Basic DMAN Validation (EXE-06.08.04-VP-470) - Validation Report

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Abstract

This document is the Validation Report for the Basic DMAN concept that has been validated through the Release 1 Validation exercise EXE-06.08.04-VP470. This exercise, conducted by DSNA, consisted in a series of live trials performed in the Paris Charles de Gaulle (CDG) airport environment during summer 2011.

This document also contents inputs from Frankfurt and Zurich Airports. These inputs, provided by SEAC, are based on the experience in their operational environment (no exercise conducted). In Zurich, the DMAN (DARTS) is operated according to Method 2, as defined in the P06.08.04 Basic DMAN OSED, which gives a broader perspective to the results presented in this report.

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Executive summary

This document is the Validation Report for the Basic DMAN concept (as developed in P6.8.4) towards E-OCVM V3 (See Ref. [6]).

This report presents the results of the live trials conducted by DSNA at the Paris Charles de Gaulle (CDG) airport during summer 2011.

It provides evidences of usability of the Basic DMAN in particular through the analysis of its impact on the following key areas:

- Predictability;
- Capacity (Airport);
- Environment;
- Cost-effectiveness; and
- Safety.

This document also contents inputs from Frankfurt and Zürich Airports. These inputs, provided by SEAC, are based on the experience in their operational environment (no exercise conducted).

In Zurich, the DMAN (DARTS) is operated according to Method 2, as defined in the P06.08.04 Basic DMAN OSED, which gives a broader perspective to the results presented in this report.

Main conclusions are:

- Average taxi times are significantly reduced;
- Fuel Burn and $C0_2$ are significantly decreased;
- Respect of CFMU slots is improved;
- Delay at the runway is reduced;
- Off-Block punctuality is improved ;
- Operational Off-Block procedures are well respected but could be better applied but could be better applied by flight crews;
- The DMAN HMI is usable and rather satisfactory to the tower controllers.

1 Introduction

1.1 Purpose and scope of the document

This document is the Validation Report for the Basic DMAN concept (as developed in P6.8.4) towards E-OCVM V3 (See Ref. [6]).

This report presents the results of the live trials defined in the *Basic DMAN Validation Plan* (See [15]) conducted by DSNA at the Paris Charles de Gaulle (CDG) airport during summer 2011.

As described in the validation plan the main goals of this validation were:

- To validate the Basic DMAN Operational requirements as defined in the Basic DMAN OSED (See Ref. [14]);
- To verify the initial procedures using a Basic DMAN (in respect to the Operating Method 1 described in the basic DMAN OSED);
- To validate the benefits of a basic DMAN operating on a highly complex platform.

Three (3) exercises were planned for this validation:

- A validation of Basic DMAN Operational Requirements;
- An assessment of the Operational Performance of Basic DMAN (measures);
- An evaluation of the Basic DMAN HMI Operability.

The results of each individual exercise are presented in chapter 6 of this document.

Those results are complemented with results provided by SEAC for Frankfurt and Zurich Airports (presented in chapters 4 and 5 of this document).

In Zurich, the DMAN (DARTS) is operated according to Method 2, as defined in the P06.08.04 Basic DMAN OSED, which gives a broader perspective to the results presented in this report.

1.2 Intended audience

This document is firstly intended for the SESAR Programme participants, in particular:

- **SESAR WP03:** While this project performs its own integrated validation, the strategy, techniques and tools may be used in future integrated validation that would include DMAN.
- **SESAR WP06.02:**The outcomes of the higher level validation objectives of this project feed into the validation of the SESAR Airport concept for Step1.
- **SESAR WP05.02:** As Federating Project involved in the R1 SE#2 for reviewing EXE-06.08.04-VP-470
- **SESAR WP06.03:**Since the higher level validation objectives provide validation information to the SESAR Airport concept for Step1, WP 06.03 should be aware of the outcomes of this validation.
- **SESAR WP06.08.04:**The live trials of the effects of a Basic DMAN operating on a highly complex platform will serve, inter alia, to validate the Basic DMAN Operational requirements used, within P06.08.04, as a basis for further DMAN improvements.
- **SESAR WP16:**This validation should provide the inputs to the CBA as specified by WP16. As such the validation strategy adopted in this document should be aligned to the higher level WP16 strategy.
- **SESAR WP12.03.05:** Validation of Basic DMAN should also provide inputs to the Technical Project in charge of developing the DMAN within SESAR.

More generally, this document is also intended for the European ATM community that might be interested in the results related to Basic DMAN implementation.

1.3 Structure of the document

The structure of this Validation report follows the SESAR Validation report template (See ref. [3]&[4])

- **Chapter 1** (the present section) provides general information about the document;
- **Chapter 2** details the context of the validation. It recalls in particular information on the performance results expected from the trials;
- **Chapter 3** describes the conduct of the validation. It details in particular the deviations from the Validation Plan (Ref. [15]);
- **Chapter 4** provides a synthesis of the validation exercises results; It contains also results provided by SEAC regarding the DMAN operating in Zürich and Frankfurt;
- **Chapter 5** contains the conclusions and recommendations related to the validation of the Basic DMAN concept. This chapter is a consolidated view encompassing also considerations on the DMAN operating in Zürich and Frankfurt;
- **Chapter 6** provides the detailed results of the validation exercises performed in Paris-CDG;
- **Chapter 7** lists the reference and applicable documents.

Additionally, the Appendices provide:

- Some results regarding some tower controller's task, and on the DMAN HMI usability (graphs).
- Specific CDG metrics provided by ADP used to calculate environmental benefits of DMAN.
- The coverage matrix between the requirements from the OSED and the validation exercises together with validation status indicators.

1.4 Acronyms and Terminology

A list of the important terminology and acronyms used in this document is presented below; they are taken, when available, from the SESAR ATM Lexicon (Ref.[9]). In case of any difference between the definitions provided here and the SESAR Lexicon, the SESAR Lexicon should be taken as the authority. Definitions under refinement are included here and will be submitted to the Lexicon when they are mature and agreed across the Programme.

Term	*Definition*
A-CDM Platform (ACISP)	The Airport CDM Information Sharing Platform (ACISP) is a generic term used to describe the means at a CDM Airport of providing Information Sharing between the Airport CDM Partners. The ACISP can comprise of systems, databases, and user interfaces.
A-CDM Process	A-CDM is the process used to calculate and continuously update the Target Off-block Time (TOBT). It also covers the adjustment and alignment between DPI and the CFMU Slot Calculation process. Currently establishing the pre-departure sequence (TSAT) is also considered a CDM-process.
ACARS	Datalink request start-up system
AOBT	The Actual Off-Block Time (AOBT) is the time the aircraft pushes back / vacates the parking position. (Equivalent to Airline / Handlers ATD – Actual Time of Departure & ACARS=OUT)
ARWT	The Actual Runway Waiting Time (ARWT) is the time spent by the aircraft waiting at the runway threshold.
ASAT	Actual Start Up Approval Time is the time that an aircraft receives its start up approval.

Term	Definition
ATOT	The Actual Take Off Time (ATOT) is the time that an aircraft takes off from the runway. (Equivalent to ATC ATD–Actual Time of Departure, ACARS = OFF).
AXOT	The Actual taXi Out Time (EXOT) is the actual taxi time between off-block and take-off.
CPDS	Collaborative Pre Departure Sequence: set of departure tools and procedures
CTOT	The Calculated Take Off Time (CTOT) is a time calculated and issued by the appropriate Central Management unit, as a result of tactical slot allocation, at which a flight is expected to become airborne. (ICAO Doc 7030/4 – EUR, Table 7)
Departure Management Service	Departure Management Service describes the procedures used to establish sequences and target times planned by the departure manager.
Departure Manager (DMAN)	DMAN is a planning system to improve departure flows at one or more airports by calculating the Target Take Off Time (TTOT) and Target Start Up Approval Time (TSAT) for each flight, taking multiple constraints and preferences into account.
Departure Rate	Rate of flights at the departure from a runway: Minimum average separations in seconds between 2 take-offs.
DPI	Departure Planning Information message: Message from Airport to CFMU. *See A-CDM Manual (Ref. [18]) for details.*
EIBT	The Estimated In-Block Time (IOBT) is the estimated time that an aircraft will arrive in-blocks. (Equivalent to Airline/Handler ETA – Estimated Time of Arrival).
EOBT	The Estimated Off-Block Time (EOBT) is the estimated time at which the aircraft will start movement associated with departure (ICAO).
E-OCVM	European Operational Concept Validation Methodology
ERWT	The Estimated Runway Waiting Time (ERWT) is the estimated duration the aircraft will have between its arrival at the runway to access the next **available take-off slot** if leaving at TOBT.
EXOT	The Estimated taXi Out Time (EXOT) is the estimated taxi time between off-block and take-off. This estimate includes any delay buffer time at the holding point or remote de-icing prior to take off.
Holding point	Position in the runway access area where aircraft stops and waits for the line-up clearance on the runway.
Human Performance	A measure of human functions and action in a specified environment, reflecting the ability of actual users and maintainers to meet the system's performance standards, including reliability and maintainability, under the conditions in which the system will be employed.

Term	*Definition*
Push-Back	Movement of an aircraft on the ground consisting of leaving the parking area in reverse motion as far as alignment on the taxiway.
ROT	Runway Occupancy Time
Runway availability delay	The Runway availability delay represents the time an aircraft has to wait before its actual departure slot on the runway.
Runway Pressure	The Runway Pressure represents the maximum number of flights allowed to wait at the last holding point for take-off.
SID	The Standard Instrument Departure (SID) represents the departure route of the aircraft to the ACC entry point.
SOBT	The Scheduled Off-Block Time (SOBT) is the time that an aircraft is scheduled to depart from its parking position (the coordinated Airport Slot and normally the time that the Aircraft Operators publish in their timetables).
SUT	System Under Test
TOBT	The Target Off-Block Time (TOBT) is the time that an Aircraft Operator or Ground Handler estimates that an aircraft will be ready, all doors closed, boarding bridge removed, push back vehicle available and ready to start up / push back immediately upon reception of clearance from the Tower Controller.
TSAT	The time provided by ATC taking into account TOBT, CTOT and/or the traffic situation that an aircraft can expect start-up / push-back approval Note: The actual start up approval (ASAT) can be given in advance of TSAT
TSAT Window	A time-frame of +/- 5 minutes around the TSAT, in which a Start-Up and Push-Back approval may be issued.
TTOT	*The Target Take Off Time taking into account the TOBT/TSAT plus the EXOT.* Each TTOT on one runway is separated from other TTOT or TLDT to represent vortex and / or SID separation between aircraft.
Variable Taxi Time	Variable Taxi Time is the estimated time that an aircraft spends taxiing between its parking stand and the runway or vice versa. Variable Taxi Time is the generic name for both inbound as outbound taxi time parameters, used for calculation of TTOT or TSAT. Inbound taxi time (EXIT) includes runway occupancy and ground movement time, whereas outbound taxi time (EXOT) includes push back & start up time, ground movement, remote or apron de-icing, and runway holding times.

2 Context of the Validation

2.1 Concept Overview

In terms of improvement, Basic DMAN permits:

- To share Pre-Departure Sequence planning,
- To share a same real-time vision of the Take-Off Sequence,
- To anticipate the flow variation (Departure demand) more precisely
- To monitor flight progress using the off-block target of each flight
- To take airport resources availability into account in the prediction
- To take airport capacity more precisely into account
- To be clearer on the priorities used to allocate runway slot
- To reduce runway waiting time (engines running)
- To regulate Start-Up request (TOBT adherence)
- To enhance ATFCM (and the overall network) prediction if the dissemination of DPIs is activated

Implementing DMAN concept in combination with A-CDM, the expected benefits are:

- Improving safety by reducing taxi times or number of ground movement in the same time,
- Fuel saving and noise reduction by reducing taxi times and waiting times,
- Facilitating ATC Start-Up deliveries by regulating the request,
- Increasing capacity by using airport resources efficiently,
- Improving network predictions by providing departure information to CFMU.

In this context, the validation activities conducted by project P06.08.4 focused of the following aspects

- **The validation of the Basic DMAN Operational requirements**: i.e. **how the operational requirements are implemented** the different functions of the basic DMAN**:**
    - Pre-departure sequence management;
    - Take-Off sequence management;
    - Runway configuration management;
    - DMAN supervision.
- **The verification of initial procedures using a Basic DMAN** (in respect to the Operating Method 1 described in the basic DMAN OSED): e.g the assessment of:
    - Flight crew adherence to ATC-Crew and Start-Up procedures;
    - Tower Clearance Delivery Controller adherence to ATC-Crew and Start-Up procedures;
    - Tower Ground Controller respect of the TSAT sequence for Push-Back approval;
    - Tower Runway Controller respect/deviation from TTOT sequence calculated by DMAN;
    - Actions of the Tower Supervisor to manage runway capacity.
- **The evaluation of the benefits of operating a basic DMAN on a complex platform** based on the following measures:
    - Measure of Target Start up Approval Times (TSAT) stability (accuracy);
    - Measure of proposed Target Take Off Times (TTOT) accuracy
    - Measure of Taxi times used to establish the departure sequence
    - Measure of waiting times calculated by DMAN (Estimated Runway Waiting Time)
    - Measure of the number of departures per hour on a runway;
- **The evaluation of Human Performance aspects i.e the basic DMAN HMI usability** for the different actors involved

Three (3) exercises were defined for this validation:

- **EXE-06.08.04-VALP-0470.0100** – Basic DMAN Operational Requirements Validation
- **EXE-06.08.04-VALP-0470.0200** – Basic DMAN Operational Performance Validation
- **EXE-06.08.04-VALP-0470.0300** – Basic DMAN Operability Validation

The three exercises were conducted in parallel, under the same conditions – i.e. CDG operational platform, real traffic.
The table hereafter summarizes the main characteristics of these 3 exercises.

Validation Exercise ID and Title	•**EXE-06.08.04-VALP-0470.0100 – Basic DMAN Operational Requirements Validation** •**EXE-06.08.04-VALP-0470.0200 – Basic DMAN Operational Performance Validation** •**EXE-06.08.04-VALP-0470.0300 – Basic DMAN Operability Validation**
Leading organization	DSNA
Validation exercise objectives	•Verify Basic DMAN Operational Requirements and procedures; •Assess Operational Performance of Basic DMAN (measures); •Evaluate the Basic DMAN HMI Operability.
Rationale	Validate the usability of the functions, procedures, HMI and performance of the Basic DMAN defined **as the baseline** for the improvements to be studied in P6.8.4 (Coupling with SMAN, AMAN)
Supporting DOD / Operational Scenario / Use Case	Turn round
OI steps addressed	**TS-0201 Basic Departure Management (DMAN)**
Enablers addressed	**AERODROME-ATC-08**: Independent management of the departure and arrival sequence at the aerodrome *Modification of systems to make best use of departure and arrival sequence (Surface movement data processing system enhanced for use with departure manager, Controller HMI, en-route FDPS, ground-ground communications ...).* **PRO-051**: ATC Procedures (Airport) to assist the Ground Controller in achieving the optimal departure sequence as provided by DMAN Tool *Includes methods for sequencing via start-up/push back times, taxi routes and integrating user preferred departure sequence as needed.* **PRO-223**: ATC Procedures (Airport) related to Enhancement of Aerodrome Operations Through Departure Management **HUM172-07**: System design encompassing training feasibility
Applicable Operational Context	Airport

Expected results per KPA	**Safety**	Safety might not be improved but must not deteriorate. The improvement of safety will be however investigated.
	Environmental Sustainability	Environmental Sustainability in terms of reduced fuel burn and emissions per flight will be achieved by reduced overall departure delay (the number of flights might be increased).
	Efficiency	Efficiency of aircraft operations will slightly be improved by reduced overall departure delays. A reliable pre-departure sequence allows having reduced taxi-out and reduced runway holding times (delay partly absorbed on stand).
	Predictability	Predictability of off-block times will significantly be increased with the Basic DMAN.
Validation Technique	Using the CDG **Operational** system. •Observe the different tasks on the different working-positions and take note of the possible comments the controllers may make as well as any event (from DMAN and/or from the controller on duty) that could be discussed during the debriefing. •Ask the CDG Operational staff on duty during the sessions to fill in the appropriate questionnaire. •Record required data	
Dependent Validation Exercises	N/A	

Table 1: EXE-06.08.04-VALP-0470 Concept Overview

2.2 Summary of Validation Exercises

2.2.1 Summary of Expected Exercise/s outcomes

Stakeholders' validation expectations were identified in the P06.08.04 PIR (Ref. [10])

- **Internal stakeholders** who are part of the SESAR project and who are directly impacted by the new airport operations concept and the associated systems
- **External stakeholders** all other stakeholders.

Their expectations addressed in this V3 validation are provided in the following tables.

2.2.2 Internal stakeholders

Stakeholder	Involvement	Performance expectations
Airport Operator	Provision of validation site	Improvement of predictability of surface movements
		Meet the environmental targets and avoid environment showstoppers
ANSP	Provision of validation site	Maintain the workload of controllers at a reasonable level in spite of peaks of traffic
		Usable HMI, compatible with other controller tools
		Improvement of controllers' situational awareness
Industry	Project contributor	Ground Industry expects validated requirements that are as generic as possible to allow standardised product

Table 2: Internal Stakeholders' expectations

2.2.3 External stakeholders

Stakeholder	Involvement	Performance expectations
Airlines	End user	Improvement of taxi efficiency (reduced taxi time, reduced fuel burn) in all weather conditions
		Improvement of safety of surface movements
Airport neighbouring communities	Indirect	Reduction of aircraft noise
		Reduction of gaseous emissions
Pilot community	End user	Support during the taxi phase

Table 3: External Stakeholders' expectations

2.2.4 Benefit mechanisms investigated

The benefit mechanisms linked to the operational changes under the scope of the validation exercises are identified in the Validation Plan (See Ref. [15]) and are illustrated in the diagram hereafter.

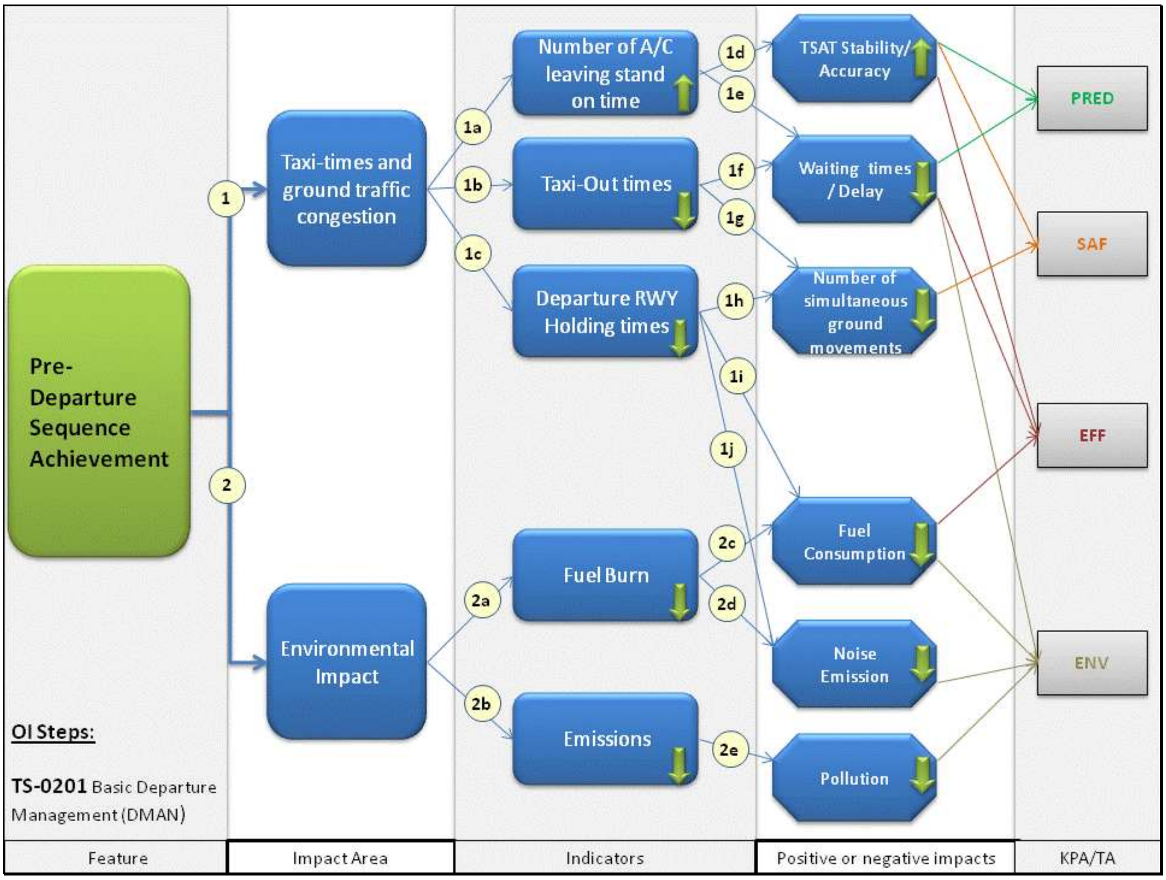


Figure 1: Basic DMAN Benefit Mechanisms Diagram

(Legend of the above diagram is available in [16] Guidelines for Producing Benefit Mechanisms V01.00.00)

Table 4 hereafter provides a brief description of the benefits mechanisms presented on the above diagram.

N°	Mechanism descriptions
1a	**Number of Aircraft leaving stand on time** A reliable pre-departure sequence allows a better prediction of off block times which implies an increase in the number of aircraft leaving their stand on time (i.e. closest to the latest TOBT)
1b	**Taxi out Times** A reliable pre-departure sequence allows having reduced taxi out times (delay partly absorbed on stand).
1c	**Departure Runway holding times / delay** A reliable pre-departure sequence allows having reduced runway holding times (delay partly absorbed on stand).
1d	**TSAT Stability/Accuracy** Increasing the number of aircraft leaving their stand on time has a positive impact on the TSAT stability and accuracy which links to Predictability, Safety and Efficiency
1e	**Waiting Times** Increasing the number of aircraft leaving their stand on time has a positive effect on the waiting times (less queues on Taxiways) which links to Predictability, Efficiency and Environmental Sustainability.
1f	**Waiting Times** Reducing the taxi out times has a positive effect on the waiting times (less queues on Taxiways) which links to Predictability, Efficiency and Environmental Sustainability.
1g	**Number of simultaneous ground movements** Reducing the taxi out times has a positive effect on the number of simultaneous ground movements which links to safety.
1h	**Number of simultaneous ground movements** Reducing the runway holding times has a positive effect on the number of simultaneous ground movements which links to safety.
1i	**Fuel Consumption** Reducing the runway holding times has a positive effect on Fuel consumption which links to Efficiency and Environmental Sustainability.
1j	**Noise Emission** Reducing the runway holding times has a positive effect on Noise Emission which links to Environmental Sustainability.
2a	**Fuel Burn** Achievement of a reliable pre-departure sequence has a positive impact on fuel burn: as Aircraft wait on stand instead of on taxiways, engine off, there is a positive impact on Fuel Burn.
2b	**Emissions** Achievement of a reliable pre-departure sequence has a positive impact on gaseous emissions: as Aircraft wait on stand instead of on taxiways, engine off, there is a positive impact on Fuel Burn and consequently on gaseous emissions and noise
2c	**Fuel Consumption** Reducing the fuel burn has a positive effect on Fuel consumption which links to Efficiency and Environmental Sustainability.
2d	**Noise Emission** Reducing the fuel burn has a positive effect on Noise Emission which links to Environmental Sustainability.
2e	**Pollution** Reducing the gaseous Emissions has a positive effect on Pollution which links to Environmental Sustainability.

Table 4: Pre-Departure Sequence Management Benefit Mechanisms descriptions

2.2.5 Summary of Validation Objectives and success criteria

2.2.5.1 Choice of metrics and indicators

Based on the list of indicators identified in the benefits mechanism diagram presented on Figure 1, the Table 5 hereafter contains the list of metrics retained for exercise EXE-06-08-04-VP-470.

Metric	Indicator	Impacted KPA
Fuel Consumption (deduced from taxi-times)	Fuel Burn	EFF
		ENV
TSAT Stability / Accuracy	Number of aircraft leaving stand on time	PRE
		SAF
		EFF
		ENV
Number of simultaneous ground movements	Taxi-out Times	SAF
	Departure Runway Holding Times	
Number of departing aircraft from a runway per hour	Departure Rate	CAP
Waiting Times /Delays	Taxi-out Times	PRE
		EFF
	Departure Runway Holding Times	ENV

Table 5: Retained indicators

2.2.6 Summary of Validation Scenarios

See Validation Plan (Ref[15]).

