS, TBS and PWS support tool developed in PJ02-01 i.e. the ORD tool (AO-0328). Hence, it is currently envisaged that the controller support tool will consist of target distance indicators (FTD and ITD) presented for each aircraft pair. The introduction of the target distance indicators will result in a change of procedures and working method for the FIN APP and TWR ATCOs as the ATCOs will then use the target distance indications to judge and achieve the required separation between different a/c pairs on the final approach. The tool will help to reduce the complexity of the final approach controller's work so reducing the controllers' workload. However at the same time the controllers will be required to work more a/c per unit time as the separations/spacings between aircraft pairs will be reduced, which could then increase controllers workload – perhaps neutralising the reduction of workload caused by the reduced complexity when using the controller support tool.

In the case where the controller support tool fails (e.g. loss of target distance indicators), ATCOs will need to revert to non-ROCAT procedures (e.g. ICAO WT or RECAT-EU separations). If ATCOs do not maintain their skills in operating without a controller support tool there may be a degradation in ATCOs ability to operate under ICAO WT separations with no tool support (see section 4.2 Competence Requirements below). For example ATCOs may not remember the ICAO WT/ RECAT EU separation distances, or they may have difficulty turning aircraft on to the base leg without TDIs and difficulty in judging the required separation to ensure the separation requirements (i.e. relevant WV and MRS are not infringed).

	Under degraded mode of operations (e.g. loss of target distance indicators) supervisors may be required to inform ATCOs to adopt the fallback WT separation scheme (e.g ICAO or RECAT-EU). Under ROCAT, operations technicians and system engineers will have the additional task of monitoring and maintaining the 'health' of the ROCAT controller support tool, and when necessary, in degraded modes intervening to restoring the additional system support of ROCAT.
1.3 TASKS	Additional tasks will be introduced for the APP & TWR supervisors as well as the technicians & system engineers (see roles and responsibilities) under degraded modes mainly. The tasks of the APP and TWR ATCOs will remain the same although operating methods will change (see above).
2. HUMAN & SYSTEM	
2.1 ALLOCATION OF TASKS (HUMAN & SYSTEM)	The ORD target distance indicators will display the required spacing on the final approach in order to help the ATCOs determine and achieve the required a/c spacing/separation under ROCAT operations. As identified in Section 1.2 above, ATCOs currently undertake mental calculations to determine spacing required between aircraft pairs on the final approach to ensure the required separation is achieved at the runway threshold but this will not be the case under ROCAT, where the distances between aircraft pairs will be calculated by the support tool (i.e. ORD tool). The support tool will provide the APP and TWR ATCOs with minimum distance to be maintained down to runway threshold. In addition, the HMI will also present the compression effect to help ATCOs deliver the required minimum separation at threshold (the initial target distance indication). This means that the system, and not the ATCO, is now calculating the required spacing between different a/c pairs.
2.2 PERFORMANCE OF TECHNICAL SYSTEM	The reliability of the controller support tool indicator depends on the accurate and timely information relating to the RWYs in use, the final approach separation and runway spacing constraints that are to be applied for each RWY in use. The reliability of the tool must be guaranteed to ensure ATCOs trust

	the tool.
2.3 HUMAN – MACHINE INTERFACE	A support tool to help the FIN APP & TWR ATCOs determine the required spacing / separation under ROCAToperations will be presented to ATCOs on the CWP HMI. It is currently anticipated that the tool will be the same as the tool developed for TBS, PWS, WDS in PJ02-01, i.e. the ORD tool (AO-0328) consisting of a Final Target Distance indicator (FTD) and Initial Target Distance indicator (ITD). The ITD presents the compression effect to help ATCOs deliver the required minimum separation at threshold. Additional information requirements for ATCOs operating under as the need for different alerts sequencing alert, speed conformance alert catch-up alert have also been proposed for the ORD tool under TBS, PWS, WDS and ROCAT.
3. TEAMS & COMMUNICATION	
3.1 TEAM COMPOSITION	No changes to the team composition are currently foreseen.
3.2 ALLOCATION OF TASKS	Allocation of tasks between the FIN APP & TWR ATCOs is currently foreseen to remain as it is under current operations.
3.3 COMMUNICATION	There may be an increase in R/T communication between Pilots & ATCOs under ROCAT e.g. pilot will be required to more systematically inform ATC of their landing stabilisation speed intent on final approach so as to enable the application of more consistent and efficient final approach spacing practice by the final approach controller plus more aircraft will be on the final approach ATCOs frequency per hour in the peak periods as ROCAT is proposed to increase RWY throughput capacity.
4. HP RELATED TRANSITION FACTORS	
4.1 ACCEPTANCE & JOB SATISFACTION	The ROCAT aircraft type based rules may affect ATCO acceptance of the new procedures, due to the potential increase in aircraft throughput and hence potential increase in ATCO workload.

The potential de-skilling with regard to ATCOs ability to judge aircraft separations by eye and to calculate / determine the required separation between a/c pairs |

	mentally may also be an issue for ATCOs that will affect job satisfaction and acceptance of the ROCAT concept with ORD. The ORD tool target distance indicators may make it easier for supervisors and other colleagues to judge ATCOs performance that could be unacceptable for some ATCOs. These factors should be avoided by creating awareness through training curricula amongst both ATCOs and supervisors.
4.2 COMPETENCE REQUIREMENTS	Existing DBS skills with no tool may erode under ROCAT with a controller support tool. ATCOs working with the target distance indicators, which could also be displayed under DBS and TBS S-PWS, may lose the skills they currently possess to determine the appropriate spacing between a/c pairs. The presence of the ORD target indications means that under normal operating conditions ATCOs will not need to use to the same extent their knowledge of a/c performance together with the changing glideslope wind speed & direction profile, and the position of lead a/c, to judge what spacing is required between each a/c pair as this will be presented to them on the HMI. However, it is expected that under certain contingency procedures in abnormal conditions or degraded modes of operations this expertise and knowledge will still be needed. ATCOs may also need to have regular refresher training to maintain their skills to be able to work under DBS with no target distance indicators, when necessary.
4.3 STAFFING REQUIREMENTS & STAFFING LEVELS	No changes to recruitment & selection currently foreseen. No long term changes to Staffing Requirements & Staffing levels currently foreseen.
4.4 Recruitment and selection process	No changes identified.
4.5 Training	The training requirements shall include the familiarisation with the ORD tool and with the related changes in operating methods and procedures for nominal, non-nominal and degraded mode operations. Awareness about the fact that ORD should not be used as an evaluation of performance of ATCOs should be included in the training material, particularly for Supervisors.

Table 3: Description of the change for Solution 02-08 Concept 3

4.1.5.3 Identification of the nature of the change for Concept 4

For Concept 4 (Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338)):

HP argument branch	Change & affected actors
1. ROLES & RESPONSIBILITIES Left column	
1.1 ROLES & RESPONSIBILITIES	The roles and responsibilities of the concerned actors, i.e. Approach (INI, INT) and Tower Runway Controller with regards to providing Air Traffic Services will not change. TWR Runway Controller role, while unchanged, is enhanced with additional information on predicted runway exit and estimated ROT.
1.2 OPERATING METHODS	The enhanced ROT tool results in minor change to the operating method for TWR ATCOs. The tool will display on ATCOs HMI the expected runway exit and ROT, taking into consideration a number of factors (e.g. aircraft type, wind speed and direction profile on the glideslope or the ground speed profile of the arriving aircraft). This ROT information is given 5 minutes before expected touch down and is static. Considering ATCOs are assessing the expected ROT continuously, based on actual performance of the aircraft, the reference operating method is not subject to significant change. Concept 4 use case assumes also coordinating the separation between the aircraft on the approach, based on the expected touchdown and ROT estimation and regular communication of ATCO expectations to the Flight Crew (also possible in present operations but to smaller extent).
1.3 TASKS	Additional tasks are introduced to ATCOs – detection and analysis of the new information available via TWR ATCO HMI containing expected ROT and exit. The task of assessment of ROT and exit choice for the arriving aircraft is automated.
2. HUMAN & SYSTEM	
2.1 ALLOCATION OF TASKS (HUMAN & SYSTEM)	The allocation of tasks between the human actors and the technical system remain unchanged. Planning of the arrival separation and runway exit

	remains allocated to TWR ATCOs, based on individual experience. The HMI input one-direction information on the expected exit the landing aircraft will vacate the RWY. The line-up clearances remains in the discretion of the ATCOs, as well as analysing the trajectory and making the decisions.
2.2 PERFORMANCE OF TECHNICAL SYSTEM	The reliability of the expected runway exit indicator depends on the specification of the aircraft and actual runway conditions. The performance of the system (i.e. achievability and realism of ROT and exit indicators) is critical for the Concept 4 utility as it impacts directly safety and human performance (especially ATCO trust).
2.3 HUMAN – MACHINE INTERFACE	Information on the expected exit taxiway is delivered on separate monitor on the right to normal ATCOs working position. The information includes the callsign and expected exit taxiway designation and predicted ROT for the leading and following a/c on the 5 minutes before landing (approximately last 5-10 miles final approach) Note: this is different from the initially planned HMI and is a direct result of validation limitations. The initial intent was to fully integrate the information into the EFS system.
3. TEAMS & COMMUNICATION	
3.1 TEAM COMPOSITION	No changes to the composition of teams are foreseen.
3.2 ALLOCATION OF TASKS	No changes to the allocation of tasks between human actors are foreseen.
3.3 COMMUNICATION	No changes in communication between ATCOs are foreseen. No impact on communication between ATCOs and flight crew is expected. No changes to the phraseology are foreseen. No changes in communication means are foreseen.
4. HP RELATED TRANSITION FACTORS	
4.1 ACCEPTANCE & JOB SATISFACTION	Full reliance on the tool indication may lead to the deskilling of ATCOs, especially the ability to judge the required separation at certain weather conditions. Go-around procedures, that might be attributed to

	inaccurate indications of ROT may lead to lack of trust and acceptance of the tool and work procedure.
4.2 COMPETENCE REQUIREMENTS	No impact in required competence identified.
4.3 STAFFING REQUIREMENTS & STAFFING LEVELS	No changes to staffing requirements and staffing levels.
4.4 Recruitment and selection process	No changes identified.
4.5 Training	Familiarisation with the set of factors affecting the expected ROT and additional training on the implication of the use of the tool for ATCOs may be necessary for building trust in the system.

Table 4: Description of the change for Solution 02-08 Concept 4

4.2 Step 2 Understand the HP implications

4.2.1 Identification of relevant arguments, HP issues & benefits and HP activities

This section describes the HP arguments that have been identified as relevant for the Solution under investigation. It also lists the Solution-specific HP issues and benefits that have been identified related to an HP argument. For each issue and / or benefit the impact on human performance as well as system performance (in terms of KPAs) must be described. From this the HP validation objectives can be defined. On the basis of the general guidance on the satisfaction of HP arguments as well as the HP issues and benefits identified for the Solution, the proposed HP activity/ies are described. Where possible potential mitigation to prevent or reduce the impact of an issue on human performance are also identified.

4.2.1.1 Identification of relevant arguments, HP issues & benefits and HP activities for Concept 1

For Concept 1 (Optimised integration of arrival and departure traffic flows with the use of a trajectory based Integrated Runway Sequence):

Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	recommended activity/ies
1.2.5	ISS-02-08-HP.0001	The new operating methods linked to the use of the Integrated Runway Sequence might not be applicable by controllers (because they are perceived as less efficient or less safe), potentially leading to one of the following situations: - Controllers follow the prescribed operating methods but with a negative impact on HP (additional workload and stress, lack of trust in the system, increased potential for errors); - Controllers don't follow the prescribed operating methods, drifting from standard procedures in a variable way, with a negative impact on HP (loss of shared situation awareness, increased potential for errors)	OBJ-02-08-HP-001	To assess if the proposed operating methods are acceptable for ATCOs when the Integrated Runway Sequence function is used, and analyse underlying factors for drift (experience, gender, etc).	Assess operational feasibility of procedures during operating method design and in RTS: -subjective methods: questionnaire, debriefings. Make sure to have representative population of ATCOs during RTS (mixed of gender, experience).
			OBJ-02-08-HP-002	To assess if the proposed operating methods with Integrated Runway Sequence are at least as efficient and safe as the baseline ones	Compare the efficiency and safety of the proposed operating methods against the baseline ones during RTS: -Objective methods: comparative measure of parameters like adherence to sequence, number of manual interventions, number of inconsistent updates (sequence and advisories), number of "operationally inefficient" advisories;

					-Subjective methods: debriefings;
1.3.3	ISS-02-08-HP.0002 (SESAR 1 ISS-06.08.04-HP-AMAN/DMAN.0005)	The Integrated Runway Sequence function may increase ATCO workload with the request to follow the Integrated Runway Sequence propositions, and may be with the need for more coordination between all the concerned actors. In turn this would have a negative impact on safety.	OBJ-02-08-HP-003	To assess if the level of workload induced by the use of the Integrated Runway Sequence and the new concept is acceptable for ATCOs.	Compare workload between baseline and proposed solution as well as underlying factors in RTS: -subjective methods: questionnaires, SHAPE AIM -objective methods: data recordings (ATCO Frequency Workload, phone coordination, number of manipulations)
1.3.5	BEN-02-08-HP.0001 (SESAR 1 ISS-06.08.04-HP-AMAN/DMAN.0007)	The Integrated Runway Sequence function is expected to improve ATCO's situation awareness on traffic (individual and team) with the provision of shared information on the departure and arrival sequences. In turn this will bring a benefit for safety.	OBJ-02-08-HP-004	To assess if situation awareness (individual and team) is increased by the use of the Integrated Runway Sequence.	Assess situational awareness in RTS: -subjective methods: questionnaires, de-briefings.
2.1.5 2.1.6	ISS-02-08-HP.0003	The sequence and advisories proposed by the Integrated Runway Sequence function might not match to the controller's logic, leading to a loss of trust in the system.	OBJ-02-08-HP-005	To assess trust in the Integrated Runway Sequence automated calculations.	Assess trust in the automatic calculations and advisories of Integrated Runway Sequence in RTS with: -objective methods: measures of sequence stability and adherence to reality (number of updates, number of manual adjustments, comparison between estimated times and actual times). -subjective methods: questionnaires, de-briefings.
2.3.1	ISS-02-08-HP.0005 (SESAR 1 ISS-06.08.04-HP-AMAN/DMAN.0008)	The Integrated Runway Sequence information provided to the tower controllers might not be usable. This in turn would have a negative impact on efficiency.	OBJ-02-08-HP-007	To assess if the new information generated by the Integrated Runway Sequence function is of use when presented in applicable HMIs.	Assess usability of Integrated Runway Sequence information during design workshops and during RTS with: -subjective methods: questionnaire, debriefings (feedback on system support)
2.3.6	ISS-02-08-HP.0007 (SESAR 1 ISS-06.08.04-HP-	The new display presenting Integrated Runway Sequence information may not be well integrated and presented in the Approach, Runway and Ground controller working positions and might not	OBJ-02-08-HP-009	To assess if the usability and ergonomics of the Integrated Runway Sequence HMIs.	Assess the usability and ergonomics of the Integrated Runway Sequence HMI on the prototype used in RTS during

	AMAN/DMAN.0009)	be usable. This in turn would have a negative impact on efficiency.			design workshops.
2.3.8	BEN-02-08-HP.0004	The display of the Integrated Runway Sequence is expected to improve situation awareness on the traffic situation for ACC, APP and TWR controllers.	OBJ-02-08-HP-011	To assess if the HMI of the Integrated Runway Sequence contributes to improve individual situation awareness for each role.	Assess HMI support to individual situation awareness for each role during design and prototyping workshops using task analysis and focus groups. Assess individual situation awareness fioor each role during RTS with: -subjective methods: questionnaire, de-briefing;
2.3.9	BEN-02-08-HP.0003	The display of the Integrated Runway Sequence is expected to improve shared situation awareness between ACC, APP and TWR controllers.	OBJ-02-08-HP-012	To assess if the HMI of the Integrated Runway Sequence contributes to improve team situation awareness.	Assess HMI support to team situation awareness during design and prototyping workshops using task analysis and focus groups. Assess team situation awareness during RTS with: -subjective methods: questionnaire, de-briefing;)
3.3.4	ISS-02-08-HP.0011 (SESAR 1 ISS-06.08.04-HP-AMAN/DMAN.0011)	The communication load of team members may increase due to the need for coordination to apply the Integrated Runway Sequence as requested, including in case of rescheduling or modification of the sequence. In turn this would have a negative impact on safety.	OBJ-02-08-HP-014	To assess if the communication load is acceptable for ATCOs when the Integrated Runway Sequence function is used.	Assess communication load in RTS *(covering normal, abnormal conditions and degraded modes of operations)*: -subjective methods: questionnaires, de-briefings -objective methods: observations and data recordings (number of phone coordination)
4.1.2	ISS-02-08-HP.0012 (SESAR 1 ISS-06.08.04-HP-AMAN/DMAN.0012)	A lack of flexibility, reduced in favour of predictability, may negatively impact job satisfaction.	OBJ-02-08-HP-015	To assess if the proposed procedures and operating methods are acceptable for ATCOs when the Integrated Runway Sequence function is used.	Discuss proposed solution with end users & get feedback on potential impact on job satisfaction related to flexibility (flexibility to make their own choices) when Integrated Runway Sequence is in use.
4.2.1	ISS-02-08-HP.0013	The automation of the integration of arrival and departure sequences might lead to a loss of skills in the long term, potentially impacting	OBJ-02-08-HP-016	To assess if the level of automation proposed by the Integrated Runway Sequence impacts the ATCOs skills in	Discuss proposed solution with end users (involving experienced and ab-initio) & get feedback on potential

		performance in case of unavailability of tools.		the long term.		impact on skills when Integrated Runway Sequence is in use.

Table 5: HP Arguments, related HP issues and benefits, and proposed HP activity for Solution 02-08 Concept 1

4.2.1.2 Identification of relevant arguments, HP issues & benefits and HP activities for Concept 3 (ROCAT)

A complete list of the HP arguments and related HP issues and benefits as well as activities conducted can be found in the PJ02-08 concept 3 HP log in Appendix K.

Please note: If the ROCAT concept is to be applied then a controller support tool is required for the final approach ATCO and Tower runway controllers. In this context the application of the ROCAT concept is dependent on the use of a controller support tool. It is proposed that the ORD tool (AO-0328) developed in PJ02-01 to support the application of TBS, PWS, and WDS, as well as reduction of MRS on the final approach in PJ02-03, is used to support the application of ROCAT based on the static definition of ROT per aircraft type.

The ORD tool (AO-0328) developed in PJ02-01 takes into consideration the ROT per a/c type. Therefore, this tool allows the application of PJ02-08 concept 3 level 1.

Therefore, the HP arguments plus HP issues, benefits and activities together with the outcomes of the V3 HP validation activities for ROCAT with ORD are documented in the HP Log.

Many of the HP issues and benefits, recommendations and requirements relating to ROCAT relate mainly to the use of the ORD. Therefore, the ROCAT HP log builds on the previous work done on the ORD tool for TBS, PWS and WDS in PJ02-01. All the issues & benefits relevant to the ORD tool should be considered for the implementation of ROCAT with ORD. As a result the ORD HP arguments, issues, benefits from the PJ02-01 HP and validation activities are also contained in the ROCAT HP Log in separate excel pages. The ORD content of the HP Log is for reference only and are not considered part of PJ02-08.

