# TSAT Expired Reduction at Amsterdam Airport Schiphol


*Figure 1: https://www.deondernemer.nl/actueel/*

# Reducing TSAT expiration in de A-CDM process of Amsterdam Airport Schiphol.

Amsterdam University of Applied Science

BSc. Aviation Operations

M.G.C.J Nijsten

January 2023

| | | |
|---|---|---|
| Student number: | 500797488 | |
| Company: | Knowledge & Development Centre Mainport Schiphol | |
| Project duration: | September 2022 – February 2023 | |
| Supervision: | Catya Zuninga Alcaraz | AUAS |
| | Koos Noordeloos | LVNL |
| | Yiannis Alexopoulos | AAS |

Schiphol Amsterdam Airport

Hogeschool van Amsterdam

LVNL

# Table of Contents

# List of Tables

# List of Figures

# List of Abbreviations

| | |
|---|---|
| AAS | Amsterdam Airport Schiphol |
| ACDM | Airport Collaborative Decision Making |
| ADR | Airport Departure Rate |
| AMAN | Arrival Manager |
| ANSP | Air Navigation Service Provider |
| AUAS | Amsterdam University of Applied Science |
| CISS | Central Information System Schiphol |
| CFMU | Central Flow Management Unit |
| CPDSP | Collaborative Pre-Departure Sequence Planning |
| CTOT | Calculated Take-Off Time |
| DMAN | Departure Manager |
| FSC | Full Service Carrier |
| LCC | Low Cost Carrier |
| LVNL | Air Traffic Control Netherlands |
| EXOT | Estimated Taxi-Out Time |
| KLC | KLM Cityhopper |
| KLM | Royal Dutch Airlines |
| KLM GS | KLM Ground Services |
| MTOM | Maximum Take-Off Mass |
| SID | Standard Instrument Departure |
| SLA | Service Level Agreement |
| TOBT | Target Off-Block Time |
| TSAT | Target Start-up Approval Time |
| TTA | Target Time of Arrival |
| TTOT | Target Take-Off Time |
| TTOT' | Earliest Possible Target Take-Off Time |
| VTT | Variable Taxi Times |
| WTC | Wake Turbulence Category |

# Preface

The subject of airport operations has always fascinated me, and I am grateful for the opportunity to conduct research on this topic for my thesis. This research is conducted at Amsterdam Airport Schiphol (AAS), with cooperation of both Schiphol and LVNL. The aim of this research is to investigate the challenges that the stakeholders face, adhering to the Target Start-up Approval Time (TSAT) and the impact of these challenges on airport operations.

The research was conducted using a combination of qualitative and quantitative methods, including interviews with ground handlers, pilots, and other stakeholders.The scope of the research is focused on finding the primary causes for

I would like to express my gratitude to my thesis supervisor, Ms. Catya Zuniga Alcaraz, for her guidance and support throughout the research process. I would also like to thank Yiannis Alexopoulos (AAS) and Koos Noordeloos (LVNL), for their guidance during this research.

The thesis is structured as follows: Chapter 1 provides an overview of the research problem and the methodology. Chapter 2 presents a theoretical framework CDM and the methodology for this research. Chapter 3 describes the validation of the personnel interviewed by a stakeholder analysis. Chapter 4 presents the findings of the research, including an analysis of the data collected from interviews. Chapter 5 discusses the implications of the findings and offers recommendations for to mitigate the implication of these findings.

## 1.1 Introduction into A-CDM

Airport Collaborative Decision Making (A-CDM) has been fully operational at Amsterdam Schiphol Airport (AAS) since 2018. The goal of A-CDM is to optimize the use of resources and reduce delays by sharing information and coordinating actions among all parties. For example, by sharing flight plan information and actual arrival times, airlines and air traffic control can work together to optimize the use of runways and taxiways, which can reduce delays for all flights. Within A-CDM there are sixteen milestones to identify crucial parts in the process of a flight. Target Start-up Approval Time (TSAT) plays a key role in this process. A-CDM aims to facilitate the sharing of operational processes and data. By sharing this data A-CDM allows the airport and handlers to make better informed decisions. The basis of A-CDM starts with 16 milestones as shown in the picture below.

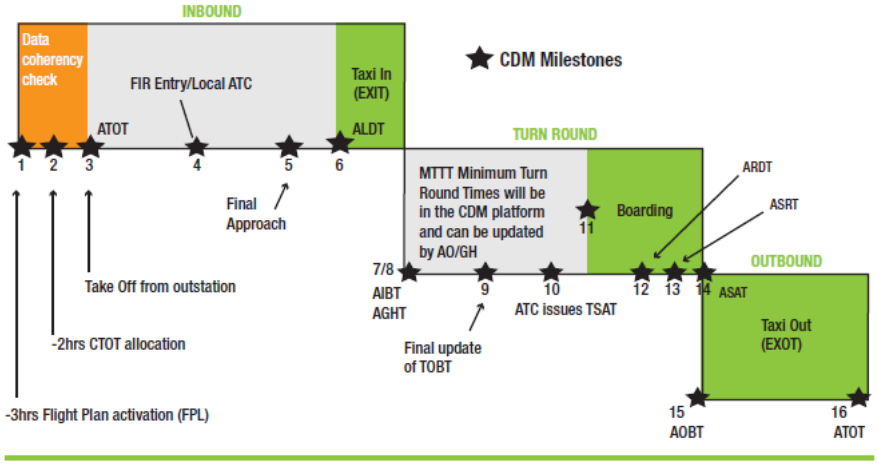


*Figure 2: A-CDM Milestone Approach (Eurocontrol, 2017)*

The most important one for this process is milestone 9, the TOBT update. For the calculation of TSAT, the TOBT is used. The objective of this research is to find the main causes of why TSAT expires at AAS. This will be done by a qualitative research, based on observations and interviews with those who are involved in the A-CDM process at AAS. This research will provide advice on possible short-term solutions that can be implemented at the airport with minimal impact on the operation. LVNL and AAS will both provide a distinct perspective on the process and therefore this thesis can be conducted with both interests at heart.

### 1.1.2 Background of the problem

As AAS is an airport with no holding point at the runway, aircraft wait at the gate when they miss their runway slot. This causes a loss of runway capacity during peak hours when an aircraft misses its TSAT window. With capacity being limited at AAS, the airport needs to use the available capacity to its full potential. When an aircraft is holding at the gate, waiting for its new TSAT window, this potentially blocks this gate for an incoming aircraft. This will require additional gate changes for the incoming aircraft, with potentially longer taxi times and relocation of the handling for the aircraft. For the A-CDM process to work, all stakeholders at the airport need to relay information about the

current status of an aircraft. The stakeholders involved are ground handlers, the airport, airlines, and air navigation services (LVNL). The airlines and the airport are most affected when TSAT expires, while it increases the workload for the air navigation services. Reducing TSAT expired is of interest to all stakeholders involved. This thesis will show the main causes behind this problem and can then determine the best solutions with minimal impact on the operation at AAS.

### 1.1.3 Problem Statement

The issue faced by AAS and LVNL is that the TSAT) provided to pilots frequently becomes invalid. As a result, the aircraft is removed from the virtual queue and capacity at the runway is lost. This loss of capacity cannot be regained as other aircraft are waiting for their TSAT window. In addition to the loss of runway capacity, this problem also results in increased fuel costs and reduced air capacity. The problem mainly occurs during the turnaround of an outbound aircraft at AAS, leading to a loss of peak runway capacity. With limited capacity at AAS and other airports, the frequent expiration of TSATs can be costly in terms of vital runway capacity

### 1.1.4 Thesis Objective

The objective of this thesis is to determine the primary causes for the expiration of TSAT at AAS.

### 1.1.5 Thesis Relevance

ACDM is designed to improve efficiency at airports. It allows airports to manage the ever-growing amount of flight movements. When the ACDM process is not working optimally the number of flight movements an airport can manage during a certain time will decrease. It is in the interest of AAS to keep its operational efficiency as high as possible to manage more flights. For LVNL the interest lies in the growing amount of traffic in the air and maintaining the runway capacity during the peak hours. With ACDM this traffic would be dispersed in such a way that its flight path should not interfere with another aircraft. By improving the adherence to the TSAT the airport and the airspace get used more efficiently.

## 1.2 Thesis Question and Scoping

This chapter will give the thesis questions. It will give the main questions, which will be answered by answering the sub-questions. Section 1.2.3
Thesis In- and Out of scope will give the in- and out of scope in this thesis. That will explain what will and what will not be done in this research. Finally, the deliverables throughout this research will be set out.

### 1.2.1 Main Thesis Question

*What are the primary causes for TSAT expiration at Amsterdam Airport Schiphol?*

### 1.2.2 Sub-Questions

1 How is TSAT calculated?
1. How are external factors influencing the sequencing algorithm in the calculation of TSAT?
2. Which airline/handler is responsible for the most TSAT expired, relatively?
3. Do the expectations of the handlers get updated through to the TOBT?
4. How and when is TOBT/TSAT updated?
5. How is CDM understanded by the stakeholders involved (handlers, pilots)?