2.2.7 Summary of Assumptions

The validation assumptions mainly concerned the general conditions of execution of the validation:

- The validation consisted of observations and measures performed on the operational CDG DMAN used in standard operational conditions (no degraded mode);
- The live trials were performed so as to not to disturb the operations;
- Observations were performed by a validation team be composed of CDG operational experts supported by DSNA experts (e.g. Human Factor, Safety Experts…).
- The validation team has been supported by technical teams in charge of recording systems used for measurements.

2.2.8 Choice of methods and techniques

Supported Metric / Indicator	Platform / Tool	Method or Technique
Fuel Consumption	Taxi times captured with AEROBAHN - CDG Operational system	Calculation based on measured taxi-times. Two sets of figures have been used: • Figures from ADP (see Annex B) • Figures from Eurocontrol CBA for Airports.
Emissions	Taxi times captured with AEROBAHN - CDG	Calculation based on measured

Supported Metric / Indicator	Platform / Tool	Method or Technique
	Operational system	taxi-times. Two sets of figures have been used: • Figures from ADP (see Annex B) Figures from Eurocontrol CBA for Airports.
Noise	N/A	N/A
Number of aircraft leaving stand on time	DMAN - CDG Operational system	Measures of TSAT, TOBT, ASAT and AOBT
Number of departing aircraft from a runway per hour	DMAN- CDG Operational system	Measures of TSAT, TOBT, ASAT, AOBT and ATOT (SARIA)
Number of simultaneous ground movements	DMAN, SARIA - CDG Operational system	Measures of TSAT, TOBT, ASAT, AOBT and ATOT (SARIA)
Waiting Times	N/A	N/A

Table 6: Methods and Techniques

2.2.9 Validation Exercises List and dependencies

The list of validation exercises establishes as follows:

- **EXE-06.08.04-VALP-0470.0100** – Basic DMAN Operational Requirements Validation
- **EXE-06.08.04-VALP-0470.0200** – Basic DMAN Operational Performance Validation
- **EXE-06.08.04-VALP-0470.0300** – Basic DMAN Operability Validation

Their relationships and dependencies are illustrated on Figure 2 hereafter.

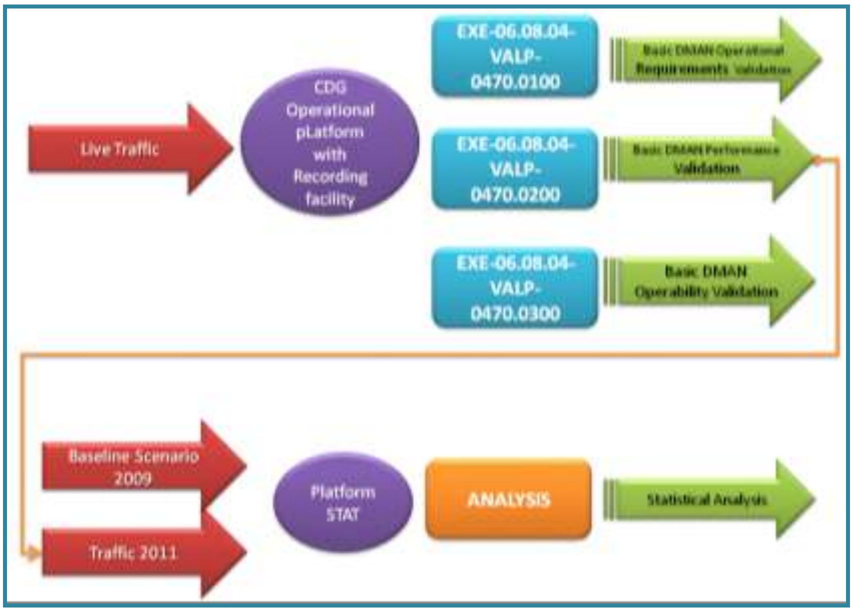


Figure 2: Validation exercises dependencies

3 Conduct of Validation Exercises

3.1 Exercises Preparation

As described in the Basic DMAN Validation Plan (see Ref. [15]), the preparation of the validation exercise consisted in:

- Familiarising with the Basic DMAN function and procedures that would be tested.
- Developing the questionnaires and preparing the briefing and debriefing of the CDG Operational staff on duty during the sessions;
- Ensuring that the recording facilities would be available during the sessions;
- Ensuring that the recorded data would be provided in a format that can be used for data analysis and exploration.

No specific training was planned for the validation, the controllers on duty having already been trained to the DMAN, as well as CDG operational experts' members of the validation team.

3.2 Exercises Execution

The actual validation schedule and the approach followed to execute the Validation Exercise are presented in the table below.

Exercise ID	Exercise Title	Actual Exercise execution start date	Actual Exercise execution end date	Actual Exercise start analysis date	Actual Exercise end date
EXE-06.08.04-VP-470	Basic DMAN validation (live trials)	06/07/2011	16/09/2011	30/08/2011	31/10/2011

Figure 3: Exercises execution/analysis dates

As planned, the validation exercise implied the observation of the following controllers' working positions located in CDG North and South Towers:

- Tower Supervisor,
- Tower Clearance Delivery Controller,
- Apron Manager,
- Tower Ground Controller,
- Tower Runway Controller.

In the framework of this exercise, three validation activities have been conducted consisting in evaluating:

- **The Basic DMAN Operational requirements**: assessment of the different functions of the basic DMAN;
- **The initial procedures using a Basic DMAN**: assessment of the application of the Operating Method 1 as defined in the Basic DMAN OSED (see Ref. [14]
- **The benefits of operating a basic DMAN on a complex platform**: assessment of the performance objectives set for this validation.

A detailed description of the validation approach followed in this exercise is presented in the Basic DMAN Validation Plan (see Ref. [15]).

3.3 Deviations from the planned activities

3.3.1 Deviations with respect to the Validation Strategy

Not Applicable.

3.3.2 Deviations with respect to the Validation Plan

1. At CDG airport, the Tower Ground Controller has currently no DMAN HMI at his disposal. On the other hand, the Apron Manager is provided with a DMAN HMI as an advisory means (no DMAN input is made on the Apron management position).
2. Holding times at the runway were not captured during the trials, however results are available from CDM@CDG team.
3. Measures of noise were not performed, no calculation have been made based on taxi-times.

4 Exercises Results

This chapter presents the synthesis of the results of Basic DMAN validation activities performed in Paris-CDG airport during summer 2011.

As the goal of this validation report is also to present results provided by SEAC regarding the DMAN systems operating in Zurich and Frankfurt, an additional section has been created in this chapter to gather these results (see §4.4).

SEAC did not conduct any SESAR validation exercise for Basic DMAN, but delivered inputs regarding their experience in their operational environments.

4.1 Summary of Exercises Results

The results of CDG validation exercise are summarised in the table below.

This table shows the summary of results compared to the success criteria identified within the Validation Plan per validation objective. The analysis covers all the validation objectives embedded in the validation exercise as per the corresponding Validation Plan (Ref. [15]).

Note: The results regarding the Human Performance related objectives as defined in the Validation Plan come from the observation and the questionnaires' answers of CDG controllers on duty that were observed by CDG operational experts. In total, this represents 48 observed controllers. The distribution of the number of controllers observed per control position is as follows (cf. 6.2.2):

Clearance Delivery controllers	12
Apron managers	5
Ground controllers	20
Runway controllers	8
Tower Supervisors	3

Some results pertaining to the workload are more specifically related to the tasks that were performed during the observation sessions. They represent a few hours of observation. In these cases, the results did not always allow concluding regarding the success criteria achievement because of a lack of representativeness.

Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Success Criterion	Exercise Results
EXE-06.08.04-VP-470	Basic DMAN validation (live trials)	**OBJ-06.08.04-VALP-0470.0100**	No adverse effects on safety	The Basic DMAN function reduces the average taxi time of aircraft compared to the baseline scenario	Taxi times reduced by 9% compared to baseline scenario (no DMAN)
		OBJ-06.08.04-VALP-0470.0150	Safety improvement from taxi times reduction	The Basic DMAN function reduces the global taxi time of aircraft compared to the baseline scenario. Number of departures might be increased	Taxi times reduced by 9% compared to baseline scenario (no DMAN) whilst operations are kept at the same level than before DMAN was introduced.
		OBJ-06.08.04-VALP-0470.0200	Improvement of Off-block times predictability	The Basic DMAN function delivers stable values of TSAT increasing the Off-block times' predictability compared to the baseline scenario	84,8% of the flights respect their TSAT window. 81 % of regulated flights respect their CFMU Slot
		OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence	The Clearance Delivery Controller can: • display and re-arrange (sorting) the pre-departure	OK : The success criterion is achieved

Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Success Criterion	Exercise Results
				sequence of flights in its HMI; • display the status of flights of the pre-departure sequence in its HMI; • remove or insert a flight in the pre-departure sequence in its HMI.	
				The Airport Tower Supervisor can: • Schedule a change of runway configuration according to the operational constraints at the airport (MET…); • Schedule a change of runway capacity to meet the performance objective of Airport Operations; • Schedule a change of runway allocation strategy to meet the performance objective of Airport Operations.	OK : The success criterion is achieved
		OBJ-06.08.04-VALP-0470.0400	Improvement of airport capacity by using airport resources more efficiently	The Basic DMAN function allows increasing average arrivals rate	No result. This objective was a bit too ambitious. Demonstrating the part attributable to DMAN was deemed far too complex.
		OBJ-06.08.04-VALP-0470.0500	Reduction of environmental impact of airport operations	Taxi-times are reduced when operating Basic DMAN	Taxi times reduced by 9% compared to baseline scenario (no DMAN)
				Waiting times engines on (ERWT) are reduced when operating Basic DMAN	No result – Data were not captured so that waiting times are actually part of global AXOT
		OBJ-06.08.04-VALP-0470.0600	Improvement of cost-effectiveness of airport operations	Taxi-times are reduced when operating Basic DMAN	Taxi times reduced by 9% compared to baseline scenario (no DMAN)
				Waiting times engines on (ERWT) are reduced when operating Basic DMAN	No result – Data were not captured so that waiting times are actually part of global AXOT
		OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in	New equipment introduced by Basic DMAN are satisfactory to the **Clearance Delivery Controllers** *At least 80% of positive*	OK: The success criterion is achieved. (integrated into the display of the previously used tool)

Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Success Criterion	Exercise Results
			the tower working positions	*answers*	
				New equipment introduced by Basic DMAN are satisfactory to the **Tower Supervisors** *At least 80% of positive answers*	OK: The success criterion is achieved. (integrated into the display of the previously used tool)
				New equipment introduced by Basic DMAN are satisfactory to the **Apron Managers** *At least 80% of positive answers*	NOK: The success criterion is not achieved.
		OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN	New tasks and responsibilities introduced by the use of the Basic DMAN is are satisfactory to the **Clearance Delivery Controllers** *At least 80% of positive answers*	OK: The success criterion is achieved. Majority of positive answers
				New tasks and responsibilities introduced by the use of the Basic DMAN is are satisfactory to the **Tower Supervisors** *At least 80% of positive answers*	OK: The success criterion is achieved. Majority of positive answers
				New tasks and responsibilities introduced by the use of the Basic DMAN is are satisfactory to the **Apron Managers** *At least 80% of positive answers*	OK: The success criterion is achieved. Majority of positive answers
		OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	Tower controllers find that the use of the Basic DMAN has a positive impact on communications between controllers. *At least 80% of positive answers*	OK: The success criterion is achieved. 100% of positive answers
				Tower controllers find that the use of the Basic DMAN has a positive impact on communications between controllers and pilots. *At least 80% of positive answers*	NOK: The success criterion is not achieved. Difficulty to contact pilots put on hold and not monitoring the frequency
		OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic	The **Clearance Delivery Controller**'s workload is reduced working with the Basic DMAN (compared with working without it).	NOK: The success criterion is not achieved. Mean score: 5,42

Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Success Criterion	Exercise Results
			DMAN	*Mean score less than 4*	
				The **Tower Supervisor**'s workload is reduced working with the Basic DMAN (compared with working without it). *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,67
				The **Apron Manager**'s workload is reduced working with the Basic DMAN (compared with working without it). *Mean score less than 4*	NOK: The success criterion is not achieved. Mean score: 4,60
				The **Ground Controller**'s workload is reduced working with the Basic DMAN (compared with working without it). *Mean score less than 4*	NOK: The success criterion is not achieved. Mean score: 4,60
				The **Runway Controller**'s workload is reduced working with the Basic DMAN (compared with working without it). *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,50
				According to the **Runway Controller**, the Basic DMAN improves runway throughput (less aircraft waiting at the runway holding point, less gaps between aircraft). *At least 80% of positive answers*	NOK: The success criterion is not achieved. 41%of positive answers *(problem of representativeness: 8 to 9 answers)*
				With the introduction of the Basic DMAN, the **Ground Controller** can issue the push-back approvals within the TSAT window *At least 80% of positive answers*	OK: The success criterion is achieved. 84% of positive answers
				With the introduction of the Basic DMAN, the **Apron Manager** can issue the push-back approvals within the TSAT window *At least 80% of positive answers*	OK: The success criterion is achieved. 100% of positive answers
				Working with the Basic DMAN, the **Clearance Delivery Controller** happened to forget to call back an aircraft for start-up *Less than 20% of positive answers*	NOK: The success criterion is not achieved. 33% of positive answers (*However this result needs to be put in perspective of the low number of answers*

Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Success Criterion	Exercise Results
					from CLD (cf. Appendix A) – Anyway it indicates an issue to be investigated regarding both procedure (pilot calling too early or not replying) and DMAN HMI)
				The update of the Basic DMAN parameters is easy for the **Tower Supervisor**. *At least 80% of positive answers*	NOK: The success criterion is not achieved. 67% of positive answers *(lack of representativeness: 3 answers)*
		OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	The **Clearance Delivery Controller** is satisfied with the ease of use of the Basic DMAN. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,25
				The **Tower Supervisor** is satisfied with the ease of use of the Basic DMAN. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 2,67
				The **Clearance Delivery Controller** is satisfied with the ease to learn to use the Basic DMAN *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,08
				The **Tower Supervisor** is satisfied with the ease to learn to use the Basic DMAN *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,00
				The **Apron Manager** is satisfied with the ease to learn to use the Basic DMAN *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,80
				The Basic DMAN HMI enables the **Clearance Delivery Controller** to easily and quickly recover from the mistakes made *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,33
				The Basic DMAN HMI enables the **Tower Supervisor** to easily and quickly recover from the mistakes made *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,67
				The **Clearance Delivery Controller** finds that the	OK: The success criterion is achieved.

Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Success Criterion	Exercise Results
				information provided by the system is easy to understand. *Mean score less than 4*	Mean score: 3,08
				The **Tower Supervisor** finds that the information provided by the system is easy to understand. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 2,33
				The **Apron Manager** finds that the information provided by the system is easy to understand. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,80
				The **Clearance Delivery Controller** finds that the organization of information on the Basic DMAN HMI is clear. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,00
				The **Tower Supervisor** finds that the organization of information on the Basic DMAN HMI is clear. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,67
				The **Apron Manager** finds that the organization of information on the Basic DMAN HMI is clear. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 2,00
				The Basic DMAN has all the functions and capabilities the **Clearance Delivery Controller** expect it to have. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,92
				The Basic DMAN has all the functions and capabilities the **Tower Supervisor** expect it to have. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,67
				The **Clearance Delivery Controller** can effectively work using the Basic DMAN. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,42
				The **Tower Supervisor** can effectively work using the Basic DMAN. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,67
				The **Apron Manager** can effectively work using the Basic DMAN.	OK: The success criterion is achieved.

Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Success Criterion	Exercise Results
				Mean score less than 4	Mean score: 1,80
		OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	New procedures introduced by the Basic DMAN between ATC and Flight Crew are easy to apply for the **Clearance Delivery Controller** *At least 80% of positive answers*	OK: The success criterion is achieved. Some difficulties mainly due to pilots not monitoring frequency
				New procedures introduced by the Basic DMAN between ATC and Flight Crew are easy to apply for the **Ground Controller** *At least 80% of positive answers*	OK: The success criterion is achieved. Some difficulties due to implementation issue
				New procedures introduced by the Basic DMAN between ATC and Flight Crew are easy to apply for the **Apron Manager** *At least 80% of positive answers*	Some difficulties due to implementation issue
		OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	No security impacts due to Basic DMAN implementation	OK: The success criterion is achieved. The tower controllers are aware of the system status.

Table 7: Summary of Validation Exercises Results

Further results are provided in the chapter 4.1.2.

4.1.1 Results on concept clarification

The results from this validation exercise clarify the need for a Basic DMAN HMI to be introduced in an electronic environment that could efficiently manage flight data updates such as the TSAT.

4.1.2 Results per KPA

KPAs	KPIs	Results
Safety	**Reduced taxi-times** **Number of simultaneous ground movements**	Average taxi time has been decreased by 9% over one year of operating the DMAN whilst operations are kept at the same level than before DMAN was introduced. Accordingly to rationale provided in the VALP, as the average taxi times are no worse using the Basic DMAN then the number of pre-tactical taxiway conflicts should not increase and consequently the safety acceptance criteria should be implicitly satisfied. Regarding safety improvement, considering that the global taxi times are as

		well no worse using the Basic DMAN a safety improvement could be gained.
Environmental Sustainability	**Fuel Burn** in relation to taxi out duration **Emissions** in relation to Fuel Burn	Average taxi time has been decreased by 9% over one year of operating the DMAN. This positive result has been correlated to a reduction in Fuel Burn and Emissions
Cost Effectiveness	**Fuel Burn** in relation to taxi out duration	Same as above.
Capacity	**Number of departing aircraft** from a runway per hour	No significant result due to insufficient quality of data collected during trials (completeness)
Efficiency	**Number of departing aircraft** from a runway per hour	No significant result due to insufficient quality of data collected during trials (completeness)
Predictability	**Stability of Target Start-up Approval Time**	**84, 8%** of the flights respect their TSAT window: i.e. the aircraft leave in a 5 minutes window around the TSAT which indicates a rather good predictability of off-block times

Table 8: Basic DMAN validation results per KPA

Besides, some Human Performance aspects were assessed through four main Human Factors issues that can have potential influences on the KPA addressed in this validation exercise (see. Ref. [15]):

- Working environment.
- Procedures, roles and responsibilities (including controllers' workload).
- Teams and communications.
- Human in the system (including DMAN HMI usability and reliability).

These HF issues aspects were assessed through observations, questionnaires and debriefing with the CDG controllers and the CDG operational experts. The results are presented in chapter 1.1.

4.1.3 Results impacting regulation and standardisation initiatives

No results impacting regulation and standardisation initiatives have been identified.

4.2 Analysis of Exercises Results

This section provides a general analysis of this exercise results, including rationale of the results, potential deviations with respect to the targets, possible reasons and relationship between the results and the appropriate assumptions.

- OK: Validation objective achieves the expectations (exercise results achieve success criteria);
- NOK: Validation objective does not achieve the expectations (exercise results do not achieve success criteria).

The table below presents the validation objectives analysis status in this exercise.

In this table, in order to simplify presentation, results are presented globally for the three exercises identified in the VALP.

Validation Objective ID	Validation Objective Title	Exercise Title	Success Criteria[1]	Exercise Results	Validation Objective Analysis Status
OBJ-06.08.04-VALP-0470.0100	No adverse effects on safety	Basic DMAN validation (live trials)	The Basic DMAN function reduces the average taxi time of aircraft compared to the baseline scenario	Average taxi time has been decreased by 9% over one year of operating the DMAN.	OK
OBJ-06.08.04-VALP-0470.0150	Safety improvement from taxi times reduction	Basic DMAN validation (live trials)	The Basic DMAN function reduces the global taxi time of aircraft compared to the baseline scenario. Number of departures might be increased	Average taxi time has been decreased by 9% over one year of operating the DMAN.	OK
OBJ-06.08.04-VALP-0470.0200	Improvement of Off-block times predictability	Basic DMAN validation (live trials)	The Basic DMAN function delivers stable values of TSAT increasing the Off-block times' predictability compared to the baseline scenario	Deviation of TSAT from TOBT is less than 5' for 93, 8% of the flights during the trials.	OK
OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence	Basic DMAN validation (live trials)	The Clearance Delivery Controller can: • Display and re-arrange (sorting) the pre-departure sequence of flights in its HMI; • Display the status of flights of the pre-departure sequence in its HMI;	Basic DMAN functions have been assessed: •Pre-departure sequence management; •Take-Off sequence management; •Runway configuration management;	OK *The assessment of Take-Off sequence management was limited to HMI aspects since Operating Method 1 in use at CDG doesn't support Take-Off sequence management.*

[1] Note that a validation objective can have more than 1 success criterion, please make them appear in the same cell.