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4.2.1.3 Identification of relevant arguments, HP issues & benefits and HP activities for Concept 4

For Concept 4 (Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338)):

Arg.	Issue ID	HP issue / Benefit	HP/Valid. Obj. ID	HP validation objective	recommended activity/ies
1.2.5.	ISS-02-08-HP.4001	The new HMI might provide information which is not consistent with the controllers judgment based on his/her experience. As a result the controller will be hesitant to follow HMI indications which in turn will create increased mental load and limit the trust in the system.	OBJ-PJ02.08-V3-VALP-HP3.1	To provide evidence showing that the end users' ability to follow Enhanced Prediction of ROT indications without loss of performance is sufficient.	Assess operational feasibility of procedures during operating method design and in RTS: -subjective methods: questionnaire, debriefings.
1.3.3.	ISS-02-08-HP.4002	ATCO workload might increase. It is not clear that the automation of ROT and exit estimation task will balance the assessment of tool output and possibly workload increase when communicating with Flight Crews.	OBJ-PJ02.08-V3-VALP-HP3.1 OBJ-PJ02.08-V3-VALP-HP3.1	To provide evidence to show Enhanced Prediction of ROT does not negatively impact the end users workload in any way	-Bedford workload assessment - ISA diagram assessment debriefing
1.3.4	ISS-02-08-HP.4003	ATCOs might trust the tool too much and follow it's indications even in the case they are clearly not feasible for the arriving A/C.	OBJ-PJ02.08-V3-VALP-OP3.1	To provide evidence that the application of Enhanced Prediction of ROT is trustworthy when integrated into a realistic environment.	-debriefing -SATI - Shape score assessment
1.3.5	ISS-02-08-HP.4004	ATCOs situational awareness affected by the introduction of the system prediction: ATCO needs to critically assimilate additional HMI information, the mental process regarding final approach separation planning might be affected.	OBJ-PJ02.08-V3-VALP-HP3.1 & OBJ-PJ02.08-V3-VALP-HP3.2	To provide evidence to show that the Enhanced Prediction of ROT does not negatively impact the end users' situation awareness in any way and supports the end users to have sufficient situation awareness to perform their tasks	China Lakes situational awareness scale SASHA - situation awareness for SHAPE Debriefing assessment and ATCOs opinion.
2.1.1	BEN-02-08-HP.4005	ATCOs responsibility of continuous estimation of	OBJ-PJ02.08-V3-	To provide evidence to show that	Assessment of Bedford Workload Scale

		the expected ROT and expected exit of arriving a/c to provide clearances is enhanced with system provided information on expected ROT and expected exit as it is automated to some extent.	VALP-HP3.1 & OBJ-PJ02.08-V3-VALP-HP3.2	Enhanced Prediction of ROT supports the end users performance.	Debriefing assessment
2.1.6	ISS-02-08-HP.4006	In specific weather conditions the system provided information might be contradictory to ATCO own assessment.	OBJ-PJ02.08-V3-VALP-HP3.2	To provide evidence that the application of Enhanced Prediction of ROT is trustworthy when integrated into a realistic environment.	Debriefing assessment
2.2.1	ISS-02-08-HP.4007	Concept 4 provides static information. ATCOs perception of this estimate of expected ROT and expected exit as out of date near the threshold might effectively negating HP benefits and make the tool unacceptable.	OBJ-PJ02.08-V3-VALP-HP3.2	To provide evidence to show that the changes to operational procedures / working method resulting from Enhanced Prediction of ROT are usable and acceptable to the end users	Assess accuracy of the system information in debriefing questionnaire. Evaluate actors assessment CARS User Acceptance Scale assessment
4.2.1	ISS-02-08-HP.4009	ATCOs skill of estimation of the ROT and RWY exit based on combination of training, experience and a/c behaviour and weather conditions might be impaired with long exposure to the information provided by the tool.	OBJ-PJ02.08-V3-VALP-HP3.2	To assess transition issues related to introduction of the Enhanced Prediction of ROT in the operational environment.	Discuss proposed solution with users and collect feedback on impact on skills affected with the use of the tool.
4.1.2	ISS-02-08-HP.4010	Relying on automated ROT and exit assessment might reduce job satisfaction and decrease performance in long term.	OBJ-PJ02.08-V3-VALP-HP3.2	To assess transition issues related to introduction of the Enhanced Prediction of ROT in the operational environment.	Discuss during debriefing the issue of automation satisfaction and possible performance issues.
4.5.3	ISS-02-08-HP.4011	ATCOs need additional training on system output limitations in order to adequately categorize and utilize the information provided	OBJ-PJ02.08-V3-VALP-HP3.2	To provide evidence to show that the end users level of trust in the enhanced Prediction of ROT is sufficient to perform their tasks efficiently, accurately and in a timely manner	Debriefing discussion.

Table 6: HP Arguments, related HP issues and benefits, and proposed HP activity for Solution 02-08 Concept 4

4.3 Step 3 Improve and validate the concept

4.3.1 Description of HP activities conducted

This section forms the actual HP plan of activities. It contains the HP activities that were selected on the basis of the relevant arguments and HP issues & benefits and the results from V2 activities.**Description of HP activities conducted for Concept 1**

For Concept 1 (Optimised integration of arrival and departure traffic flows with the use of a trajectory based Integrated Runway Sequence):

HP activity	Associated validation exercise	By when
Workshops with end users.	EXE.02-08.V3.002 EXE.02-08.V3.003	Before RTS
Debriefings during RTS	EXE.02-08.V3.002 EXE.02-08.V3.003	During and after RTS. Consolidated post-analysis until end April 2018
Subjective HP performance assessment during RTS	EXE.02-08.V3.002 EXE.02-08.V3.003	During and after RTS. Consolidated post-analysis until end April 2018
Objective HP indicators measures during RTS and post-analysis	EXE.02-08.V3.002 EXE.02-08.V3.003	During and after RTS. Consolidated post-analysis until end April 2018

Table 7: Table of proposed HP activities for Solution 02-08 Concept 1 and their priority

SOLUTION 02-08 CONCEPT 1 HP ACTIVITY 1.	
Description	Workshops with end users during the design phase to discuss about the impact of new tools and operating methods in HP, namely to assess: - Integrated Runway SequenceIntegrated Runway SequenceIntegrated Runway SequenceIntegrated Runway Sequence
Arguments & issues to be addressed	
HP OBJECTIVES	OBJ-02-08-HP-001 OBJ-02-08-HP-007 OBJ-02-08-HP-009 OBJ-02-08-HP-011 OBJ-02-08-HP-012 OBJ-02-08-HP-015

	OBJ-02-08-HP-016
Tool selected out of the HP repository	Workshop discussions supported with task analysis, HMI guidelines and cognitive walkthrough
Summary of the HP activity	Workshop discussions supported with task analysis, HMI guidelines and cognitive walkthrough

Table 8: Description of Solution 02-08 Concept 1 HP Activity 1

SOLUTION 02-08 CONCEPT 1 HP ACTIVITY 2.	
Description	De-briefings with end users (ATCOs/Supervisors) during RTS to discuss about the impact of new tools and operating methods in HP, namely to assess: - Integrated Runway SequenceIntegrated Runway SequenceIntegrated Runway SequenceIntegrated Runway SequenceIntegrated Runway SequenceIntegrated Runway Sequence
Arguments & issues to be addressed	
HP objectives	OBJ-02-08-HP-001 OBJ-02-08-HP-002 OBJ-02-08-HP-004 OBJ-02-08-HP-005 OBJ-02-08-HP-007 OBJ-02-08-HP-009 OBJ-02-08-HP-011 OBJ-02-08-HP-012 OBJ-02-08-HP-014 OBJ-02-08-HP-015 OBJ-02-08-HP-016
Required Evidence	A list of evidence related to each activity can be found in Appendix A of [2]
Tool selected out of the HP repository	N/A
Summary of the HP activity	De-briefings performed during RTS after simulation runs.

Table 9: Description of Solution 02-08 Concept 1 HP Activity 2

SOLUTION 02-08 CONCEPT 1 HP ACTIVITY 3.	
Description	Subjective HP performance assessment during RTS via questionnaires to assess: - Integrated Runway SequenceIntegrated Runway SequenceIntegrated Runway SequenceIntegrated Runway SequenceIntegrated Runway SequenceIntegrated Runway SequenceIntegrated Runway Sequence

Arguments & issues to be addressed	
HP objectives	OBJ-02-08-HP-001 OBJ-02-08-HP-003 OBJ-02-08-HP-004 OBJ-02-08-HP-005 OBJ-02-08-HP-007 OBJ-02-08-HP-009 OBJ-02-08-HP-011 OBJ-02-08-HP-012 OBJ-02-08-HP-014 OBJ-02-08-HP-015 OBJ-02-08-HP-016
Required Evidence	A list of evidence related to each activity can be found in Appendix A of [2]
Tool selected out of the HP repository	SHAPE AIM or NASA TLX for workload Questionnaires based on SHAPE situation awareness (SASHA) and trust (SATI)
Summary of the HP activity	Completion of questionnaires during RTS after simulation runs.

Table 10: Description of Solution 02-08 Concept 1 HP Activity 3

SOLUTION 02-08 CONCEPT 1 HP ACTIVITY 4.	
Description	Objective HP performance indicators measures during RTS and post-analysis to assess: - Integrated Runway Sequence
Arguments & issues to be addressed	
HP objectives	OBJ-02-08-HP-002 OBJ-02-08-HP-003 OBJ-02-08-HP-005
Required Evidence	A list of evidence related to each activity can be found in Appendix A of [2]
Tool selected out of the HP repository	N/A
Summary of the HP activity	Analysis of objective data on sequence accuracy (actual times vs target times).

Table 11: Description of Solution 02-08 Concept 1 HP Activity 4

4.3.1.2 Description of HP activities conducted for Concept 3

For Concept 3 (ROCAT – static definition of ROT per aircraft type):

HP activity	By when
RTS	EXE.02-08.V3.005

Table 12: Table of proposed HP activities and their priority for Solution 02-08 Concept 3

Activity 1.	EXE.02-08.V3.005
Description	In PJ02-08 RTS ROCAT was achieved through the use of the ORD tool which incorporated the ROT per aircraft type. ROCAT with ORD was assessed using Zurich approach environment in segregated mode runway operations on RWY 14. Two solution were assessed: • Full solution: ROCAT with ORD (ITD plus FTD) and PWS • Intermediate solution with ORD (FTD only) and RECAT EU For more details please refer to the Pj02-08 VALR and VALR RTS5
Arguments & related issues addressed	All 4 high-level HP Arguments have been covered as described in the HP Log 2nd level HP Arguments covered: - Argument 1.1.Roles and Responsibilities - Argument 1.2. Operating Methods - Argument 1.3. Tasks - Argument 2.1 Allocation of tasks (between the human and the machine) - Argument 2.2. Performance of the technical systems - Argument 2.3. Human-machine interface - Argument 3.3. Communication - Argument 4.1. Acceptance and job satisfaction - Argument 4.2. Competence requirements - Argument 4.5. Training The issues associated with each argument can be found in the HP

	Log is **Fel! Hittar inte referenskälla.**
HP objectives	Objectives relating to HP (note they are in line with the HP arguments at the second level):
	OBJ-PJ02.08-V3-VALP-HP3.1 & OBJ-PJ02.08-V3-VALP-HP3.2(covering HPArg1 and HPArg2 at the second level):
	• To provide evidence to show that the changes to end users roles, tasks and procedures resulting from ROCAT integrated in a separation delivery tool are clear, consistent and acceptable to the end users impacted.
	• To provide evidence to show that the changes to operational procedures / working method resulting from ROCAT integrated in a separation delivery tool are usable and acceptable to the end users
	• To provide evidence to show ROCAT integrated into the separation delivery tool does not negatively impact the end users workload in any way
	• To provide evidence to show that ROCAT integrated into the separation delivery tool supports the end users performance in segregated mode operations
	• To provide evidence to show that the ROCAT integrated into a separation delivery tool does not increase the potential for error in any way
	• To provide evidence to show that the ROCAT integrated into a separation delivery tool does not negatively impact the end users situation awareness in any way and supports the end users to have sufficient situation awareness to perform their tasks
	• To provide evidence to show that ROCAT integrated into a separation delivery tool is useable and acceptable to the end users under segregated mode operations
	• To provide evidence to show that the end users level of trust in the separation delivery tool with ROCAT integrated is sufficient to perform their tasks efficiently, accurately and in a timely manner
	OBJ-PJ02.08-V3-VALP-HP3.3 (covering HPArg3 at the second level):
	• To provide evidence to show ROCAT integrated into the separation delivery tool does not negatively impact the team

	structure an roles
	• To provide evidence to show the ROCAT when integrated into the separation delivery tool does not negatively impact team communication
	OBJ-PJ02.08-V3-VALP-HP3.4 (coveringHPArg4 at the first level, although second level arguments addressed in RTS)
	• To identify transition factors and possible mitigation relating to the ROCAT concept
Tools / Methods selected out of the hp repository	Usability / acceptability: modified CARS & ATCO feedback
	Workload: NASA-TLX and ISA plus ATCO feedback
	Task load: %age RT occupancy and number of a/c handled per hour
	Task performance: system performance metrics e.g. number of a/c handled per hour, accuracy of separation delivery, umber of separation infringements, number of go-arounds
	Human Error: Observations and ATCO feedback
	Situation awareness: ECTL SASHA questionnaire
	Trust: EUROCONTROL SATI questionnaire
	Other HP objectives measures based on observation and ATCo feedback
Summary of the HP activity	The RTS focused on the Zurich Approach sectors (APP-East, APP-West and Final APP) with aircraft arriving on RWY 14.
	The VAL-EXE 02-08.V3.005 RTS was conducted over a five day period between 15th of April and 19th of April 2019 in the EUROCONTROL Experimental Centre. Four fully rated Zurich Approach and Tower controllers from Skyguide participated in the RTS. Prior to the RTS, all participants received classroom training on the new concepts being tested as well as being given hands-on training with the simulator platform.
	Three different scenarios were designed to investigate the benefit of the two proposed solutions separately:
	• Reference: application of current Zurich Distance Based Separation (DBS) minima without a controller support tool (with 5 wake turbulence categories: A380, Heavy, Medium, Small, Light) and 3NM MRS (based on current Zurich

	operations);
	• Intermediate Solution: FTD with DB RECAT-EU separations and 2.5NM MRS;
	• Full solution: LORD (ITD/FTD) with TB PWS and 2.5NM MRS.
	Please refer to VALP and VALR for more details.

Table 13: Description of Solution 02-08 Concept 3 Activity 1

It should be noted that if ROCAT is to be implemented then a controller support tool is required for the approach and TWR ATCOs. It is proposed that this controller support tool is the ORD (AO-0328) developed in PJ02-01, as the ORD tool incorporates ROT based on aircraft type, as proposed by the ROCAT concept 3 Level 1.

The ORD tool was initially developed in SESAR1 P6.8.1 – the need to incorporate ROT into the ORD tool was initially identified through the validation activities conducted in P6.8.1. These activities included task analysis, controller workshops, prototyping sessions and RTSs. The results of these HP validation activities can be found in SESAR 6.8.1 HP Assessment Report.

The ORD with ROT per aircraft type has been further developed and validated in several SESAR PJ02-01 and PJ02-03 V3 activities. These HP validation activities include a number of workshops, prototyping sessions and real time simulations, which have been used to identify ORD requirements for applying TBS, WDS, PWS, ROT and Gaps for mixed mode operations in large and very large airport and highly complex and very highly complex TMA environments.

Hence, the ORD tool used in PJ02-08 RTS5 is the ORD tool (AO-0328) developed and validated from these previous activities. For more information on the ORD tool and the activities conducted prior to PJ02-08 RTS5 please refer to the PJ02-01 and Pj02-03 SPR-INTEROP/OSED and VALR.

4.3.1.3 Description of HP activities conducted for Concept 4

For Concept 4 (Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338)):

HP activity	By when
Consultations/workshops with end users.	Before RTS
Debriefings after RTS	Immediately after RTS. Consolidated post-analysis until end July 2019
Subjective HP performance assessment during RTS	During and after RTS. Consolidated post-analysis until end July

	2019
Objective HP indicators measures during RTS and post-analysis	During and after RTS. Consolidated post-analysis until end July 2019

Table 14: Table of proposed HP activities and their priority for Solution 02-08 Concept 4

Solution 02-08 Concept 4 HP Activity 1.	
Description	Workshops and consultations with end users during the design and testing phase to discuss about the impact of new tools and operating methods in HP, to provide information and training and to assess::
Arguments & issues to be addressed	1.2.5 Operating methods (procedures) can be followed in an accurate, efficient and timely manner. ISS-02-08-HP.4001 1.3.4 The level of trust in the new concept/the new procedures is appropriate. ISS-02-08-HP.4003 2.1.1 The task allocation between the human and the machine is consistent with automation principles. BEN-02-08-HP.4005 2.1.6 The level of trust in automated functions is appropriate.ISS-02-08-HP.4006 4.2.1 Knowledge, skill and experience requirements for human actors have been identified. ISS-02-08-HP.4009
HP OBJECTIVES	OBJ-PJ02.08-V3-VALP-HP3.1 & OBJ-PJ02.08-V3-VALP-HP3.2
Tool selected out of the HP repository	Workshop discussions supported with task analysis, HMI guidelines and cognitive walkthrough
Summary of the HP activity	Workshop discussions supported with task analysis, HMI guidelines and cognitive walkthrough

Table 15: Description of Solution 02-08 Concept 4 Activity 1

Solution 02-08 Concept 4 HP	

EUROPEAN UNION   EUROCONTROL

Activity 2.	
Description	Debriefings after RTS with end users conducted immediately after RTS execution to collect evidence on the tasks performance bases.
Arguments & issues to be addressed	1.2.5 Operating methods (procedures) can be followed in an accurate, efficient and timely manner. ISS-02-08-HP.4001
	1.3.4 The level of trust in the new concept/the new procedures is appropriate. ISS-02-08-HP.4003
	1.3.5 Human actors can maintain a sufficient level of situation awareness. ISS-02-08-HP.4004
	2.1.1 The task allocation between the human and the machine is consistent with automation principles. BEN-02-08-HP.4005
	2.1.6 The level of trust in automated functions is appropriate.ISS-02-08-HP.4006
	2.2.1 The accuracy of information provided by the system is adequate for carrying out the task. ISS-02-08-HP.4007
	4.2.1 Knowledge, skill and experience requirements for human actors have been identified.ISS-02-08-HP.4009
	4.2.3 Potential interferences between existing and new knowledge & skills are identified. ISS-02-08-HP.4010
	4.5.3 The required types of training (i.e. classroom, simulator, on-the job training) are identified.ISS-02-08-HP.4011
HP OBJECTIVES	OBJ-PJ02.08-V3-VALP-HP3.1 & OBJ-PJ02.08-V3-VALP-HP3.2
Required Evidence	A list of evidence related to each activity can be found in Appendix A
Tool selected out of the HP repository	Semi-structured interviews supported with task analysis and interview guide. Interviews transcript coding.
Summary of the HP activity	Semi-structured interviews supported with task analysis

Table 16 Description of Solution 02-08 Concept 4 Activity 2

Solution 02-08 Concept 4 HP Activity 3.	
Description	Subjective HP performance assessment during RTS, executed with questionnaires.
Arguments & issues to be addressed	11.3.3 The level of workload (induced by cognitive and/or physical task demands) is acceptable ISS-02-08-HP.4002

1.3.4 The level of trust in the new concept/the new procedures is appropriate. ISS-02-08-HP.4003

1.3.5 Human actors can maintain a sufficient level of situation awareness. ISS-02-08-HP.4004

2.1.1 The task allocation between the human and the machine is consistent with automation principles. BEN-02-08-HP.4005

2.1.6 The level of trust in automated functions is appropriate.ISS-02-08-HP.4006

2.2.1 The accuracy of information provided by the system is adequate for carrying out the task. ISS-02-08-HP.4007

4.2.1 Knowledge, skill and experience requirements for human actors have been identified.ISS-02-08-HP.4009

4.5.3 The required types of training (i.e. classroom, simulator, on-the-job training) are identified.ISS-02-08-HP.4011 |
| HP OBJECTIVES | OBJ-PJ02.08-V3-VALP-HP3.1

&

OBJ-PJ02.08-V3-VALP-HP3.2 |
| Required Evidence | A list of evidence related to each activity can be found in Appendix A |
| Tool selected out of the HP repository | Questionnaires |

Table 17 Description of Solution 02-08 Concept 4 Activity 3

Solution 02-08 Concept 4 HP Activity 4.	