### 1.2.3 Thesis In- and Out of scope

This thesis will help tackle the problem of TSAT expiring at AAS. It will be done by qualitative research. In-depth data analysis will not be part of this research. Most of the findings of this research will come from interviews with personnel that are involved in the A-CDM process and observations of the process. This includes observations of the turn-around of aircraft at AAS. This thesis will only take into account normal day-to-day operations. That means that de-icing and adverse weather conditions will be excluded. There will be data on TSAT expirations included. This will be used to show the significance of this problem, and why it should be addressed. This data will not be used for testing a hypothesis by the use of data analysis.

## 1.3 Thesis Design

The first part of this thesis design chapter will look at the current literature on ACDM and inductive research. It will look at research about how inductive research can be performed.

### 1.3.1 Literature Review

There has been a lot of research on how inductive research should be approached. (Gioia, Corley, & Hamilton, 2012) described a method on how to conduct proper inductive research. This source is important to this thesis because “qualitative research has been critiqued as too often lacking in scholarly rigor” (Gioia, Corley, & Hamilton, 2012). They make multiple suggestions on how to conduct such inductive research. A couple of those suggestions that will be taken into account in this thesis are listed below:

- “Assume that people in organizations know what they are training to do and can explain their thoughts, intentions, and actions”
- Make use of multiple data sources, such as archives, field observations, and documentation, but base your research on the interviews held with these people in the organization.
- The people that are interviewed are afraid of the backlash certain research can have on their own person at work. This can be solved by promising anonymity instead of confidentiality.
- Before starting the interviews with the employees, make sure that the questioning is focused on the main research question. Be prepared to adjust the questioning in real time if an answer leads to a new insight.

These suggestions for conducting inductive research while still remaining the same validation as quantitative research are vital for this thesis. That is why these suggestions, and the research proposal will be taken into account in the methodology of this research.

When interviewing certain people for a qualitative research the best approach would be the semi structured interview approach (Leech, 2002). This type of interview provides an insider's perspective while still allowing for some quantitative analysis of the interview responses. The most important part of the interview is gaining rapport with the interviewee. This means that the person that is interviewed is convinced that he is being heard. The best way to do this is to "seem professional and generally knowledgeable, but less knowledgeable than the respondent on the particular topic of the interview" (Leech, 2002). The source also recommends a couple of other suggestion to use in the interview, which will be taken into account in the methodology of the final thesis.

A lot of research has been done into the effects of A-CDM on airports. (Verkerk, 2018) research the information position of the turnaround coordination in managing the TOBT. This research addresses the vital role TOBT has in the A-CDM process. All the TSAT calculations at a CDM airport begin with an update of the TOBT. This research (Verkerk, 2018) helps understand what that role is, and how the turnaround coordinator helps with keeping the TOBT up to date. As the TSAT calculation starts with TOBT, keeping the TOBT up to date is vital to keeping the TSAT reachable. It also researches what role the turnaround coordinator plays in this process. As will be described in the methodology, one of the positions that will be interviewed in this thesis will be the turnaround coordinator. They play an important part in the A-CDM process. Contrarily to the (Verkerk, 2018) research, this thesis will not be conducting such a large-scale data analysis at the airport.

Another research by a TU Delft student touches upon the working of Arrival Management (AMAN) and Departure Management (DMAN) systems (Derks, 2020). This research explains how the DMAN works in calculating the TTOT. It takes into account the different variables such as TOBT, EXOT, and the Airport Departure Rate. These variables are the base of TSAT calculations as they determine the TSAT based on TOBT and Variable Taxi Times (VTT).

The operations manual of CDM operations at AAS will give insight into how ACDM is implemented at AAS (Schiphol Airport , 2019). It has explanations and guides on how the procedures of ACDM take place at AAS. It will help this research by understanding the procedures and processes at AAS. It is important to this research to know how ACDM is working to make any kind of recommendations about the current operations at AAS. The specific procedures that are interesting for this research are the procedures of the TOBT and TSAT. As said before, TOBT is vital to correct TSAT calculations. Furthermore, the process of information sharing between stakeholders is important. For ACDM to work all stakeholders have to continuously share their information about the status of a flight. AAS has the Airport Central Information System Schiphol (CISS) as a platform for the CDM system (Schiphol Airport , 2019).

The implementation manual of Eurocontrol (Eurocontrol, 2017), will be used to compare their recommendations about how to implement ACDM to (Schiphol Airport , 2019) on how it is implemented at AAS. The Eurocontrol manual touches on pre-departure sequencing which determines the TSAT based on the TOBT. By understanding how this pre-departure sequencing works, a better understanding of TSAT will be obtained.

While there has been a lot of research on the effect of ACDM on an airport's operation capabilities, research into TSAT adherence has been limited. As the sources above used different methods to research ACDM, this research will provide a different insight into TSAT adherence with the use of

different methods.

### 1.3.2 Thesis Methodology

This methodology chapter will provide insight into how this research is going to be conducted. It will discuss the methods used to answer the main question in this research: *What are the three main causes that the TSAT expires at Amsterdam Airport Schiphol?*

The first two sub-questions are answered by the help of desk research. The Eurocontrol (2017) and Schiphol Airport (2019) A-CDM manual will be used to answer the first sub-question. These manuals consist of literature on how A-CDM is applied at AAS and how A-CDM is designed to work at airports. The Eurocontrol (2017) manual will be used to compare the manuals and see what difference AAS has used in their implementation of A-CDM.

Karapetyan, et al (2015) helped answer the second subquestion. This research found similarities when building automated pre-departure sequencer for airports, the sequencing algorithm used in the TSAT calculation. This combined with the knowledge about wake turbulance categories (WTC) and Calculated Take Off Times (CTOT), helped answer the second subquestion.

The third subquestion shows how significant the problem is at AAS. This subquestion is answered with the help of databases that track every A-CDM variable of every flight. By analysing this data this thesis can ascertain why it is important to address this problem. This database is provided by AAS.

The last three subquestions are answered with inductive research methods. These methods consist of, interviewing personnel that plays a role in the A-CDM process (for example turnaround coordinators), and observing turnarounds at the airport to observe what is happening in de A-CDM process.

Personnel that play a role in the turnaround process of an aircraft is partly responsible for updating the TOBT during that process. By interviewing them, it can be ascertained where the problem occurs within the complete chain. Furthermore, by doing these interviews an image can be formed about the conditions these people need to work in. This helps in finding the reasons why TSAT expires at AAS. 3.1 gives a stakeholder analysis which can justify the persons interviewed. The persons interviewed for this research is showed below.

*Table 1: List of persons interviewed and function (own source)*

| **Name** | **Company** | **Function** |
|---|---|---|
| Fabiënne Nieuwlaat | LVNL | Outbound planner, CDM workgroup |
| Timo van der Wal | AAS | Gate planner, CDM workgroup |
| Wouter van der Voort | Viggo | Lead Coordinator Schiphol |
| Stijn Gommers | KLM | Manager HUB coordination |
| Ritsaart Kreiken | KLM Cityhopper (KLC) | Captain Embraer |
| Sven Pots | Aviapartner | Operations Supervisor |
| Stefan de Jong | LVNL | Ground controller |

# 2. Theoretical Framework

This chapter will review the literature used to answer the first two sub-questions. These questions will be answered by conducting desk research. Below will outline the important literature with their relevance to this research. This literature used for the first two sub-questions are answered in 4.1 **Error! Reference source not found.** And 4.2 2.5 How are input factors influencing the sequencing algorithm in the calculation of TSAT?

## 2.1 How is TSAT calculated?

This chapter will answer the first subquestion of this thesis: “how is TSAT calculated”. It will give a bit of a background on the milestone approach of A-CDM before diving into the TSAT calculation. It will take a look at Eurocontrol (2017) on how they propose this calculation. In Chapter 3 Case Study, the differences with AAS will be discussed

## 2.2 CDM Milestone approach

The milestone approach consists of 16 different milestones each representing a critical moment in a flight. The picture below shows these 16 milestones.