Validation Objective ID	Validation Objective Title	Exercise Title	Success Criteria[1]	Exercise Results	Validation Objective Analysis Status
			• Remove or insert a flight in the pre-departure sequence in its HMI.	•DMAN supervision.	
			The Airport Tower Supervisor can: • Schedule a change of runway configuration according to the operational constraints at the airport (MET…); • Schedule a change of runway capacity to meet the performance objective of Airport Operations; • Schedule a change of runway allocation strategy to meet the performance objective of Airport Operations.		
OBJ-06.08.04-VALP-0470.0400	Improvement of airport capacity by using airport resources more efficiently	Basic DMAN validation (live trials)	The Basic DMAN function allows increasing average arrivals rate	N/A	N/A
OBJ-06.08.04-VALP-0470.0500	Reduction of environmental impact of airport operations	Basic DMAN validation (live trials)	Taxi-times are reduced when operating Basic DMAN	Average taxi time has been decreased by 9% over one year of operating the DMAN.	OK
			Waiting times engines on (ERWT) are reduced when operating Basic DMAN	N/A	
OBJ-06.08.04-VALP-0470.0600	Improvement of cost-effectiveness of airport operations	Basic DMAN validation (live trials)	Taxi-times are reduced when operating Basic DMAN	Average taxi time has been decreased by 9% over one year of operating the DMAN.	OK
			Waiting times engines on (ERWT) are reduced when operating Basic DMAN	N/A	
OBJ-06.08.04-VALP-0470.0700	Assessment of the level	Basic	New equipment introduced by	OK: The success criterion	OK

Validation Objective ID	Validation Objective Title	Exercise Title	Success Criteria[1]	Exercise Results	Validation Objective Analysis Status
	of satisfaction regarding the Basic DMAN integration in the tower working positions	DMAN validation (live trials)	Basic DMAN are satisfactory to the **Clearance Delivery Controllers** *At least 80% of positive answers*	is achieved	
			New equipment introduced by Basic DMAN are satisfactory to the **Tower Supervisors** *At least 80% of positive answers*		
OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN	Basic DMAN validation (live trials)	New tasks and responsibilities introduced by the use of the Basic DMAN is are satisfactory to the **Clearance Delivery Controllers** *At least 80% of positive answers*	OK: The success criterion is achieved	OK
			New tasks and responsibilities introduced by the use of the Basic DMAN is are satisfactory to the **Tower Supervisors** *At least 80% of positive answers*		
			New tasks and responsibilities introduced by the use of the Basic DMAN is are satisfactory to the **Apron Managers** *At least 80% of positive answers*		
OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	Basic DMAN validation (live trials)	Tower controllers find that the use of the Basic DMAN has a positive impact on communications between controllers. *At least 80% of positive answers*	OK: The success criterion is achieved	OK
			Tower controllers find that the use of the Basic DMAN has a	NOK: The success criterion is not achieved.	NOK

Validation Objective ID	Validation Objective Title	Exercise Title	Success Criteria[1]	Exercise Results	Validation Objective Analysis Status
			positive impact on communications between controllers and pilots. *At least 80% of positive answers*	Difficulty to contact pilots put on hold and not monitoring the frequency	
OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic DMAN	Basic DMAN validation (live trials)	The **Clearance Delivery Controller**'s workload is reduced working with the Basic DMAN (compared with working without it). *Mean score less than 4*	NOK: The success criterion is not achieved. Mean score: 5,42	NOK *Side effect due to pilots not monitoring frequency*
			The **Tower Supervisor**'s workload is reduced working with the Basic DMAN (compared with working without it). *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,67	OK
			The **Apron Manager**'s workload is reduced working with the Basic DMAN (compared with working without it). *Mean score less than 4*	NOK: The success criterion is not achieved. Mean score: 4,60	NOK *Implementation issue*
			The **Ground Controller**'s workload is reduced working with the Basic DMAN (compared with working without it). *Mean score less than 4*	NOK: The success criterion is not achieved. Mean score: 4,60	NOK *Implementation issue*
			The **Runway Controller**'s workload is reduced working with the Basic DMAN (compared with working without it). *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,50	OK
			According to the **Runway Controller**, the Basic DMAN improves runway throughput (less aircraft waiting at the runway holding point, less	NOK: The success criterion is not achieved. 41%of positive answers	*Lack of representativeness*

Validation Objective ID	Validation Objective Title	Exercise Title	Success Criteria[1]	Exercise Results	Validation Objective Analysis Status
			gaps between aircraft). *At least 80% of positive answers*		
			With the introduction of the Basic DMAN, the **Ground Controller** can issue the push-back approvals within the TSAT window *At least 80% of positive answers*	OK: The success criterion is achieved. 84% of positive answers	OK
			With the introduction of the Basic DMAN, the **Apron Manager** can issue the push-back approvals within the TSAT window *At least 80% of positive answers*	OK: The success criterion is achieved. 100% of positive answers	OK
			Working with the Basic DMAN, the **Clearance Delivery Controller** happened to forget to call back an aircraft for start-up *Less than 20% of positive answers*	OK: The success criterion is achieved. 33% of positive answers	NOK *However this result needs to be put in perspective of the low number of answers from CLD (Lack of representativeness)* *Anyway it indicates an issue to be investigated regarding both procedure (pilot calling too early or not replying) and DMAN HMI*
			The update of the Basic DMAN parameters is easy for the **Tower Supervisor**. *At least 80% of positive answers*	NOK: The success criterion is not achieved. 67% of positive answers *(lack of representativeness: 3 answers)*	*Lack of representativeness*
OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	Basic DMAN validation (live trials)	The **Clearance Delivery Controller** is satisfied with the ease of use of the Basic DMAN. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,25	OK
			The **Tower Supervisor** is	OK: The success criterion	OK

Validation Objective ID	Validation Objective Title	Exercise Title	Success Criteria[1]	Exercise Results	Validation Objective Analysis Status
			satisfied with the ease of use of the Basic DMAN. *Mean score less than 4*	is achieved. Mean score: 2,67	
			The **Clearance Delivery Controller** is satisfied with the ease to learn to use the Basic DMAN *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,08	OK
			The **Tower Supervisor** is satisfied with the ease to learn to use the Basic DMAN *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,00	OK
			The **Apron Manager** is satisfied with the ease to learn to use the Basic DMAN *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,80	OK
			The Basic DMAN HMI enables the **Clearance Delivery Controller** to easily and quickly recover from the mistakes made *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,33	OK
			The Basic DMAN HMI enables the **Tower Supervisor** to easily and quickly recover from the mistakes made *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,67	OK
			The **Clearance Delivery Controller** finds that the information provided by the system is easy to understand. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,08	OK
			The **Tower Supervisor** finds that the information provided by the system is easy to understand. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 2,33	OK
			The **Apron Manager** finds that the information provided by the system is easy to	OK: The success criterion is achieved. Mean score: 1,80	OK

Validation Objective ID	Validation Objective Title	Exercise Title	Success Criteria[1]	Exercise Results	Validation Objective Analysis Status
			understand. *Mean score less than 4*		
			The **Clearance Delivery Controller** finds that the organization of information on the Basic DMAN HMI is clear. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,00	OK
			The **Tower Supervisor** finds that the organization of information on the Basic DMAN HMI is clear. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,67	OK
			The **Apron Manager** finds that the organization of information on the Basic DMAN HMI is clear. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 2,00	OK
			The Basic DMAN has all the functions and capabilities the **Clearance Delivery Controller** expect it to have. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,92	OK
			The Basic DMAN has all the functions and capabilities the **Tower Supervisor** expect it to have. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,67	OK
			The **Clearance Delivery Controller** can effectively work using the Basic DMAN. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 3,42	OK
			The **Tower Supervisor** can effectively work using the Basic DMAN. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,67	OK
			The **Apron Manager** can effectively work using the Basic DMAN. *Mean score less than 4*	OK: The success criterion is achieved. Mean score: 1,80	OK
OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	Basic DMAN	New procedures introduced by the Basic DMAN between	NOK: The success criterion is not achieved.	NOK

Validation Objective ID	Validation Objective Title	Exercise Title	Success Criteria[1]	Exercise Results	Validation Objective Analysis Status
		validation (live trials)	ATC and Flight Crew are easy to apply for the **Clearance Delivery Controller** *At least 80% of positive answers*	Some difficulties mainly due to pilots not monitoring frequency	
			New procedures introduced by the Basic DMAN between ATC and Flight Crew are easy to apply for the **Ground Controller** *At least 80% of positive answers*	NOK: The success criterion is not achieved. Some difficulties due to implementation issue	NOK
			New procedures introduced by the Basic DMAN between ATC and Flight Crew are easy to apply for the **Apron Manager** *At least 80% of positive answers*	NOK: The success criterion is not achieved. Some difficulties due to implementation issue	NOK
OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	Basic DMAN validation (live trials)	*None defined*	OK: The success criterion is achieved. The tower controllers are aware of the system status.	OK

Table 9: Overview: Validation Objectives, Exercises Results and Validation Objectives Analysis Status

It is worth noting that a detailed requirements coverage matrix is given in given in Annex C.

4.2.1 Statistics provided by CDM@CDG team

This section provides results corresponding to the trials period (July-August 2011) based on the 6 daily indicators monitored by the CDM@CDG team.

CDM@CDG team designates the partners (Airport assistants, Airlines, Air Traffic control, Weather service, Airport management …) involved in the CDM process in place at CDG airport and sharing information and performance indicators (via a website (www.cdmcdg.net)).

4.2.1.1 Taxi Times

The average taxi-time is measured as the difference between the ATOT and the AOBT: it encompasses thus all delays during taxi phase including waiting time at the threshold (ARWT). These delays appear in red on Figure 4 hereafter whilst the standard taxi-times are represented in blue.
For the considered period, the average global taxi-time is **16, 1** minute whilst the average delay is **3, 7** minutes.

CDG's objective is to have an **annual** average taxi time lower than 16, 2 minutes by 2015.

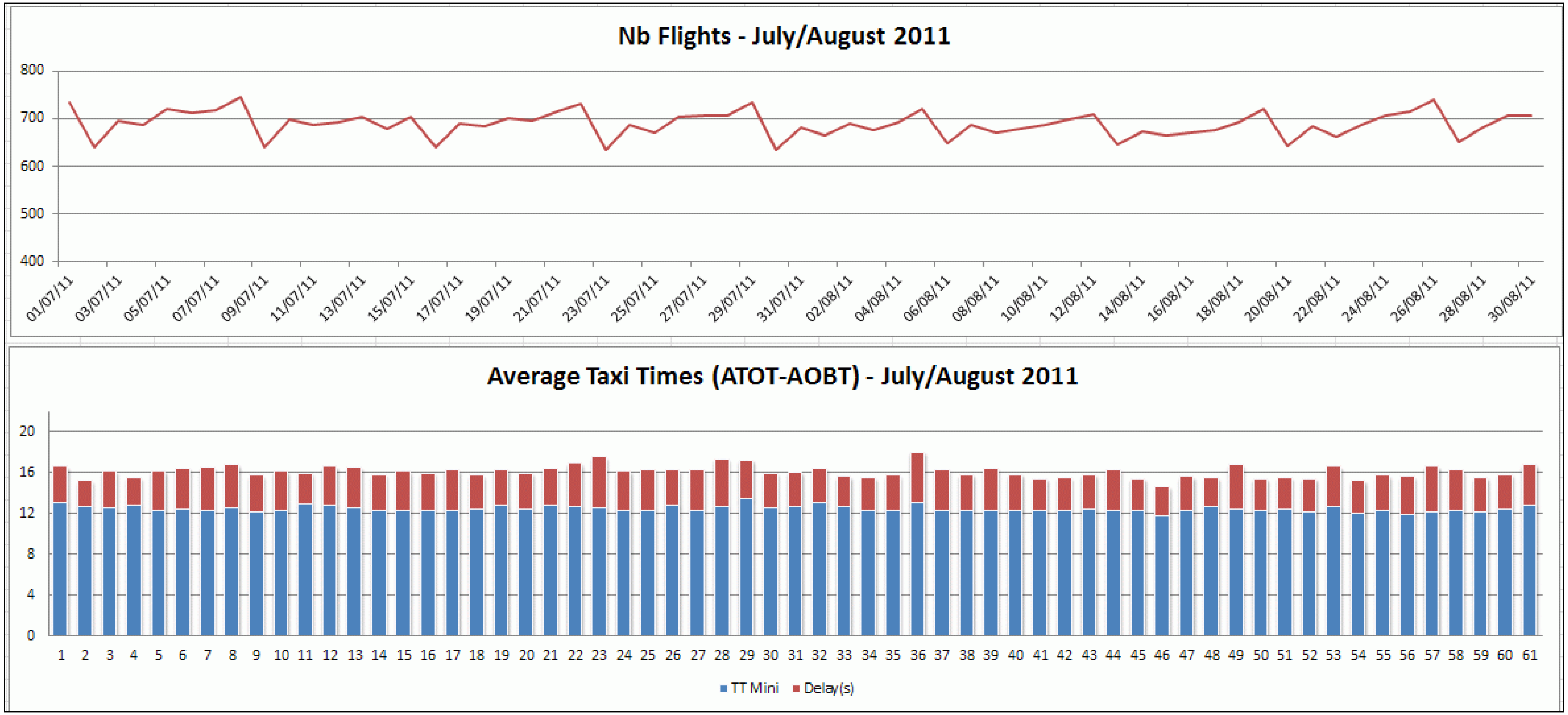


Figure 4: CDG – Average Taxi-Times (July / August 2011)

Compared to the previous period without DMAN operating, the gain for global outbound taxi-times is around **9%**, without any negative effects on inbound taxi-times which remain stable.

4.2.1.2 Adherence to CFMU slots

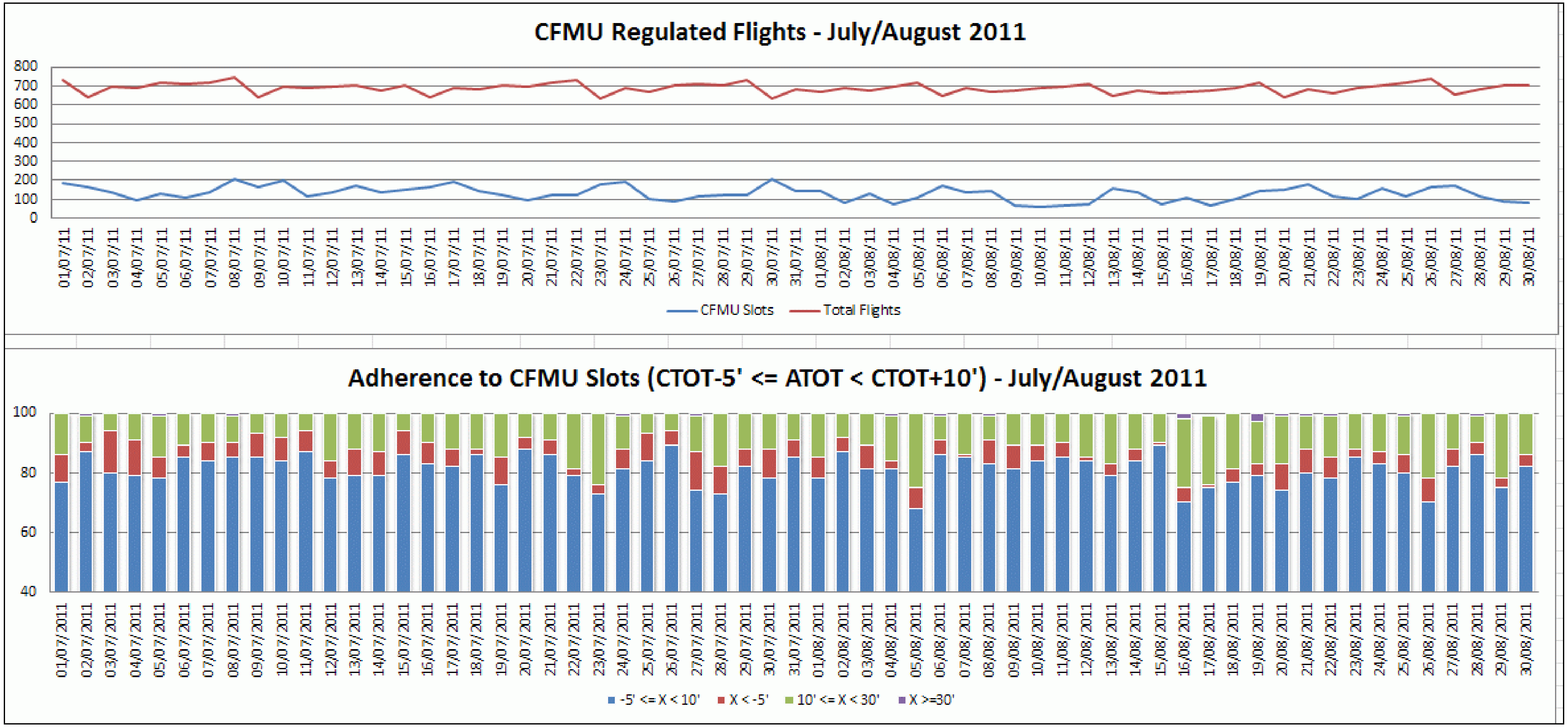


Figure 5: CDG – Adherence to CFMU Slots (July / August 2011)

This indicator measures the respect of CFMU' slot (Take-off between CTOT - 5 minutes and CTOT + 10 minutes).

CDG's objective is to have more than 80% adherence to CFMU slots (The percentage of flights respecting this objective are represented in blue on the figure above). For the considered period, **81%** respect their CFMU slot.

	Dec. 2009 - Apr. 2010	Dec. 2010 - Apr. 2011	Difference
On time departures	75,64%	**83,98%**	**+ 8,34%**
Late departures	10.74%	10,54%	- 0,20%
Early departures	13,62%	5,48%	**- 8,14**%

Table 10: CDG: Slot adherence improvement

Table 10 above illustrates the improvement of Slot adherence between early 2010 when no DMAN was operating and early 2011. On average for these four months an increase of **8, 34** % of the number of departures on-time can be observed, mainly due to a reduction of early departures.

4.2.1.3 Off-Block punctuality

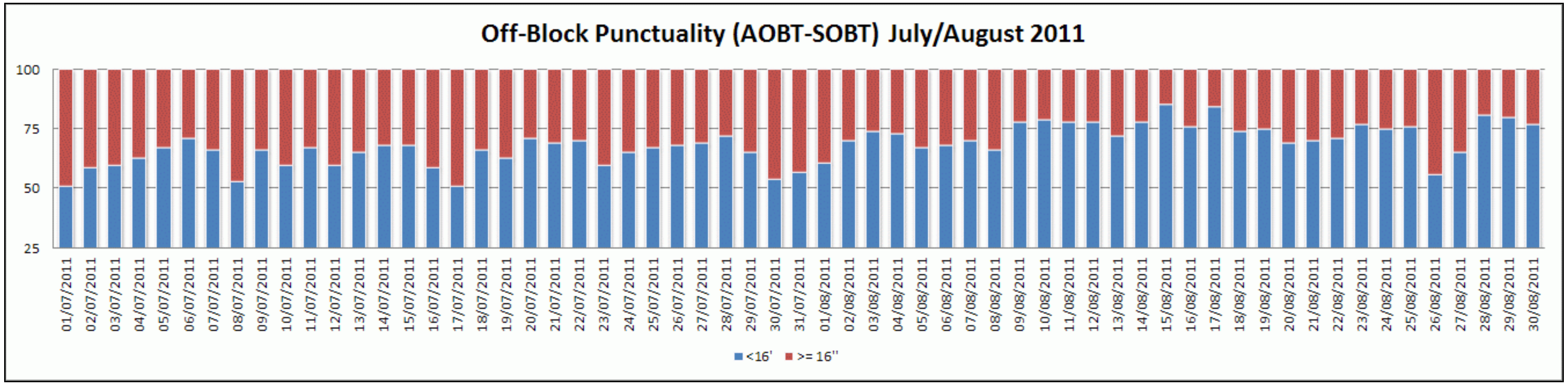


Figure 6: CDG – Off-Block punctuality (July / August 2011)

This third indicator measures the punctuality of off-blocks times compared to those coordinated by the COHOR program. (COHOR is an independent, non-profit making organisation, financed by some French carriers and airports (Paris, Lyon & Nice). COHOR is appointed since 1995 by the French Authorities to allocate slots at busy airports. On average, for the considered period **68, 4%** of the flights complied with their scheduled Off-Block Time (i.e. the difference was less than 16 minutes).

	2010	2011	Difference
January	64%	74%	**+ 10%**
February	66%	79%	**+ 13%**
March	77%	84%	**+ 7%**
April	75%	81%	**+ 6%**

Table 11: CDG: Off-Block punctuality improvement

Table 11 above illustrates the improvement of Off-Block punctuality between early 2010, when no DMAN was operating, and early 2011.

4.2.1.4 Airside Impact (non-regulated flights)

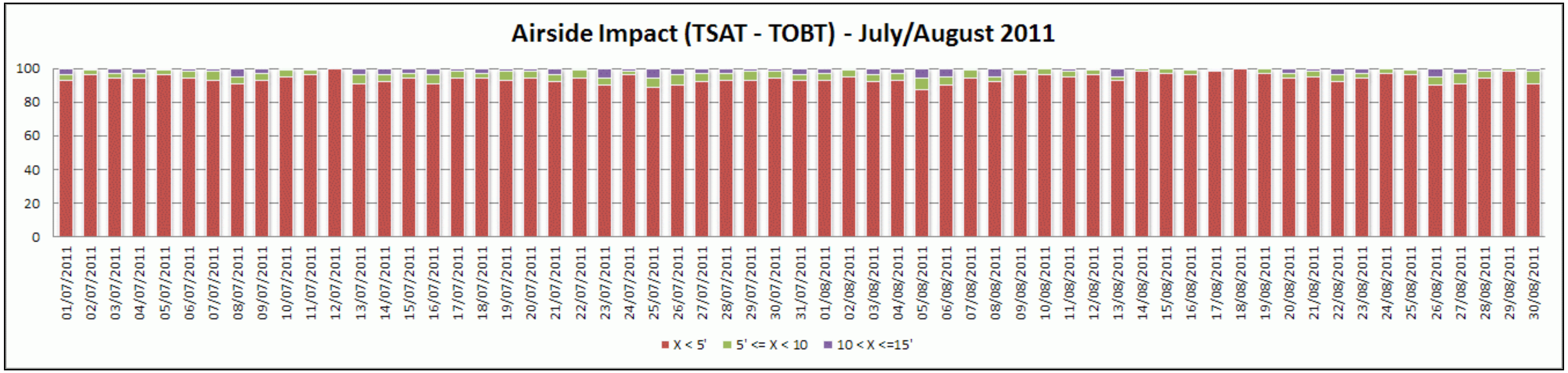


Figure 7: CDG – Airside Impact (July / August 2011)

This fourth indicator measures the delay due to local constraints by comparing the TSAT calculated by the DMAN to the airlines target Start-Up time (Either the SOBT from COHOR, or the last TOBT).

The objective for CDG is that no delay should be generated [by ATC] when the capacity is higher than the demand: 100% of the flights should have their TSAT equal to their TOBT when no local constraints apply.

As illustrated on Figure 7 above, for the concerned period, **93, 8%** of the flights have their TSAT less than 5' after their TOBT. The figures from July 2010 on this indicator were **86%** which means an improvement of **7.8**% over one year.

4.2.1.5 Adherence to the TSAT window

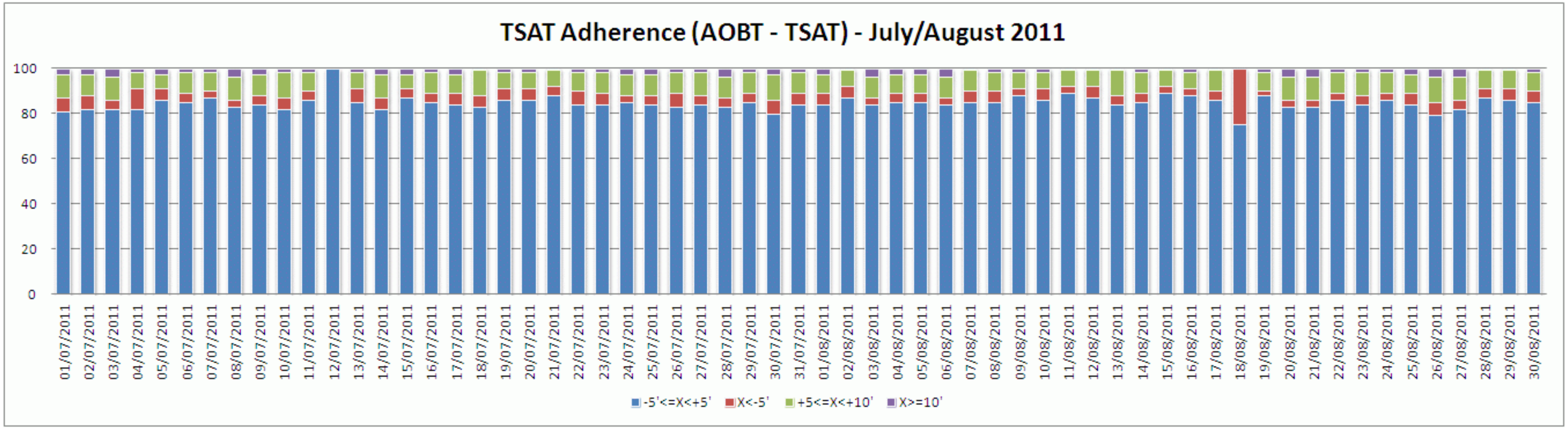


Figure 8: CDG – Adherence to TSAT window (July / August 2011)

This indicator measures the respect of the operational Off-Block procedures: the aircraft must leave in a 5 minutes window around the TSAT.

CDG's objective is that 100% of the flights leave the block in at their TSAT +/- 5 min. As illustrated on Figure 8 above, for the concerned period, **84, 8%** of the flights meet this objective.

4.2.1.6 Delay between Start-Up Approval and Off-Block

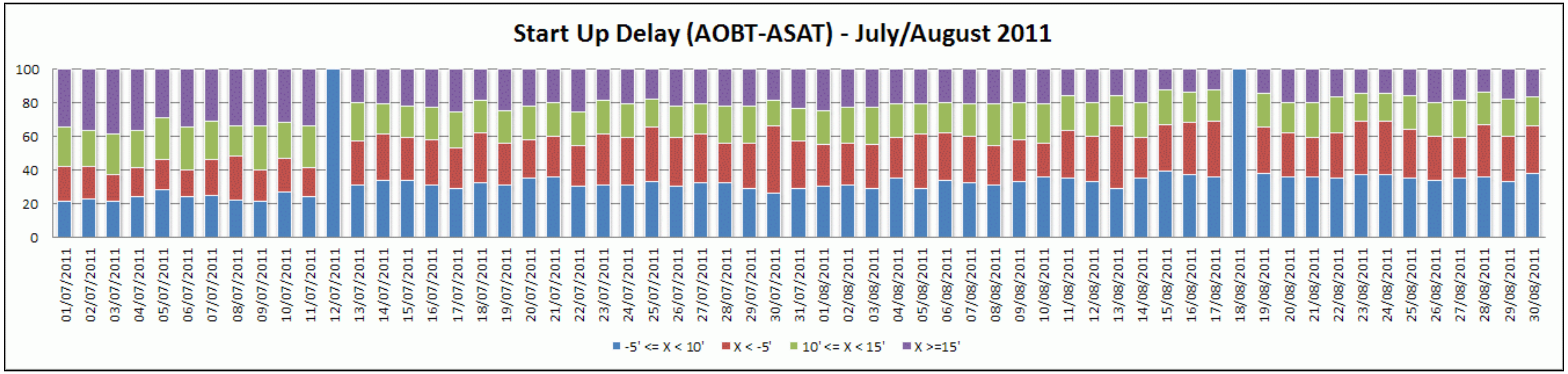


Figure 9: CDG – Delay between Start-Up Approval and Off-Block (July / August 2011)

This indicator measures the capacity of the flights to respect their allocated start-up slot as the difference between AOBT and ASAT. Taking into account the new procedures, acceptable values for this indicator must be comprised between 0 and 15 minutes without local constraint. As illustrated on the figure above, for the concerned period, **78, 3%** of the flights meet this objective.