Description	Objective HP performance assessment during RTS, performed with real time data recordings, e.g. ISA real-time workload scale and observations.
Arguments & issues to be addressed	1.3.3 The level of workload (induced by cognitive and/or physical task demands) is acceptable ISS-02-08-HP.4002
HP OBJECTIVES	OBJ-PJ02.08-V3-VALP-HP3.1 & OBJ-PJ02.08-V3-VALP-HP3.2
Tool selected out of the HP repository	ISA workload measurements, Post-RTS recoding analysis.
Summary of the HP activity	Real time data collection and post ante analysis, observations and interviews analysis

Table 18 Description of Solution 02-08 Concept 4 Activity 4

4.4 Step 4 Collate findings & conclude on transition to next V-phase

4.4.1 Summary of HP activities results & recommendations / requirements

4.4.1.1 Summary of HP activities results & recommendations / requirements for Concept 1

The table hereafter provides a summary of the HP argument and related issues / benefits along with the HP activities conducted during the V3 validation phase. It reports on the outcomes of HP issues that were included into the V3 HP assessment plan. For each argument and issue / benefit the results/evidence obtained from the activities conducted are briefly described along with the recommendations and / or requirements generated.

The status of each HP issue is also given. The status of an issue / benefit can either be 'closed', 'open', 'cancelled': An issue is considered 'closed' when the issue had been sufficiently answered or no additional activities relating to that issue are foreseen as necessary; An issue is considered as being 'open' when the issue has been either: partially addressed and more studies are needed or; the issue had been addressed by certain activities but as a result other related issues had arisen or; when no activity has been performed to date to address a specific issue. An issue is considered as being 'cancelled' when the activities conducted have shown the issue to be not relevant to the given concept under investigation.

The HP recommendations and requirements fall into one of several categories:

- System design
- OPS (operating methods / procedures)
- New objective
- Training
- Other

In addition, HP recommendations can relate to test and validation activities that need to be conducted in later V phases in order to investigate issues/benefits and potential mitigation in more detail.

For Concept 1 (Optimised integration of arrival and departure traffic flows with the use of a trajectory based Integrated Runway Sequence):

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
	Arg. 1.2.5: Operating methods (procedures) can be followed in an accurate, efficient and timely manner.						
ISS-02-08-HP.0001	The new operating methods linked to the use of the Integrated Runway Sequence might not be applicable by controllers (because they are perceived as less efficient or less safe), potentially leading to one of the following situations: - Controllers follow the prescribed operating methods but with a negative impact on HP (additional workload and stress, lack of trust in the system, increased potential for errors); - Controllers don't follow the prescribed operating methods, drifting from standard procedures in a variable way, with a negative impact on HP (loss of shared situation	open	OBJ-02-08-HP-001 OBJ-02-08-HP-002	Workshops De-briefings after simulation runs	Feedback obtained in de-briefings and workshops showed that the ATCOs found the new operating methods linked to the use of an Integrated Runway Sequence acceptable in both nominal and non-nominal situations.	Clarify new working methods for each role and provide appropriate training before deployment.	N/A

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
	awareness, increased potential for errors)						

Arg. 1.3.3: The level of workload (induced by cognitive or physical demand) is acceptable.

| ISS-02-08-HP.0002 | The Integrated Runway Sequence function may increase ATCO workload with the request to follow the Integrated Runway Sequence propositions, and may be with the need for more coordination between all the concerned actors. In turn this would have a negative impact on safety. | open | OBJ-02-08-HP-003 | Debriefings Subjective HP assessment during RTS (questionnaires) | Feedback from debriefings and questionnaires indicate that the level of mental and physical workload is lower while using an Integrated Runway Sequence than using a standalone AMAN and a standalone DMAN. | Verify impact on physical and mental ATCOs workload prior to deployment including qualitative and quantitative measures (number/duration of coordination actions, number of manual updates). | N/A |

Arg. 1.3.5: Human actors can maintain a sufficient level of situation awareness.

| BEN-02-08-HP.0001 | The Integrated Runway Sequence function is expected to improve ATCO's situation awareness on traffic (individual and team) with the provision of shared information on the departure and arrival sequences. In turn this will bring a benefit for safety. | open | OBJ-02-08-HP-004 | Debriefings Subjective HP assessment during RTS (questionnaires) | De-briefings and questionnaires showed that the solution improved shared awareness between TWR and APP compared to the baseline scenario. Individual situation awareness was also identified to improve in nominal situations and remain acceptable in non-nominal | Verify impact of the use of an Integrated Runway Sequence on ATCOs team and individual situation awareness prior to deployment. Analyse APP ATCOs situation awareness improvement with the combined use of Integrated Runway Sequence and | N/A |

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requir ements
					situations. However, it was identified that situation awareness of APP ATCOs could be further enhanced with the combined use of Integrated Runway Sequence and Separation Delivery indicators, especially in mixed mode during heavy traffic situations.	Separation Delivery indicators.	

Arg. 2.1.5: Human actors can acquire an adequate mental model of the machine and its automated functions.

Arg. 2.1.6: The level of trust in automated functions is appropriate.

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requir ements
ISS-02-08-HP.0003	The sequence and advisories proposed by the Integrated Runway Sequence function might not match to the controller's logic, leading to a loss of trust in the system.	open	OBJ-02-08-HP-005	Debriefings Subjective HP assessment during RTS (questionnaires) Objective HP indicators measures during RTS (sequence	The feedback from de-briefings and the objective data collected during the validation exercises (number of manual changes, comparative TTOT-ATOT, TSAT-ASAT, TLDT-ALDT measures of sequence accuracy and reliability) show that the level of ATCO's trust in the Integrated Runway Sequence solution is high.	Verify impact on ATCOs trust in the system prior to deployment including qualitative and quantitative measures (sequence accuracy and reliability, number of required sequence manual updates).	N/A

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
				accuracy)			

Arg. 2.3.1: The level of information provided satisfies the information requirements of the human.

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
ISS-02-08-HP.0005	The Integrated Runway Sequence information provided to the tower controllers might not be usable. This in turn would have a negative impact on efficiency.	open	OBJ-02-08-HP-007	Workshops, debriefings Subjective HP assessment during RTS (questionnaires)	In general, the ATCOs feedback on information presented was positive and HMI improvements since V2 improved the usability.	Address HMI usability from the very beginning prior to deployment.	

Arg. 2.3.6: The usability of the user interface (input devices, visual displays/output devices, alarms&alerts) is acceptable.

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
ISS-02-08-HP.0007	The new display presenting Integrated Runway Sequence information may not be well integrated and presented in the Approach, Runway and Ground controller working positions and might not be usable. This in turn would have a negative impact on efficiency.	open	OBJ-02-08-HP-009	Workshops Debriefings Subjective HP assessment during RTS (questionnaires)	In general, the ATCOs feedback on information presented was positive and HMI improvements since V2 improved the usability.	Address HMI usability from the very beginning prior to deployment.	N/A

Arg. 2.3.8: The user interface design supports a sufficient level of individual situation awareness.

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
BEN-02-08-HP.0004	The display of the Integrated Runway Sequence is expected to improve situation awareness on the traffic situation for ACC, APP and TWR controllers.	open	OBJ-02-08-HP-011	Workshops Debriefings Subjective HP assessment during RTS (questionnaires)	De-briefings and questionnaires showed that the solution improved individual situation awareness in nominal situations and remained acceptable in non-nominal situations. However, it was identified that situation awareness of APP ATCOs could be further enhanced with the combined use of Integrated Runway Sequence and Separation Delivery indicators, especially in mixed mode during heavy traffic situations.	Verify impact of the user interface design on ATCOs individual situation awareness prior to deployment. Analyse APP ATCOs situation awareness improvement with the combined use of Integrated Runway Sequence and Separation Delivery indicators.	N/A

Arg. 2.3.9: The user interface design supports a sufficient level of team situational awareness.

BEN-02-08-HP.0003	The display of the Integrated Runway Sequence is expected to improve shared situation awareness between ACC, APP and TWR controllers.	open	OBJ-02-08-HP-012	Workshops Debriefings Subjective HP assessment during RTS (questionnaires)	De-briefings and questionnaires showed that the solution improved shared awareness between TWR and APP compared to the baseline scenario.	Verify impact of the user interface design on ATCOs team situation awareness prior to deployment.	N/A

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
Arg. 3.3.4: The communication load of team members is acceptable in normal and abnormal conditions and degraded modes of operations.							
ISS-02-08-HP.0011	The communication load of team members may increase due to the need for coordination to apply the sequence as requested, including in case of rescheduling or modification of the sequence. In turn this would have a negative impact on safety.	open	OBJ-02-08-HP-014	Debriefings Subjective HP assessment during RTS (questionnaires)	De-briefings and questionnaires showed that the solution implied a reduction of communication workload linked to a better shared situation awareness allowed by the Integrated Runway Sequence.	Verify impact on ATCOs communication workload prior to deployment in nominal and nominal situations, including situations of degraded modes.	N/A
Arg. 4.1.2: The impact of changes on the job satisfaction of affected human actors has been considered.							
ISS-02-08-HP.0012	A lack of flexibility, reduced in favour of predictability, may negatively impact job satisfaction.	closed	OBJ-02-08-HP-015	Workshops Debriefings Subjective HP assessment during RTS (questionnaires)	The impact in job satisfaction between the baseline scenario and the solution scenario was considered negligible: the big change is already to introduce an AMAN.	N/A	N/A
Arg. 4.2.1: Knowledge, skill and experience requirements for human actors have been identified.							
ISS-02-08-HP.001	The automation of the integration of arrival and departure sequences might lead to a loss of	open	OBJ-02-08-HP-016	Workshops	The impact in skills between the baseline scenario and the solution scenario was considered negligible:	Verify impact on ATCOs skills after deployment.	N/A

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
3	skills in the long term, potentially impacting performance in case of unavailability of tools.			Debriefings	the big change is already to introduce an AMAN and to automate the sequence building. In general, it is difficult to get any evidence on impact in skills prior to deployment, only a forecast. Therefore, the HP issue should by principle remain open until post deployment analysis.		

Table 19: Summary of the HP results and recommendations/ requirements for each identified issue & related argument for Solution 02-08 Concept 1

4.4.1.2 Summary of HP activities results & recommendations / requirements for Concept 3

The results, recommendations and requirements for Pj02-08 Concept 3 ''ROCAT – static definition of runway occupancy time per aircraft type'' can be found in the HP Log in

Please note: If the ROCAT concept is to be applied then a controller support tool is required by the final approach ATCO and Tower runway controllers. Therefore, in this context the application of the ROCAT concept is dependent on the use of a controller support tool. It is proposed that the ORD tool (AO-0328) developed in PJ02-01 to support the application of TBS, PWS, and WDS, as well as reduction of MRS on the final approach in Pj02-03, is used to support the application of ROCAT based on the static definition of ROT per aircraft type.

The ORD tool (AO-0328) takes into consideration the ROT per a/c type. Therefore, this tool allows the application of Pj02-08 concept 3 level 1.

In the HP log the HP results/outcomes of Pj02-08RTS5, recommendations and requirements validation activities PJ02-08 RTS5 specifically for ROCAT with ORD are documented.

However, many of the HP issues and benefits, recommendations and requirements relating to ROCAT relate to the ORD which takes into consideration ROT as well as WT separations and MRS. Therefore, the ROCAT HP log builds on the previous work done on the ORD tool for TBS, PWS and WDS in PJ02-01 – and all recommendations and requirements relating to the ORD tool are required for the implementation of ROCAT with ORD. As a result the ORD recommendations and requirements elicited from the PJ02-01 HP and validation activities are also contained in the ROCAT HP Log in separate excel pages. The ORD content of the HP Log is for reference only and is not considered part of PJ02-08.

4.4.1.3 Summary of HP activities results & recommendations / requirements for Concept 4

The table hereafter provides a summary of the HP argument and related issues / benefits along with the HP activities conducted during the V3 validation phase. For each argument and issue / benefit the results/evidence obtained from the activities conducted are briefly described along with the recommendations and / or requirements generated.

The status of each HP issue is also given. The status of an issue / benefit can either be 'closed', 'open', 'cancelled': An issue is considered 'closed' when the issue had been sufficiently answered or no additional activities relating to that issue are foreseen as necessary; An issue is considered as being 'open' when the issue has been either: partially addressed and more studies are needed or; the issue had been addressed by certain activities but as a result other related issues had arisen or; when no activity has been performed to date to address a specific issue. An issue is considered as being 'cancelled' when the activities conducted have shown the issue to be not relevant to the given concept under investigation.

The HP recommendations and requirements fall into one of several categories:

- System design
- OPS (operating methods / procedures)
- New objective
- Training
- Other

In addition, HP recommendations can relate to test and validation activities that need to be conducted in later V phases in order to investigate issues/benefits and potential mitigation in more detail.

For Concept 4 (Optimised use of RWY capacity for medium airports with the use of enhanced prediction of Runway Occupancy Time (ROT) (AO-0338)):

Issue ID	HP issue / Benefit	HP Issue/ Benefit Status	HP/ Valid. Obj. ID	activity conducted	results / evidence	recommendations	requirements
Arg. 1.2.5: Operating methods (procedures) can be followed in an accurate, efficient and timely manner.							
ISS-02-08-HP.4001	The new operating method and the new HMI might provide information which is not consistent with the controller's judgment based on his/her experience. As a result the controller will be hesitant to follow HMI indications which in turn will create increased mental load and limit the trust in the system.	closed	OBJ-PJ02.08-V3-VALP-HP3.1	subjective methods: questionnaire, debriefings.	Feedback obtained in de-briefings and in questionnaire showed that the ATCOs found the new operating method usable in nominal Feedback showed some concerns about system capability in degraded mode (not part of the RTS).	Provide training on system capabilities and system input parameters used for calculation of the expected ROT and expected exit	System overlay shall shut down in case of errors in source data generating only a single error message. System function reinstatement following a failure shall communicated with a message to Tower ATCO.
Arg. 1.3.3: The level of workload (induced by cognitive or physical demand) is acceptable.							
ISS-02-08-HP.400	ATCO workload might increase. It is not clear that the automation of ROT and exit estimation task will	closed	OBJ-PJ02.08-V3-VALP-	Bedford workload	Feedback from debriefings and questionnaires indicate that the level of mental and physical	N/A	N/A

2	balance the assessment of tool output and possibly workload increase when communicating with Flight Crews.		HP3.2 assessment ISA tool assessment debriefing	workload is not changed while using the tool, as compared to reference scenario. Significant difference in the researched population occurred in measured ISA values and between scenarios.		

Arg. 1.3.4: The level of trust in the new concept/the new procedures is appropriate.

ISS-02-08-HP.4003	ATCOs might trust the tool too much and follow it's indications even in the case they are clearly not feasible for the arriving A/C.	open	OBJ-PJ02.08-V3-VALP-OP3.1	Debriefings Subjective HP assessment during RTS -SATI - Shape score assessment	Questionnaires showed average scores in SATI assessment. No risk of overconfidence detected. In debriefings controllers raised some reservations on the applicability of the parameters presented by the tool. As a result if conditions on final approach are variable the recommendation might be not valid.	Improve the design to provide ATCO with a dynamic expected ROT and expected exit, based on the actual behaviour of the aircraft on the final approach. These recommendations should start 5 min prior to expected touchdown and finish updating 2NM before threshold.	N/A

Arg. 1.3.5 Human actors can maintain a sufficient level of situation awareness.

ISS-02-08-HP.4004	ATCOs situational awareness affected by the introduction of the system prediction: ATCO needs to critically assimilate additional HMI information, the mental process regarding final	closed	OBJ-PJ02.08-V3-VALP-HP3.1 & OBJ-	China Lakes situational awareness scale SASHA - situation awareness for	The feedback from debriefing and the subjective data collected in questionnaires presents moderate improvement in perceived ATCO situational awareness The evaluation of situational	N/A	ROT estimate and exit indication shall be integrated into TWR ATCO CWP in a way that assures the display of this

	approach separation planning might be affected.		PJ02.08-V3-VALP-HP3.2	SHAPE Debriefing assessment and ATCOs opinion.	awareness indicated that the HMI design accepted for validation was much inferior to initially planned (full integration to EFS).		information as near to other flight information as possible to maintain legibility.

Arg. 2.1.1: The task allocation between the human and the machine is consistent with automation principles.

BEN-02-08-HP.4005	ATCOs responsibility of continuous estimation of the expected ROT and expected exit of arriving a/c to provide clearances is enhanced with system provided information on expected ROT and expected exit as it is automated to some extent.	closed	OBJ-PJ02.08-V3-VALP-HP3.1 & OBJ-PJ02.08-V3-VALP-HP3.2	Assessment of Bedford Workload Scale Debriefing assessment	Debriefing show moderate slightly positive enhancement of ATCOs situational awareness thanks to use of the tool. Workload impact is neutral.	N/A	N/A

Arg. 2.1.6: The level of trust in automated functions is appropriate.

ISS-02-08-HP.4006	In specific weather conditions the system provided information might be contradictory to ATCO own assessment.	open	OBJ-PJ02.08-V3-VALP-HP3.1	Debriefing	Debriefing presents some reservations on the tool capabilities, questioning its indication in possible adverse weather conditions. RTS only consisted of good weather conditions.	Provide adequate training on the tool capabilities. Any future RTS should include adverse weather.	N/A

Arg. 2.2.1: The accuracy of information provided by the system is adequate for carrying out the task.

ISS-02-	Concept 4 provides static	open	OBJ-	Questions on	Debriefing presents some	See HP.4003	N/A

08-HP.4007	information. ATCOs perception of this estimate of expected ROT and expected exit as out of date near the threshold might effectively negating HP benefits and make the tool unacceptable.		PJ02.08-V3-VALP-HP3.1	system information in debriefing Other RTS actors assessment and opinions CARS User Acceptance Scale	reservation on the output of the tool, which is static on the last final. This may decrease Concept 4 performance when conditions on final approach are variable or when Flight Crew deviates from estimated typical approach pattern.		

Arg. 4.2.1: Knowledge, skill and experience requirements for human actors have been identified.

ISS-02-08-HP.4009	ATCOs mental capability of estimation of the ROT and RWY exit based on combination of training, experience and a/c behaviour and weather conditions might be impaired with long exposure to the information provided by the tool	open	OBJ-PJ02.08-V3-VALP-HP3.1 & OBJ-PJ02.08-V3-VALP-HP3.2	debriefing	Debriefing indicates concerns of ATCO, that long exposure to the tool usage might limit their current capability to estimate ROT and expected exit	Provide recurrent training to maintain the ROT estimate skill based on ATCO judgement .	N/A

Arg. 4.2.3: Potential interferences between existing and new knowledge & skills are identified.

ISS-02-08-HP.4000 10	Relying on automated ROT and exit assessment might reduce job satisfaction and decrease performance in long term..	closed	OBJ-PJ02.08-OBJ-PJ02.08-V3-VALP-	Debriefing and open ended questions.	ATCO expressed concerns on the tool output being in line with their own assessment depending on the wind direction and runway	Recommendation from HP.4003.	N/A

			HP3.2		condition. The RTS did not included adverse weather and degraded RWYCC in any scenarios.		