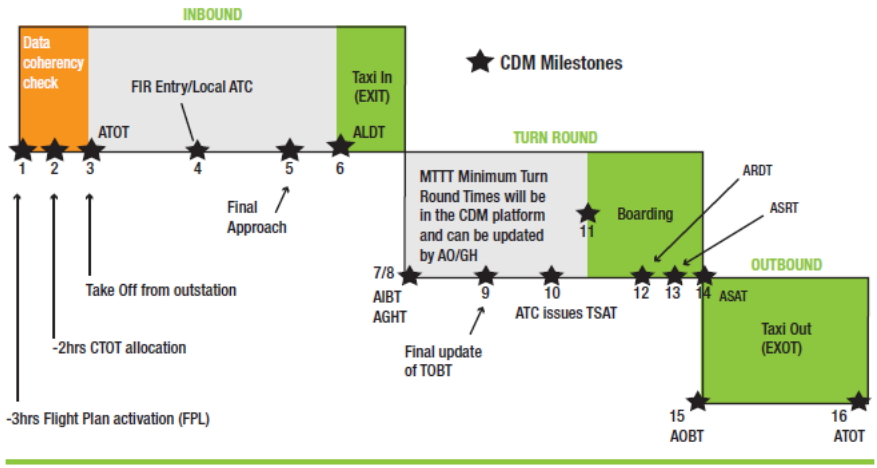


*Figure 3: Milestone Approach (Eurocontrol, 2017)*

The calculation of the TSAT (milestone 10) relies heavily on the TOBT, which is the critical milestone 9, where the final update of TOBT is done. As outlined by Eurocontrol (2017), TOBT is defined as "the time at which the Aircraft Operator or Ground Handler provide their most accurate TOBT taking into account the operational situation." This means that the airline operating the aircraft, or the ground handler responsible for the aircraft, are responsible for providing updates to the TOBT. In the case of AAS, KLM acts as both the airline and the ground handler.

It is important to note that the TOBT is an estimate of the time at which the aircraft will be ready for departure and it's a fundamental element in the A-CDM process. It's used to calculate the TSAT,

which is the time at which the aircraft's departure clearance is expected to be issued. The TSAT is in turn used by Air Traffic Control (ATC) and other airport partners to plan and coordinate the aircraft's movement on the airport surface, and plan the use of the runway and airspace.

In case of inconsistencies or unavailability of the TOBT the TSAT calculation will be affected and in the worse case, it would lead to expired TSAT. Therefore, it's crucial for the Aircraft operator/Ground handler to provide accurate and updated TOBT to ensure smooth airport operation.

## 2.3 TSAT according to Eurocontrol

Figure 4 shows a diagram for the calculation of TSAT according to Eurocontrol. This calculation starts, as stated in 0, with the TOBT. This is the time the aircraft is completely ready for start-up according to the airline/ground handler. By adding the Estimated Taxi-Out Time (EXOT) to the TOBT, the Earliest Possible Target Take-Off Time (TTOT') is calculated. This time needs to be adjusted for current limiting factors with regards to runway capacity, wake turbulence category and CTOT. This algorithm, the Collaborative Pre-Departure Sequence Planner will be discussed in section 2.4. This algorithm plans the particular flight in the sequencing based on these rules and creates a Target Take-Off Time (TTOT). This is the time the aircraft is supposed to be at the runway, ready for take-off. The EXOT is subtracted again from the TTOT, and the result of this calculation is the TSAT. The EXOT is based on the gate the aircraft is departing from and the current runway in use.

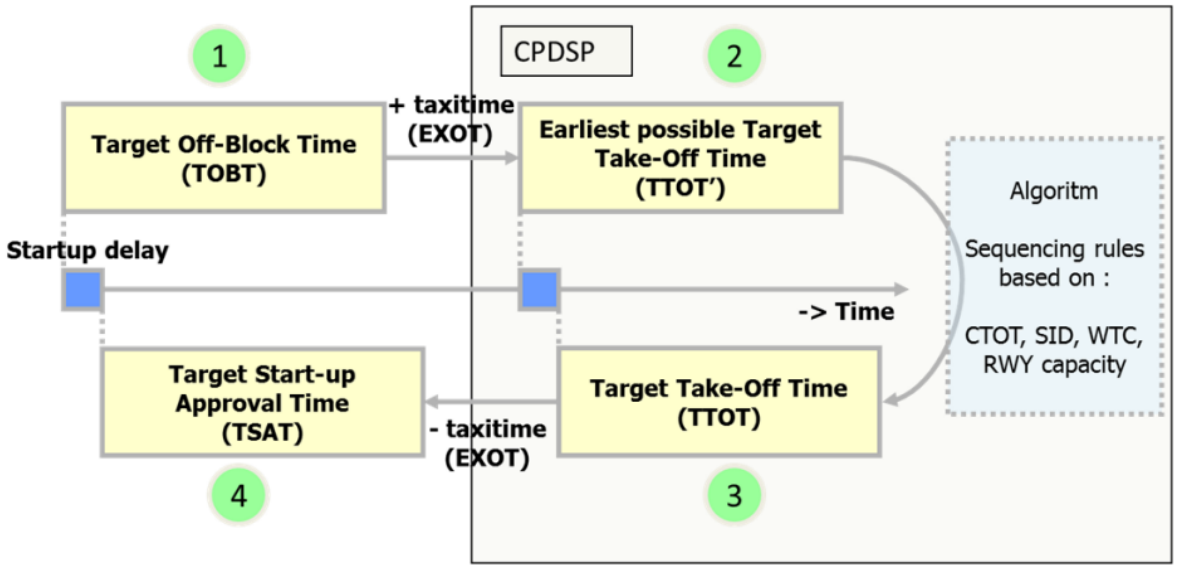


*Figure 4: Collaborative Pre-Departure Sequence Planner (CPDSP)*

## 2.4 Difference from Eurocontrol with AAS

The calculation for the TSAT does not differ from AAS to Eurocontrol. With the implementation of A-CDM at AAS there are some differences to Eurocontrol. Eurocontrol (2017) suggests a maximum number of TOBT updates before the flight gets removed from the queue. This is not implemented at AAS because they believe that the more TOBT updates, the more accurate the information is going

to get. Some flights are excluded from this calculation process. Schiphol Airport (2019) states that VFR flights and flights with a suspended flight plan do not participate in the planning process.

## 2.5 How are input factors influencing the sequencing algorithm in the calculation of TSAT?

This subchapter will focus on the second subquestion of this thesis. It will dive into the sequencing algorithm used for creating a pre-departure sequence at AAS. The function and objective of the pre-departure sequence planning will be looked at as well as what different variables the algorithm contains, and what the influence of those variables is. In this chapter a combination of 4 aircraft is used to explain the different factors on the sequence. The composition of this sequence contains an Upper Heavy (B), Lower Heavy (C), Upper Medium (D), and Lower Medium (E).

### 2.5.1 Function of pre-departure sequence planning

Creating a pre-departure sequence planning allows for aircraft to reduce waiting time at the runway holding point, which includes cost and environmental savings (Single European Sky ATM Research, 2014). This sequence makes sure that aircraft that would normally be waiting at the runway, wait at their stand with the engines off.

Section 2.6 will touch upon the different variables used in the CPDSP, and how these influence the sequence planning.

## 2.6 Different variables in the algorithm

For the CPDSP there are a couple of different variables that determine in what sequence the aircrafts can depart. Below will show those variables, explain what they mean and how they influence the sequence.

### 2.6.1 Wake Turbulence Category

Wake Turbulence Category splits different types of aircraft into categories based on Maximum Take-Off Mass (MTOM) and wingspan. An aircraft creates wake turbulence because high pressure air from the bottom of your wing escapes around the wingtip, moving up towards the lower pressure area on the top of the wing. This movement creates a vortex where air is rotating inwards behind the wing. Figure 5 shows a visualisation of this process.

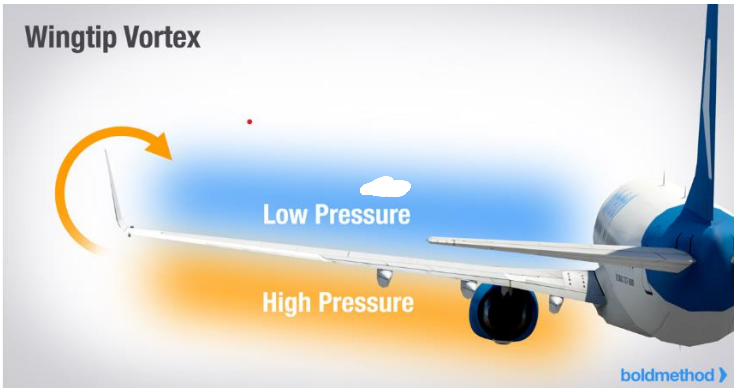


*Figure 5: Wake Turbulence (Boldmethod, 2020)*

These vortices form a disturbed airflow behind the aircraft. This disturbed air is dangerous for the aircraft following. There have been numerous incidents in the past caused by wake turbulence. To prevent this happening to departing aircraft following each other, EASA developed categories which distinguish the different types based on weight and wingspan. Figure 6 shows these different classes of aircraft-based om MTOM and wingspan.