4.2.1.1 Delay at the runway threshold during peak hours

Time period (LT)	2010	2011	Improvement
6H-7H	209	178	**-15%**
9H-10H	234	214	**-9%**
12H-13H	262	239	**-8%**
18H-19H	240	151	**-37%**

Table 12: CDG: Delay at runway threshold during peak hours (seconds)

Table 12 above illustrates the reduction of the delay at runway threshold during peak hours between March 2010 (2995 flights) when no DMAN was operating and March 2011 (2739 flights).

4.2.2 Analysis of Taxi Times measured during the trials

This section provides results of analyses performed by DSNA/DTI/PER on a sample of flights recorded during the trials. It is worth noting that only 25% of those data were usable (completeness of the recordings).

In the end the sample used in this analysis is as follows:

- •2010: (baseline) 9839 flights between July 11th and September 1st
- •2011 : 9073 flights between July 10th and August 31st

The global departure traffic variations are illustrated on the figure hereafter.

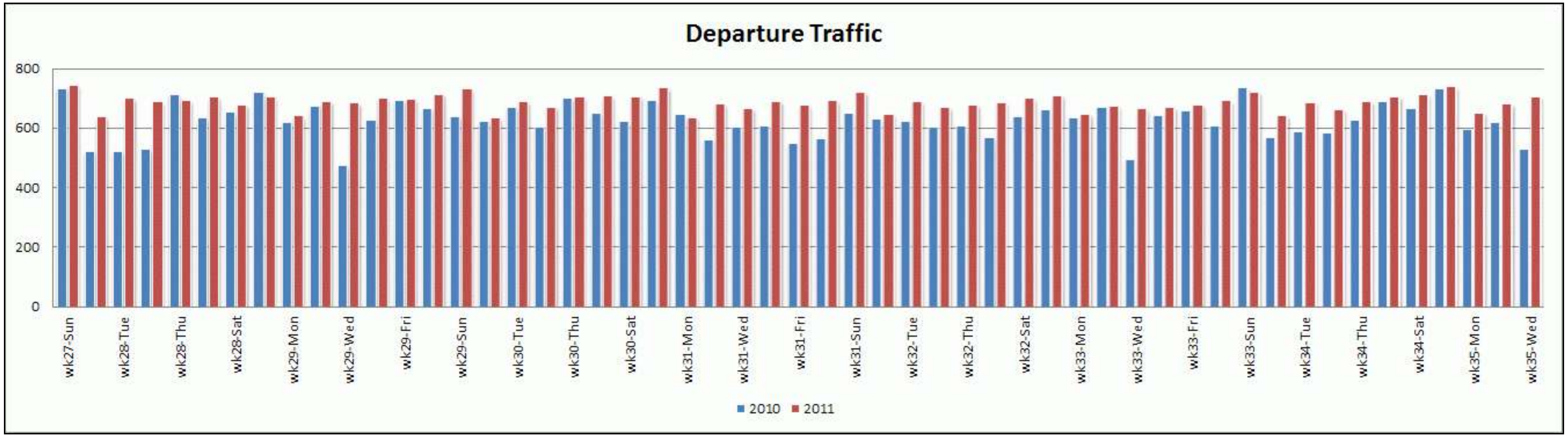


Figure 10: CDG – Departure Traffic during trials

4.2.2.1 Taxi times distribution

As illustrated on Figure 12 below, average taxi time has decreased by **9%** in 2011, going from 10min 53s in 2010 to 9min 58s in 2011.

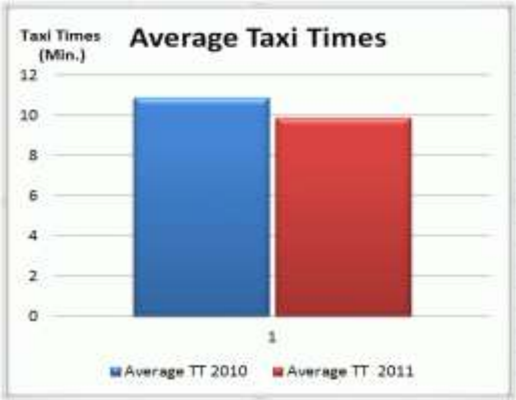


Figure 11: CDG – Average Taxi Times (Comparison Summer 2010 vs. 2011)

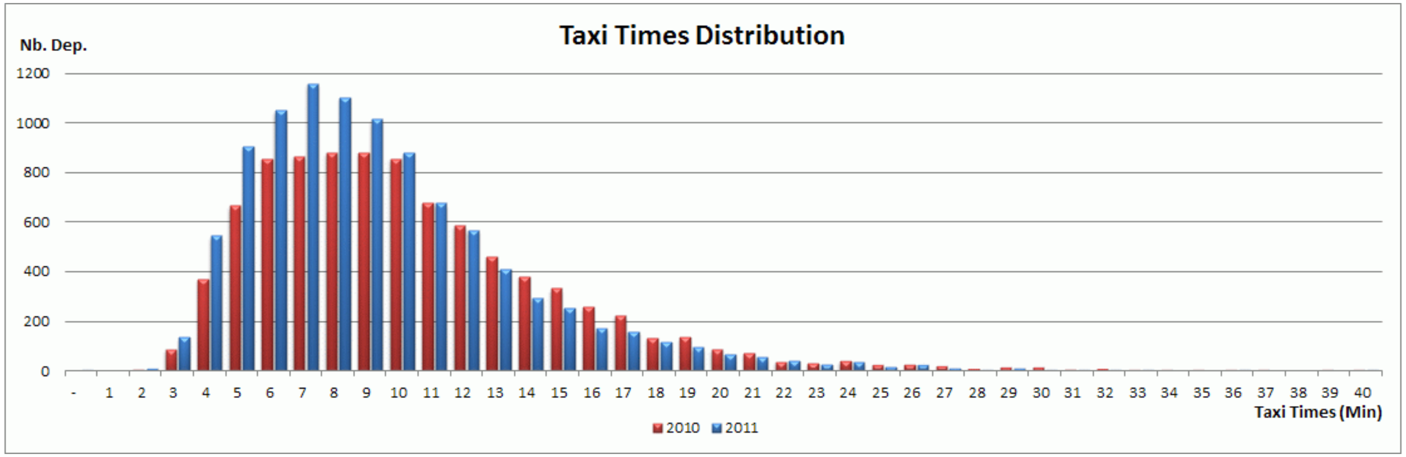


Figure 12: CDG – Taxi Times Distribution (Comparison Summer 2010 vs. 2011)

In 2010 as well as in 2011, the Taxi Times distributions are closed to normal distribution. About 80% of Taxi Times values are within one standard deviation away from the mean.

4.2.2.2 Average taxi times per runway

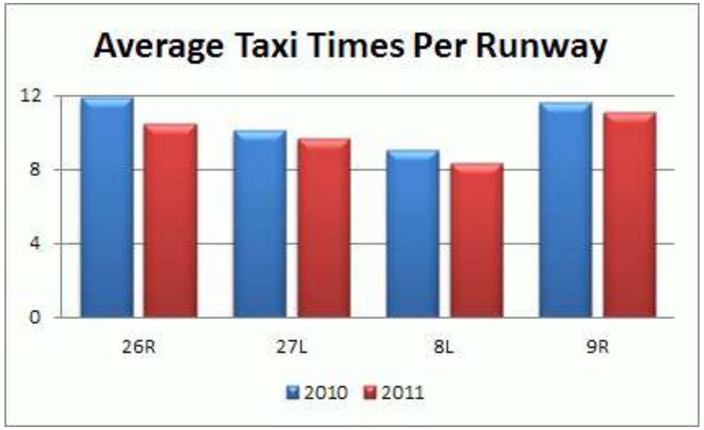


Figure 13: CDG – Average Taxi Times per runway (Comparison Summer 2010 vs. 2011)

The focus is only on runways 26R, 27L, 8L and 9R which stand for 99.7% and 99.8% of the total number of departures respectively in 2010 and 2011. Average taxi time has decreased in 2011 for any of this runway (by 12% for 26R, 4% for 27L, 7% for 8L and 5% for 9R).

4.2.2.3 Average taxi times per day of the week

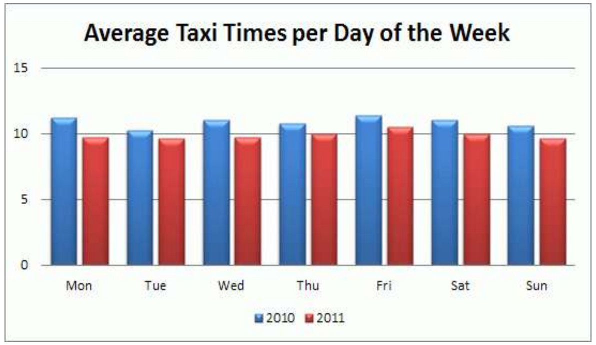


Figure 14: CDG – Average Taxi Times per day (Comparison Summer 2010 vs. 2011)

Average taxi time per day of the week has decreased in 2011 for any day of the week. The biggest decreases are observed on Mondays and Wednesdays

4.2.2.4 Average taxi times per take off time

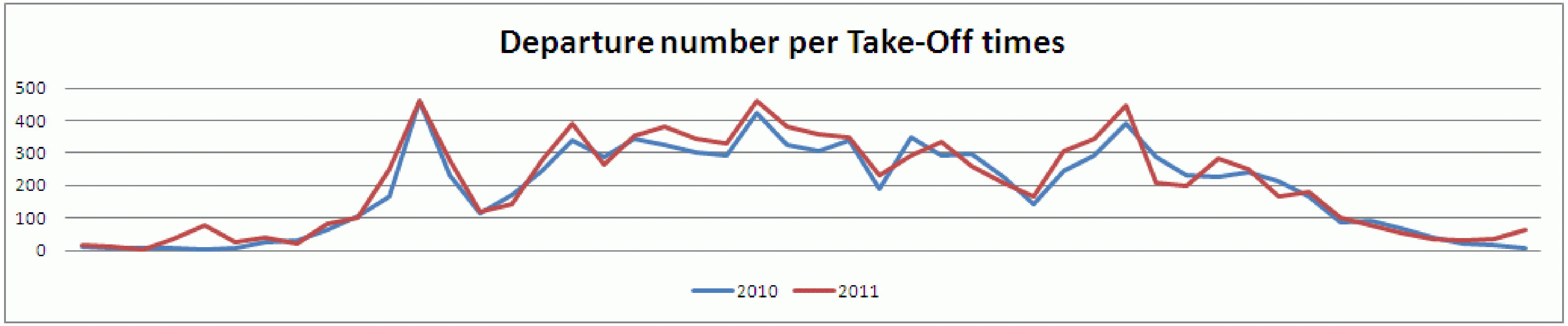


Figure 15: CDG – Departures number per take off time (Comparison Summer 2010 vs. 2011)

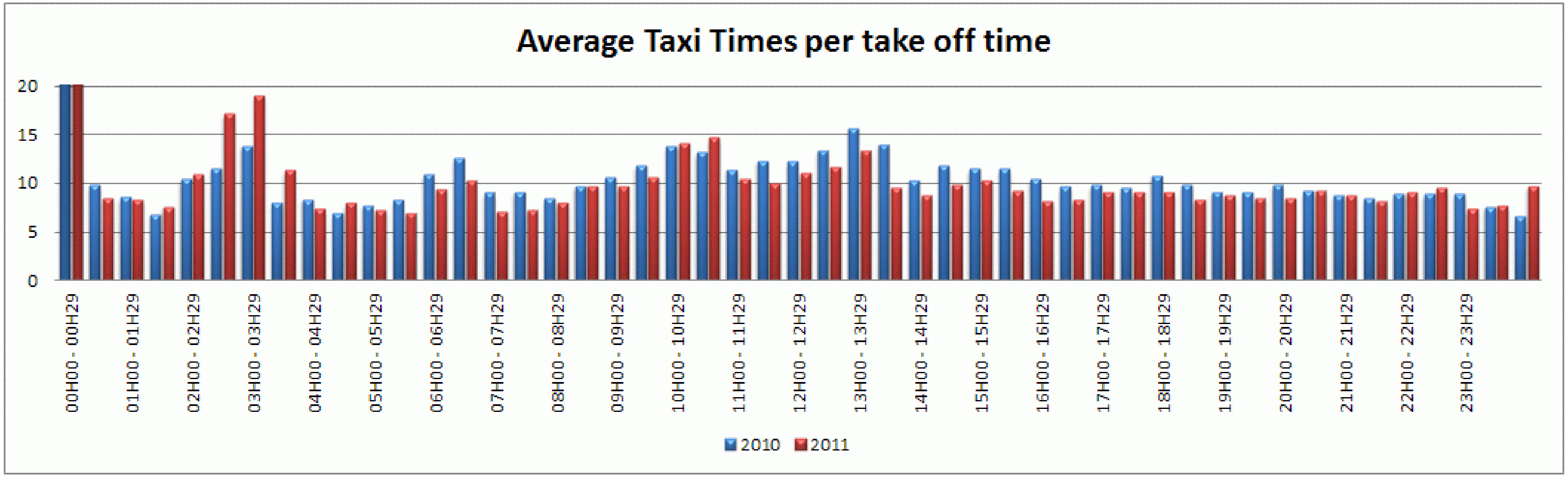


Figure 16: CDG – Average Taxi Times per take off time (Comparison Summer 2010 vs. 2011)

Average taxi-time in peak hours has decreased in 2011 although traffic has increased in the same period.

4.2.3 Analysis of the Environmental impact

The results presented here correspond only to a first approach and would require further investigation to refine, inter alia, the benefits that are clearly attributable to the DMAN.

4.2.3.1 Methodology

The environmental benefit of the DMAN operating at CDG has been evaluated by correlating the gain observed for taxi times to a reduction in Fuel Burn and Emissions.

An accurate average taxi time gain per flight has been calculated for 3 aircraft turbulence categories based on actual aircraft type found in the data recorded during the trials.
This average taxi time gain per flight has been then extrapolated to the outbound traffic between September 2010 and September 2011 (260 000 flights) in order to provide an annual figure (See Table 13 below).

Aircraft Turbulence Category	Percentage of overall departure traffic	Average Taxi Times gain per flight	Extrapolated yearly Taxi Times gain (minutes)
Heavy	21,69%	49 s	46064
Medium	77,69%	72 s	242380
Light	0,62%	142 s	3815

Table 13: CDG - Average TT gain per Aircraft Turbulence Category

These gains have been the correlated to a reduction in Fuel Burn and Emissions by using two different sets of figures (see Table 14):

- A set from **ADP** (Aéroport De Paris) based on data collected from the airlines operating at CDG;
- A set from **EUROCONTROL** standard values for CBAs.

Aircraft Turbulence Category	Fuel Flow (Kg/mn per A/C)		Emissions Factors					
	ADP[2]	ECTL	CO_2 (ADP)	CO2	CO	NoX	SO_2	HC
Heavy	34,61	16,95	3,15	3,149	0,033	0,004	0,001	0,009
Medium	10,42	11,3	3,15	3,149	0,033	0,004	0,001	0,009
Light	5,5	5,65	3,18	3,149	0,033	0,004	0,001	0,009

Table 14: Aircraft indices for 1minute taxi-out (Fuel and emissions)

4.2.3.1 Results

4.2.3.1.1Benefits per flight at CDG

The two diagrams hereafter illustrate the benefits per flight.

For aircraft in the medium turbulence category, which represent almost 78% of the traffic at CDG, the gain in Fuel Burn is **14.6 Kg** per flight corresponding to **46.6 Kg of CO_2**.

[2] The ADP figures presented in Table 14 are resulting from the calculation of an average FB and C02 based on data provided by ADP (See Annex B). However, it must be noted that **actua**l Aircraft type and related FB and CO2 metrics have been used to produce results presented in Table 15.

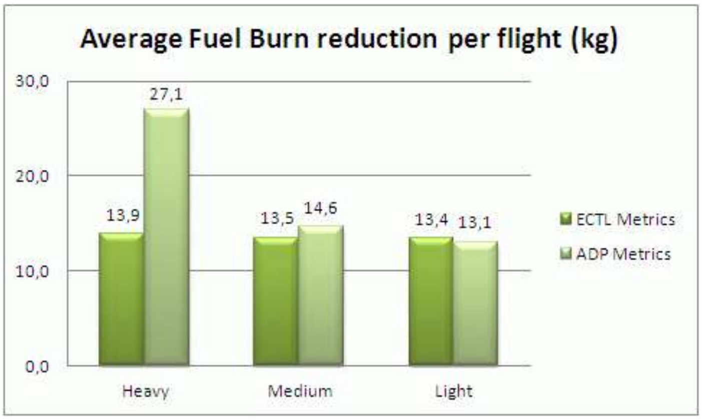


Figure 17: CDG – Average Fuel Burn reduction per flight

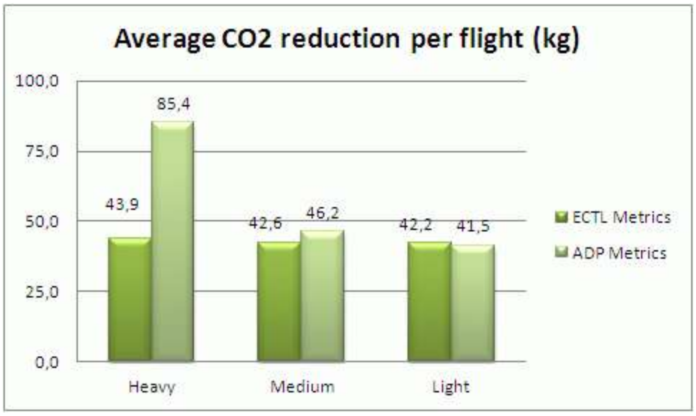


Figure 18: CDG – Average CO_2 reduction per flight

4.2.3.1.1Extrapolated benefits per year at CDG

Table 15 and Table 16 present the reduction of Fuel Burn and Emissions extrapolated to the outbound traffic between September 2010 and September 2011 (260 000 flights).

Aircraft Turbulence Category	FB Reduction (t)	Emissions Reduction (t)				
		CO_2	CO	NoX	$S0_2$	HC
Heavy	1594	5022,0	52,6	6,4	1,6	14,3
Medium	2526	7955,6	83,3	10,1	2,5	22,7
Light	21	66,7	0,7	0,1	0,0	0,2
TOTAL	**4141**	**13044,3**	**136,6**	**16,6**	**4,1**	**37,3**

Table 15: CDG – Benefits per year calculated with ADP figures

Aircraft Turbulence Category	FB Reduction (t)	Emissions Reduction (t)				
		CO_2	CO	NoX	$S0_2$	HC
Heavy	780,8	2458,7	25,8	3,1	0,8	7,0
Medium	2738,9	8624,8	90,4	11,0	2,7	24,7
Light	21,6	67,9	0,7	0,1	0,0	0,2
TOTAL	**3541**	**11151,3**	**116,9**	**14,2**	**3,5**	**31,9**

Table 16: CDG – Benefits per year calculated with ECTL figures

Again, for aircraft in the medium turbulence category, the annual gain in Fuel Burn is more than **2500 tons** corresponding to around **8000 tons of CO_2**.

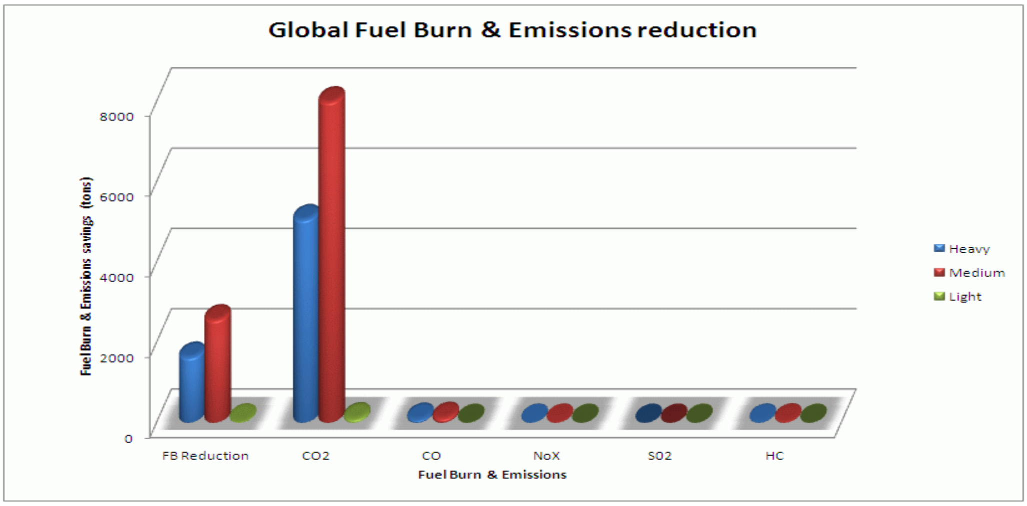


Figure 19: CDG – Global reduction in Fuel Burn & Emissions

In total, for all turbulence categories, the annual gain in Fuel Burn is more than **4000 tons** corresponding to around **13 000 tons of CO_2**.

4.2.4 Human Performance related results

4.2.4.1 Efficiency

The results are related to **OBJ-06.08.04-VALP-0470.0300**.

The Basic DMAN HMI provided to the Clearance Delivery controller and to the Tower Supervisor allows them to achieve the Pre-Departure Sequence.

The Basic DMAN HMI meets the following operational requirements presented in the OSED of the Basic DMAN (see Ref. [14]).

Regarding the Clearance Delivery Controller, the Basic DMAN HMI allows:

- To display and re-arrange (sorting) the pre-departure sequence of flights in its HMI.
- To display the status of flights of the pre-departure sequence in its HMI.

The task of removing or inserting a flight in the pre-departure sequence in the HMI is currently carried out in CDG by the Collaborative Pre Departure Sequence after coordination with the Clearance Delivery Controller. The system has been split into two: the TSAT calculator is hosted by the CPDS which has the means to manage a flight plan (architecture solution).

Regarding the Airport Tower Supervisor, the Basic DMAN HMI allows:

- To schedule a change of runway configuration according to the operational constraints at the airport (MET…).
- To schedule a change of runway capacity to meet the performance objective of Airport Operations.
- To schedule a change of runway allocation strategy to meet the performance objective of Airport Operations.

As explained in the Basic DMAN Validation Plan, the Ground controller has no DMAN HMI at his disposal in CDG (see Ref. [15]). None of the operational requirements pertaining to this control position has been assessed.

4.2.4.2 Working environment

These results are related to **OBJ-06.08.04-VALP-0470.0700**.

Reminder: In CDG, the Apron and the Ground control positions do not yet have a specific HMI at their disposal for the TSAT monitoring. The initial focus in terms of implementation was on the Clearance Delivery and the Tower Supervisor control positions. The process of HMI integration is ongoing regarding the Apron and the Ground control positions.

The Apron and the Ground controllers still work with paper strips, on which the TSAT information is presented. A DMAN screen has also been placed above the Apron control position (head-up display) as an advisory means.

The impact of the introduction of the DMAN on the working positions and the integration of the DMAN in its environment were assessed through observation and addressed in a questionnaire provided to the CDG operational expert observers.

The DMAN is well integrated into the Clearance Delivery and the Tower Supervisor control positions.

- On the Clearance Delivery working position, the DMAN screen is placed in front of the Clearance Delivery controller as their main tool.

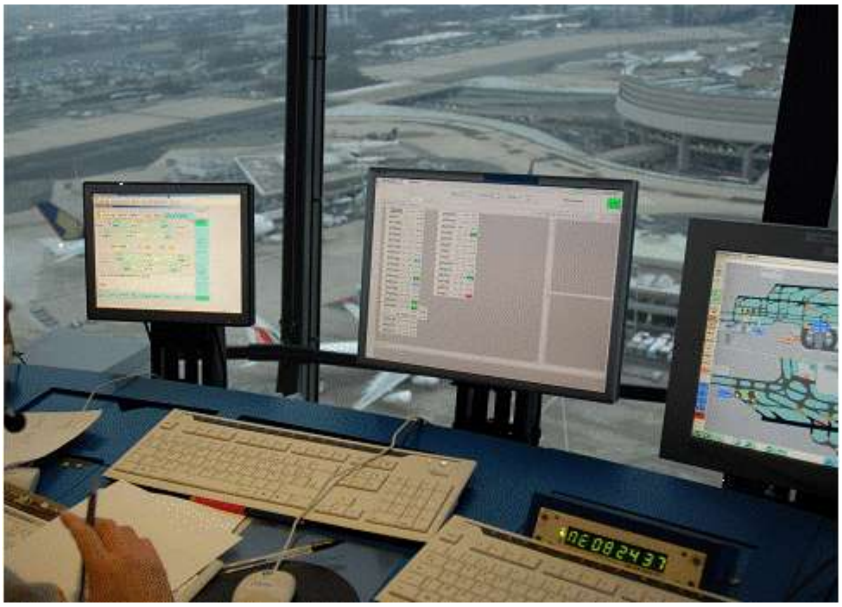


Figure 20: CDG - Clearance Delivery working position with the DMAN HMI in the centre

- On the Tower Supervisor, the DMAN screen is placed among the set of screens (aside the AMAN) making up the working position, easily accessible to the Supervisor.