Arg. 4.5.3: The required types of training (i.e. classroom, simulator, on-the job training) are identified. (V3 only)

ISS-02-08-HP.40011	ATCOs need additional training on system output limitations in order to adequately categorize and utilize the information provided	open	OBJ-PJ02.08-V3-VALP-HP3.2	Debriefing	Debriefing analysis presents some ATCOs expected that the wind direction is not accounted by the tool. Wind direction is accounted for in the calculation of the expected ROT and expected exit, showing some shortcomings of the initial briefing and training but also indicating that proper training on the Concept 4 operation can be essential in building user trust especially in case of machine learning based solutions.	Provide adequate training on the tool operation.	N/A

Table 20: Summary of the HP results and recommendations/ requirements for each identified issue & related argument for Solution 02-08 Concept 4

4.4.2 Maturity of the Solution

4.4.2.1 Maturity of the Solution for Concept 1

	Maturity checklist for finalising the V3 assessment (Concept 1)		
ID	**Question**	**Answer** Fill in 'yes' or 'no'.	**Comments** Please substantiate your answer.
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?	YES	*Refer to section 4.2.1.3 of this document*
2	Are the benefits and issues in terms of human performance and operability related to the proposed solution sufficiently assessed (i.e. on the level required for V3)?	YES	*Refer to section 4.2.1.3 of this document*
3	Have all the parts of the solution/concept been considered?	YES	*Refer to section 4.1.1.1*
4	Have potential interactions with related projects/concepts been considered and addressed?	YES	*N/A for Concept 1.*
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	YES	*Refer to section 4.2.1.3 of this document*
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?	YES	*Refer to section 4.2.1.3 of this document*
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	YES	*Refer to VALR ([5])*
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	YES	*Refer to section 4.2.1.3 of this document*
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?	YES	*Refer to OSED Part I [1]*
10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	YES	*Refer to section 4.2.1.3 of this document and to VALR conclusions ([5])*

11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	YES	*Refer to section 4.2.1.3 of this document*
12	Have the major factors that can influence the transition feasibility (e.g. changes in competence requirements, recruitment and selection, training needs, staffing requirements, and relocation of the workforce) been addressed? Are there any ideas on how to overcome any issues?	YES	*Refer to section 4.2.1.3 of this document*
13	Have any impacts been identified that may require changes to regulation in the area of HP/ATM? This includes changes in roles & responsibilities, competence requirements, or the task allocation between human & machine.	NO impact on regulation	*Refer to section 4.1.5.1 of this document*
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	N/A (no next phase)	*Refer to Appendix C of this document*

Table 21: PJ02-08 Concept 1 HP maturity check list for V3 completion

4.4.2.2 Maturity of the Solution for Concept 3

	Maturity checklist for finalising the V3 assessment (Concept 3)		
ID	Question	Answer *Fill in 'yes' or 'no'.*	Comments *Please substantiate your answer.*
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?	Yes	*Based on the Change and Argument Identification section, 25 issues /benefits have been identified, covering all 4 HP Arguments for ROCAT in segregated mode with ORD. For a detailed view on the issues, consult the ROCAT-Issue-Objective-Outcome section of the HP Log.* *ll 4 high-level HP Arguments have been covered as described in the HP Log Appendix K.* *2nd level HP Arguments covered:* *- Argument 1.1.Roles and Responsibilities* *- Argument 1.2. Operating Methods* *- Argument 1.3. Tasks* *- Argument 2.1 Allocation of tasks (between the human and the machine)* *- Argument 2.2. Performance of the technical systems* *- Argument 2.3. Human-machine interface* *- Argument 3.3. Communication* *- Argument 4.1. Acceptance and job satisfaction* *- Argument 4.2. Competence requirements* *- Argument 4.5. Training* *All the arguments were addressed in PJ02-08 RTS5. The results are documented in the HP Log in Appendix K.* ***In addition:*** *Previous validation activities conducted in SESAR1 P6.8.1 and SESAR2020 Pj02-01 and PJ02-03 on the ORD tool where ROT per a/c type has been integrated into the tool with other related concepts such as TB PWS and 2NM MRS are also relevant, i.e.* *EXE.PJ02.01 RTS2* *EXE.PJ02.01RTS3a* *EXE.PJ02.01 RTS4a* *EXE.PJ02.01RTS4b* *EXE.PJ02-03RTS2*
2	Are the benefits and issues in terms of human performance and operability related to the proposed solution sufficiently assessed (i.e. on the level required for V3)?	Yes	*All issues/benefits related to ROCAT(segregated mode) have been assessed in the validation activities conducted as part of PJ02-08 and where necessary mitigation (i.e. recommendation and requirements proposed)* *All Outcomes from RTS5 have been detailed in the ROCAT-Issue-Objective-Outcome section of the HP Log for concept 3.The Recommendations and Requirements Registers where the rationale columns offer a more in depth explanation on the findings.*

3	Have all the parts of the solution/concept been considered?	Yes	*All parts of the solution/concept have been considered, based on ROCAT with a controller support tool such as ORD on the basis of the change and argument identification step- which represented the starting point of the HP activities.*
4	Have potential interactions with related projects/concepts been considered and addressed?	Yes	*The list of the related projects/solutions has been identified in the HP Log Appendix K.* *List of related projects:* *• SESAR Project PJ02 Increased Runway and Airport Throughput, e.g. ORD (AO-0328), PWS-A (AO-0 306)-PJ02-01* *MRS to 2.0NM (AO-0309) Pj02-03* *ROCAT was integrated with PWS and ORD as one potential solution in Pj02-08 RTS5*
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	Yes	*The level of human performance needed to achieve the desired system performance has been assessed and confirmed as consistent with human capabilities.* *Detailed in HP Log Arg. 1 and Arg. 2 Appendix K.*
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?	Yes	*The results obtained from a HP perspective are in line with the proposed targets as all HP related validation objectives have been successfully covered and mitigation were proposed for all issues where appropriate.*
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	Partially	*In PJ02-08 RTS5 only the approach sectors were simulated with controllers that were both Approach and Tower rated, i.e. the TWR runway controller position was not validated. Furthermore, no abnormal or degraded mode scenarios were tested in PJ02-08 RTS5.* *However, the tower runway controller position was tested with the ORD tool in PJ02-01. Abnormal and degraded mode scenarios with the ORD tool were also tested in PJ02-01.*
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	Yes	*The Pj02-08 RTS5 validation results confirm that the interactions between human and technology are operationally feasible and consistent with agreed HP requirements. For a detailed view on the identified issues and the results of the validations, please consult all sections related to ROCAT in the current HP Log Excel document Appendix K plus Pj02-08 VALR*
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?	Yes	*The relevant SESAR documentation had been updated i.e. SPR-Interop/OSED*

10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	Yes	*The outcome of the PJ02-08 RTS5 with associated recommendations and requirements can be found in the "ROCAT-Issue-Objective-Outcome" and the ''Recommendations and Requirements register'' sections of the HP Log Appendix K.*
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	Yes	*The recommendation and requirements of the Pj02-08 RTS5 is to be found in the "ROCAT-Issue-Objective-Outcome" and ''Recommendations and Requirements register'' sections of the HP Log Appendix K. .*
12	Have the major factors that can influence the transition feasibility (e.g. changes in competence requirements, recruitment and selection, training needs, staffing requirements, and relocation of the workforce) been addressed? Are there any ideas on how to overcome any issues?	Yes	*None have been identified*
13	Have any impacts been identified that may require changes to regulation in the area of HP/ATM? This includes changes in roles & responsibilities, competence requirements, or the task allocation between human & machine.	No	
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	Yes	*Please refer to the "ROCAT-Issue-Objective-Outcome" section of the HP Log Appendix K. Mitigation for issues identified in the RTS5 have been proposed. Therefore, all identified issues and benefits have been closed for ROCAT for V3.*

Table 22: PJ02-08 Concept 3 HP maturity check list for V3 completion

4.4.2.3 Maturity of the Solution for Concept 4

ID	Question	Answer *Fill in 'yes' or 'no'.*	Comments *Please substantiate your answer.*
	Maturity checklist for finalising the V3 assessment (Concept 4)		
1	Has a Human Performance Assessment Report been completed? Have all relevant arguments been addressed and appropriately supported?	YES	*Refer to section 4.1.2.3**Fel! Bokmärket är inte definierat.** of this document*
2	Are the benefits and issues in terms of human performance and operability related to the proposed solution sufficiently assessed (i.e. on the level required for V3)?	NO	*Refer to section 4.1.2.3 of this document* *Some limitations of the EXE.02-08.V3.004 contingency platform made the HP assessment difficult. Contingency platform required HMI different than intended which had significant impact on validation results – especially with regard to human error.* *Traffic simulation on the contingency platform was not sufficiently diverse to reflect expected operating conditions.*
3	Have all the parts of the solution/concept been considered?	YES	*Concept 4 has been assessed independently from other concepts in solution PJ.02-08*
4	Have potential interactions with related projects/concepts been considered and addressed?	NO	
5	Is the level of human performance needed to achieve the desired system performance for the proposed solution consistent with human capabilities?	YES	*Refer to section 4.1.2.3 of this document*
6	Are the assessments results in line with what is targeted for that concept? If not, has the impact on the overall strategic performance objectives/targets been analysed?	YES	*Refer to section 4.1.2.3 of this document*
7	Has the proposed solution been tested with end-users and under sufficiently realistic conditions, including abnormal and degraded conditions?	NO	*Testing of the concept conducted for degraded mode but not for adverse weather conditions.* *Some aspects of simulation lacked satisfactory level of realism on the contingency platform.*
8	Do validation results confirm that the interactions between human and technology are operationally feasible, and consistent with agreed human performance requirements?	YES	*Refer to section 4.1.2.3of this document*
9	Have all relevant SESAR documentation been updated according to the HP activities outcomes (OSED, SPR)?	NO	*Refer to OSED Part I [1]*

10	Do the outcomes satisfy the HP issues/benefits in order to reach the expected KPA?	NO	*Refer to section 4.1.2.34.2.1.3 of this document and to VALR conclusions.* *Some aspects of the RTS were not conclusive on the performance result.*
11	Have HP recommendations and HP requirements correctly been considered in HMI design, procedures/documentation and training?	YES	*Refer to section 4.1.2.3 of this document*
12	Have the major factors that can influence the transition feasibility (e.g. changes in competence requirements, recruitment and selection, training needs, staffing requirements, and relocation of the workforce) been addressed? Are there any ideas on how to overcome any issues?	YES	*Refer to section 4.1.2.3of this document*
13	Have any impacts been identified that may require changes to regulation in the area of HP/ATM? This includes changes in roles & responsibilities, competence requirements, or the task allocation between human & machine.	NO impact on regulation	*Refer to section 4.1.2.3of this document*
14	Has the next V-phase sufficiently been prepared (additional testing conditions, open HP issues to be addressed)?	N/A (no next phase)	*Refer to Appendix F of this document*

Table 23: PJ02-08 Concept 4 HP maturity check list for V3 completion

5 References

Human Performance

[1] 16.06 Strawman Paper on Case Building in SESAR SWP 16.6

[2] 16.04.01 Evolution from the ATM HF case to a HP Case Methodology for SESAR, HP assessment process for projects in V1, V2 or V3. D10-001, 00.01.00

[3] 06.09.03 D05.1 Single Remote Tower Validation Plan – Appendix Human Performance Assessment Plan

[4] 16.06.05 D 27 HP Reference Material D27

[5] 16.04.02 D04 e-HP Repository - Release note

Solution Documents

[1] SESAR 2020 Solution 02-08 SPR-INTEROP/OSED for V3 – Part I, D6.1.203

[2] SESAR Solution 02.08 Validation Plan (VALP) for V3 –Part I, D6.1.22

[3] SESAR Solution 02-08 Validation Plan (VALP) for V3 –Part IV – Human Performance Assessment Plan (HPAP), D6.1.23

[4] SESAR 2020 Solution 02-08 SPR-INTEROD/OSED for V2 – Part IV – Human Performance Assessment Report (HPAR), D6.1.10

[5] SESAR Solution 02-08 D6.1.23 Validation Report (VALR) for V3

Appendix A   Additional HP activities conducted for Concept 1

N/A

Appendix B   Additional HP activities conducted for Concept 3

It should be noted that if ROCAT is to be implemented then a controller support tool is required for the final approach and tower runway controllers. It is proposed that this controller support tool is the ORD (AO-0328) developed in PJ02-01, as the ORD tool incorporates ROT based on aircraft type, as proposed by the ROCAT concept 3 Level 1.

The ORD tool was initially developed in SESAR1 P6.8.1 – the need to incorporate ROT into the ORD tool was initially identified through the validation activities conducted in P6.8.1. These activities included task analysis, controller workshops, prototyping sessions and RTSs. The results of these HP validation activities can be found in SESAR 6.8.1 HP Assessment Report.

The ORD with ROT per aircraft type has been further developed and validated in several SESAR Pj02-01 and Pj02-03 V3 activities with other concepts such as TBS, PWS and WDS in PJ02-01 and reduction of MRS on the final approach based on RSP to 2NM within PJ02-03. These activities include a number of workshops, prototyping sessions and real time simulations which have been used to identify ORD requirements for applying TBS, WDS, PWS, ROT and Gaps for mixed mode operations in large and very large airport and highly complex and very highly complex TMA environments.

Hence, the ORD tool used in PJ02-08 RTS5 is the ORD tool (AO-0328) developed and validated from these previous activities. For more information on the ORD tool and the activities conducted prior to PJ02-08 RTS5 please refer to the PJ02-01 and Pj02-03 SPR-INTEROP/OSED and VALR.

Appendix C   Additional HP activities conducted for Concept 4

During Concept 4 validation additional activities measuring Human Performance aspect were conducted. During validation scenarios controllers marked their workload every 60 seconds using special application. After the validation exercise, participants were asked to fill set of questionnaires aiming to assess the chosen metrics. Five different questionnaires were chosen for HP assessment.

ISA workload - Controller 1

ENTER ISA WORKLOAD VALUE

LAST ISA VALUE: 2

5 (Overload)

4 (Fully loaded)

3 (Reasonable)

2 (Light Work)

1 (Nothing to do)

Figure 2. ISA workload measurement application panel

Assessment Methodology

ISA real-time workload scale

"ISA (Instantaneous Self-Assessment) is one of the most frequently used measures of mental workload in real–time simulations. ISA is a measurement method using five-point rating scale that was originally developed at the ATMDC (Air Traffic Management Development Centre, National Air Traffic Services) to assess mental workload in real time. ISA was developed as a tool that an operator could use to estimate their perceived workload during real-time simulations. The operator is prompted at regular intervals to give a rating of 1 to 5 of how busy he is (1 means nothing to do, 5 means overloaded)."[1]

Level	Workload	Spare Capacity	Description
5	Very high (overload)	None	Behind on tasks; losing track of the full picture.
4	High (fully loaded)	Very little	Non-essential tasks suffering. Could not work at this level very long.
3	Fair (reasonable)	Some	All tasks well in hand. Busy but stimulating pace. Could keep going continuously at this level.
2	Low (light work)	Ample	More than enough time for all tasks. Active on ATC task less than 50% of the time.

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[1] ISA workload, Eurocontrol HP repository, accessed 18.07.2019, https://ext.eurocontrol.int/ehp/?q=node/1585

1	Low (nothing to do)	Very much	Nothing to do. Rather boring.

Table 24 ISA rates with detailed description

During validation exercise controllers were asked to record their perceived level of workload every one minute using keypad or mouse. Application prepared for recording ISA was so simple that did not interfere with the primary task and did not increase workload level.

Bedford Workload Scale

"Bedford Scale aims to identify operator's spare mental capacity while completing a task. It is a uni-dimensional rating, where the dimension is assessed using a hierarchical decision tree that guides the operator through a ten-point rating scale, each point of which is accompanied by a descriptor of the associated level of workload. The scale ranks whether it was possible to complete the task, if workload was tolerable for the task, and if workload was satisfactory without reduction. The Bedford scale was originally developed for pilots". [2]

Bedford Scale contains two measurements - average (score average) and peak (score peak) workload experienced during the run.

10-point scale

Higher score means lower workload; better result

China Lakes Situational Awareness Scale

China Lakes Scale aims to identify operator's situational awareness while completing a task. It is very similar to Bedford scale, where a hierarchical decision tree guides the operator through ten-point rating scale and each point is associated with a descriptor of situational

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[2] Bedford Scale, Eurocontrol HP Repository, accessed 18.07.2019, https://ext.eurocontrol.int/ehp/?q=node/1643,

awareness level. The scaleranks whether it was possible to complete the task, if situational awareness was acceptable for the task, and if the level of situational awareness was satisfactory without reduction.

10-point scale

Higher score means higher situational awareness; better result

CARS User Acceptance Scale

"The Controller Acceptance Rating Scale (CARS) is a simple, scalar measure and indicator of satisfactory human-system performance. It measures operational acceptability of the system or some of its components as being seen as effective and suitable by controllers who participate in the development of new tools or important changes.

The air traffic controller rates how well the overall system (software, hardware and user) is working. Each controller is asked to rate the system according to his own experience, from his particular sector position.

CARS results provide a numerical record of development progress and software acceptance during development and implementation of software changes during operational evaluation or in operational settings considered ready for daily use in operations".[3]

CARS provides developers and assessors of created ATM systems or their components with a mean of determining how well controllers and work and perform controlling traffic during simulations before the system is deployed into daily use.

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[3] CARS Scale, Eurocontrol HP Repository, accessed 18.07.2019, https://ext.eurocontrol.int/ehp/?q=node/1610,

CARS consists of a series of yes/no questions describing the system performance on the evaluated scenario. This provides a numeric rating for system performance. Response structure is based on a hierarchical decision tree, similar to Bedford and China Lakes scale[4]

10-point scale

Higher score means higher user acceptance; better result

SASHA - Situation Awareness for SHAPE

"The SASHA questionnaire serves to assess the effect of automation on controller situation awareness."[5]

Questions in SASHA are formulated to address three different aspects of situational awareness:

Information extraction

Integration

Anticipation

It consists of 6 questions with scale ranging from "never" to "always". For two of those questions (question 1 and 4) higher score means better result, whereas for the remaining ones lower score indicates better awareness.

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[4] CARS Scale, Eurocontrol HP Repository, accessed 18.07.2019, https://ext.eurocontrol.int/ehp/?q=node/1610,

[5] SASHA Scale, Eurocontrol HP Repository, accessed 18.07.2019, https://ext.eurocontrol.int/ehp/?q=node/1609

- 7-point scale

- 6 questions

- Q1 and Q4: higher score means higher rating, Q2, Q3, Q5 and Q6: lower score means higher rating

SATI - SHAPE Automation Trust Index

"SATI is part of the SHAPE questionnaires where it is the term of the trust measure. Its goal is to provide a means of measuring trust at some level, so leading to the identification of trusted and usable ATC automation tools and ultimately to effective combined human-automation ATM system performance.

The SATI is part of the SHAPE questionnaires. The SHAPE questionnaires were developed to assess the effect of automation on controller workload, situation awareness, teamwork and trust in the system.

The SATI questionnaire serves to assess the effect of automation on controller trust in the system."[6]

SATI assesses human trust in developed ATC systems, it is primarily concerned with computer-assistance tools and other forms of automation support. It aims to cover different system aspects:

- Utility/Liking: Question 1

- Reliability: Question 2

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[6] SATI Scale, Eurocontrol HP Repository, accessed 18.07.2019, https://ext.eurocontrol.int/ehp/?q=node/1594

- Accuracy: Question 3

- Understandability: Question 4

- Robustness: Question 5

- Confidence: Question 6

Each question concerns a different aspect of the system. Questions are scored on 0-6 point scale.