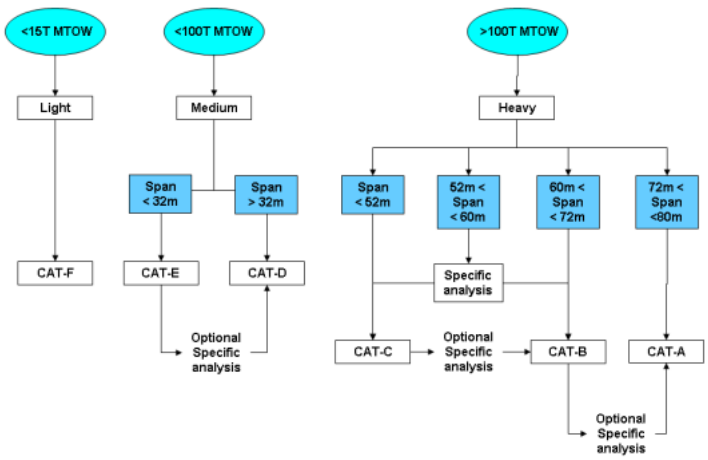


*Figure 6: Categorisation process and criteria for assigning an existing aircraft type into RECAT-EU scheme (Eurocontrol, 2018)*

There are two ways to avoid wake turbulence affecting the performance of the aircraft enroute, laterally or vertically. On departure these two options are limited. This is solved by simply waiting long enough for the aircraft in front to get ahead to a point where the following aircraft is not affected anymore. With heavy aircraft able to follow lighter aircraft much closer than the other way around. Table two shows the minimum separation between the different classes of aircraft in NM/seconds.

*Table 2: RECAT-EU wake separation rules ICAO WTC NM/sec (MovingDot, 2020)*

| Follower / Lead | | Super Heavy | Upper Heavy | Lower Heavy | Upper Medium | Lower Medium | Light |
|---|---|---|---|---|---|---|---|
| | | A | B | C | D | E | F |
| Super Heavy | A | 3 / 80 | 6 / 100 | 6 / 120 | 7 / 140 | 7 / 160 | 8 / 180 |
| Upper Heavy | B | 3 / 80 | 3 / 80 | 3 / 80 | 4 / 100 | 5 / 120 | 6 / 140 |
| Lower Heavy | C | 3 /80 | 3 / 80 | 3 / 80 | 3 / 80 | 4/ 100 | 6 / 120 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Upper Medium | D | 3 / 80 | 3 / 80 | 3 / 80 | 3 / 80 | 3 / 80 | 5 / 120 |
| Lower Medium | E | 3 / 80 | 3 / 80 | 3 / 80 | 3 / 80 | 3 / 80 | 4 / 100 |
| Light | F | 3 / 80 | 3 / 80 | 3 / 80 | 3 / 80 | 3 / 80 | 3 / 80 |

This means that the sequencing algorithm looks at the different categories of aircraft available for departure. From there it calculates the sequence with minimal total waiting time for the following aircraft. This could mean that it groups aircraft with the same class together, or a combination of different classes following each other. This is dependent on the different classes of aircraft waiting for their TSAT. If you use the four aircraft in the introduction in the order: B-D-E-C. The distance required for all four aircraft to take-off would be: 4 NM + 3 NM + 3 NM = 10 NM. There are multiple combinations possible. The algorithm would look for the combination that uses the less space or time on the runway. In this case that would be this combination, but in reality, the selection of aircraft could be much bigger than four.

### 2.6.2 Calculated Take-Off Time (CTOT)

CTOT a take-off time given by Eurocontrol. It overrides the local TTOT and determines when an aircraft needs to take-off. The time is provided by the Central Flow Management Unit (CFMU). The calculation of CTOT start by looking at what time an aircraft is supposed to arrive at the destination airport, Target Time of Arrival (TTA). It uses 4D trajectories, defined by consecutive waypoints in three spatial dimensions and their corresponding timestamps, Nosedal et al, 2014. If the algorithm predicts an imbalance at a certain ATM sector, it issues a regulation to maximize the rate of flights entering the ATM sectors at a given time. This is done by issuing a CTOT to delay a certain flight at its departure airport. This is done to preserve fuel and carbon emissions in the air. When a CTOT is not given, air traffic controllers manoeuvre the aircraft at a tactical level consistency of holding stacks, headings or speed variations. These manoeuvres come at a high operational and fuel costs. By replanning the aircraft at their departure airport this algorithm causes less fuel burn in the air. The algorithm identifies aircraft “hotspots” all over the European airspace and tries to disperse those flights over time. Looking back at the example of the previous chapter. If Eurocontrol sets a CTOT for aircraft E, that causes that aircraft to depart after C, in this combination: B-D-C-E. The minimum distance required is now 4 NM + 3 NM + 4 NM = 11 NM. The CTOT issued causes for a delay at the airport which in turn causes for more separation on the runway.

### 2.6.3 Standard Instrument Departure Routes (SID)

Standard Instrument Departure (SIDs) are designed to get an airplane to the enroute phase of the flights safely, and also reduce pilot and ATC workloads. Below is an image for a SID chart for runway 36C (Zwanenburgbaan) used at AAS.

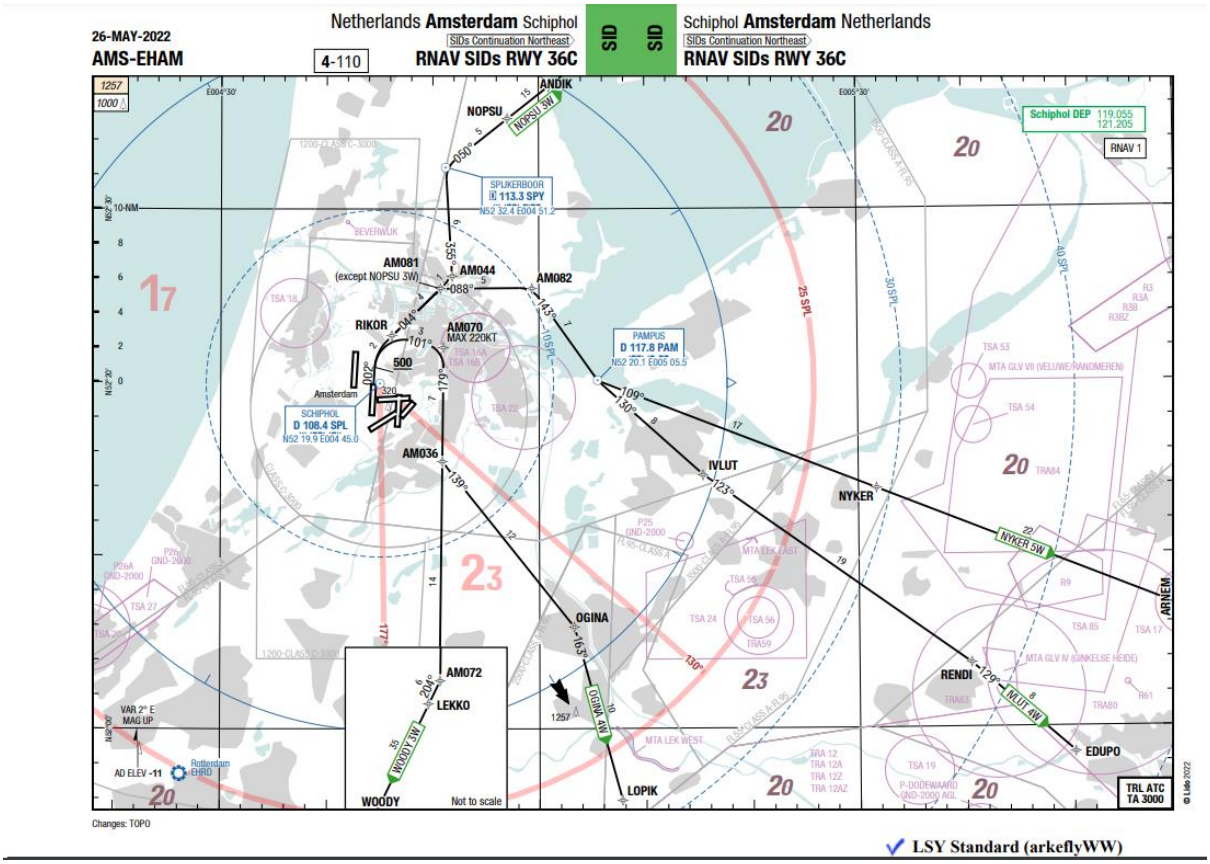


*Figure 7: RNAV SIDs RQY 36C Schiphol (Lido Lufthansa Systems)*

Based on the certain SID a flight is using for departure they can be split in the sequence. In the figure above if the first aircraft in the sequence uses the RIKOR – AM081 SID, the following aircraft can take-off closer when it uses a different SID, for example the AM036 - LEKKO SID. This causes closer following of aircraft which increase the use of the runway capacity. There are multiple different SID combination for every runway configuration that is used at AAS, 2.4.3.4 Runway Capacity will explain more about the different runway configuration at AAS. These options allow the sequencer to plan the departing aircraft closer together.

### *2.4.3.4 Runway Capacity*

The runway usage at AAS also has an influence on the sequencer. AAS consist of six runways, three parallel runways (18L/36R, 18C/36C, and 18R/36L), and three runways in different directions (09/27, 06/24, and 04/22).