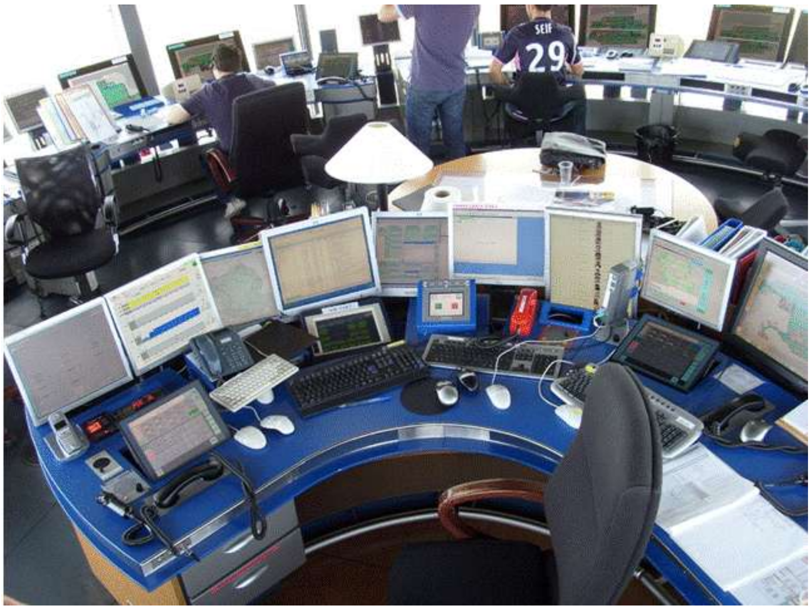


Figure 21: CDG - Tower Supervisor working position with the DMAN HMI on the left

4.2.4.3 Procedures, roles and responsibilities

These results are related to **OBJ-06.08.04-VALP-0470.0800**.

The work organisation put in place with the introduction of the DMAN, and the issues regarding procedures in terms of (complete / partial) system failures or corrupted data were assessed through observation and addressed in the dedicated questionnaires on the controllers' tasks, and in the dedicated questionnaire to the CDG operational expert observers.

Controllers and pilots have to apply certain procedures in order that the DMAN utility is optimal. From the observations of the operational experts and the answers given by the observed controllers, the pilots did not seem to always adhere to these procedures. The following cases were noticed during the observation sessions:

- Some called too early according to their TSAT.
- Some did not monitor the frequency after having received their departure clearance (i.e. squawk code, SID, RWY) without their start-up approval.
- Some pushed back earlier than their TSAT, and arrived at the holding point too early according to their slot.

Some problems were also observed regarding the AOBTs that were not sent, which triggered new TSAT while the aircraft was taxiing.

The pilots should contact the Clearance Delivery controller or perform a Request for Departure Clearance Downlink (RCD) to request the departure clearance and the start-up approval at TOBT – 10 min.

According to the flight's TSAT, two possibilities can occur:

- If TSAT=TOBT, the Clearance Delivery controller issues the departure clearance and the start-up approval simultaneously via radio or by data link in case of RCD.
- If TSAT>TOBT, the flight is put on hold: the Clearance Delivery controller issues the departure clearance with mention of allocated runway, SID and TSAT via radio or by data link in case of RCD. The pilot is to monitor the Clearance Delivery controller's frequency from the TOBT on, as the TSAT can improve up to the TOBT.

When contacting the Clearance Delivery controller, the pilot should have an estimate of the flight's current TSAT. The fact that some pilots call too early according to their TSAT may be due to not being acquainted with the Collaborative Pre Departure Sequence (CPDS) rules. It also happens that the pilots call early because they need to know their SID and RWY.

After having received their departure clearance, the flights put on hold should theoretically be ready at the TOBT and monitor the frequency. However, before the push-back, the pilots are often busy and seem not to always have the availability to do so.

When an aircraft pushes back, the Actual Off-Block Time is sent to the Collaborative Pre Departure Sequence (CPDS). However, the manual AOBT input is not always done, and the automatic AOBT (automatically detecting the push-back) does not always work. Therefore, the CPDS does not know that the aircraft is taxiing. The aircraft being considered as not having left the stand, the CPDS does not freeze the TSAT and calculates a new CTOT because of the delay. Thus, an aircraft may have its TSAT and CTOT updated while taxing. This updating generates, as a consequence, a new printing of paper strips on the Apron and Ground positions (as well as on the departure positions in the approach control room). These supplementary paper strips make the tasks of the Apron and Ground controllers more difficult: they have to sort them out, and they have to make sure about the current TSAT of a flight.

All the above mentioned situations contributed to increase the tower controllers' workload (cf. below Controllers' workload).

CDG operational observers noticed that the procedures were globally adhered to by the controllers despite the workload induced by the cases presented above. However the improvement of pilots' knowledge of the procedures is still considered as necessary to the DMAN effectiveness.

Some results per question and controller on some tower controllers' tasks performed during the observation sessions are presented in Appendix A.

Controllers' workload

The results are related to OBJ-06.08.04-VALP-0470.1000.

A question related to the workload perceived during the observation session was asked to the controller observed at the end of the observation session. Its purpose was to gain the controllers' feedback about the workload they have felt during the time of the observation session.

The question was: "**I find my workload is reduced working with the DMAN (compared with working without the DMAN)**"

The controllers were asked to rate their response to the question from ''strongly agree'' (1) to '' strongly disagree'' (7).

STRONGLY AGREE	1	2	3	4	5	6	7	STRONGLY DISAGREE

This question was addressed to all the tower control positions.

The table below presents the workload question scores for all the controller observed. Scores are averaged to obtain the overall scale score per tower control position. Low scores are better than high scores due to the anchors used in the 7-point scales.

Any score over 4 would be an indication of high workload.

Workload	CLD controller	Apron Manager	Ground controller	Runway controller	Tower Supervisor
Mean score	**5,42**	**4.6**	**4.6**	**3.5**	**3.67**
Standard deviation	1.83	2.41	2.06	1.69	1.53
Median	6	6	4	3	4

Table 17: Mean workload results for all the observed tower controllers

The workload is perceived as rather high by the observed Clearance Delivery, the Apron and the Ground controllers:

- Regarding the Clearance Delivery controller, this is mainly a side effect due to the increased number of messages exchanged with the pilots, in addition to the TSAT monitoring task.
- Regarding the Apron and the Ground controllers, this is due to the implementation issue (i.e. no dedicated HMI on the Apron and Ground control positions supporting the TSAT monitoring task). It is rather a TSAT management issue than a DMAN issue.

The workload is perceived as having not increased by the observed Runway controllers and Tower Supervisors:

- Regarding the Runway controller, workload may not be reduced, but rather the pressure at the holding point (i.e. less aircraft waiting at the holding point). The load at the holding point does not change the Runway controller's workload. The arrival traffic is the same.
- Regarding the Tower Supervisor, the DMAN is a new tool on the position. The parameters input seem not to take too much time. There is mainly a need to familiarize with the tool. The work with the DMAN is considered as easy and accurate.

4.2.4.4 Teams and communications

The results are related to **OBJ-06.08.04-VALP-0470.0900**.

New team relations and communications introduced with the DMAN, as well as considerations of the aforementioned procedural aspects were assessed through observation and addressed in the dedicated questionnaires on the controllers' tasks, and in the dedicated questionnaire to the CDG operational experts observers.

Communications between pilots and controllers can be time consuming, especially regarding the Clearance Delivery controller when trying to contact the pilots to provide them with their start-up approval while they do not monitor the frequency. This problem occurs with the pilots using the radio or the ACARS procedure.

The Clearance Delivery controllers also sometimes have to explain the difference between the TSAT and the CTOT, which tend to be confused by some pilots. They also sometimes have to explain to the pilots the TSAT and CTOT modifications, although these modifications are often due to an action carried out by the airline companies.

These explanations give extra work to the controllers and overload the frequency, especially during rush hours.

The ACARS procedure shows limitations:

The ACARS procedure allows sending messages via datalink. The problem with the use of the ACARS procedure is that currently, the Clearance Delivery controller can only send one message to a pilot. If a pilot asks early for start-up using the ACARS procedure, the Clearance Delivery controller answers by sending back the departure clearance by datalink, which includes a message asking the pilot to monitor the Clearance Delivery controller's frequency in order to obtain the start-up approval according to their TSAT. Thus the start-up approval cannot be sent via datalink but has to be provided via the radio, which adds to the workload, especially as most of the time the pilots do not monitor the frequency.

Before the DMAN, the Clearance Delivery controller only had one message to send to the pilots by ACARS (including all the information, and the start-up approval). With the DMAN, they have to call them via radio in addition.

Standardisation is on-going on this issue (datalink system application document: ED-85A)

Another current ACARS limit is the fact that the preformatted message cannot be changed: no information can be added, highlighted, etc. There is a small free text part lost among the rest of the information, not visible to the pilots.

Regarding communications between controllers, the Clearance Delivery controller sometimes needs the help of the Tower Supervisor to make the coordination with the Collaborative Pre Departure Sequence (CPDS) in case of possible problems.

4.2.4.5 Human in the system

The results are related to **OBJ-06.08.04-VALP-0470** and **OBJ-06.08.04-VALP-0470.1200.**

The Basic DMAN HMI usability (indication of 'reliability status', data outages, etc) and reliability (processing of erroneous/corrupted data ~ anomalies) were assessed through observation and addressed in the dedicated questionnaires to the controllers observed, as well as the controllers' workload.

DMAN HMI usability

Questions related to the Basic DMAN HMI were asked to the observed controllers at the end of the observation session. It consisted of several questions to complete:

1. Overall, I am satisfied with how easy it is to use the DMAN
2. It was easy to learn to use the DMAN
3. The DMAN HMI enables to easily and quickly recover from the mistakes made
4. The information provided for the system is easy to understand

5. The organization of information on the DMAN HMI is clear
6. The DMAN has all the functions and capabilities I expect it to have
7. I can effectively work using the DMAN

The Clearance Delivery controller and the Tower Supervisor were provided with all the questions fill in.

The Apron manager only had questions 2, 4, 5 and 7 to answer, the other ones relating to the HMI manipulation being not relevant, as the Apron manager can only check the HMI, not making inputs.

The Runway controller and the Ground controller were not concerned by the HMI usability questionnaire as there is no DMAN HMI on the CDG Runway and Ground control positions.

These HMI usability questions gave the CDG tower controllers an opportunity to express their reactions to the DMAN they used. It aimed at understanding what aspects of the DMAN they were particularly concerned about and the aspects they were satisfied with.

In the questionnaire the controllers were asked to rate their responses to the questions from ''strongly disagree'' (1) to '' strongly agree'' (7).

STRONGLY AGREE	1	2	3	4	5	6	7	STRONGLY DISAGREE

The table below presents the HMI usability questionnaire scores for all the controller observed. Scores are averaged to obtain the overall scale score per tower control position. Low scores are better than high scores due to the anchors used in the 7-point scales.

Any score under 4 would be an indication of a good level of HMI usability.

HMI usability	CLD controller	Apron manager	Tower Supervisor
Mean score	**3.3**	**1.85**	**2.1**
Standard deviation	1.71	0.75	0.77
Median	3	2	2

Table 18: Synthesis of mean HMI usability results for all the observed tower controllers

Regarding the Clearance Delivery controller

It seems that the existing problems come not so much from the DMAN HMI itself as from the communications and procedures issues described above, and the induced workload (cf. above Procedures, roles and responsibilities & Teams and communications).

The DMAN HMI seems rather satisfactory. A search function in the FDPS of flight plans that are not in the DMAN list would however be useful. Some other information, such as the reason for a delay, details of the regulations, etc., which are currently available on the CFMU Human Machine Interface (CHMI, currently available on the Tower Supervisor's working position) might be useful in the DMAN to the Clearance Delivery controllers.

Regarding the Apron manager

The Basic DMAN HMI seems globally to be satisfactory to the observed Apron managers. A means to sort out the flights by parking stands in addition to the alphabetical order, runway order, or TSAT hour order will be implemented in a next version of the Basic DMAN HMI dedicated to the Apron control.

Regarding the Tower Supervisor controller

The DMAN seems globally easy to use to the Tower Supervisors that were observed. The use of the DMAN in degraded operations (de-icing, snow clearing), which are not frequent situations, needs some experience in the right choice of parameters (i.e. runway pressure / capacity). CDG Tower Supervisors only had one winter season's use of the DMAN. A lot of training and courses are planned for the Supervisors regarding the management of these situations.

Some results per question and controller on the HMI usability are presented in the form of graphs in Appendix A.

DMAN HMI reliability

The DMAN HMI is reliable and allows the tower controllers to effectively perform their tasks.

4.2.4.6 Results related to Security

The results are related to OBJ-06.08.04-VALP-0470.1300.

The tower controllers are aware of the system status and reliability through DMAN HMI indications informing them about the system functioning, functioning in a degraded mode, or not functioning.

In case of degraded modes, procedures are planned for the Tower Supervisor to change the DMAN procedure of use or to shift to the backup system.

4.2.5 Unexpected Behaviours/Results

None.

4.3 Confidence in Results of Validation Exercises

4.3.1 Quality of Validation Exercises Results

The validation exercise could unfold as planned without major problems.

4.3.2 Significance of Validation Exercises Results

Qualitative data

The questionnaires are based on qualitative scales. The mean score represents the results together with the standard deviation and the median.

- The standard deviation is a statistical measure of dispersion from the mean value. It indicates the degree of variability within a set of data. A low standard deviation means that the scores are tightly clustered around the mean in a set of data; a high standard deviation means that they are widely scattered. Smaller standard deviations represent a greater confidence in the data provided.
- The median is a measure of central tendency. The median is the middle of a distribution: half the scores are above the median and half are below the median.

Only descriptive statistics were used with the data coming from the questionnaires.

4.4 Additional results

As mentioned above this section presents results provided by SEAC regarding the DMAN systems operating in Zurich and Frankfurt.

4.4.1 Results from Zurich Airport

In order to optimize all operations at an airport, the organizations (air traffic control, airlines, handling agents) involved in the process have to be integrated in an overall operations planning system. Collaborative Decision Making (CDM) is the key to harmonise the aircraft turnaround process, to align all individual processes to a common target and therefore to improve the overall result. This is the goal of Delair's *DARTS* system, the Departure and Arrival Traffic Management System.
Darts harmonizes air traffic operations at airports by implementing the following measures:

- Planning an optimum overall sequence of arrivals and departures early and in advance, so that better use of the runway system is achieved.
- Constantly comparing planned operations to current operations and initiating updates to the plan in the event of deviations, in order to present a realizable, optimal schedule at all times.
- Supplying relevant information for the respective work stations in due time for all organizations involved.

At Zurich, the system *DARTS* has been operational in use since March 2003 and is presently realised as a purely departure management system (DMAN). Based on the flight plan, the airport slot, the RWY concept, the restrictions and limitations of the airspace, the wake turbulence category, the a/c speed class and the departure fix, the system calculates the best possible take off time. According to the start-up and/or pushback times, the taxi times from the stand to the RWY, the system calculates the adequate off block time. With this method a continuous flow of traffic on the taxiways is granted. The queuing of a/c on the taxiways waiting for departure is downsized to the minimum. *DARTS*' planning results are suggestions which the controllers can accept or modify by means of corresponding input devices. Changes to planned operations automatically result in the plan being updated and new data being transmitted to every connected system.

The system *DARTS* is designed as a cooperative arrival and departure planning system (AMAN / DMAN) for calculating the ideal arrival and departure sequence, and the resulting optimum landing and take-off times. This will be the future of *DARTS* here at Zurich Airport.

Figure 22 hereafter presents the figures related to the environmental benefits analysis performed for *DARTS* in 2004.

The environmental benefit of *DARTS* has been evaluated by assessing the "artificial" delay caused by the system, i.e. the time that aircraft have been kept waiting with their engines turned off rather than have them waiting queued with engines at idle. This was done by analysing the IR89 delay codes assigned to departing aircraft. Given the different operating regimes (summer, winter, snow/ice operations, limited visibility and strong Easterly winds), the total *DARTS* attributable delay time is estimated to about 1,740 hours for 2004.

The aircraft have then been grouped in similar size/engine performance and specific fuel and emission factors applied. Reflecting the fleet mix and technology of 2004, a total of 1,150 t of fuel (3'600 t CO_2), 4.2 t NO_x, 4.0 t HC and 33.7 t CO has been saved on emissions.

4.4.1.1 Zurich Airport figures

Ecological benefit analysis of "*darts*" for 2004

Aircraft Group	IR89 STT Min/d	STT weight	WTT Min/d	WTT weight	Fog Min/d	Fog weight	Easterly Winds Min/d	Easterly Winds weight	Snow/Ice OPS Min/d	Snow/Ice OPS weight	Total	*darts* atributable	Total Minutes
Big	4	55%	9	39%	4	2%	30	2%	34	2%	100%	90%	2270
Medium	12	55%	15	39%	30	2%	25	2%	4	2%	100%	90%	4477
Small	118	55%	107	39%	259	2%	326	2%	563	2%	100%	90%	42463
Regional	150	55%	102	39%	276	2%	408	2%	64	2%	100%	90%	45086
Business	0	55%	0	39%	0	2%	0	2%	-	2%	100%	90%	-
Turboprop	38	55%	16	39%	43	2%	80	2%	34	2%	100%	90%	10025
Propeller	0	55%	0	39%	0	2%	0	2%	-	2%	100%	90%	-
Total	322		249		612		869		699				104321

Aircraft Group	Emission factors: Fuel Flow kg/s*AC	NOx g/kg*AC	HC g/kg*AC	CO g/kg*AC	PM g/kg*AC	Fuel t/a	Emissions: NOx kg/a	HC kg/a	CO kg/a	PM kg/a	Taxi Emissions (2004): Total NOx t/a	*darts* NOx t/a	Total %
Big	0.59	4.32	4.62	29.00		80.24	347	371	2327	-			
Medium	0.44	4.23	4.38	26.20		119.24	504	522	3124	-			
Small	0.22	3.87	3.00	31.90		565.61	2189	1697	18043	-			
Regional	0.13	2.82	3.59	26.70		343.56	969	1233	9173	-			
Business	0.06	3.52	21.00	64.40		-	-	-	-	-			
Turboprop	0.07	4.44	4.42	24.90		42.10	187	186	1048	-			
Propeller	0.00	1.03	53.50	774.00		-	-	-	-	-			
Total						1150.75	4196	4009	33715	-	102.8	4.2	4.1%

PM: Particulate Matter

Savings on emissions by darts

Reduction of taxi emissions on NOx by darts

Figure 22: ZRH: Ecological benefit analysis of DARTS

4.4.2 Results from Frankfurt Airport

Frankfurt Pre-Departure Sequencer is a DMAN following Operating Method 1. It has been in operations since February 2011.

The following sections will present the findings with respect to different KPIs.

4.4.2.1 Outbound Punctuality

IATA Punctuality improved by **7**% compared to the year before.

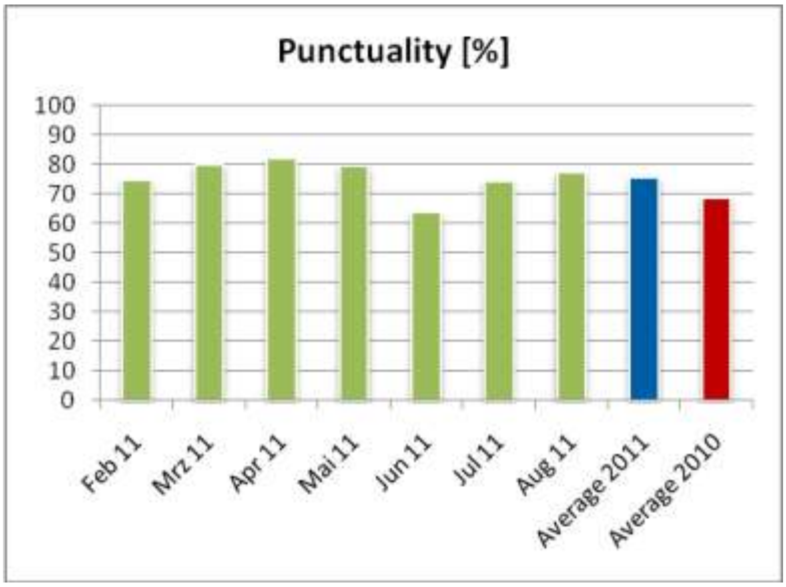


Figure 23: FRA: Outbound punctuality improvement

4.4.2.2 Stability of stand and gate planning

The stability of stand and gate planning is represented by the percentage of flights without change in stand after “Ten Minutes Outbound” datum. This value increased by 4%.

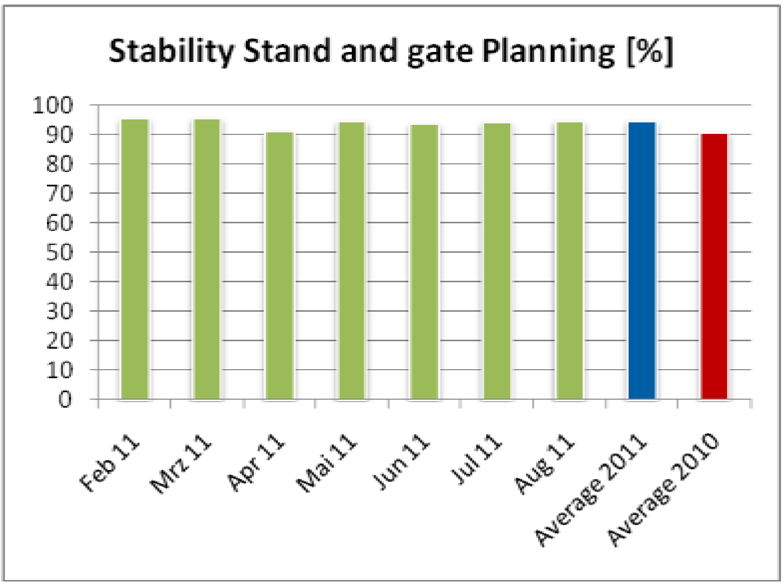


Figure 24: FRA: Stability of Stand and Gate planning

4.4.2.3 TOBT Quality

4.4.2.3.1 Percentage |TOBT-AOBT|<=5 min

With the instalment of the A-CDM process airlines were urged to file and update their TOBTs as accurately as possible, which is a prerequisite for a high quality of pre-departure planning. The percentage of flights with |TOBT-AOBT|<=5 minutes was increased by 18% (for flights without CTOT)

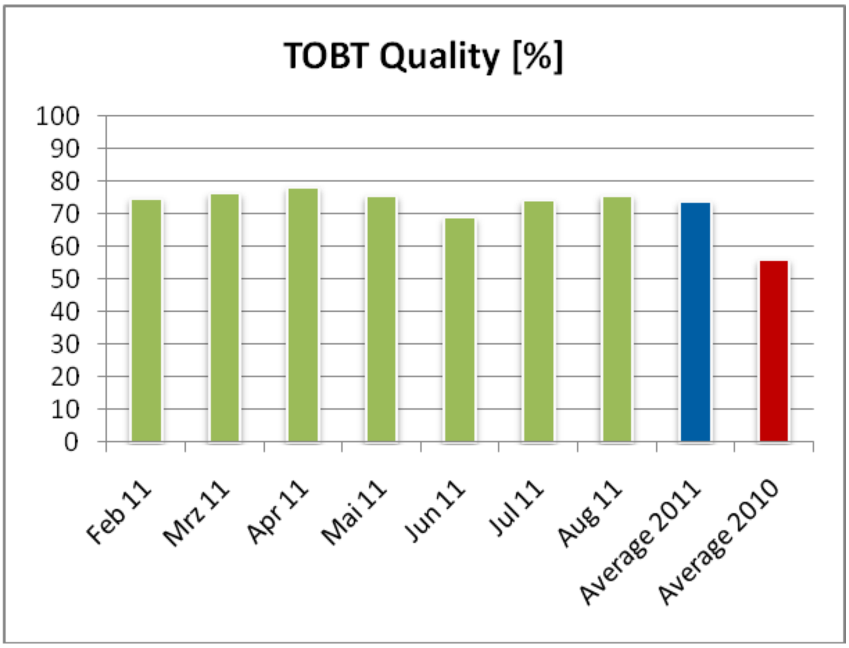


Figure 25: FRA: TOBT quality (%)

4.4.2.3.2Average deviation |TOBT-AOBT|

The average deviation of |TOBT-AOBT| for flights without CTOT was reduced by 4min 25 sec

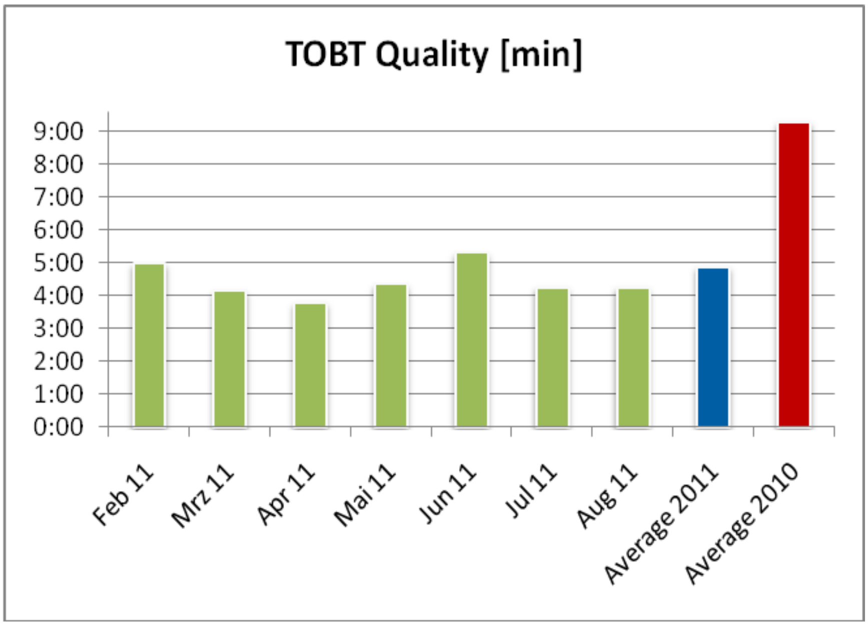


Figure 26: FRA: TOBT quality (Min)

4.4.2.4 TSAT Update frequency

On average there are approximately two TSAT updates per flight.