- 7-point scale

- Higher score means higher rating of system aspect

6 questions - each measures different system aspect

Assessment Results

ISA real-time workload scale

In Figure 3 Distribution of ISA values for each scenario (from 1 to 6) and controller we can see the results of ISA workload measurements for each scenario and controller. Each scenario contains series of measured values. Plot presents distribution of ISA values using boxplot - median, quartiles, minimum and maximum are shown. There is a significant difference in results between controllers - first controller was overloaded in almost each scenario, when second controller most often felt that there was nothing to do (value 2) or had light work (value 2).
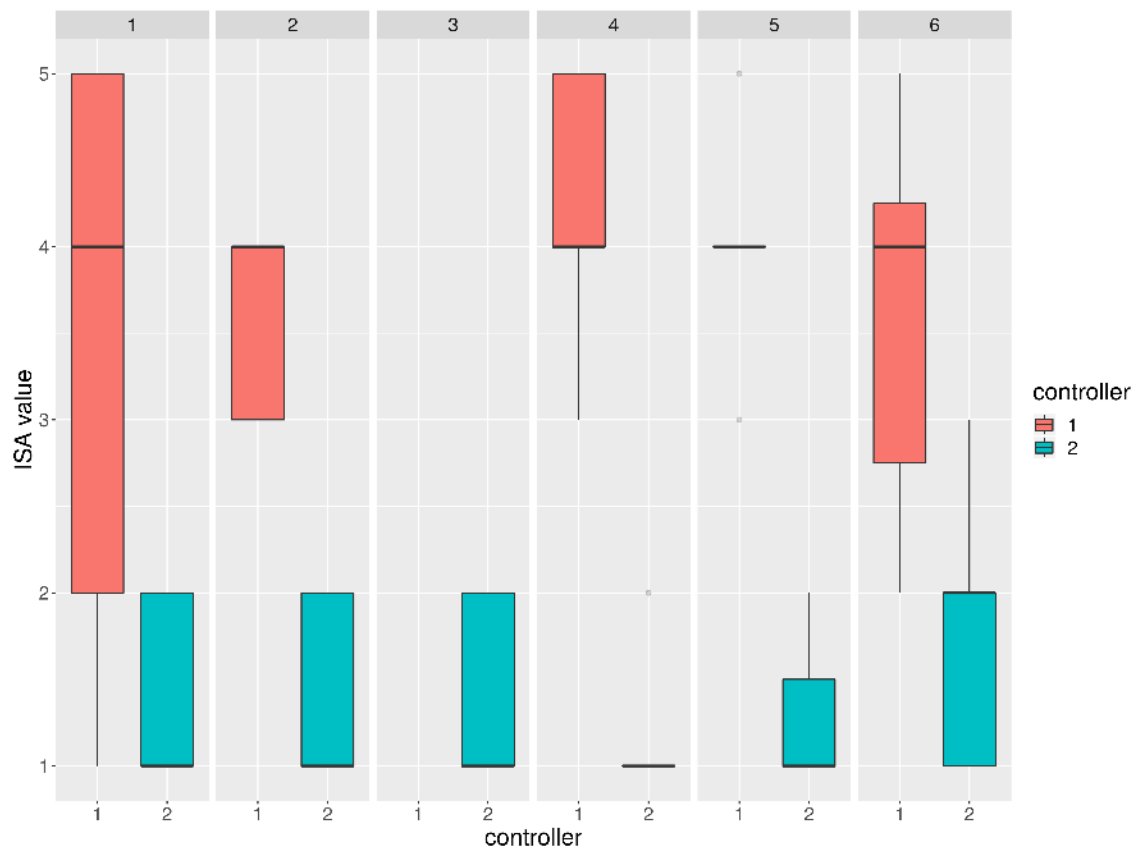
Figure 3 Distribution of ISA values for each scenario (from 1 to 6) and controller

Figure 4 shows that workload may have changed during exercises. In case of second controller variance is small, but in case of first controller, especially in scenario 1 and 6, sense of workload have drastically changed during the exercise.
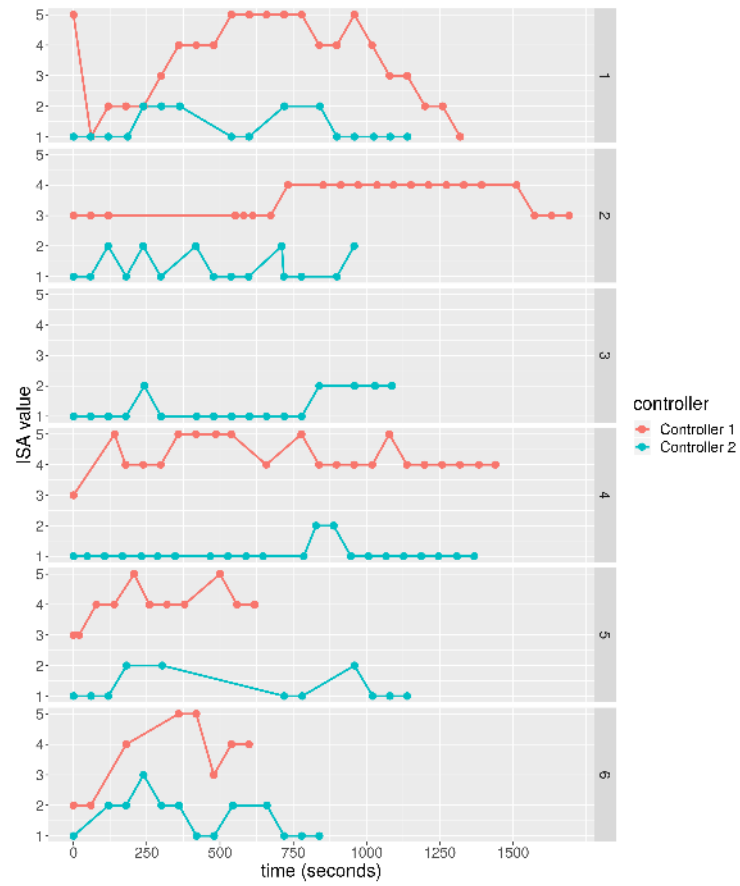
Figure 4 ISA values time series for each scenario (from 1 to 6) and controller

In Figure 5 are shown differences in distribution of ISA workload between nominal, with recommendations from system, and reference, without recommendations, scenarios. There were two reference scenarios (1 and 4) and four nominal (2, 3, 5, and 6). Second controller generally did not experience significant workload (Figure 2), median of his rates is 1 (nothing to do) both in case of nominal and reference scenarios. Median of rate for first controller is 4 (fully loaded) for both scenarios types, but distribution of reference scenarios values is moved to higher values, third quartile is 5 (overload) and first quartile for nominal is 3 (reasonable). It may suggest that recommendations impact on slightly less work.
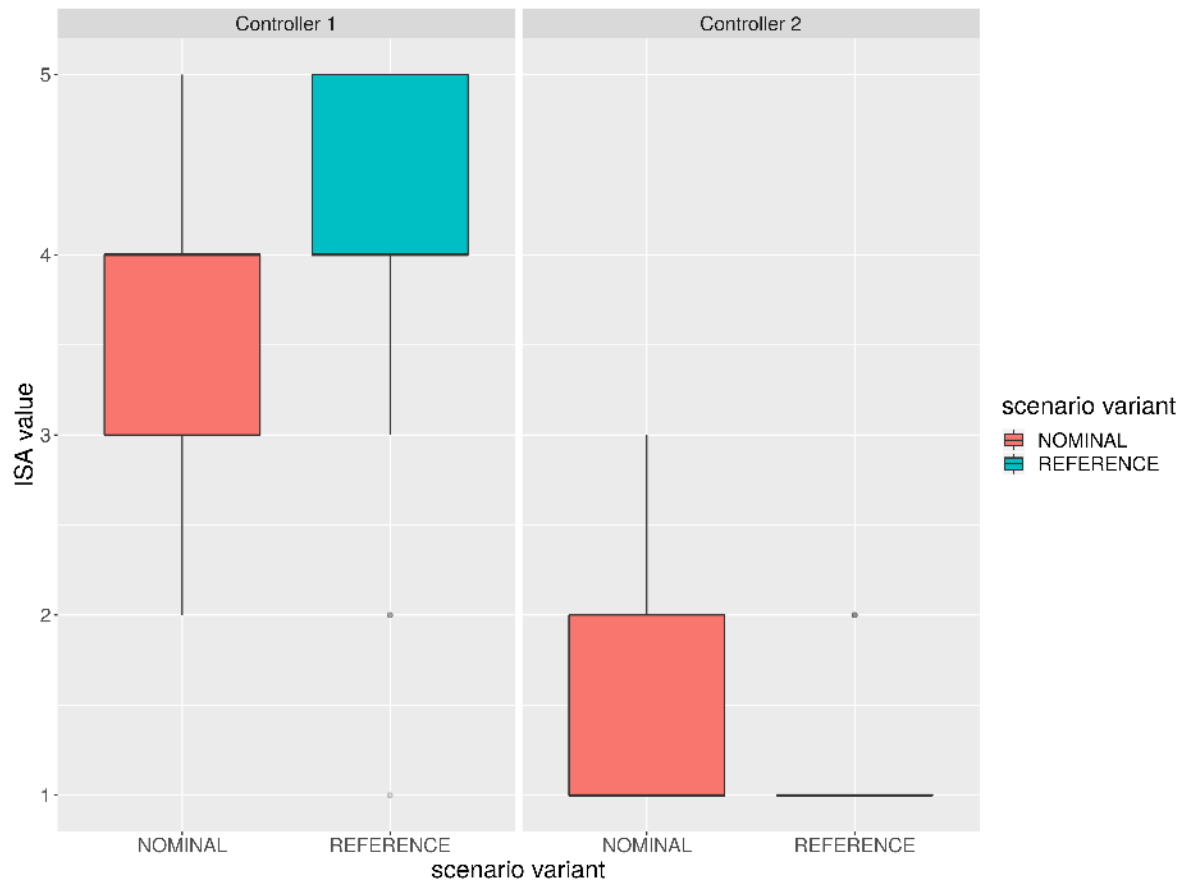
Figure 5 Distribution of ISA values for each scenario group (reference and nominal) and controller

Figure 6 shows that for first controller there were two short periods with small workload for reference scenario, but apart from it, reference scenarios needed more workload.
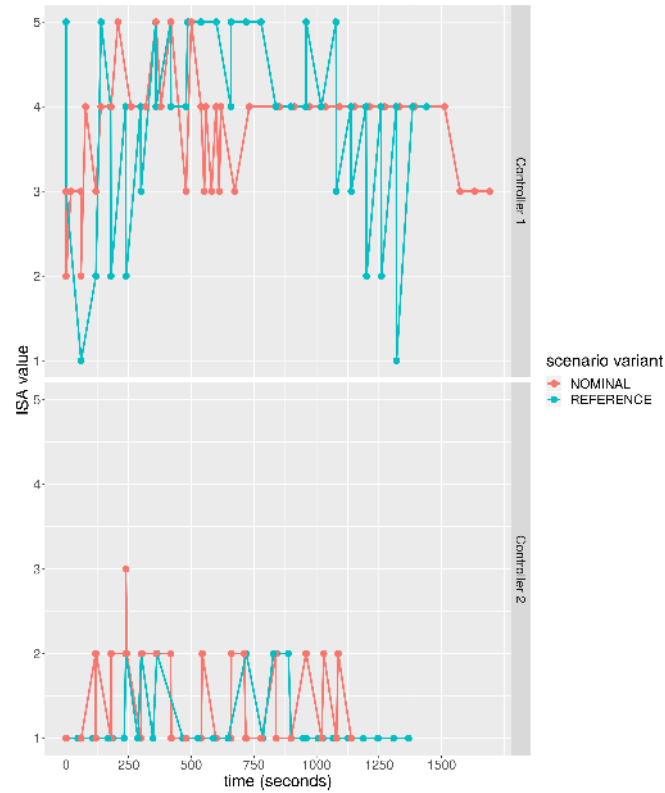

Figure 6 ISA values time series for each scenario group (reference and nominal) and controller

Figure 7 shows distribution of ISA rates depending on time of exercise. It was divided into five minutes blocks (i-th block is i-th 5 minute block from beginning of scenario). As for previous statistics there is no significant difference for controller 2, but for first controller interesting pattern may be observed. At the beginning and end of the exercise there were less work (median 3 - reasonable), than in the middle of the exercises (median 4 - fully loaded).
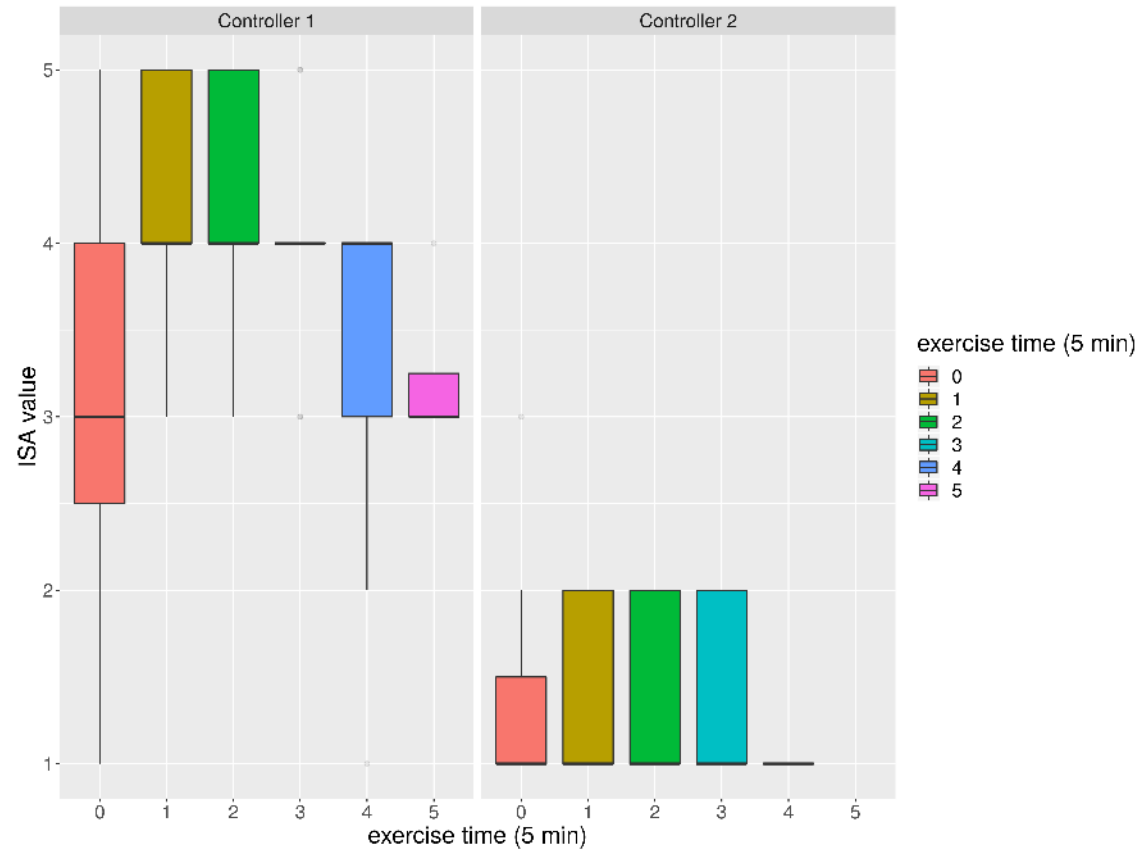
Figure 7 Distribution of ISA values depending on time of exercise (5 minutes blocks)

Bedford Workload Scale

Scores, as measured by Bedford scale, for validation participants are shown in Figure 8. The figure shows distribution of scores for exercise participants, when aggregated by scenarios and traffic variants. Facets are made by metric type.

There is a significant difference in scores between the participants, both in average and peak workload metrics measured by the questionnaire.

Amount of workload for participant 1 was higher, which is especially pronounced in the case of peak workflow, where score of 4 indicates "Very high workload with almost no spare capacity but no impact to the primary ATM task", being in the group of intolerable workflow. Median peak score for the second participant is 6 - "Reduced spare capacity. Additional or other tasks cannot be given the desired amount of attention", which translates to satisfactory workload with reduction of capacity. There was one scenario (scenario 3) for the second participant which was associated with a low workload (score of 9).

Median of average amount of workflow for the first participant is 6, a satisfactory workload with reduction of capacity. For the second participant, median is 8, a satisfactory workload without reduction of capacity - "Enough spare capacity for all desirable additional tasks".
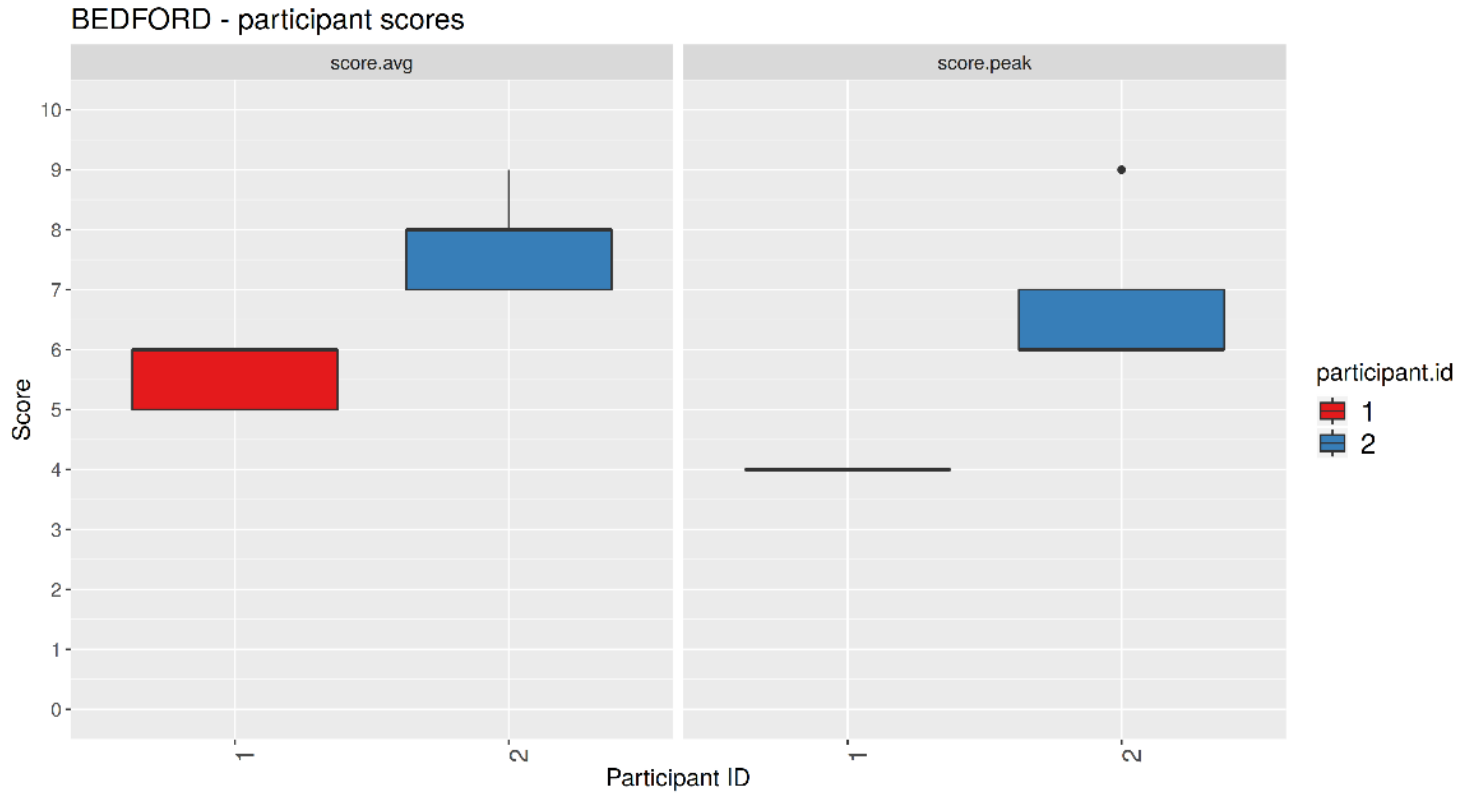
Figure 8 Bedford Workload - participant scores

Different scenarios were associated with different amount of workflow, as depicted in Figure 9. Shown distributions are gathered across participants and scenario variants to show score distribution per scenario for each of the two metrics.

Median average workflow is between 6 and 7, with scenarios 2, 3 and 4 achieving highest scores. Highest workload was observed in case of scenario 6.