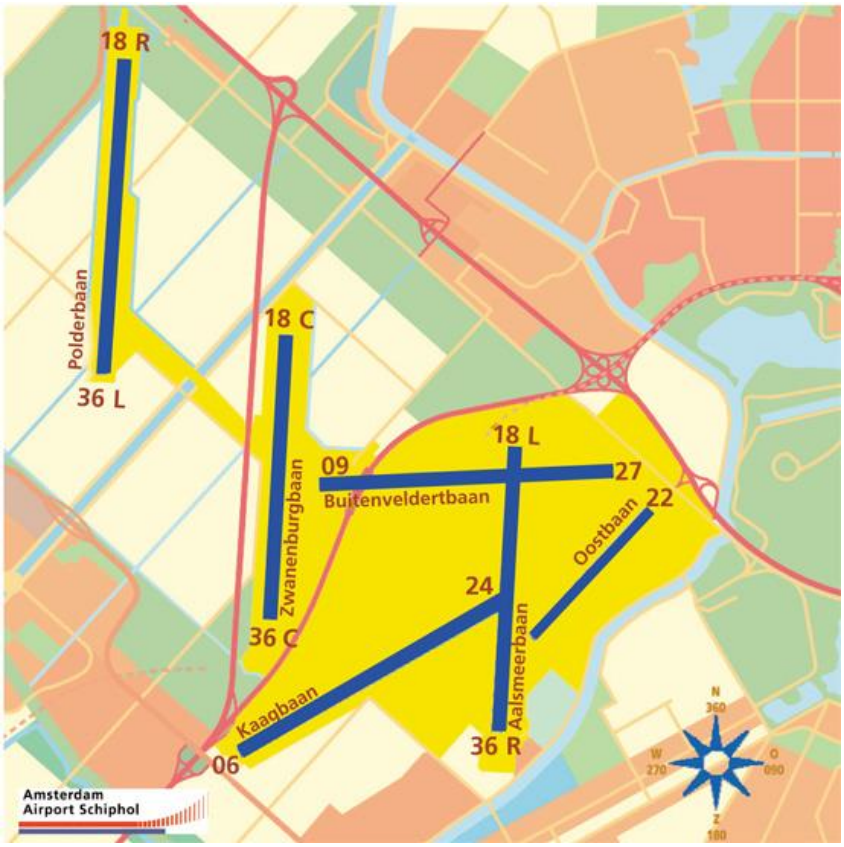


*Figure 8: Start- en landingsbanen Schiphol Airport*

At peak hours Schiphol mostly uses a 2-1 or 1-2 configuration. This means that during the inbound peak two runways are used for landing and one for take-off. During the outbound peak 1 runway is used for landing and two for take-off. Schiphol has to comply to certain noise regulation. This means that they can not use every combination at any time. But in the most optimal scenario, with little to no wind, they can use two runways in different direction that do not cross each other. For example, 36C and 09 for take-off and 06 for landing. This configuration uses different directions for take-off so that aircraft do not have to wait for each other on the runway. There are multiple combinations possible depending on wind direction, time of day, visibility and weather. This is all taken into account in the sequencer to create the most optimal departure sequence.

# 3. Case Study

This section of the thesis includes an analysis of the stakeholders involved in the problem of expired TSAT at AAS. The stakeholder analysis is done to identify the key individuals and groups who are affected by this problem and whose perspectives are important to consider when seeking to understand and address the issue. Additionally, this section will also provide data and evidence to support the importance of this thesis

## 3.1 Stakeholder analysis

This stakeholder analysis will determine what different stakeholders there are in the CDM process of AAS. It looks at the influence of each stakeholder as well as the interest of the stakeholders.

In the CDM process of AAS there are four major stakeholders taking part. The list below shows those four stakeholders.

- Amsterdam Airport Schiphol
- Ground Handlers
- Air Navigation Service Provider
- Airlines

### 3.1.1 Amsterdam Airport Schiphol

AAS' main objective is to provide the infrastructure to the companies that want to use the airport. It does so by providing the necessary terminal, gates, taxiways, runways and baggage facilities. Their goal is to provide for as much flight movements per day as possible. AAS is part of the Royal Schiphol Group, which further consists of Rotterdam The Hague Airport and Lelystad Airport. Royal Schiphol Group also holds a majority stake in Eindhoven Airport and Maastricht-Aachen Airport.

AAS directly serves 81 airlines, and another 31 via code sharing agreements (CAPA , 2022). The major airline serving AAS is KLM, they will be highlighted in the Airlines section of this stakeholder analysis. AAS served over 71 million passengers in 2019, ranking them as the third busiest airport in Europe. With over 300 destinations, AAS connects most of the world.


*Figure 9: Route Map Schiphol Airport (CAPA , 2022)*

Over the last couple of months AAS has had a problem with staffing shortages around the Netherlands. This causes large queues around security during the summer of 2022 as well as problems with the baggage, as there were not enough platform employees. These problems caused long delays and even multiple cancelations of flights as passengers and baggage were not able to reach their flight.

The interest for a well running CDM process for AAS is high. The chaos during the summer of 2022 showed the effects of delays and cancelations on the airport. Due to the shortages and noise nuisance limits, AAS has a maximum flight movement of 440,000 a year (Government of the Netherlands, 2022).

During the peak hours at AAS the demand of infrastructure (gates), is bigger than the supply. This forces LVNL to disperse the incoming arrivals over a greater period of time. When there are a lot of delays on the ground the situation worsens. With a well-established CDM process, these delays are known of in advance. Giving the airport time to communicate this to LVNL which accordingly can reduce the number of incoming flights in advance, possibly even before take-off at their outstation.

### 3.1.2 Ground Handlers

Ground handlers make sure that incoming flights are unloaded and loaded again for departure with different requirements depending on the airline. There are a total of 12 different ground handlers active at AAS. Below shows a list of the six most important handlers.

- KLM Ground Services (KLM GS)
- Viggo
- Aviapartner
- Dnata
- Swissport
- Menzies

This list can be divided into two sections, KLM GS and Viggo on one hand and the other four on the other. KLM GS and Viggo serve just one specific airline. Viggo serves Transavia and KLM GS serves KLM and their partner airlines (Delta, Etihad and China Eastern). These airlines more or less have the same Service Level Agreement (SLA). This means that the ground handler has to perform the more or less the same tasks for every flight. This makes communicating about the expected TOBT easier.

The other four handlers have a different pool of customers. These customers differ from Full-Service Carriers (FSC's) to Low Cost Carriers (LCC's). The difference in handling these different carriers is huge, and even between the carriers there are difference. This makes it hard for the handler to set an accurate TOBT for every flight.

For all handlers it is important to know of any delay in the process as they can direct resources (equipment and personnel) to other flights. If communicated correctly the handler can for example use a pushback truck for flight B if they know flight A has a delay.

Besides the interest the ground handlers have, the influence of this stakeholder is big. The ground handler is the one that sets the TOBT. The coordinator on the ground relays information of the progress of the turnaround to the coordinator in the office. They then set the TOBT accordingly.

### 3.1.3 Air Navigation Service Provider

The Air Navigation Service Provider (LVNL) makes sure that the aircraft can move around the area of the airport and on the ground. At AAS this is done by LVNL. They ensure the safe and efficient passage of aircraft in their airspace. The airspace around AAS is divided into three sections: CTR (tower), TMA (Approach), and CTA (Area). The figure below shows a visualisation of these sections.

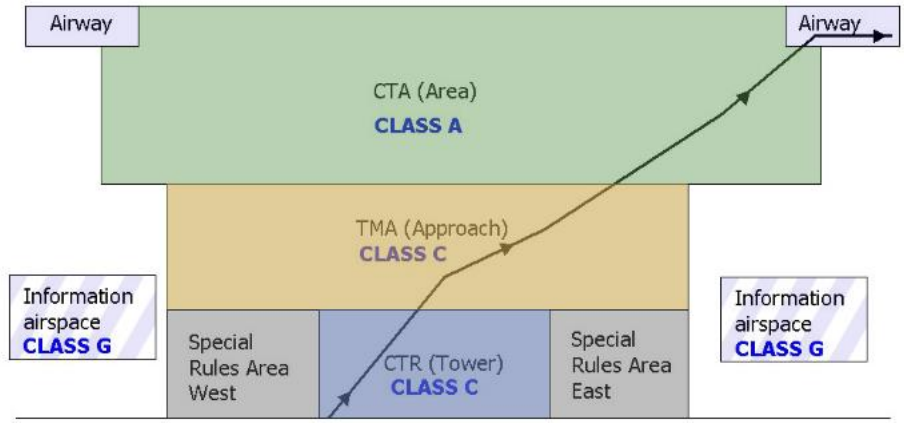


*Figure 10: Simplified Diagram of Airspace (IVAO, 2022)*

LVNL uses CDM to create a pre-departure sequence for departing aircraft. This sequence is created automatically by the CPDSP. When the aircraft calls for departure in their TSAT window, the controller can provide a taxi instruction to the runway. The interest for an accurate TSAT is big. If an aircraft misses their TSAT, it triggers the algorithm to create a new sequence. This affects the controllers. LVNL does not have an influence on the TOBT. They just use the given TOBT to create the TSAT.