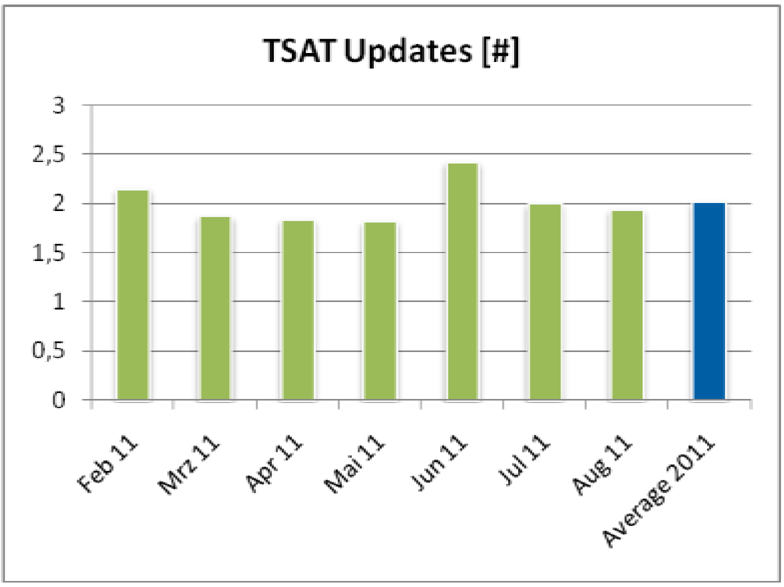


Figure 27: FRA: TSAT updates

4.4.2.5 AXIT

The AXIT is measured as AIBT-ALDT. Basic DMAN has a slight positive effect on inbound taxi times. Stand conflicts are incorporated in the Pre-Departure Sequencer priority rules.

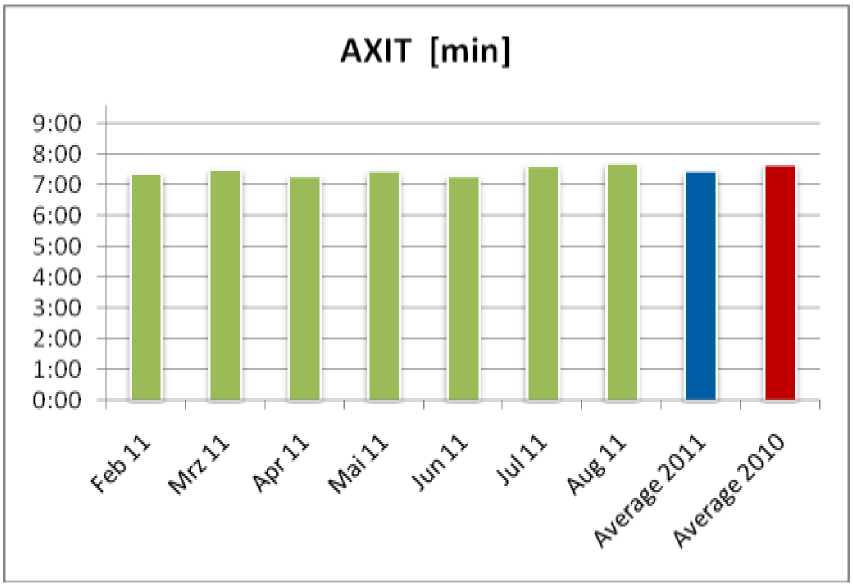


Figure 28: FRA: AXIT

4.4.2.6 AXOT

AXOT is calculated from ATOT-AOBT.

The benefit on taxi out times (also following section) is not as high as expected, since a demand capacity balancing is not yet instated in FRA. DMAN algorithms comprise giving priority to inbound flights in stand and gate management. Therefore parking positions have to be vacated by the outbound flights, contributing to additional taxi time at the runway or in remote holding.

Taxi time Outbound includes Push-back Start-Up and Line-Up.

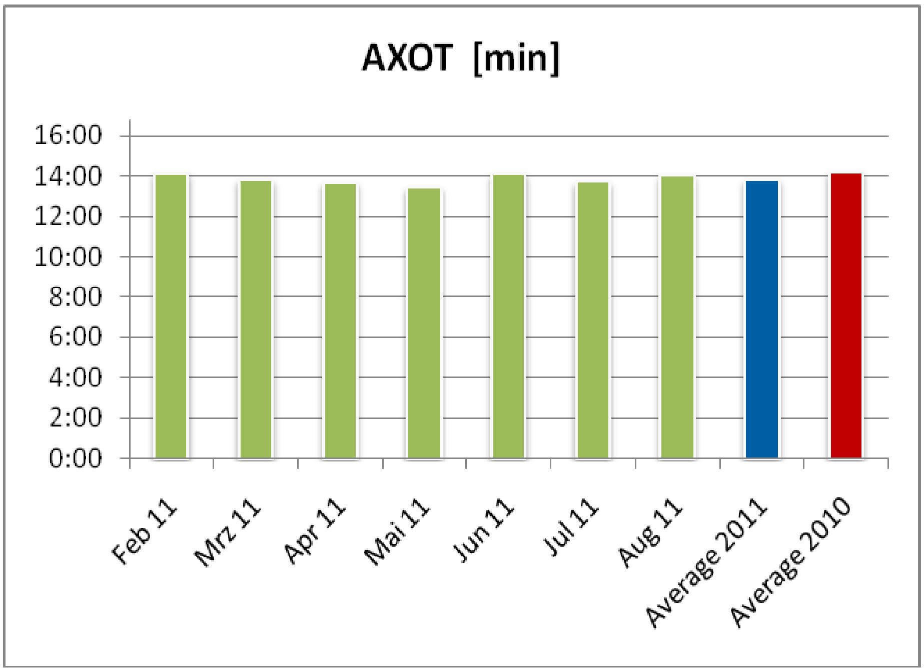


Figure 29: FRA: AXOT

4.4.2.7 TTOT Quality

TTOT quality is represented by the percentage of flights with |ATOT -TTOT|<=5 min. Its average value is 88% for the period from Feb to Aug 2011. The last TTOT is issued with AOBT. In average this occurs 13 min before ATOT.

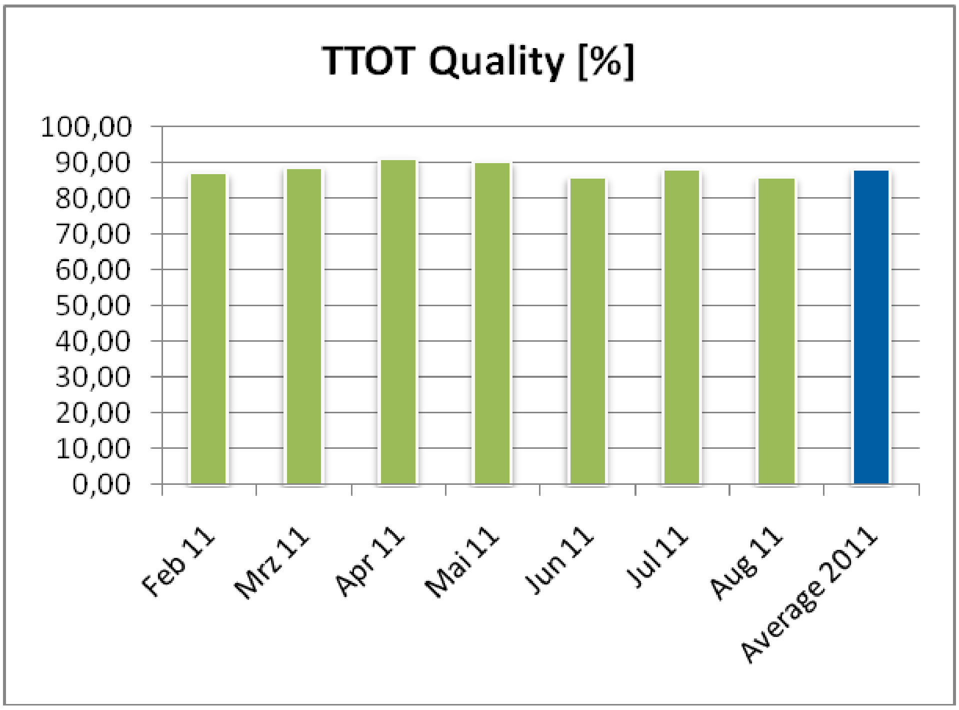


Figure 30: FRA: TTOT Quality

4.4.2.8 Slot adherence

The slot adherence value represents the percentage of flights with ATOT within slot tolerance window (CTOT -5min /+10min). The Pre-Departure Sequencer considers CFMU slots to have the highest priority.

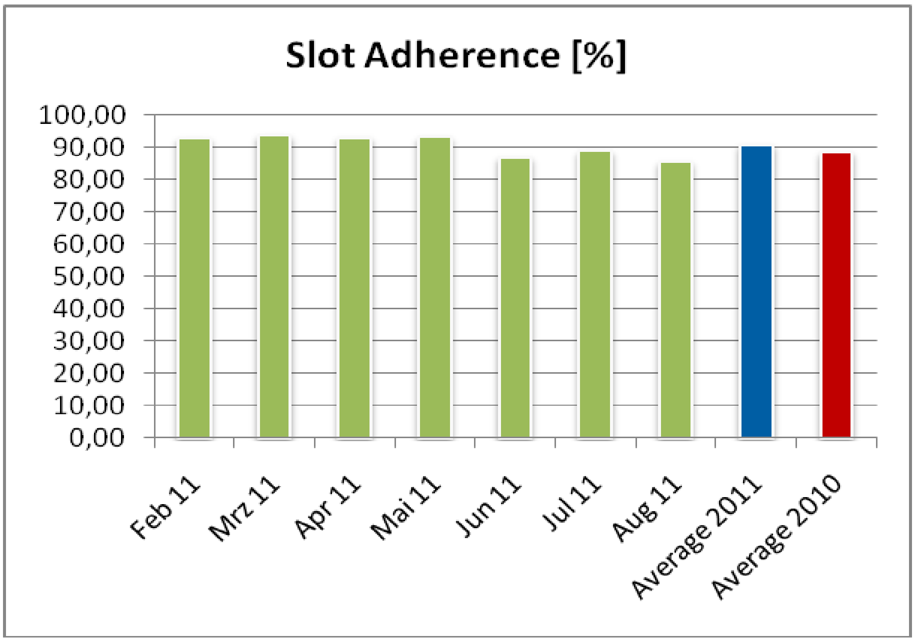


Figure 31: FRA: Slot Adherence

5 Conclusions and recommendations

5.1 Conclusions

- The DMAN HMI is usable and rather satisfactory to the tower controllers.
- However, procedures are not always applied by the flight crews, which lead to an increase of the Clearance Delivery controller's workload (pilots not monitoring the frequency while waiting for start-up approval). The increase of workload is also related to many TSAT updates mainly due to TOBT updates.
- Workload is maintained regarding the Runway controller and the Tower Supervisor. It is however increased on the Apron and Ground control positions, mainly due to the fact that these control positions are not provided yet with an HMI supporting the TSAT management.
- Results regarding the KPAs are summarized in the table hereafter.

Indicator	Result	Status
Taxi Times	Average taxi times are significantly reduced	
Environmental impact	Significant reduction in Fuel Burn and $C0_2$	
Adherence to CFMU Slots	A high percentage of flights respect their CFMU slot	
Delay at the runway	Delay at the runway is reduced significantly	
Off-Block punctuality	Off-Block punctuality is improved	
Procedures	Operational Off-Block procedures are well respected	

Table 19: Conclusions: Basic DMAN validation results

Legend

	Very Satisfying
	Satisfying
	Unsatisfying
	Very Unsatisfying

5.2 Recommendations

- Ensure that all pre-departure management procedures to apply when a DMAN is used are familiar to all actors involved: flight crews, airlines, ground handlers, ATC.
- Investigate on how to improve the quality (accuracy) of TOBT (CDM process).
- From a DMAN perspective, there should be a limit for the number of TOBT updates in order to limit the number of TSAT changes. Prior to the implementation of a DMAN it is important to reach an agreement on this limit between the ATC, the Airport Operator, and the main airline(s).
- Investigate the impact of introducing a DMAN for all the Tower Controller Working Positions (do not limit to Clearance Delivery and Supervisor) **before putting the system into service**.

- Investigate the impact of introducing a DMAN regarding the influence on procedures and systems. There might be side-effects (e.g. when datalink is available, current ACARS capacities do not allow the provision of more than one message to an aircraft; it results in an increase of the R/T usage).
- Additional planning functions (DCB) are needed to support the Supervisor in ensuring efficient capacity usage.
- Additional support function is needed to support the Apron managers in their job (**pushback**).

6 Validation Exercise report (DSNA)

This chapter provides the validation exercise report for the live trials performed in the Paris Charles de Gaulle (CDG) airport environment in July/August 2011 with the participation of tower controllers from CDG airport.

The exercise scope, the conduct of the validation exercise, and the conclusions and recommendations are presented here below.

The summary of the exercise results is presented in chapter 4 as there is only one set of results to be presented for CDG validation exercise. Results are not copied out in this part of the document in order to avoid redundancy.

As defined in the validation plan ([15]) three exercises have been initially identified corresponding to the different areas of the validation of the basic DMAN, namely:

- **EXE-06.08.04-VALP-0470.0100** – Basic DMAN Operational Requirements Validation;
- **EXE-06.08.04-VALP-0470.0200** – Basic DMAN Operational Performance Validation;
- **EXE-06.08.04-VALP-0470.0300** – Basic DMAN Operability Validation.

As all this exercises ran in parallel, under the same conditions – i.e. CDG operational platform, real traffic – it is **not necessary** to distinguish between these three exercises in this chapter to avoid superfluous complexity. However, the coverage matrix presented in ANNEX C provides the required level of mapping.

6.1 Exercise Scope

Departure Management encompasses procedures used to establish sequences and target times (TSAT/TTOT) with the support of a Departure Manager (DMAN). The definition for DMAN established within the Project P06.08.04, accepted by the wide majority of stakeholders, and in line with Airport-CDM concept (see Ref. [18]) is as follows:

> *DMAN is a planning system to improve departure flows at one or more airports by calculating the Target Take-Off Time (TTOT) and Target Start-Up Approval Time (TSAT) for each flight, taking multiple constraints and preferences into account.*

A Basic DMAN is designed to support current Departure Management procedures which are established for controlling target times at start-up approval (see P06.08.04 D32 Basic DMAN OSED Ref. [14]).

The main function of the Basic DMAN is to **deliver a pre-departure sequence** (i.e. an order of aircraft automatically generated by their TSAT).

The Basic DMAN provides specific HMI for different actors:

- Tower Supervisor,
- Tower Delivery Controller,
- Apron Manager.

The main goals of this validation exercise were:

- To validate the Basic DMAN Operational requirements as defined in the Basic DMAN OSED.
- To verify initial procedures using a Basic DMAN (in respect to the Operating Method 1 described in the basic DMAN OSED).
- To validate the benefits of a basic DMAN operating on a highly complex platform.

This exercise was a V3 validation as the system being validated is actually operating in CDG airport. This V3 validation was meant to validate the agreed generic operational concept for a basic DMAN within an Airport CDM context, which is an enabler for further improvements of the DMAN.

The validation mainly consisted of observations and measures performed on the operational CDG DMAN used in standard operational conditions (no degraded mode).

Further details are provided in 06.04.04 Basic DMAN Validation Plan (see Ref. [15]).

6.2 Conduct of Validation Exercise

6.2.1 Exercise Preparation

Questionnaires were designed for each of the following tower control position:

- Tower Supervisor,
- Tower Clearance Delivery Controller,
- Apron Manager,
- Tower Ground Controller,
- Tower Runway Controller.

The CDG operational experts performing the observation had to give a dedicated questionnaire to the each controller observed at the end of the observation session in order to collect information on the controller and on their opinion about the DMAN HMI usability, the tasks performed with it and their perceived workload using it.

A questionnaire was also designed for the CDG operational expert performing the observation. It was meant to collect information on the context of the observation and on the observation they made during the sessions.

Besides, the validation team ensured that the recording facilities were available during the sessions and that the recorded data could be provided in a format that could be used for data analysis and exploration.

6.2.2 Exercise execution

The Basic DMAN observation sessions in CDG spread over 27 days on July and August 2011.

In total, 48 observation sessions were carried on CDP tower control positions by 8 CDG operational experts. The number of observation sessions on each tower control position is presented in the table below:

	Clearance Delivery controller position	Apron manager position	Ground controller position	Runway controller position	Tower Supervisor position
Number of observations	12	5	20	8	3

Table 20: Number of observation sessions on each CDG tower control position

As described in the Basic DMAN Validation Plan (see Ref. [15]), the approach followed during the execution of the validation exercise was as follows:

A CDG operational expert observed a controller carrying out his/her tasks on a particular tower control position during at least one hour. The operation expert noted all relevant aspect related to the management of the departure traffic with the support of the Basic DMAN, as well as all other relevant contextual event.

At the end of the observation session, the CDG operational expert gave to the controller observed the questionnaire dedicated to the tower control position he/she just held.

At the end of all the observation sessions, the CDG operational experts were interviewed by the Human Factors expert in order to get their feedback on their observations.

The CDG controllers whose activity was observed in the Basic DMAN context of use were all qualified on all the tower control positions, except one.

The table below presents some of the characteristics of the controllers observed during the observation sessions.

Age			Months/Years of qualification on the CWP				
20-30	31-40	50+	CLD	GRD	APRON	RWY	SUPV
20	23	5	1,5 years to 9 years	1 year to 30 years	3 years to 27 years	8 months to 9 years	1 month to 30 years

Table 21: Characteristics of the CDG controllers observed during the observation session

6.2.3 Deviation from the planned activities

Regarding the DMAN HMI availability

In CDG airport, the Ground controller is not provided with a DMAN HMI. The TSAT information is currently presented on the paper strips. However, Ground controllers were observed as planned in order to assess the impact of the Basic DMAN on their activity.

Regarding the planning

The observation sessions took place in July and August 2011. It did not extend to September 2011.

6.3 Exercise Results

6.3.1 Summary of Exercise Results

The summary of the exercise results is presented in chapter 4.

6.3.2 Results on concept clarification

Results on the concept clarification are presented in chapter 4.1.1.

6.3.3 Results per KPA

Results are presented in chapter 4.1.2.

6.3.3.1 Results impacting regulation and standardisation initiatives

See chapter 4.1.3.

6.3.3.2 Analysis of Exercise Results

The exercise results analysis is presented in chapter 1.1.

6.3.3.3 Unexpected Behaviours/Results

See chapter 4.2.5.

6.3.4 Confidence in Results of Validation Exercise

6.3.5 Quality of Validation Exercise Results

See chapter 4.3.1.

6.3.5.1 Significance of Validation Exercise Results

See chapter 4.3.2.

6.4 Conclusions and recommendations

6.4.1 Conclusions

The DMAN HMI is usable and rather satisfactory to the tower controllers.

However, procedures are not always applied by the flight crew, which leads to an increase of the Clearance Delivery controller's workload (pilots not monitoring the frequency while waiting for start-up approval). The increase of workload is also related to many TSAT updates mainly due to TOBT updates.

Workload is maintained regarding the Runway controller and the Tower Supervisor. It is however increased on the Apron and Ground control positions, mainly due to the fact that these control positions are not provided yet with an HMI supporting the TSAT management.

6.4.2 Recommendations

Ensure that procedures to apply when a DMAN is used on an airport are familiar to flight crews.

Reduce the number of TOBT updates in order to limit the number of TSAT changes.

Improve ACARS capacities in order to allow the provision of more than one message to an aircraft, and in order that the preformatted messages can be modified by the controller whenever necessary.

An electronic flight strip system should be available on the Apron and Ground control positions. It would solve the problem of workload increase (task load).

7 References

7.1 Applicable Documents

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

[1] SESAR V&V Strategy
[2] SESAR SEMP v2.0
[3] Template Toolbox Latest version
[4] Requirements and V&V Guidelines Latest version
[5] Toolbox User Manual Latest version
[6] European Operational Concept Validation Methodology (E-OCVM) - 2.0 [March 2007]
[7] SESAR B4.2 Actors - Roles and Responsibilities, Ed. 00.01.03, dated 2010/11/29
[8] SESAR Operational Focus Area, Ed. 02.00.00, dated 2011/04/15
[9] SESAR ATM Lexicon (SESAR ATM lexicon website).
[10] SESAR P06.08.04 Project Initiation Report, Coupled Arrival and Departure Management, Edition 00.02.00, dated 2010/11/10
[11] SESAR Definition Phase – European ATM Master Plan - Ed. 1.0 - 2009.03.30 (SESAR ATM MasterPlan)

7.2 Reference Documents

The following documents provide input/guidance/further information/other:

[12] SESAR Airport DOD Step 1 - V01.04.00 – dated 2011/03/17
[13] SESAR Airport Validation Strategy Step 1 – V00.01.01 - dated 2011/04/04
[14] SESAR P06.08.04 D32 Basic DMAN OSED V00.02.00 - dated 2011/11/30
[15] SESAR P06.08.04 D34 Basic DMAN VALP V00.02.00 - dated 2011/11/30
[16] Guidelines for Producing Benefit Mechanisms V01.00.00
[17] SESAR B4.1 Validation targets for Step 1 - Draft, dated 2011/05/17
[18] EUROCONTROL A-CDM Manual
[19] EUROCONTROL Guidance for Human Factors Integration – Ed. 2.0 - dated 2007/06/29.

Appendix A Results on controllers' tasks and HMI usability

Results per question and controller on some tower controllers' tasks performed during the observation sessions, and on the HMI usability (graphs) are provided below.

Tower controllers' tasks

Questions related to the tasks performed in the context of the Basic DMAN during the observation session were asked to the observed controllers at the end of the session. It consisted of one to three questions to complete, the questions being specific to a control position.