More notable differences in scores are observed in case of peak workload, where scenario 3 was rated as one with the lowest workload (this is due to being given score of 9 by one of the participants). Scenarios 4, 5 and 6 are scored as the ones with higher peak workload.
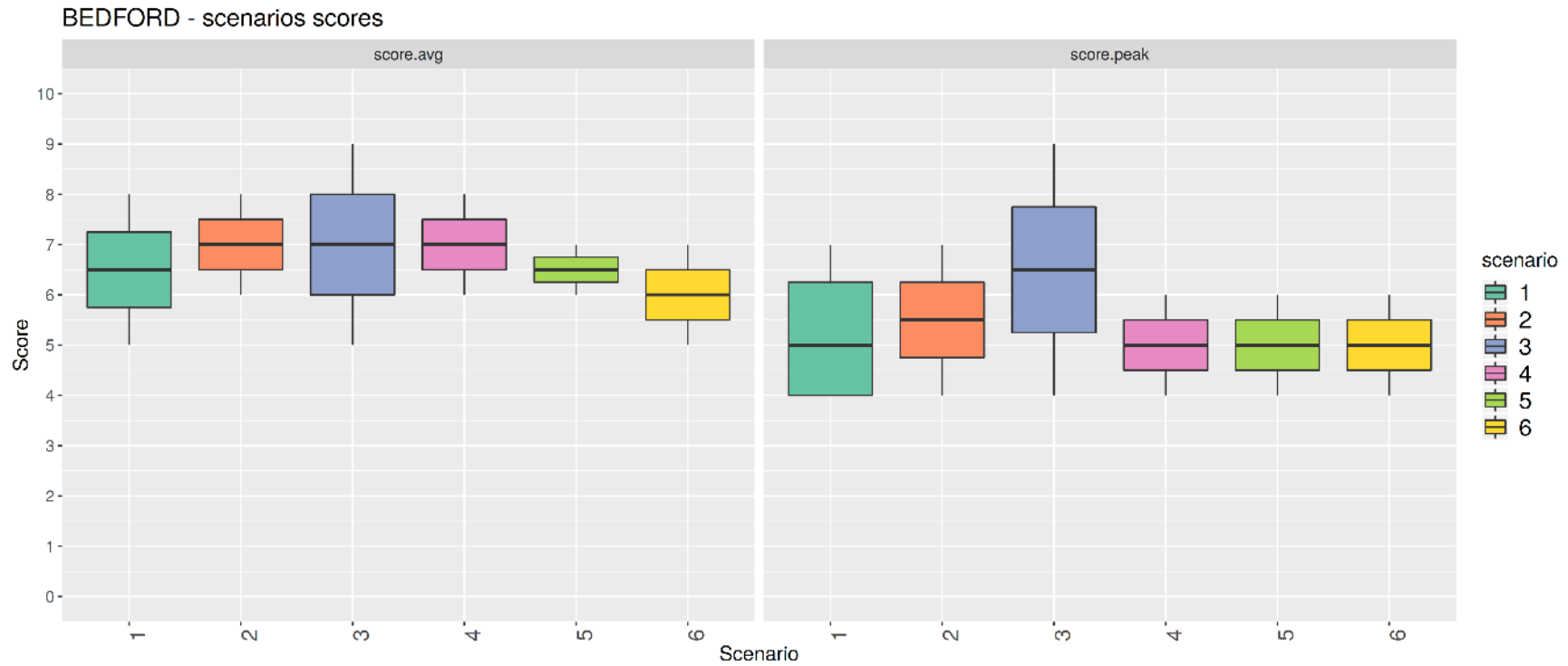

Figure 9 Bedford Workload - scenario scores

Scenarios were rated differently by the participants, with some having more significant differences in scores than the others. This is shown in Figure 10. Faceting is done by scenarios.

Scores are aggregated across scenario variants and both metrics, showing distributions of scores for each scenario and each participant.

Participant 1 generally indicates higher workload during the exercise. The most significant difference occurs for scenario 3, with one score of 4.5 and the other one of 9. Scenarios 5 and 6 were the most demanding.
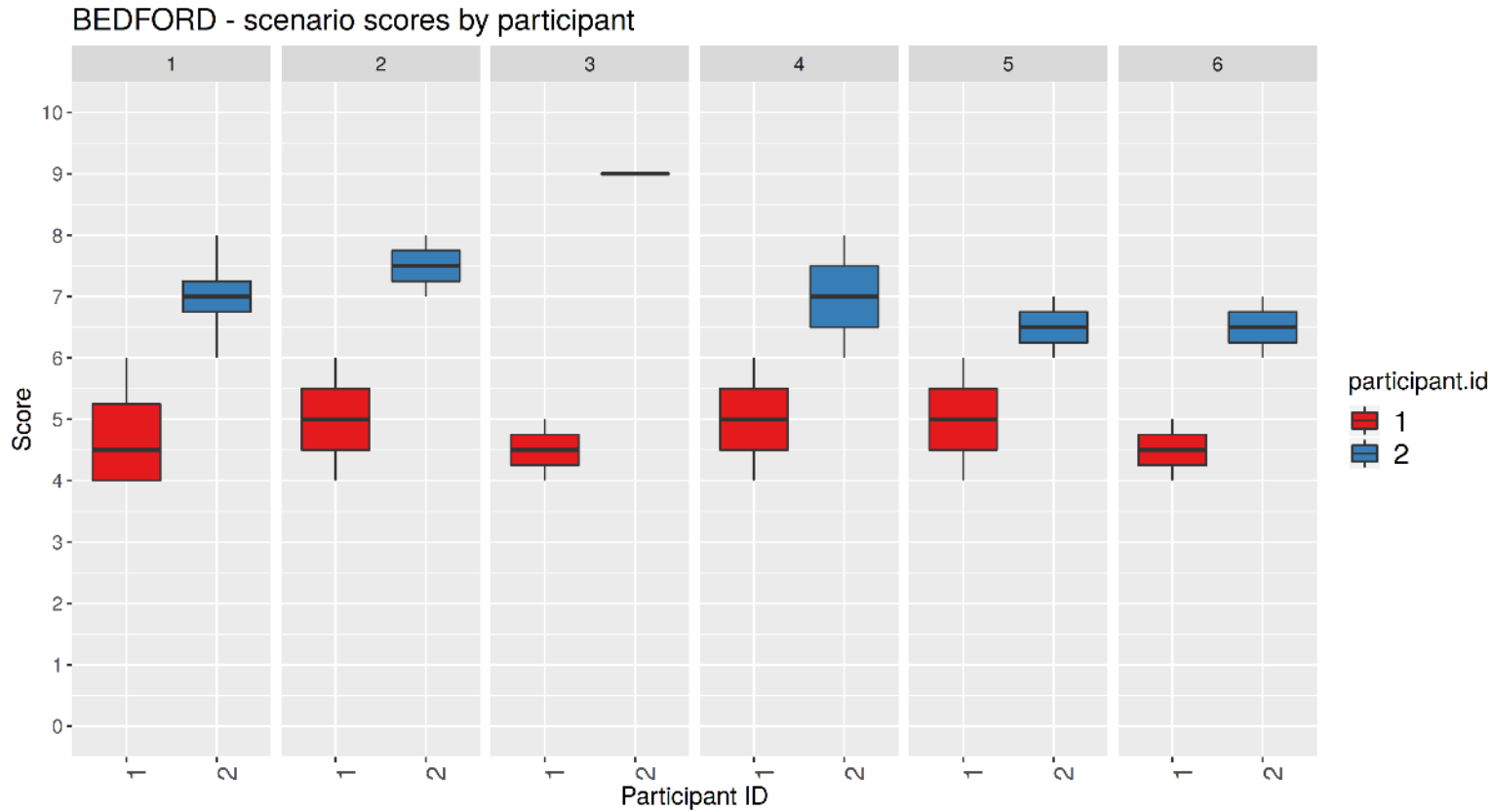
Figure 10. Bedford Workload - scenario scores for participants

China Lakes Situational Awareness Scale

Situational awareness results, as measured by China Lakes scale, are shown in Figure 11. Results were aggregated by scenarios and variants and show distribution of scores for each of the participants.

Participant 2 had higher situational awareness during the exercise. This confirms the lower workload he indicated, as measured by Bedford scale. In this case, the difference is smaller, with median of 8 indicating satisfactory level of awareness ("My SA with respect to the task was good. I was able to perform the task well most of the time") for participant 2 and median of 7, indicating acceptable, but not satisfactory level of SA ("My SA with respect to the task was not complete. I was able to perform the task, but not satisfactorily") for participant 1.
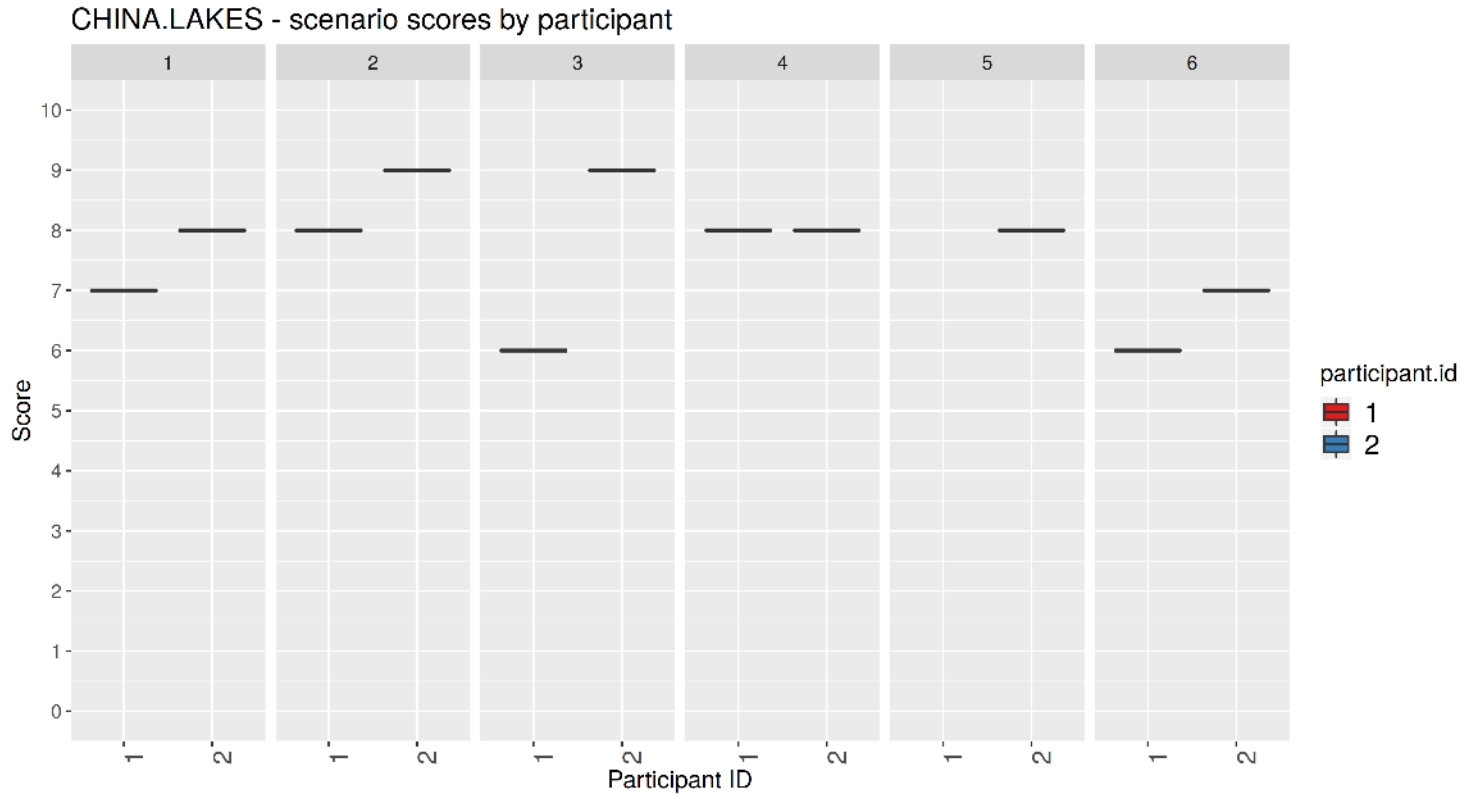
Figure 11 China Lakes Situational Awareness - participant scores

Situational awareness varied among different scenarios, as shown in Figure 12. Results were aggregated by participant and scenario variant.

Awareness varies between median of 6.5 and 8.5, indicating acceptable or satisfactory situational awareness. Participants had the highest awareness in scenario 2, with median of 8.5. The lowest score was reported in scenario 6, confirming Bedford results, which also indicated that scenario 6 was one of the more difficult ones.
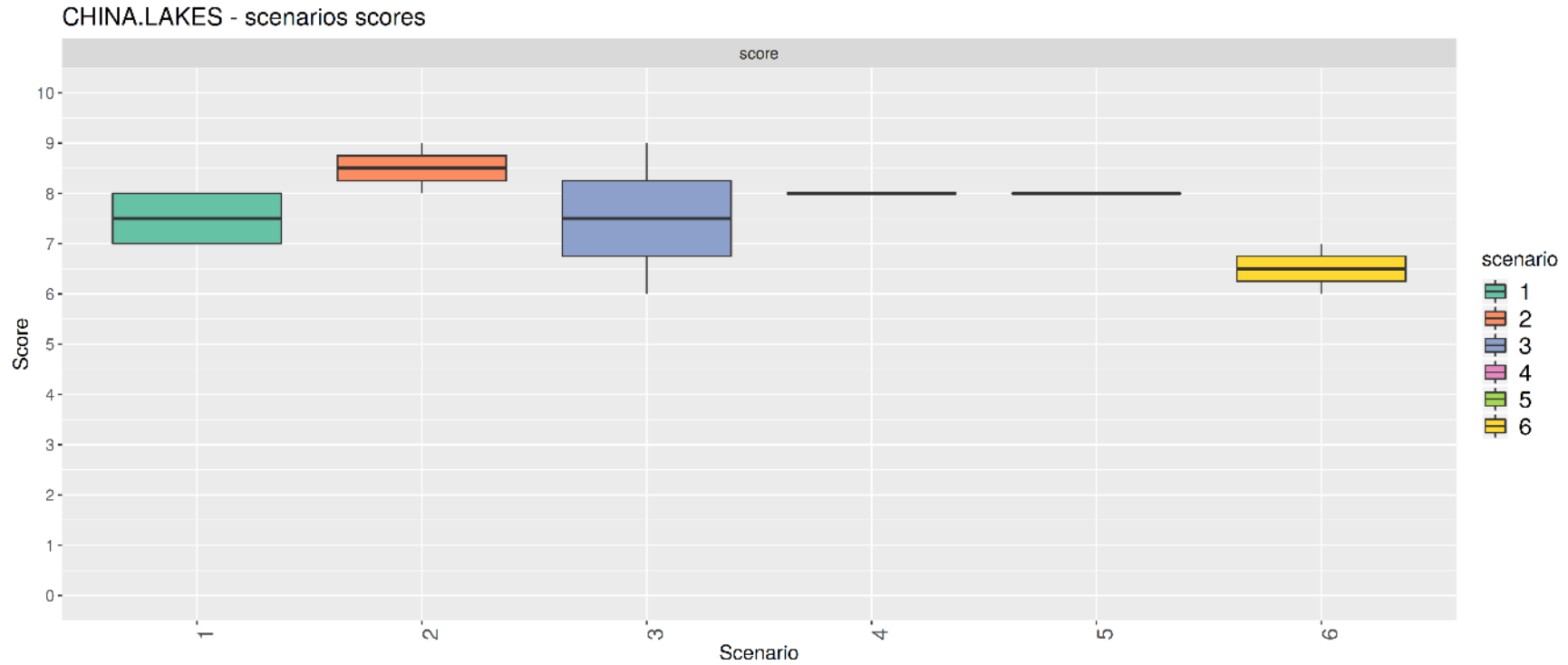

Figure 12 China Lakes Situational Awareness - scenario scores

Results for awareness for each scenario and participant are shown in Figure 13. In this setting, there is no variation (boxes are flat), as in most cases only one scenario variant was assessed or the score for both variants was the same.

Concluding, scenario 6 had the lowest situational awareness, whereas scenario 2 had the highest. Most significant difference in scenario assessment by participants is observed in scenario 3. Scenario 4 was given equal ratings.
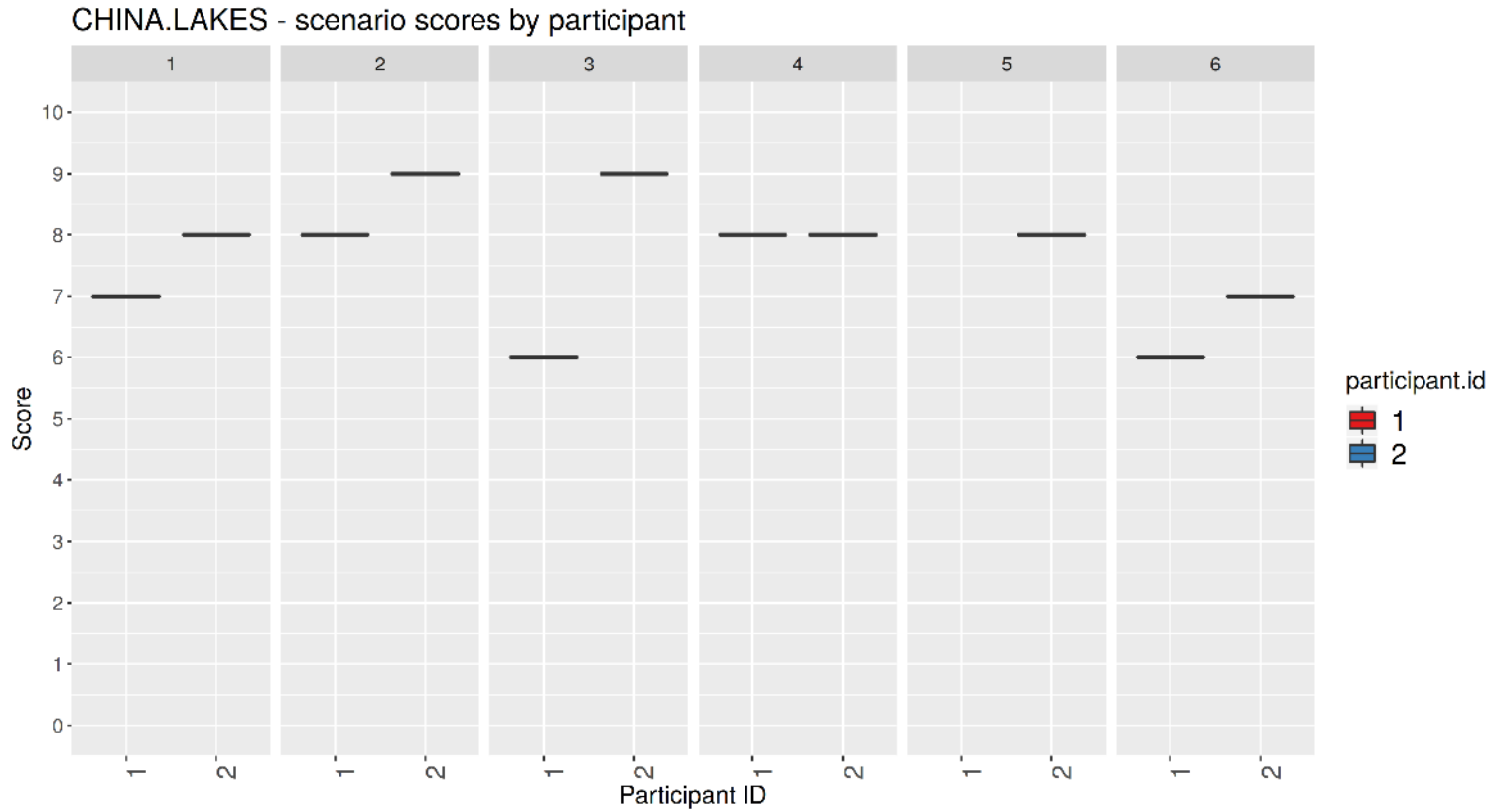
Figure 13 China Lakes Situational Awareness - scenario scores for participants

CARS User Acceptance Scale

Participant ID	Result
1	6
2	4

Table 25 CARS Scale results

Participant 1 indicated that system is not satisfactory without an improvement, but an adequate performance is attainable with tolerable workload. Score of 6 translates to "Moderately Objectionable Deficiencies. Considerable controller compensation to achieve adequate performance".