### 3.1.4 Airlines

As stated in 3.1.1, AAS serves 81 directly, with the biggest customer being KLM. For this stakeholder analysis there will be made a distinction between FSC's and LCC's, because they have different interest in the CDM process.

#### *3.1.4.1 Full-Service Carriers*

FSC's rely on AAS to make the connections in their network. If a turnaround is delayed, it might threaten the ability for passengers to make their connections. When informed about any possible delay in advance, the airlines can then inform their passengers and take measures accordingly. The influence of this stakeholder is minimal. The handling is done by a different company (see 3.1.2). The airlines are required to inform the other stakeholders of any delay in the incoming flight. The other stakeholders can then use this information to plan their operations accordingly.

#### *3.1.4.2 Low-Cost Carriers*

For a LCC to be cost effective, they require as less downtime (time an aircraft spends on the ground) as possible. Any delay during the different phases of a flight, costs the airlines money. Therefore, they benefit from less delays during the turn around. There is another difference between a FSC and an LCC. The turnaround of a LCC is done by multiple different companies. This means that all those companies need to communicate with each other, which is a difficult concept to accomplish. Just as the FSC's, the LCC's are required to inform the other stakeholders of any delay in the incoming flight.

### 3.1.5 Power-Interest Matrix

All the interests of the different stakeholders and their power in the system can be put in a power-interest matrix. This visualises the text from chapter 3.1. The matrix is shown below.

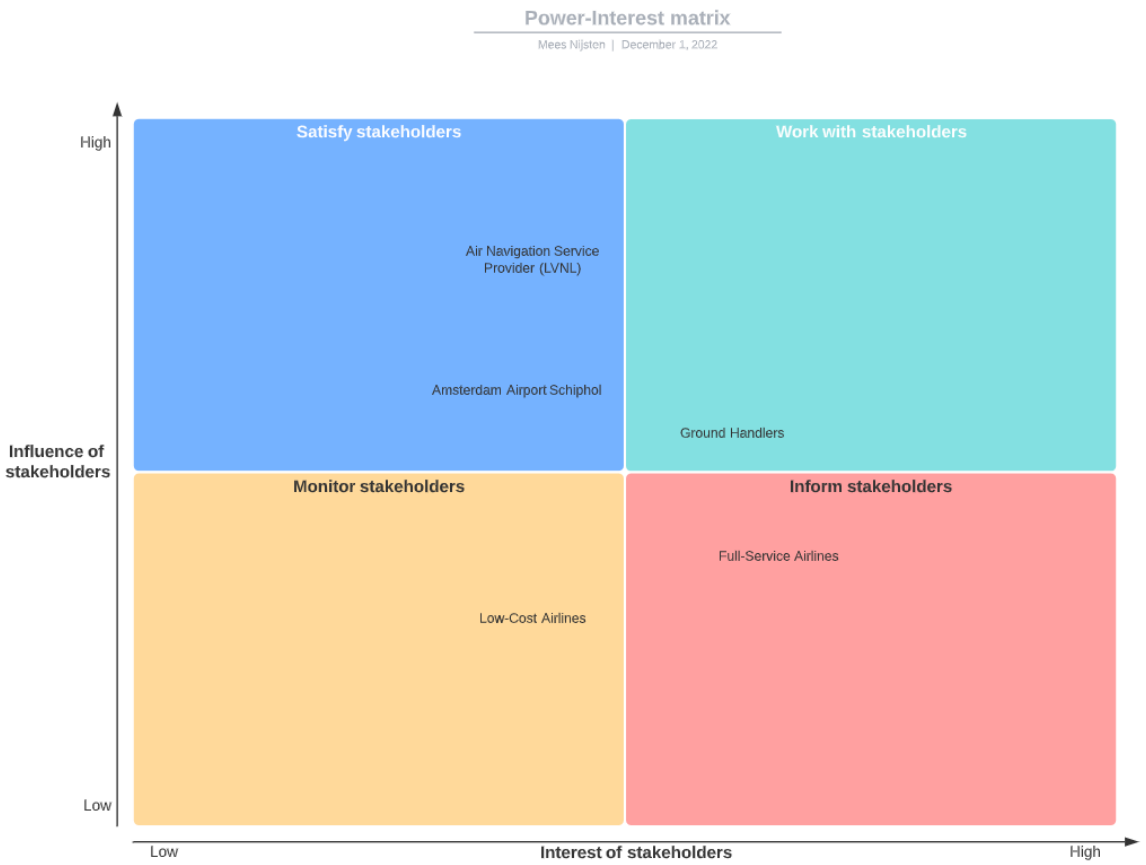


*Figure 11: Power-Interest Matrix (own source)*

This stakeholder analysis justifies the interviewing of personnel giving in section 1.3.2 in Table 2. This table provides a balanced list of names between different ground handlers, as well as representatives from AAS and LVNL.

## 3.2 Data analysis

This chapter will take a look at the CDM dashboard provide by AAS. The most important tables and graphs from this dashboard are included with an explanation and a conclusion about what can be derived from these figures.

### 3.2.1 TSAT Expired Per Ground Handler

*Table 3: TSAT Expired per Ground Handler (AAS CDM Dashboard)*

| Date | Dec/21 | Jan/22 | Feb/22 | Mar/22 | Apr/22 | May/22 | Jun/22 | Jul/22 | Aug/22 | Sep/22 | Oct/22 | Average |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ground Handler** | | | | | | | | | | | | |
| Aviapartner | 13,25% | 8,19% | 14,62% | 12,67% | 28,95% | 26,91% | 37,76% | 37,57% | 28,07% | 40,02% | 29,55% | 25,23% |
| KLM GS | 4,82% | 3,34% | 4,53% | 4,30% | 9,66% | 10,97% | 14,05% | 12,49% | 7,82% | 13,60% | 7,80% | 8,49% |
| Swissport | 24,94% | 14,26% | 20,65% | 17,92% | 27,65% | 34,37% | 37,69% | 42,68% | 35,28% | 37,08% | 30,37% | 29,35% |
| Menzies | 13,82% | 9,58% | 17,70% | 11,91% | 21,07% | 19,06% | 17,59% | 15,71% | 11,53% | 18,47% | 13,20% | 15,42% |
| Dnata | 11,07% | 8,83% | 9,94% | 8,62% | 10,47% | 7,93% | 10,72% | 14,29% | 10,68% | 12,00% | 9,17% | 10,34% |
| Viggo | 18,22% | 11,20% | 18,72% | 15,19% | 22,83% | 25,95% | 28,62% | 24,12% | 19,76% | 28,40% | 22,80% | 21,44% |

Table three shows the percentage of aircraft that got expired, per ground handler, in the period between December 2021 and October 2022. This data is derived from the CDM dashboard provided by AAS. Between June 2022 and Augustus 2022 there is a significant increase in the TSAT expired percentages. This can be explained by the security personnel shortages during that time at AAS. This shortage caused massive cues at AAS that reached to outside the terminal. Furthermore, this table shows that KLM Ground Services scores significantly better than the other ground handlers.

### 3.2.2 TOBT Update Lead Time

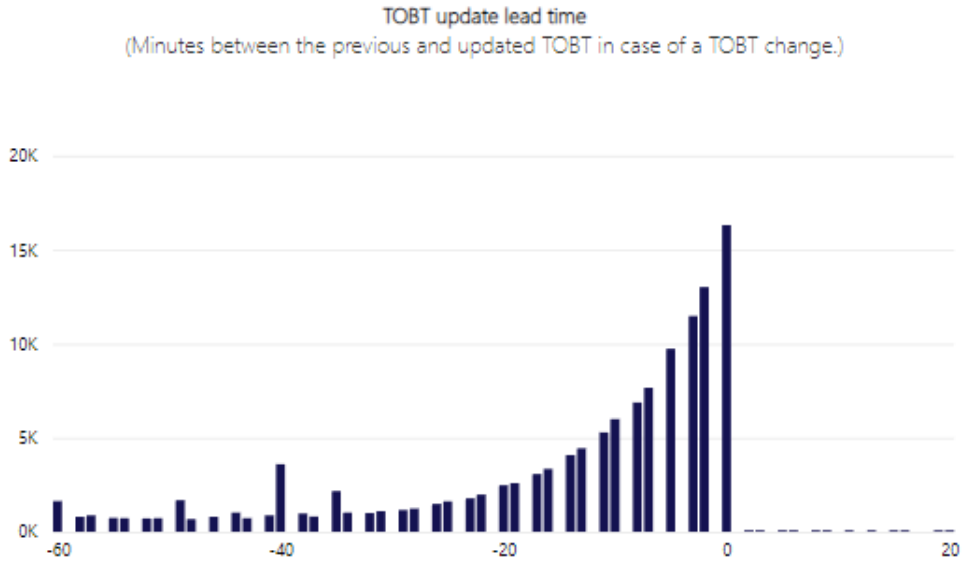


*Figure 12: TOBT Update Lead Time (AAS CDM Dashboard)*

Figure 12 shows the TOBT update lead time. This means the number of updates relative to the TOBT time. It shows that the most updates take place in the last 20 minutes before TOBT, with the last five to ten minutes before TOBT. This tendency of late updating was also concluded by Verkerk (2018) at Brussels Airport. In that research this late updating was caused among other things by the SLA the ground handler there had. At AAS the multiple different ground handlers all have different SLA's. Even within one ground handler they can have different SLA's depending on the airline they serve. Aviapartner handles 24 different airlines at AAS as well as Menzies who handles 31 different airlines. A big contrast to for example Viggo, who handles only 2 different airlines.