Clearance Delivery controller task-related questions:

Clearance Delivery controller task-related questions	1) In the previous working period, I had to ask for manual input from GLD		2) In the previous working period, I happened to forget to call back an aircraft for start-up		3) In the previous working period, I happened to make a mistake on the DMAN HMI	
Answer	Yes	No	Yes	No	Yes	No
TOTAL nb of answers	**4**	**8**	**4**	**8**	**2**	**9**

1) The Clearance Delivery controller asked manual input from GLD because of:

- An inconsistency between the TSAT and the CTOT.
- 3 to 4 TOBT requested (coordination performed by the Tower Supervisor), airlines having failed to do so.
- One or two flights not succeeding in updating their TOBT.

2) The Clearance Delivery controller forgot to call back an aircraft for start-up approval because of:

- Several actions to perform in short time (e.g. TSAT monitoring, flights put on hold…).
- TSAT changing.
- Too many pilots not monitoring the frequency.

3) The Clearance Delivery controller made a mistake on the DMAN HMI because of:

- Late call-back of pilots having then gone over their TSAT window.
- Forgot to activate one flight (no click on the HMI).

Apron / Ground controller task-related question:

Apron/Ground controller task-related question	In the previous working period, I could issue the push-back approvals within the TSAT window (TSAT -5min, TSAT +5min)	
Answer	Yes	No
Apron answers	5	0

Ground answers	16	3
TOTAL nb of answers	**21**	**3**

15 controllers stated they could issue the push-back approvals within the TSAT window.

3 stated they could not for the following reasons:

- Difficulty to monitor the TSAT on the Ground control position in rush hours.
- Terminal 1 taxiway congestion.

One controller answered (s)he could not tell (no answer).

Runway controller task-related questions:

Runway controller task-related questions	1) In the previous working period, it happened that many aircraft were waiting at the runway holding point.		2) In the previous working period, there were times I found there were gaps between aircraft	
Answer	Yes	No	Yes	No
TOTAL nb of answers	**6**	**2**	**4**	**5**

1) The Runway controllers who answered that it happened that many aircraft were waiting at the runway holding expressed the following reasons:

- Runway inspection.
- Some heavy aircraft in the beginning of the sequence that created several minutes of wake vortex, as well as medium traffic in the middle of the heavy.
- Due to a RANUX departure rerouted to the southern runways that caused some delay to aircraft arriving at the holding point.

2) The Runway controllers who answered that there were times there were gaps between aircraft expressed the following reasons:

- Because of the heavy aircraft (cf. above).
- Not enough traffic at that time.
- Runway controller’s efficiency.

Tower Supervisor task-related questions:

Tower Supervisor task-related questions	1) In the previous working period, I have updated DMAN parameter(s)		2) I could update the DMAN easily	
Answer	Yes	No	Yes	No
TOTAL nb of answers	**2**	**1**	**2**	**1**

1) Some Tower Supervisors had to update the following DMAN parameter(s) during the observation sessions:

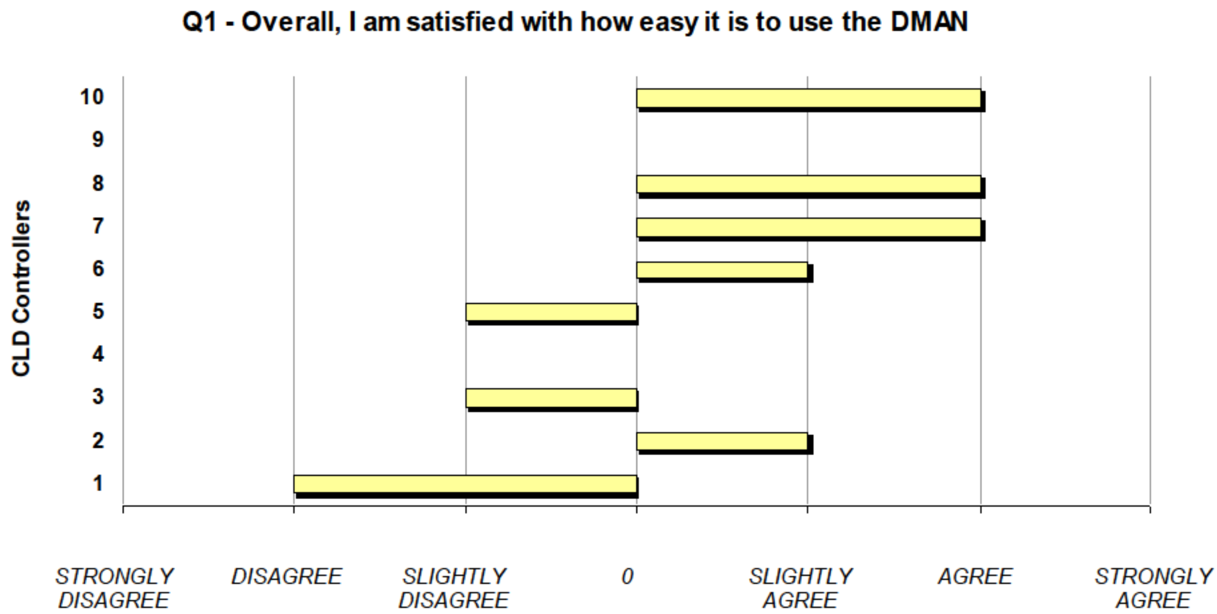
- Runway pressure.
- Strategy allocation because of works at runway 08 threshold and unbalanced traffic load between North and South.

2) Two Tower Supervisors updated the DMAN easily over one who stated it could be a lack of use.