Participant 2 rated the system as safe and controllable but an adequate system performance is not attainable with tolerable workload, where a score of 4 is described as "Major Deficiencies. System is controllable. Some compensation is needed to maintain safe operations".

SASHA - Situation Awareness for SHAPE

Another measurement of situational awareness is SASHA, which concentrates on information extraction, integration and anticipation. Figure 14 shows distribution of overall scores (scores averaged over questions) for participants. Aggregation was done over scenarios and traffic variants. Results are consistent with Bedford and China Lakes, with participant 2 indicating higher situational awareness - median of 4.75 in comparison to 3.0 for participant 1.
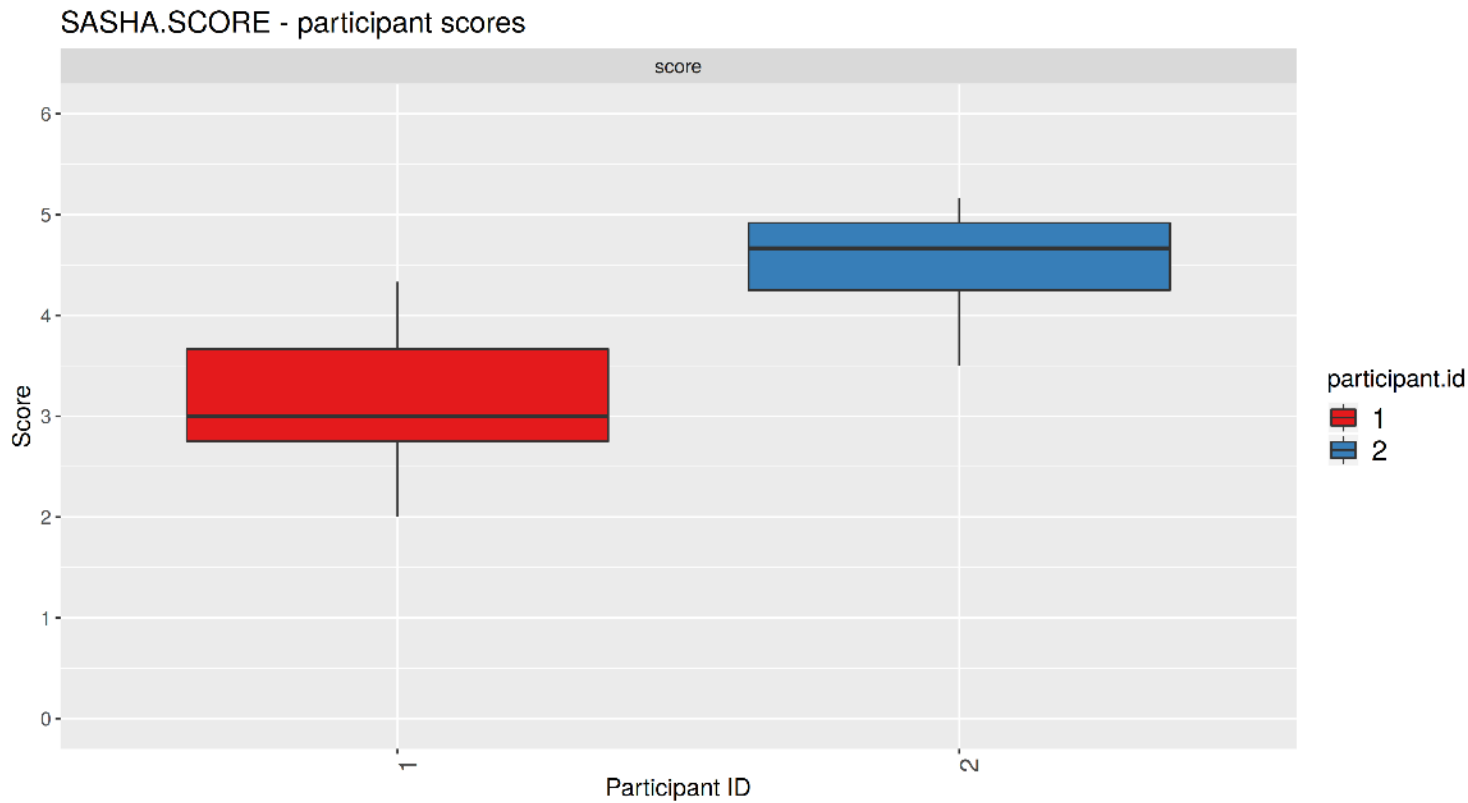
Figure 14 SASHA overall score - participant scores

Distribution of scores for different scenarios Figure 15 is similar to China Lakes assessment. Consistently with China Lakes, scenario 6 was evaluated as the most demanding one, with average score median equal to 2.75. In contrast to this, scenario 3 was given the highest average score with median around 4.60. Rest of the scenarios were evaluated similarly, with median scores ranging from 3.80 to 4.40.

Figure 15 SASHA overall score - scenario scores

Depending on the scenario, results for different aspects of situational awareness varied, as shown in Figure 16. Faceting is done by questions, where for each questions scores for all the scenarios are shown.
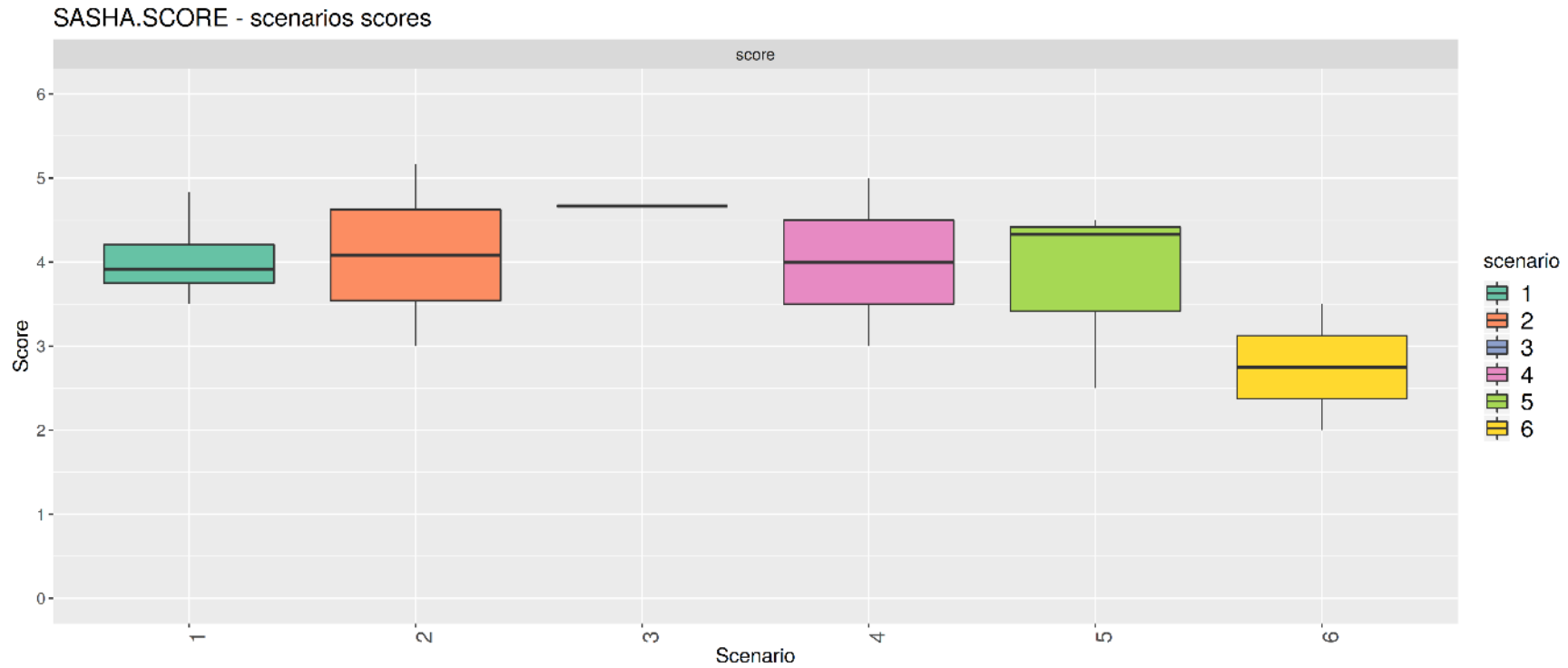
Here, higher results for questions 1 and 4 indicate higher scores, whereas originally for the rest of the questions lower result would indicate higher score (according to the 6 - x formula for those questions). Scores have been transformed using the formula, therefore higher score for those questions means higher result.

Question 1: "… I was ahead of the traffic." - participants were able to easily predict traffic in scenario 3, whereas scenario 2 was the most difficult in this aspect. Results for other scenarios indicate an ability to generally predict the trafic well (median of 4 and above)

Question 2: "… I started to focus on a single problem or a specific area of the sector." - participants were able to keep a satisfactory view on the situation in scenario 3 (median of 6), whereas they had to focus on specific areas or problems in scenario 2 (median of 2.5). For other scenarios median was 4 or above, thus signifying no significant issues with keeping a more general outlook.

Question 3: "… there was a risk of forgetting something important (like transferring

an a/c on time or communicating a change to an adjacent sector)." - participants were able to remember everything important in scenario 3 (median of 6). This was the easiest scenario. Most difficult scenario was 1. In other scenarios there was a moderate risk of forgetting something important (median between 3 and 4).

Question 4: "… I was able to plan and organise my work as I wanted." - participants were able to plan their work well in scenario 2 (median of 5). Scenarios of moderate difficulty were 1 and 4. In scenarios 3, 5 and 6 it was difficult to plan and organize the work.

Question 5: "… I was surprised by an event I did not expect (like an a/c call)." - in most of executed scenarios, there were no significant amount of surprising events - an exception is scenario 6 with median of 1. Scenario 2 was moderately difficult (median of 3.5). Easiest scenario was 3 with median of 6.

Question 6: "… I had to search for an item of information." - participants had difficulty finding items of information in scenarios 3, 5 and 6 (median of 2). Least difficulties were encountered during scenario 2 (median of 5.5).
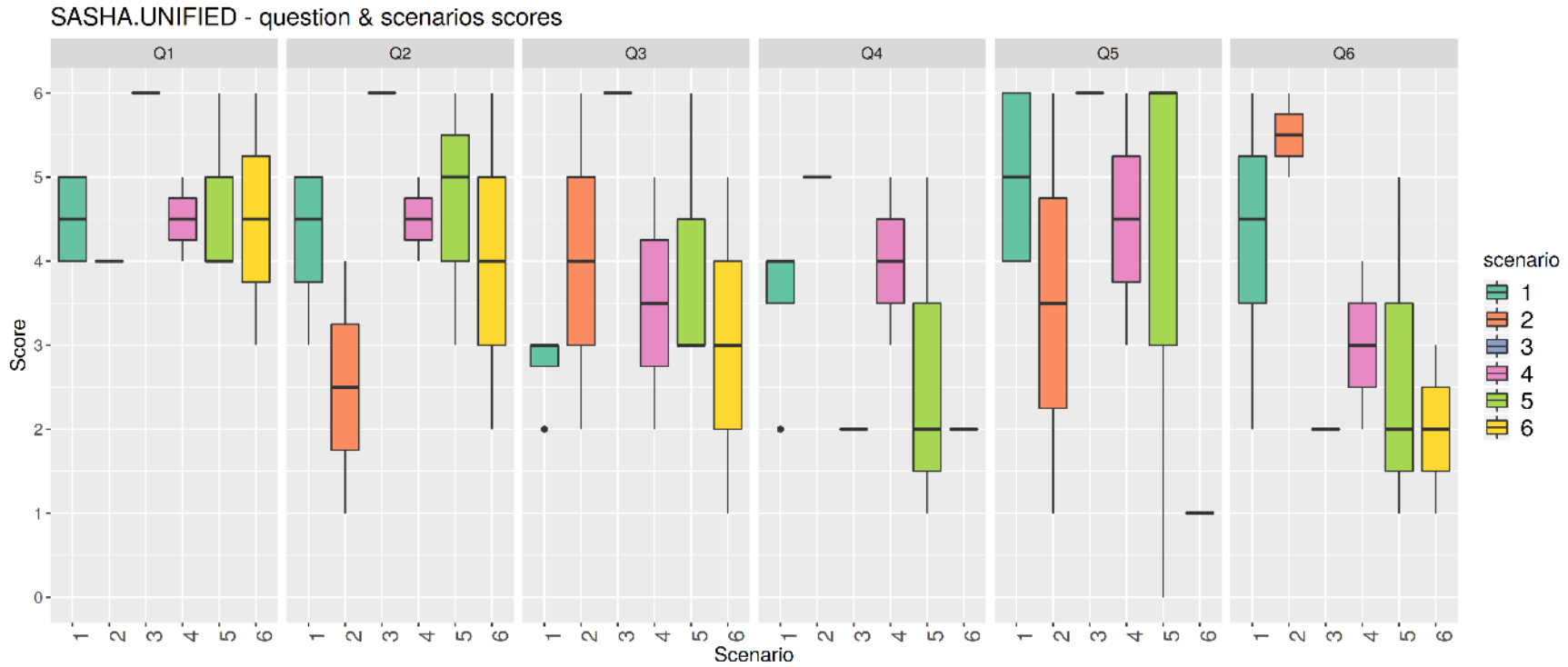
Figure 16 SASHA question scores – scenarios

Perception of aspects of situational awareness differed between the participants, as depicted in Figure 17. Faceting is done by questions, for each questions scores for both participants are shown.

Participants agree that it was not difficult to be ahead of the traffic (Q1).

Most significant differences are seen in terms of being able to keep a view on the situation (Q2), possibility of forgetting something important (Q3) and being surprised by an unexpected event. Those aspects were assessed as notably more difficult by participant 2.

Ability to plan and organize their work was mediocre, without a very significant difference (Q4). This is the case also for having to search for an item of information (Q6).
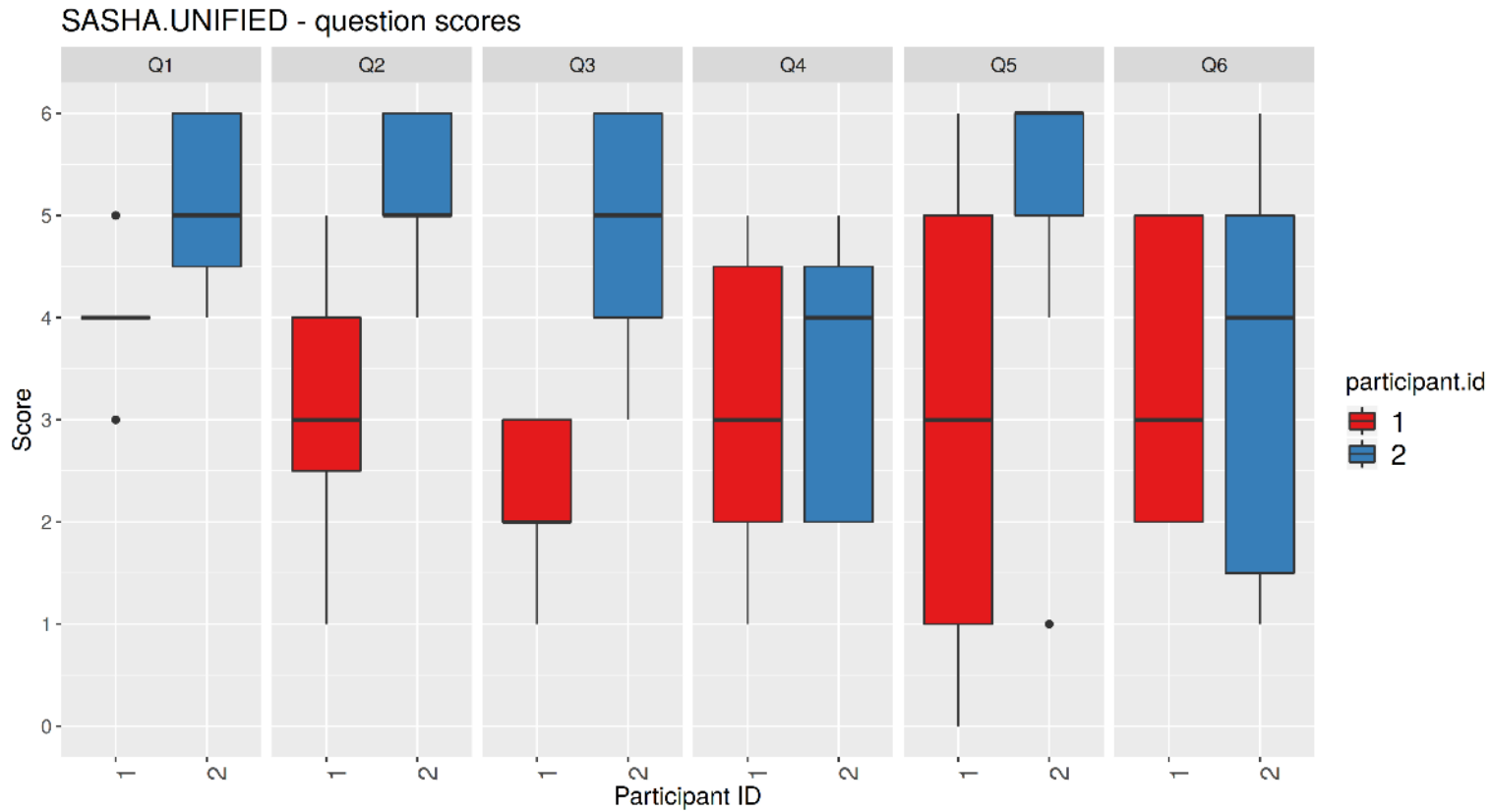
Figure 17 SASHA question scores by participants

SATI - SHAPE Automation Trust Index

SATI measures trust of the controller for developed automation solution, evaluating six different aspects of the system. Overall score is given as average over the questions.