# 4 Interview Analysis

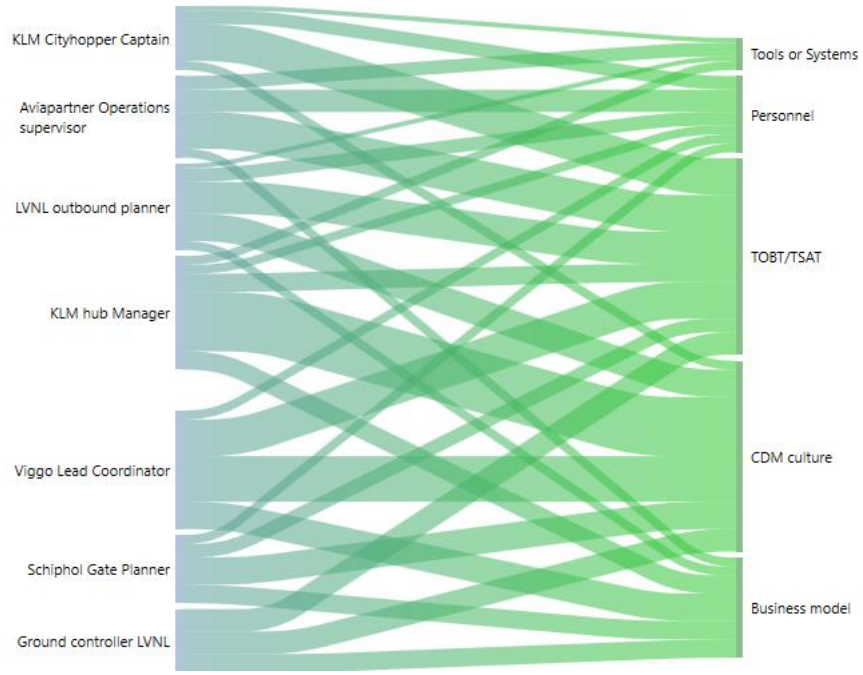


*Figure 13: Interview Code Analysis (own source)*

This chapter summarises the outcome of the interviews aiming to understand why TSAT expires. This qualitative analysis was made using ATLAS.ti. This analysis resulted into 5 groups of answers from the different stakeholders. 4.1.1 until 4.1.5 show the different groups of answers with additional information on the meaning of these groups.

## 4.1.1 Tools or Systems

The code group tools or systems consist of 2 subcodes: software/hardware, and new tools for monitoring. This group identifies problems with the tooling available for the different stakeholders. Three different stakeholders have indicated that they have issues with the available software/hardware. KLC captain, KLM Hub manager, and Aviapartner Operation Supervisor.

KLC captain said that the CDM screens are available on the VDGS (Visual Docking Guidance System), but not every stand has the VDGS available. He also indicated that the presence of the VDGS does not have an impact on the TSAT performance of the flight crew.

KLM hub manager indicated that the person responsible for updating the TOBT is sometimes overwhelmed by the available information, which he would like to see as a dark cockpit principle so they can focus on the flights that have the highest priority.

KLM Hub manager, Aviapartner Operation Supervisor, and LVNL outbound planner have indicated that they would like to see an implementation of deeplearning of the turnaround process. That means that cameras on the platform would indicate when a turnaround has been completed. This

could allow the ATC tower to check whether or not aircraft are ready with their turnaround.

### 4.1.2 Personnel

The code group personnel include all indicated problems relating to the staff facilitating the airport operations. This group includes the subcodes, different SLA's, experience/training, and staff shortages. Every stakeholder included in the interviews, expect ground controller LVNL, indicated that the problems with the staff shortages at Schiphol are influencing the TSAT adherence.

With the problems at security, the gate agent above the wing can not get an accurate estimation on when all passengers will be on board. This is due to a lack of communication between the stakeholders. This hinders the ability of the gate agent to provide the turnaround coordinator with a TOBT. Below the wing the problems with baggage staff results in the same problem as above the wing.

Different SLA's will be touched upon in 4.1.3 but it does result in a problem for the personnel in the turnaround. A ground handler which serves different airlines also have many different SLA's. Some do provide a turnaround coordinator, and some do not. As indicated by Aviapartner Operations Supervisor, "Not every aircraft has a turnaround coordinator. This is contractually agreed with the airline". If this turnaround coordinator is not included in the turnaround, the accuracy of the TOBT drops. This is because the foreman on the platform has different priorities than just updating the TOBT.

Viggo has indicated in the interview that experience and training are also a problem for the understanding of the CDM process. With a crew that shifts to new personnel every couple of months it is very hard to create a stable base with knowledge about CDM. This causes that the personnel that works on the platform does not have enough knowledge about CDM to really understand the impact of TOBT and TSAT.

### 4.1.3 Business model

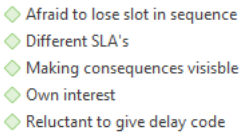


*Figure 14: Subcodes in codegroup business model (own source)*

Figure 14 shows the subcodes that are included in the codegroup Business model. All stakeholders except for the KLC captain mentions one of these codes at least two times in the interviews. First the ground handlers are afraid that by updating the TOBT, they will lose their spot in the sequence to a much later TSAT. KLM hub manager: "The Duty Turnaround Manager thinks, do not put my TOBT away because then my TSAT will be set far back." This thinking causes many handlers to update the TOBT either too late or not at all.

Different SLAs are difficult for the ground handler to deal with. They are not going to put people in place during the turnaround, if they are not paid for it. There is also a problem that third-party companies, where some ground handlers rely on such as fuelling and cleaning, are not required to

give estimated time of arrivals. This hinders the ground handlers to set an accurate TOBT because they do not know when their other turnaround services are going to arrive.

Viggo lead coordinator and the ground controller from LVNL indicated that many stakeholders act out of their own interests. This hinders the CDM process. Many turnaround coordinators look at one flight and do not have an overview of multiple flights at AAS. While with CDM, the benefit for one flight might disturb many other flights. The consequences of not or late updating of the TOBT need to be made visible for the ground handler. That way they get the incentive to make accurate estimations on the TOBT, which benefits all other flights at the airport.

Ground handlers are punished by the airline when they have a TSAT delay. This delay can be generated by the sequencer itself. This should not be the fault of the ground handler. Therefor ground handler is reluctant to give a delay code. This makes it hard to find out where the delay was formed, and who was at fault during the turnaround or earlier stages of the flight. Also, the ground handler does not have an incentive to work properly under CDM. The do not get rewarded if the TOBT is updated in advance.

### 4.1.4 CDM culture

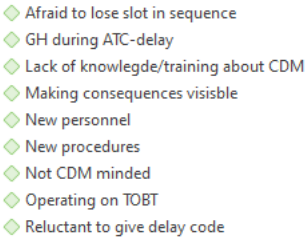


*Figure 15: Subcodes in codegroup CDM culture (own source)*

Ground handlers have the tendency to finish the turnaround in the time between TOBT and TSAT (ATC-delay). KLM hub manager called it the “casino-effect”: “what the DTM does, which is not allowed, they sometimes gamble in the TSAT window.” This means that they do not update the TOBT, because they think they can still make up for the time lost during the turnaround, in the ATC-delay. When for whatever reasons they are not able to finish the turnaround, TSAT expires.

Multiple ground handlers and the KLC captain have indicated that the knowledge about CDM, by the employees that need to work the turnaround, leaves a lot to be desired. Gate agents and turnaround coordinators do not have the knowledge to have the bigger picture in mind when handling an aircraft. For a single flight they know how to update the TOBT and what that is, but they lack the overview of the consequences of their actions. Therefor one single flight might do just fine, but several other flights are disturbed by their actions.