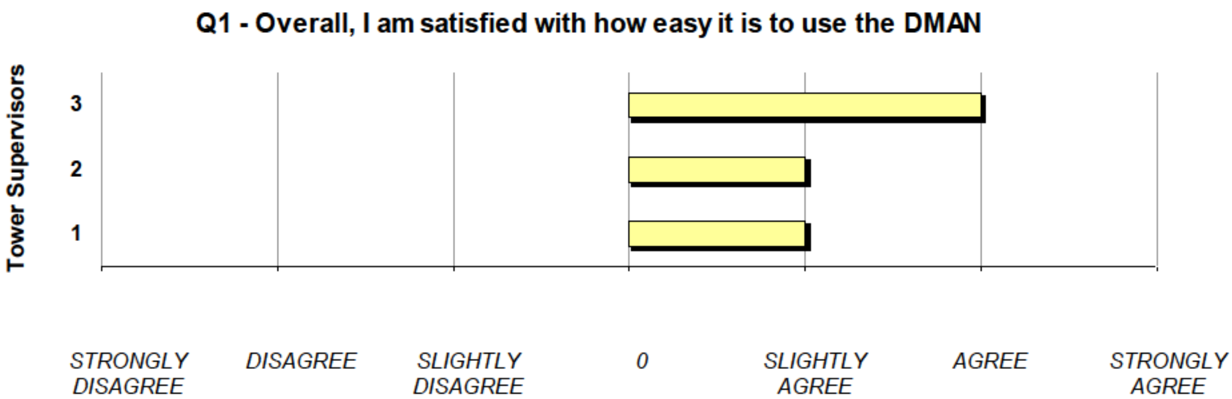
HMI usability

1. Overall, I am satisfied with how easy it is to use the DMAN

Clearance Delivery controllers

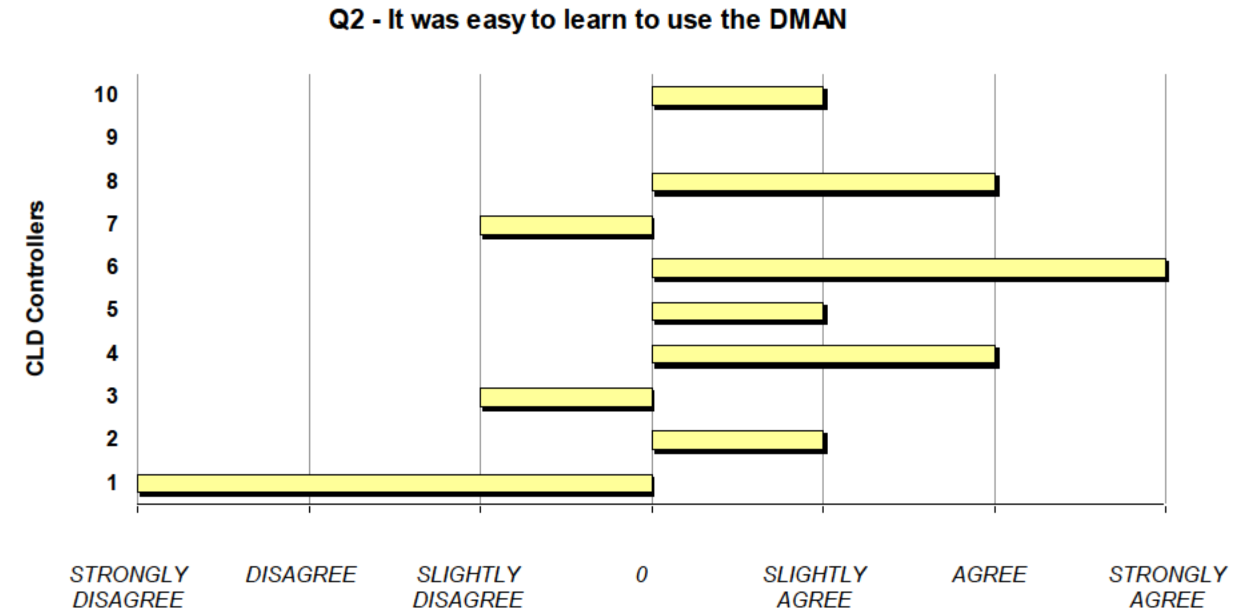


Tower Supervisors

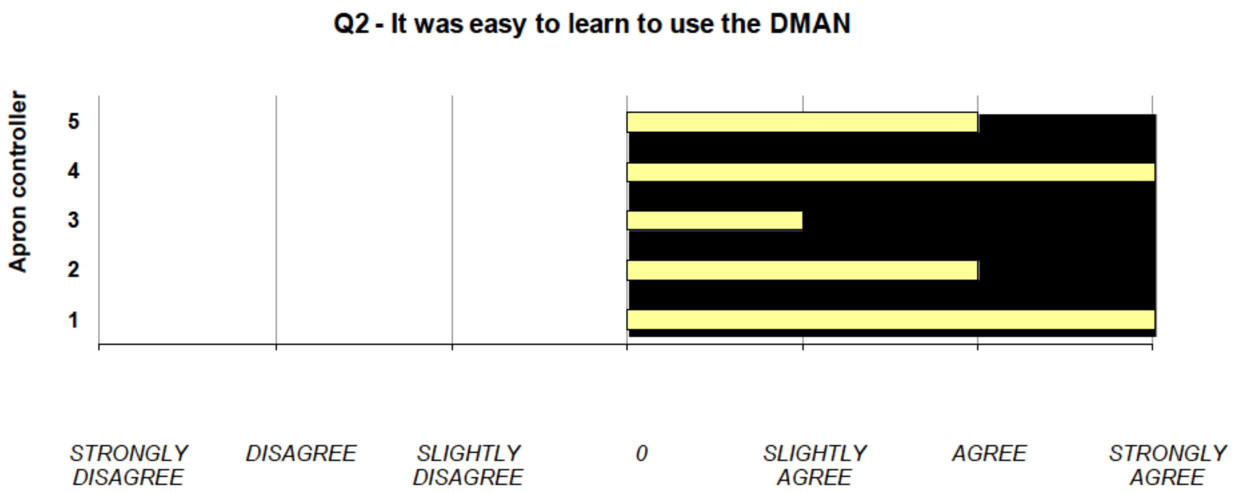


2. It was easy to learn to use the DMAN

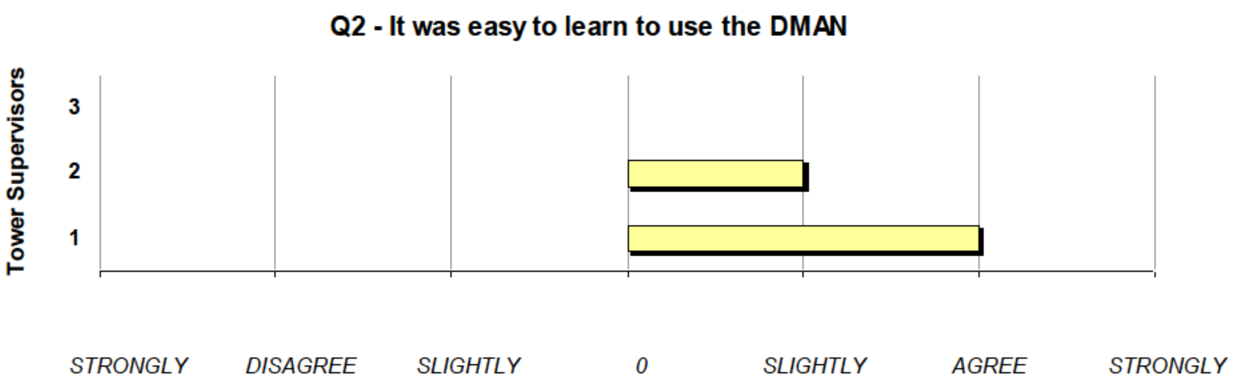
Clearance Delivery controllers



Apron managers



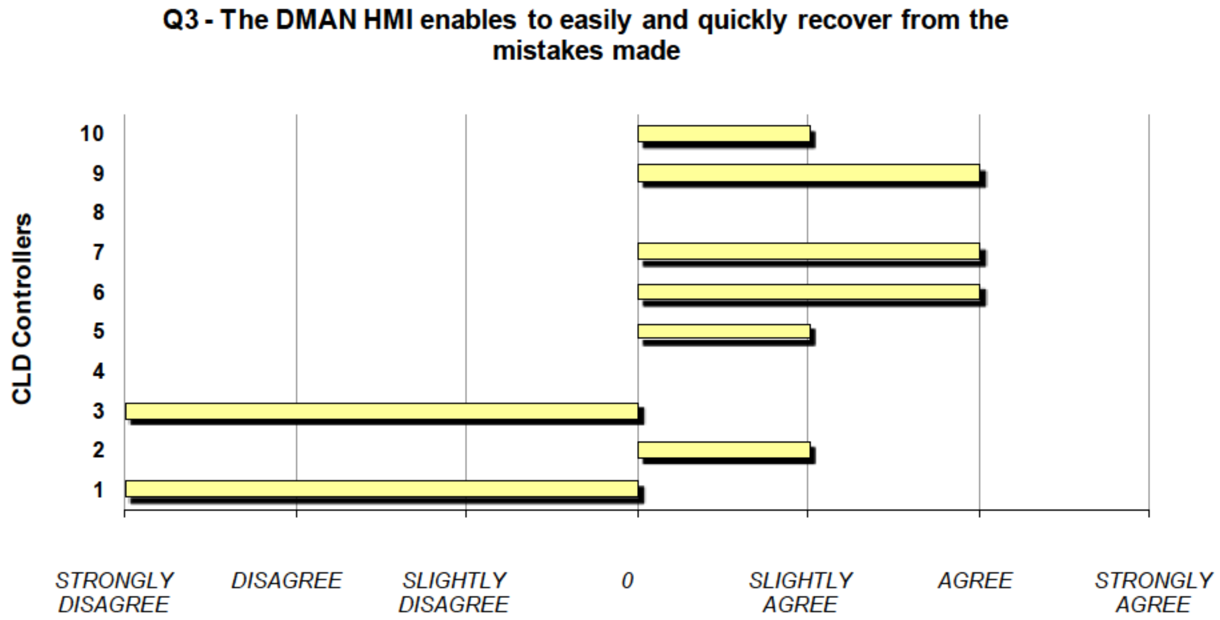
Tower Supervisors



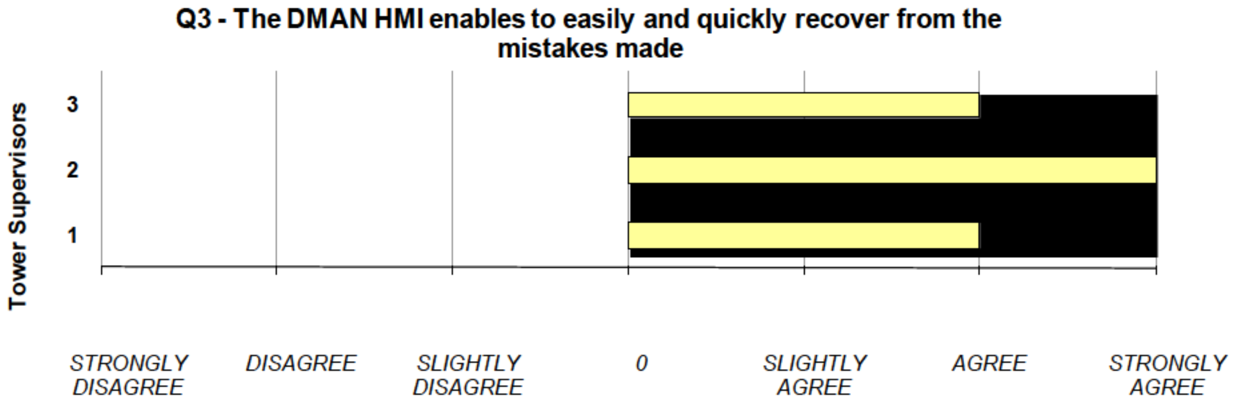
DISAGREE DISAGREE AGREE AGREE

3. The DMAN HMI enables to easily and quickly recover from the mistakes made

<u>Clearance Delivery controllers</u>

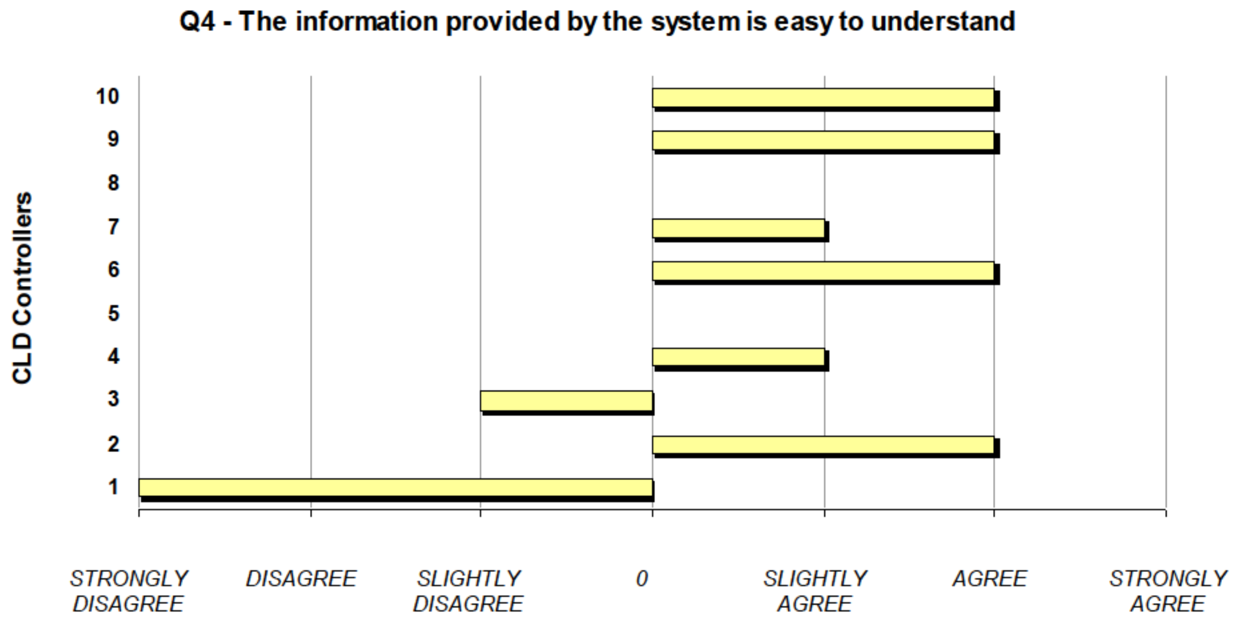


<u>Tower Supervisors</u>

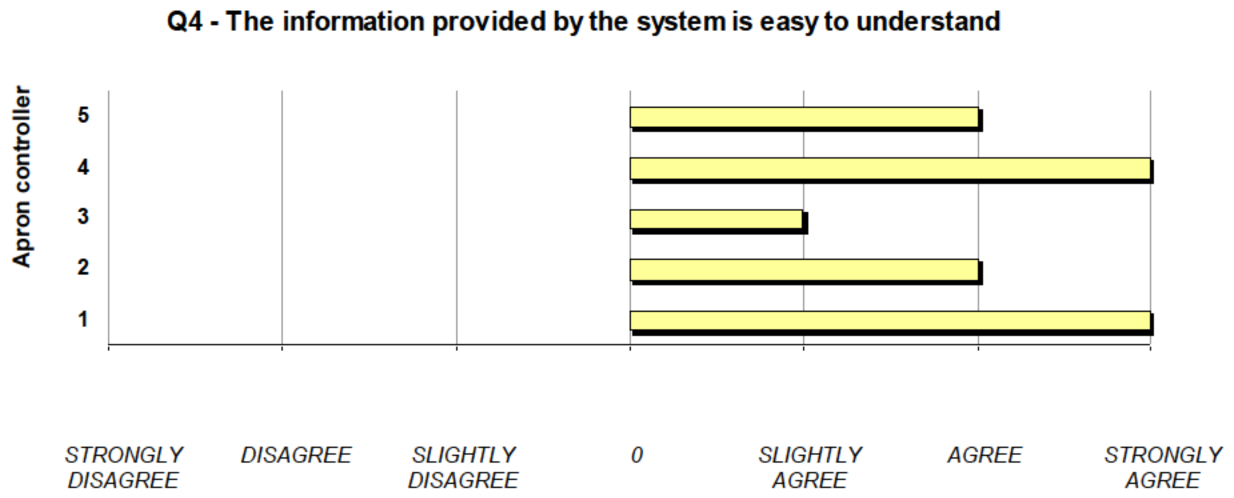


4. The information provided by the system is easy to understand

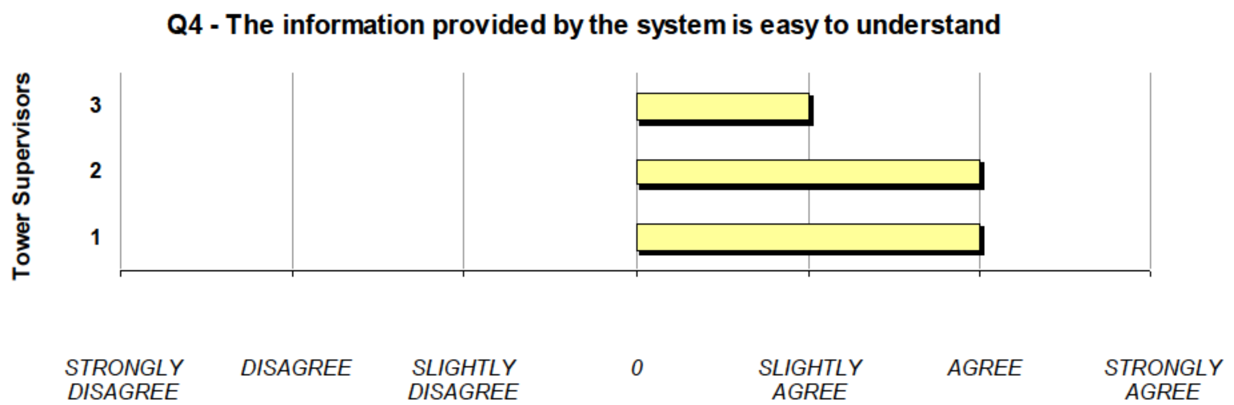
<u>Clearance Delivery controllers</u>



<u>Apron managers</u>

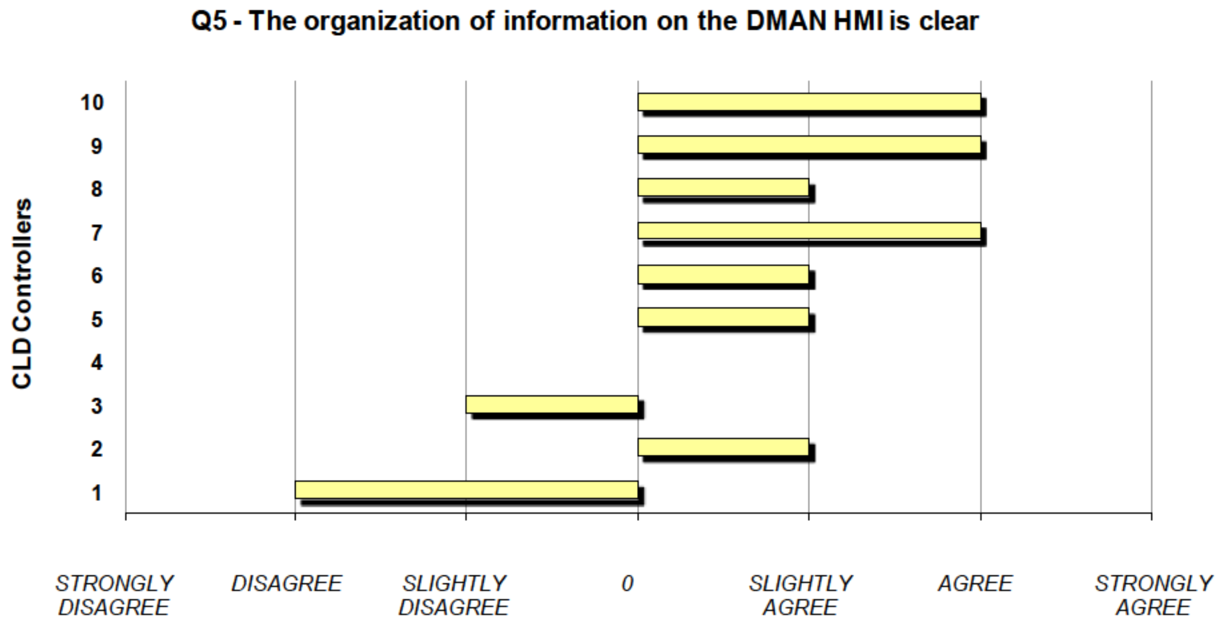


<u>Tower Supervisors</u>

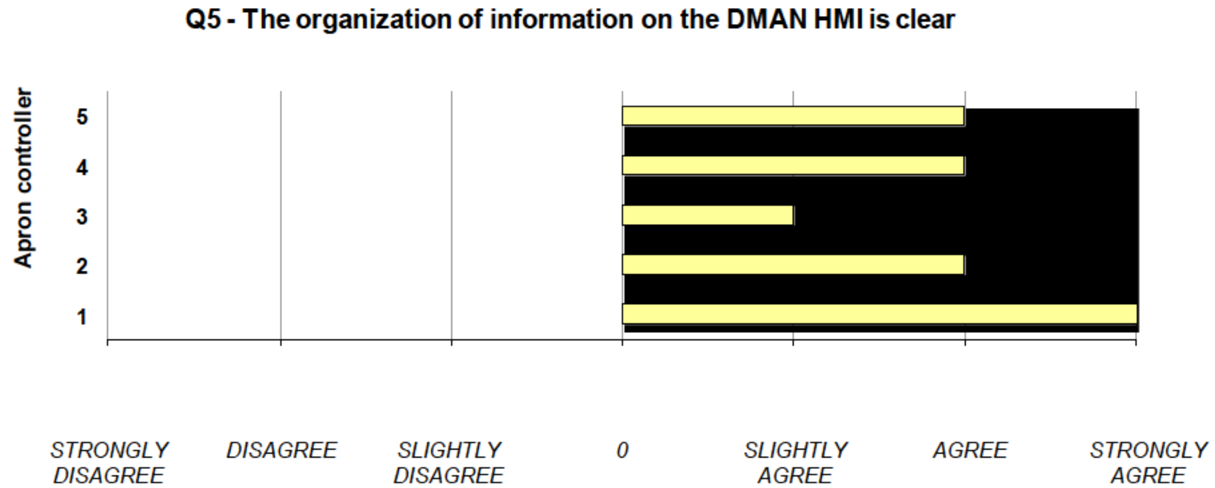


5. The organization of information on the DMAN HMI is clear

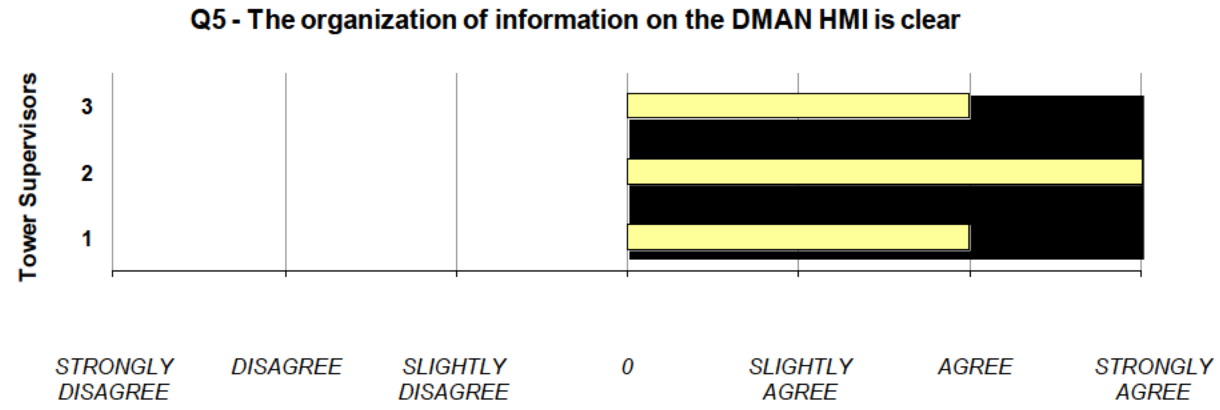
<u>Clearance Delivery controllers</u>



<u>Apron managers</u>

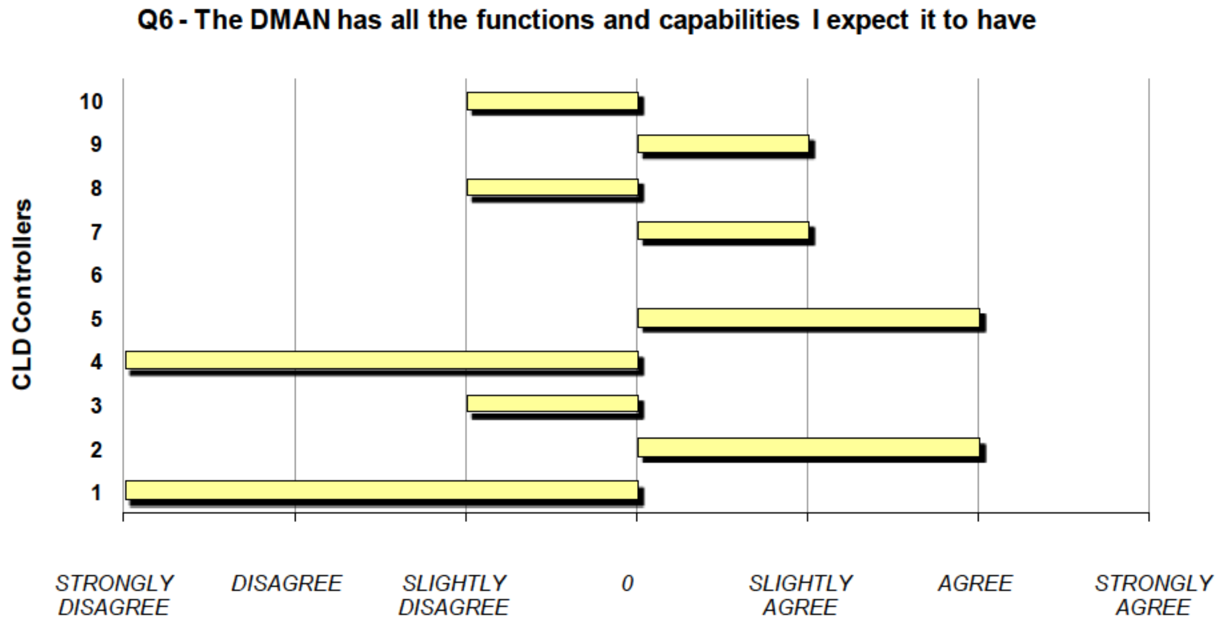


<u>Tower Supervisors</u>

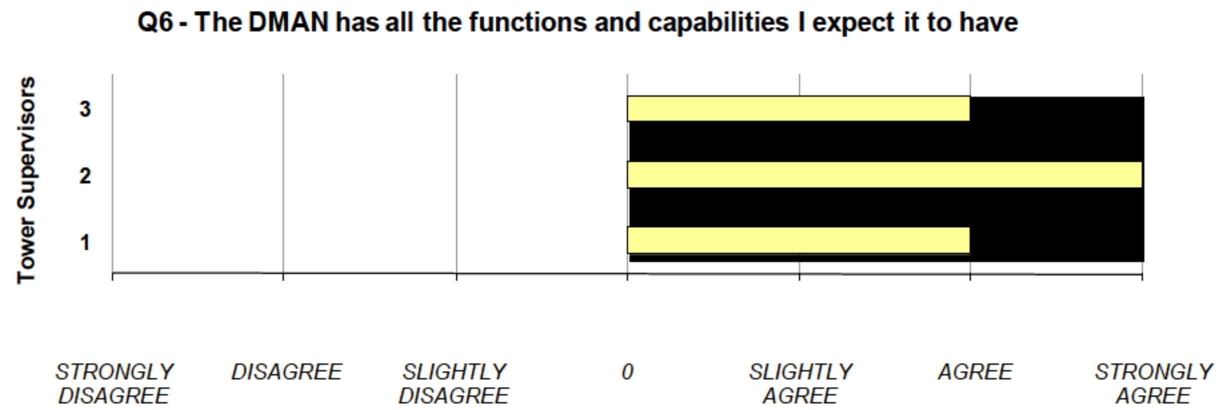


6. The DMAN has all the functions and capabilities I expect it to have

<u>Clearance Delivery controllers</u>

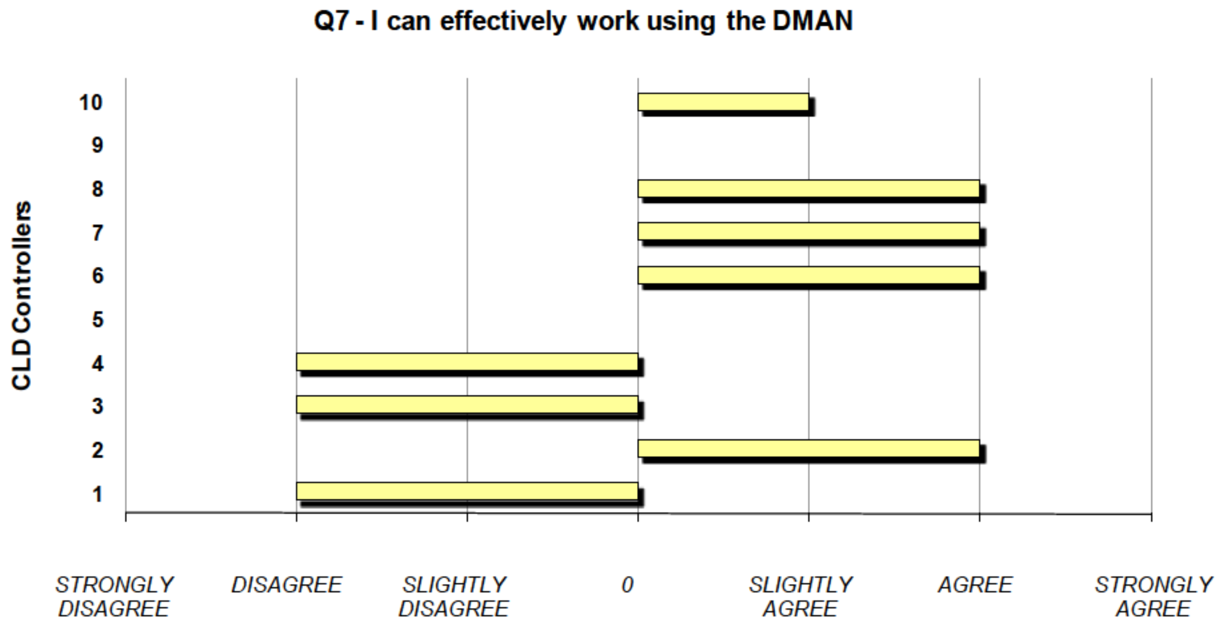


<u>Tower Supervisors</u>

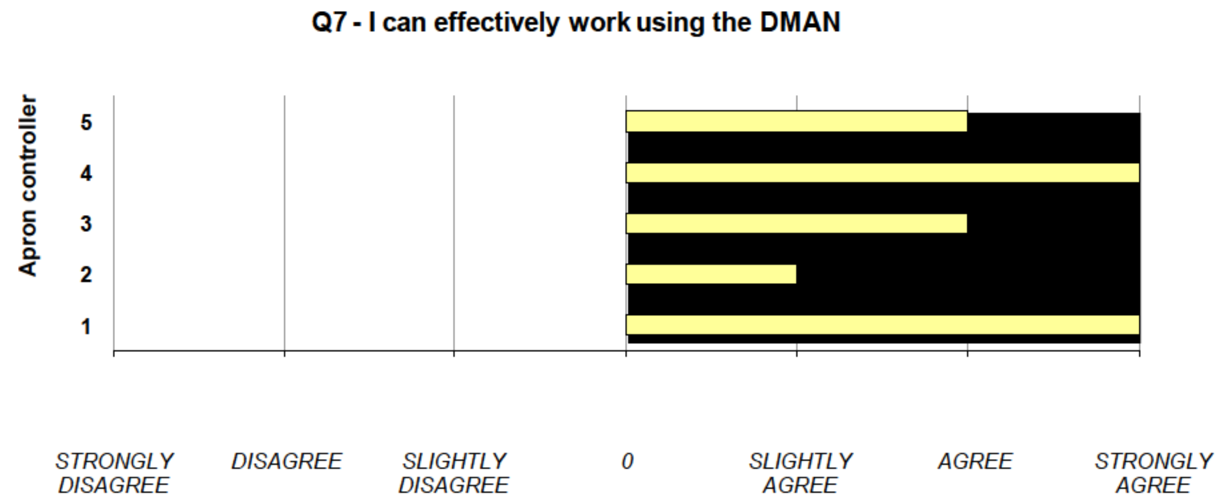


7. I can effectively work using the DMAN

Clearance Delivery controllers

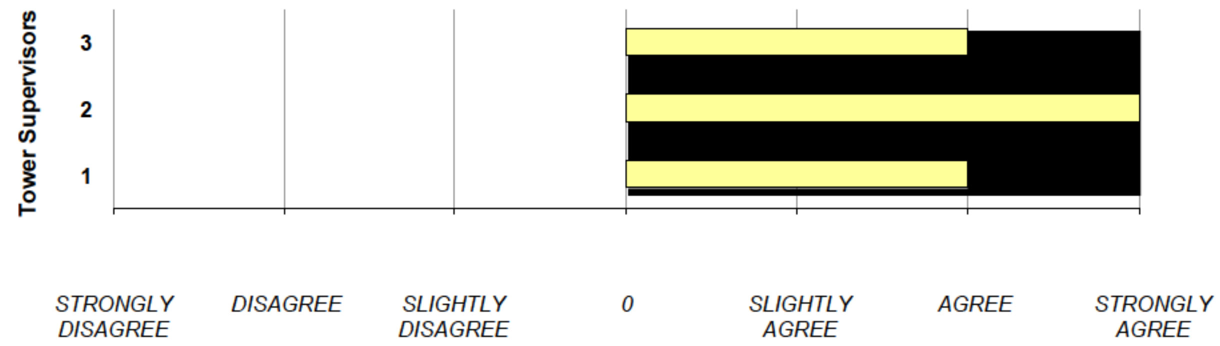


Apron managers



Tower Supervisors

Q7 - I can effectively work using the DMAN



Appendix B ADP figures

This appendix presents figures from ADP (Aéroport De Paris) used in this Validation Report.

The table below gives, **for each aircraft types present in the data captured during the trials**, the values of fuel and CO2 for 60 seconds taxi-out used to calculate savings in Fuel Burn and Emissions.

ICAO Aircraft Type	Category	FB (Kg/mn)	C02 (Kg)	ICAO Aircraft Type	Category	FB (Kg/mn)	C02 (Kg)
A306	Heavy	24,6	77,7	**B772**	Heavy	34,1	107,7
A310	Heavy	25	78,3	**B773**	Heavy	36	113,8
A318	Medium	11,3	35,6	**B77W**	Heavy	45,6	144,1
A319	Medium	11,3	35,6	**C25B**	Light	5,5	17,5
A320	Medium	12,1	38,3	**COL4**	Light	5,5	17,5
A321	Medium	13,6	42,8	**CRJ1**	Medium	6	18,8
A332	Heavy	27,2	86,1	**CRJ2**	Medium	5,9	18,5
A333	Heavy	33,6	106,2	**CRJ7**	Medium	8,3	26,2
A342	Heavy	29,8	94	**CRJ9**	Medium	7,7	24,3
A343	Heavy	29,8	94	**D328**	Medium	5,1	16
A345	Heavy	55,2	174,4	**DH8D**	Medium	5,1	16
A346	Heavy	55,2	174,4	**E135**	Medium	5,5	17,5
AT43	Medium	5,1	16	**E145**	Medium	5,5	17,5
AT45	Medium	5,1	16	**E170**	Medium	7,7	24,3
AT72	Medium	5,1	16	**E190**	Medium	10,1	31,9
B190	Medium	2	6	**F100**	Medium	14,3	45,1
B463	Medium	9,8	30,9	**F27**	Medium	5,4	16,9
B733	Medium	14,9	47	**J328**	Medium	5,1	16
B734	Medium	14,9	47	**LRJ**	Medium	5,1	16
B735	Medium	13,7	43,2	**MD11**	Heavy	24,6	77,7
B736	Medium	12	37,9	**MD81**	Medium	16,4	52
B737	Medium	13,5	42,6	**MD82**	Medium	16,4	52
B738	Medium	13,6	42,8	**MD83**	Medium	16,1	51
B744	Heavy	47,8	150,9	**MD90**	Medium	16,1	50,8
B752	Medium	21,6	68,3	**RJ85**	Medium	10,9	34,4
B753	Medium	22,8	72	**SR20**	Light	5,5	17,5
B762	Heavy	25	78,9	**SR22**	Light	5,5	17,5
B763	Heavy	25,6	80,8				

Figure 32: ADP Aircraft indices for 1minute taxi-out (Fuel and CO2)

Appendix C Coverage Matrix

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
REQ-06.08.04-OSED-0100.0020	Basic DMAN Inputs – Exchanges with ATC systems	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0100.0030	Basic DMAN Inputs – Exchanges with A-CDM systems	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0100.0040	Basic DMAN Inputs – Exchanges with EFS systems	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0100.0050	Basic DMAN Outputs – Exchanges with A-CDM systems	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0100.0060	Basic DMAN Outputs – Exchanges with EFS systems	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0010	Basic DMAN Pre-Departure Sequence - Planning Horizon	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0020	Basic DMAN Pre-Departure Sequence – Flight Elig bility	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0030	Basic DMAN Pre-Departure Sequence – Manual insertion of a flight in the sequence	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
REQ-06.08.04-OSED-0200.0040	Basic DMAN Pre-Departure Sequence – Reference time for sequence computation	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0050	Basic DMAN Pre-Departure Sequence – Sequence computation principles	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0060	Basic DMAN Pre-Departure Sequence – CTOT constraints	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0070	Basic DMAN Pre-Departure Sequence – Taxi Times constraints	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0080	Basic DMAN Pre-Departure Sequence - Airport preferences	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0090	Basic DMAN Pre-Departure Sequence – Time-based sequence updates	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0100	Basic DMAN Pre-Departure Sequence – Event-based sequence updates	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0110	Basic DMAN Pre-Departure Sequence – Sequence updates notification	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0120	Basic DMAN Pre-Departure Sequence - Manual removal of a flight from the sequence	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0130	Basic DMAN Pre-Departure Sequence - Impact of removed flights on the sequence	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
REQ-06.08.04-OSED-0200.0140	Basic DMAN Pre-Departure Sequence - Manual re-sequencing of a flight	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0150	Basic DMAN Pre-Departure Sequence - Automatic re-sequencing of a flight	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0160	Basic DMAN Pre-Departure Sequence – TSAT output	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0100	No adverse effects on safety	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0150	Safety improvement from enhanced controller situational awareness	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0200	Improvement of Off-block times predictability	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0500	Reduction in fuel burn and gaseous emissions between stand and take-off.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0600	Improvement of cost-effectiveness of airport operations	OK	OK	OK
REQ-06.08.04-OSED-0200.0170	Basic DMAN Pre-Departure Sequence - Automatic removal of a flight from the sequence before Start-Up	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0180	Basic DMAN Pre-Departure Sequence - Automatic removal of a flight from the sequence after Start-Up	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0200.0190	Basic DMAN Take-Off Sequence – TTOT output	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
REQ-06.08.04-OSED-0300.0010	Basic DMAN – Runway configuration	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0400.0010	Basic DMAN System Supervision	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
REQ-06.08.04-OSED-0400.0020	Basic DMAN - Manual control of exchanges with A-CDM systems	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	NOK	NOK	NOT COVERED
REQ-06.08.04-OSED-0900.0010	Basic DMAN HMI – Delivery services	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic DMAN	OK	OK	OK
					OBJ-06.08.04-VALP-	Validation of DMAN HMI usability	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
					0470.1100				
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	NOK	NOK	NOK
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK
REQ-06.08.04-OSED-0900.0020	Basic DMAN Delivery HMI – Flight status	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic DMAN	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK
REQ-06.08.04-OSED-0900.0030	Basic DMAN Delivery HMI – Manual removal/re-sequencing of a flight	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic DMAN	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK
REQ-06.08.04-OSED-0900.0040	Basic DMAN Delivery HMI – Manual insertion of a flight in the Pre-Departure sequence	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic DMAN	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
REQ-06.08.04-OSED-0900.0050	Basic DMAN Delivery HMI – Displaying the flight list	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic DMAN	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK
REQ-06.08.04-OSED-0900.0060	Basic DMAN HMI – Apron/Ground services	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic DMAN	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK
REQ-06.08.04-OSED-0900.0080	Basic DMAN Apron/Ground HMI - Flight status	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
					OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic DMAN	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK
REQ-06.08.04-OSED-0900.0090	Basic DMAN Apron/Ground HMI - Displaying the flight list	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
				Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
				Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK
				Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	OK	OK	OK
				Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic DMAN	OK	OK	OK
				Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	OK	OK	OK
				Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	OK	OK	OK
				Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK
REQ-06.08.04-OSED-0900.0100	Basic DMAN HMI – Supervision services	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
					OBJ-06.08.04-VALP-0470.0900	Assessment of the impact of the Basic DMAN on communications between controllers, and between controllers and pilots	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1000	Assessment of controllers' workload reduction when using the Basic DMAN	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK
REQ-06.08.04-OSED-0900.0110	Basic DMAN Supervisor HMI – Runway configuration	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK
REQ-06.08.04-OSED-0900.0120	Basic DMAN Supervisor HMI – A-CDM systems switch	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	NOK	NOK	NOT COVERED
			EXE-06.08.04-VALP-0470.0300	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	NOK	NOK	NOT COVERED
					OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	NOK	NOK	NOT COVERED
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	NOK	NOK	NOT COVERED
					OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	NOK	NOK	NOT COVERED
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	NOK	NOK	NOT COVERED
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	NOK	NOK	NOT COVERED
REQ-06.08.04-OSED-0900.0130	Basic DMAN Supervisor HMI – Runway allocation strategy	TS-0201	EXE-06.08.04-VALP-0470.0100	Basic DMAN Operational Requirements Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK
			EXE-06.08.04-VALP-	Basic DMAN Operability Validation	OBJ-06.08.04-VALP-0470.0300	Achievement of Pre-Departure Sequence from the human factors point of view.	OK	OK	OK

Requirement ID	Requirement Title	OI Step	Exercise ID	Exercise Title	Validation Objective ID	Validation Objective Title	Validation Objective Analysis Status per exercise	Validation Objective Analysis Status	Req. V&V Status
			0470.0300		OBJ-06.08.04-VALP-0470.0700	Assessment of the level of satisfaction regarding the Basic DMAN integration in the tower working positions.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.0800	Assessment of the level of satisfaction using the Basic DMAN.	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1100	Validation of DMAN HMI usability	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1200	Validation of usability of DMAN procedures	OK	OK	OK
					OBJ-06.08.04-VALP-0470.1300	Management of security incident related performance impacts	OK	OK	OK

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