Distribution of overall scores for participants is shown in Figure 18, where the aggregation was made over scenarios. Consistently with previous human performance measures, score for participant 2 is higher, with median above 3.5, whereas for participant 1 median is around 2.75.
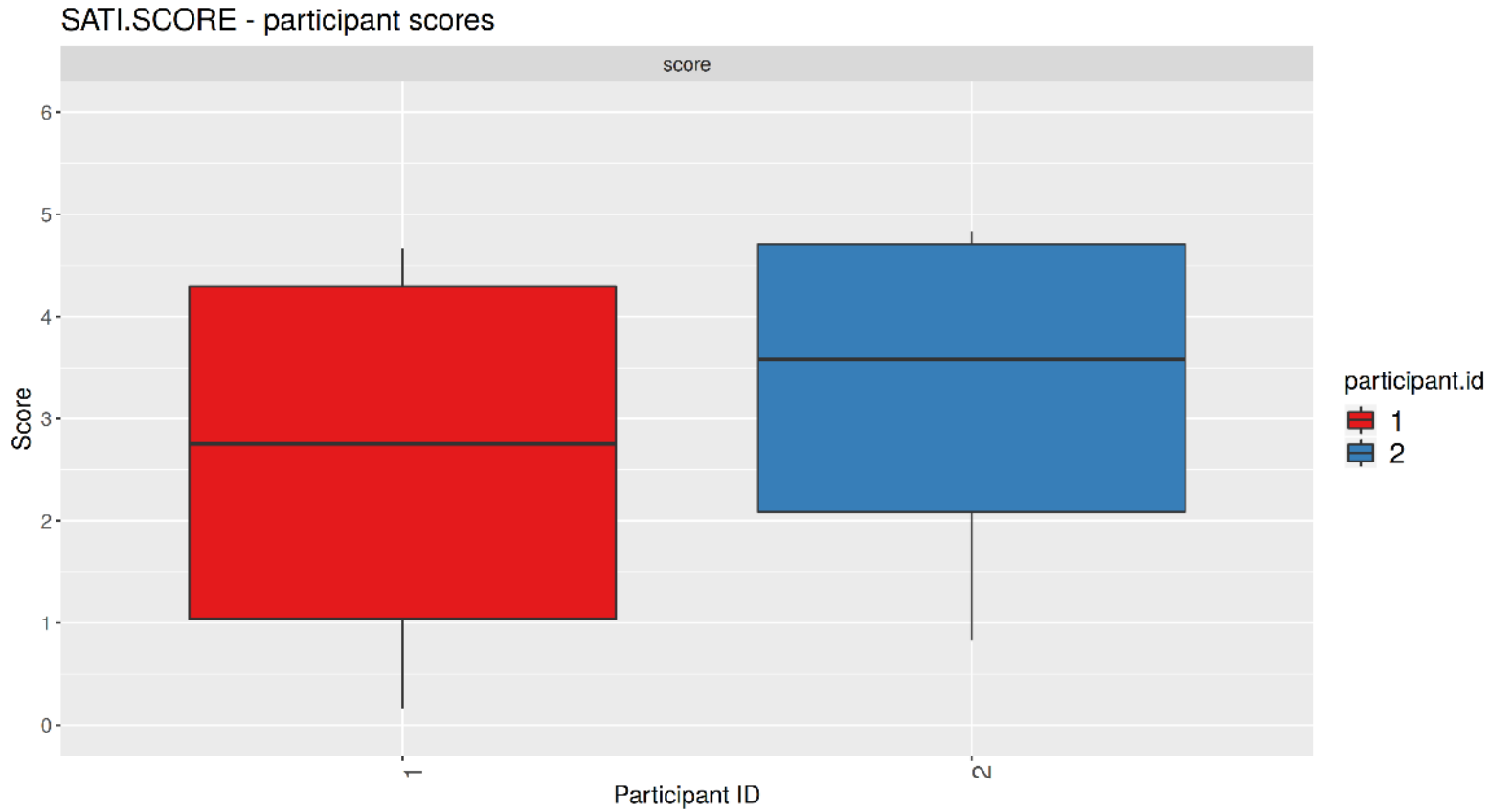
Figure 18 SATI overall score for participants

SATI questionnaires were evaluated only for a nominal subset of scenarios, namely scenarios 2, 3, 5 and 6. Overall scores for each participant in each scenario are shown in Figure 19. Faceting is done by scenarios, where for each scenario scores for both participants are shown.

There is an agreement of scenarios ratings between the participants. Agreement is perfect for scenario 5, which is also the scenario with overall highest rating (4.67). In scenarios 2 and 3 scores are very close, with difference less than 1. Most significant difference in agreement is noted for scenario 6, where the difference is of 1.25. Scenario 2 is rated highly, between 4 and 5. Scenario, in which the system was least trusted is scenario 3, where scores for both participants are less than 1.
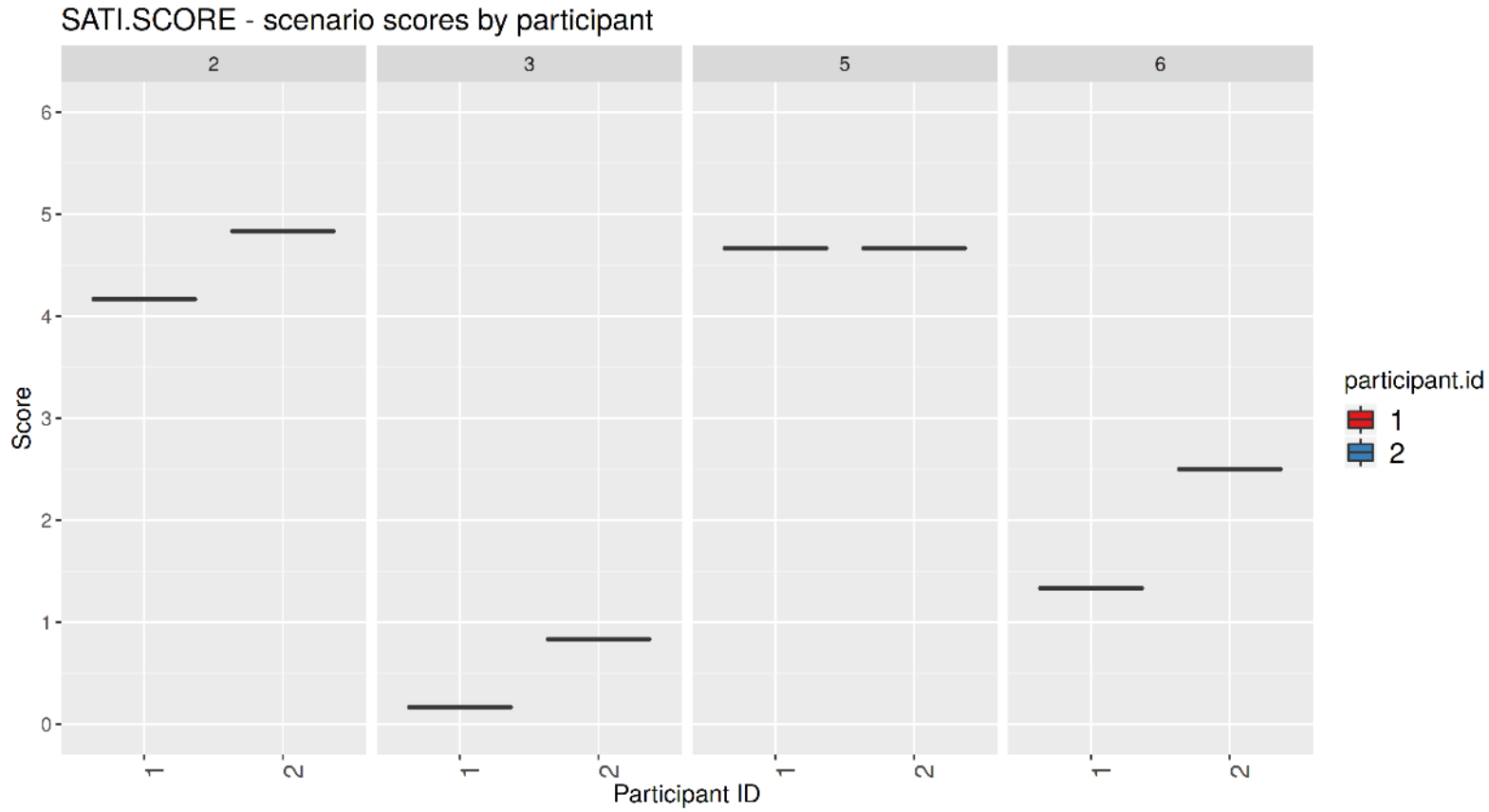
Figure 19 SATI overall scores for participants and scenarios

Each question in SATI measures a different aspect of system trust, it is therefore possible to extend the analysis to each of the aspects. Score distribution for different questions for each of scenarios is shown in Figure 20. Faceting is done by questions, where for each question scores for all measured scenarios are shown.

Scores and questions are described in Table 26 SATI Scale questions results.
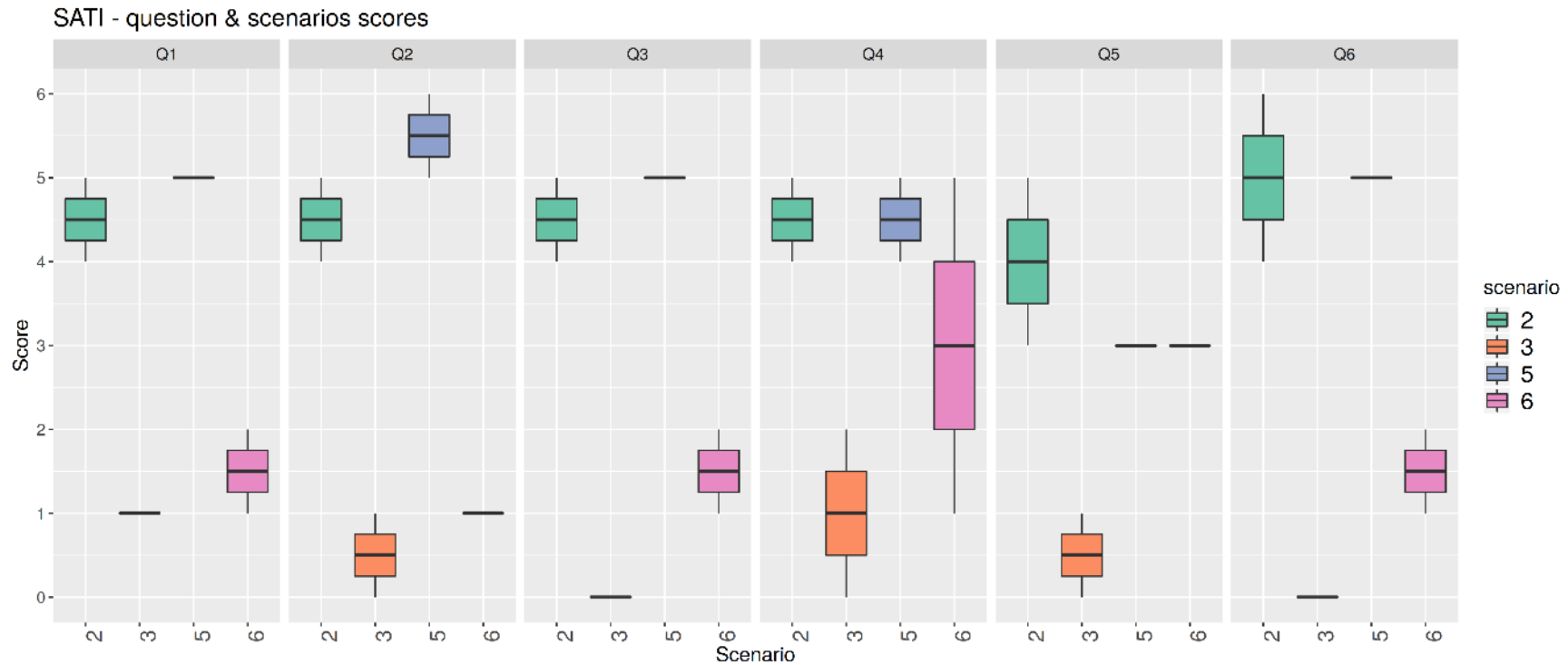
Figure 20 SATI question scores for participants and scenarios

Question	Subtest	Question	Score
Q1	Utility	...the system was useful	Scenarios 2 and 5: high, 4.5 and above. Scenarios 3 and 6: low, above 2.
Q2	Reliability	...the system was reliable	Scenarios 2 and 5: high, 4.5 and above. Scenarios 3 and 6: low, 1 or lower.
Q3	Accuracy	...the system worked accurately	Scenarios 2 and 5: high, 4.5 and above. Scenarios 3 and 6: low, 1 or lower.
Q4	Understanding	...the system was understandable	Scenarios 2 and 5: high, 4.5. Scenario 3: low, 1.

			Scenario 6: medium, 3
Q5	Robustness	…the system worked robustly	Scenario 2: high, 4. Scenario 3: low, 0.5. Scenario 5 and 6: medium, 3.
Q6	Confidence	…I was confident when working with the system	Scenarios 2 and 5: high, 4.5. Scenario 3: very low, 0. Scenario 6: low, 1.5.

Table 26 SATI Scale questions results

Participants trusted the system in scenarios 2 and 5, consistently scoring the system high in all measured subtests, except for one medium score in measurement of system robustness (Q5) during scenario 5.

This is in stark contrast to evaluation results for scenarios 3 and 6, where the system was uniformly rated low across all aspects, with one exception of scenario 6 in measurement of system understandability (Q4), where the score was medium. Worst ratings, score of 0, were given during scenario 3 for measurements of system accuracy (Q3) and confidence when working with the system (Q6).

Appendix D   HP Recommendations Register for Concept 1

The table below collects the HP recommendations identified in the different PJ02-08 V3 validation exercises of Concept 1.

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HP Recommendations Register for Solution 02-08 Concept 1										
Refer ence	Type of recommendation	Recommendation	Rationale	Assessment source + Reference report	Scope (Air, Air/Ground, Ground)	Concept/ solution Involved	Recommend ation status	Rationale in case of rejection	Comments
HP_R _C_10 1	Training	Clarify new working methods for each role and provide appropriate training before deployment.	To properly ensure that new operating methods linked to the use of an Integrated Runway Sequence are followed in an accurate, efficient and timely manner.	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	-	-
HP_R _C_10 2	Validation	Verify impact on physical and mental ATCOs workload prior to deployment including qualitative and quantitative measures (number/duration of coordination actions,	To properly ensure that level of workload linked to the use of an Integrated Runway Sequence is acceptable.	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	-	-

		number of manual updates).							
HP_R_C_10 3	Validation	Verify impact of the use of an Integrated Runway Sequence on ATCOs team and individual situation awareness prior to deployment.	To properly ensure that human actors can maintain a sufficient level of situation awareness while using and Integrated Runway Sequence	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	-	-
HP_R_C_10 4	Validation	Analyse APP ATCOs situation awareness improvement with the combined use of Integrated Runway Sequence and Separation Delivery indicators.	To explore further situation awareness improvement for APP ATCOs especially in situations of heavy traffic.	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	-	-
HP_R_C_10 5	Validation	Verify impact on ATCOs trust in the system prior to deployment including qualitative and quantitative measures (sequence accuracy and reliability, number of required sequence manual updates).	To properly ensure that human actors can acquire an adequate mental model of the Integrated Runway Sequence function and to ensure that the level of trust in that function is appropriate	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	-	-
HP_R_C_10	Validation	Address HMI usability from the very beginning prior to	To properly make sure that the level of information provided	V3 VALR (**Fel! Hittar inte**	Ground	PJ02-08	open	-	-

6		deployment.	by the Integrated Runway Sequence satisfies the information requirements of concerned ATCOs and that the usability of the Integrated Runway Sequence user interface is acceptable.	referenskälla.)					
HP_R _C_10 7	Validation	Verify impact of the user interface design on ATCOs individual situation awareness prior to deployment.	To properly ensure that the Integrated Runway Sequence user interface design supports a sufficient level of individual situation awareness.	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	-	-
HP_R _C_10 8	Validation	Verify impact of the user interface design on ATCOs team situation awareness prior to deployment.	To properly ensure that the Integrated Runway Sequence user interface design supports a sufficient level of team situation awareness.	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	-	-
HP_R _C_10	Validation	Verify impact on ATCOs communication workload prior to deployment in	To properly ensure that the communication load	V3 VALR (**Fel! Hittar inte**	Ground	PJ02-08	open	-	-

9		nominal and nominal situations, including situations of degraded modes.	linked to the use of an Integrated Runway Sequence is acceptable in normal and abnormal conditions and degraded modes of operations	referenskälla.)				
HP_R_C_110	Validation	Verify impact on ATCOs skills after deployment.	In order to ensure that impact of the use of an Integrated Runway Sequence in ACC, APP and TWR ATCOs skills is properly identified.	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	-	-

Table 27: HP recommendations for Solution 02-08 Concept 1

Appendix E   HP Recommendations Register for Concept 3

Refer to HP Log in Appendix K **Fel! Hittar inte referenskälla.**

Appendix F   HP Recommendations Register for Concept 4

HP Recommendations Register for Solution 02-08 Concept 4									
Reference	Type of recommendation	Recommendation	Rationale	Assessment source + Reference report	Scope (Air, Air/Ground, Ground)	Concept/ solution Involved	Recommendation status	Rationale in case of rejection	Comments
HP_R_D_101	Training	Provide training on system capabilities and system input parameters used for calculation of the expected ROT and expected exit	To ensure consistency between ATCOs expectations on tool indications and own judgement	V3 VALR **(Fel! Hittar inte referenskälla.)**	Ground	PJ02-08	open		
HP_R_D_102	Development	Improve the design to provide ATCO with a dynamic expected ROT and expected exit, based on the actual behaviour of the aircraft on the final approach. These	To ensure ATCOs trust the systems indications in dynamic environments	V3 VALR **(Fel! Hittar inte referenskälla.)**	Ground	PJ02-08	open		

		recommendations should start 5 min prior to expected touchdown and finish updating 2NM before threshold.						
HP_R_D_103	Training	Provide adequate training on the tool limitations.	To ensure ATCO trust in the system information in specific degraded conditions, especially in adverse weather conditions	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	
HP_R_D_104	Validation	Validate the system with integrated EFS HMI.		V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	
HP_R_D_105	Operations	Provide recurrent training to maintain the ROT estimate skill based on ATCO	To ensure ATCOs mental capability of estimation of	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	

		judgement	the ROT and RWY exit based on combination of training, experience and a/c behaviour and weather conditions is not impaired with long exposure to the information provided by the tool					
HP_R_D_106	Validation	Any future RTS should include adverse weather	To explore all weather conditions and HP influence in adverse conditions	V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ02-08	open	

Table 28: HP recommendations for Solution 02-08 Concept 4

Appendix G   HP Requirements Register for Concept 1

N/A

Appendix H   HP Requirements Register for Concept 3

Refer to HP Log in Appendix K

Appendix I   HP Requirements Register for Concept 4

HP Requirements Register for Solution 02-08 Concept 4									
Reference	Type of requirement	Requirement	Rationale	Assessment source + Reference report if available	Scope (Air, Air/Ground, Ground)	Concept / solution Involved	Requirement status	Rationale in case of rejection	Comments
HP_R_F_101	Functional	System overlay shall shut down in case of errors in source data generating only a single error message.	RTS tested degraded service mode with repetitive error messages. It has been judged useless by ATCO. Recommendation has been made to handle failures with one message and system HMI function disabling.	EXE.02-08.V3.004 debriefing - V3 VALR (**Fel! Hittar inte referenskälla.**)	Ground	PJ.02-08, Concept 4	accepted	N/A	N/A

| HP_R_F_102 | Functional | System function reinstatement following a failure shall communicated with a message to Tower ATCO. | Extension of HP_R_F_101. If a single message communicates failure another message shall communicate functionality reinstating. | EXE.02-08.V3.004 debriefing - V3 VALR (**Fel! Hittar inte referenskälla.**) | Ground | PJ.02-08, Concept 4 | accepted | N/A | N/A |
| HP_R_F_103 | HP | ROT estimate and exit indication shall be integrated into TWR ATCO CWP in a way that assures the display of this information as near to other flight information as possible to maintain legibility. | Multiplication of HMI decreases situational awareness and may decrease other aspects of HP. | EXE.02-08.V3.004 - V3 VALR (**Fel! Hittar inte referenskälla.**) | Ground | PJ.02-08, Concept 4 | accepted | N/A | N/A |

Table 29: HP Requirements for Solution 02-08 Concept 4

Appendix J   HP Log for Concept 1

No HP Log has been maintained for the Concept 1. PJ02-08 HP practitioners working on Concept 1 prefer to use directly the HPAP and HPAR documents in order to reduce workload and avoid potential errors linked to the split of information among different documents.

Appendix K   HP Log for Concept 3

Pj02-08_Sol 3
ROCAT_HP Log

Appendix L   HP Log for Concept 4

No HP Log has been maintained for the Concept 4. PJ02-08 HP practitioners working on Concept 4 prefer to use directly the HPAP and HPAR documents in order to reduce workload and avoid potential errors linked to the split of information among different documents.

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