KLM hub manager indicated that many of their systems are working parallel to the CDM system. They use their own different timestamps for different phases of the turnaround. “At the moment we still have too many different times, which really creates some confusion in the systems. One controls TOBT, the other controls the doors-closed performance, the other at a different time.” When using all those different times, it is easy to get lost on the TOBT. This creates inaccuracies in the TOBT.

### 4.1.5 TOBT/TSAT

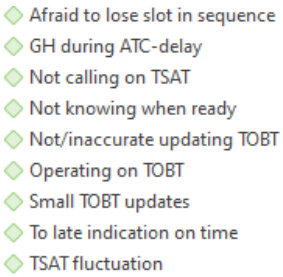


*Figure 16: Subcodes in codegroup TOBT/TSAT (own source)*

Aviapartner serves many different airlines, some of which are not used to fly to a CDM airport. This creates confusion for the pilots flying the aircraft. Minutes before pushback the cockpit is very busy with paperwork and other preparation for the flight. Pilots do forget to call in their TSAT window which automatically leads to a TSAT expired. Other problem with that is in combination with TSAT fluctuation. KLC captain indicated that the TSAT is jumping back and forth in time considerably more than at other airports. This also causes confusion for the pilots which may lead to missing their TSAT window when busy with other procedures in the cockpit.

The predictability of the TOBT is very difficult. The accuracy of the TOBT is vital for a viable TSAT. This accuracy is hindered by the personnel problems 4.1.2 touched upon. Also, the third-party companies play a role in this, as explained in 4.1.3. Personnel that need to set the TOBT get their information to late from personnel in the operation. Viggo lead coordinator: “information exchange must be proactive, which is often not the case at the moment.” Also confirmed by the KLM hub manager: “Qualitative feedback is one of the major issues from a KLM perspective, which is why it is not always possible to focus on the TOBT in time.” This an inaccurate TOBT, which causes problems with the viability of the TSAT.

KLC captain and LVNL outbound planner indicated that it is standard practise at other airports to operate on TOBT and not on TSAT. The focus should be on the TOBT. For example, the pushback is send on TSAT and not on TOBT. This can solve the problem of not have a pushback available when you are ready, and the other way around.

Lastly, LVNL ground controller pled for the removal of small (less than 5 minutes) updates of the TOBT. This causes changes in the TSAT for up to nine aircraft. This would also help in decreasing the fluctuation of the TSAT.

# 5 Conclusion

This research has been conducted to find the causes of TSAT expiration at Amsterdam Airport Schiphol. This has been done by qualitative research into the different stakeholders involved in the CDM process at AAS. By interviewing different stakeholders involved in the CDM process, the biggest problems are found. Derived from the interview analysis there are five major categories of problems which deliver the most problems for TSAT adherence, according to the personnel interviewed.

1. The business models of ground handling companies can cause delays for flight operations at AAS.
    a. Operating out of their own interest, their working method does not always provide the best overall performance at AAS. Although it is understandable from an individual business perspective, it is detrimental for the CDM process. A small delay for one aircraft leads to TSAT fluctuation for other aircraft.

    b. While some ground handlers get paid to provide a turnaround coordinator at every flight, some ground handlers do not. In this case the responsibility for updating the TOBT falls to someone who is not trained for updating the TOBT. More importantly, this person has a lot of other responsibilities, which conflicts with his task to pay attention to update the TOBT on time.

2. Personnel issues has been affecting the TSAT adherence performance. In the interviews two types of issues came up.

    a. First of all, the staff deployment is affecting the ability of each handler for handling the aircraft within the contractually agreed time. A minimal staffing puts extra pressure on the person responsible for updating the TOBT. Nevertheless, deployment of personnel should not be an issue for TSAT expiration itself. As long as the TOBT gets updated, delays itself are not a problem for TSAT performance.
    b. It was indicated that the quality and working experiences of personnel is affecting their TSAT adherence performance. All this caused by todays staff hiring issues.

3. The third category of problems has everything to do with the CDM culture at AAS. While CDM has been around for a couple of years now, it is not always given the highest priority for the people working in the operation.

    a. For instance, it seems to be not known to personnel that, besides the fact that timely updating of TOBT is crucial for TSAT planning for their own aircraft, delays for one aircraft can have an impact on other aircraft. If TOBT is updated correctly, delays on itself are not a problem for TSAT expiration. It all comes down to the understanding of the people who work on the platform, that they play an essential part of the CDM process at AAS.
    b. Another problem related to this is that the ground handlers are finishing their handling process in the time between the TOBT and TSAT. This is not according to the AAS CDM manual. If the handler is not able to finish the turnaround before TSAT. Then the TSAT expires automatically. Ground control has to plan this aircraft manually in the sequence

again.

4. The fourth category of problems has its roots in incorrect updating the TOBT and the consequences for the TSAT.

    a. If the TOBT is not updated, when a delay occurs, the TSAT is not feasible. Therefor the TSAT will automatically expire.
    b. TSAT fluctuation also affect TSAT expired performance. The TSAT of one aircraft can fluctuate due to TOBT changes of other aircraft. According to multiple interviewees, this happens frequently. This conflicts with the crews' flight preparations and the ability to adhere to their TSAT.

5. The use of different software also affects TSAT adherence performance.

    a. Ground handlers use their own software next to the CDM software from AAS. They use different times for their own performance measuring. These times differ from the TOBT time, which cause discrepancies between their end of handling time and the TOBT.

These five factors combined are the primary causes for TSAT expiration at Amsterdam Airport Schiphol.

# 6 Recommendations

It is recommended to give personnel that work on the aircraft stands a better understanding of the CDM process. This can be achieved by both better information sharing with the personnel that work on these platforms as well as encouraging working according to the CDM principles.

The first step to better understand the CDM process would be more training all personnel involved in the CDM process. This would include both ground handling personnel as pilots. This can be done by giving mandatory workshops for new personnel as well as for personnel that is already active at the airport. This would help to understand to the need for correct and on-time CDM data and processes. This gives them the necessary knowledge to understand what the influence of their actions are on their own operations and the rest of the airport operations.

For pilots it can be included in their pre-flight briefing documents for both domestic as international pilots. It could also be included in their yearly recurrent training if it is implemented by the home airlines flying from and to AAS.

The second step would be a system where ground handlers are reminded of the actions they take throughout the turnaround process. This would mean that ground handlers get a scorecard of their CDM performance based on their TOBT and TSAT performance which they have realised (weekly or monthly). Updates of the TOBT that are more than 10 minutes prior to their last TOBT should be rewarded. This incentivizes the ground handler to update their TOBT in advance, creating a better pre -departure sequence for itself, and other aircraft. On the contrary, updates from less than 5 minutes prior to their last TOBT should be discouraged in the scoring system. With this scoring system, it can be visualist that a TSAT expiration has to be avoided. Even if the ground handler is not accountable for the delay, it may be caused by third party companies, they are accountable for updating the TOBT. Therefor Third party companies such as, fueling, catering, and cleaning, should be required to give the ground handlers updates on their arrival time. This way the ground handlers can act accordingly to prevent late updates of the TOBT.

Optionally, this system can be supplemented with deep learning turnaround cameras on the platform. These cameras can detect when a turnaround is finished. These deep learning cameras can, over time, automatically predict the TOBT based on the activities around the aircraft. For the system recommended by this thesis, this is not the use of the cameras that is intended.

As mentioned earlier, ground handlers that finish their turnaround process in the time between TOBT and TSAT, those handlers cause TSAT expirations. The deep learning turnaround cameras can detect when tasks of the turnaround handling are finished after the TOBT. This should also reflect in the score that the ground handlers receive.

# References


AeroGuard Flight Training Center . (2020). *IFR Departure Procedures*. Retrieved from Fly AeroGuard : https://www.flyaeroguard.com/learning-center/ifr-departure-procedures/

Azungah, T. (2018). *Qualitative research: deductive and inductive approaches to data analysis.* Bolgatanga: Department of Management Studies, Bolgatanga Polytechnic.

Boldmethod. (2020, 12 10). *No Matter What You Fly, This Wake Turbulence Accident Could Happen To You*. Retrieved from Boldmethod: https://www.boldmethod.com/learn-to-fly/aerodynamics/avoiding-en-route-wake-turbulence-on-your-next-flight-any-aircraft/

Bolle, K. D. (2013, 12 04). *Airport Collaborative Decision Making (A-CDM) Concept Elements: Setting Milestones*. Retrieved from New Airport Insider: https://newairportinsider.com/articles/airport-collaborative-decision-making-a-cdm-concept-elements-setting-milestones

CAPA . (2022). *Amsterdam Airport Schiphol* . Retrieved from CAPA: https://centreforaviation.com/data/profiles/airports/amsterdam-schiphol-airport-ams

Derks, J. L. (2020). *Coordinated Arrival and Departure Management for Dependent Runway Operations.* Delft: TU Delft.

Dusseldorf Airport. (2018). *Facts on Airport Collaborative Decision Making.* Munich: ACDM Germany.

Eurocontrol. (2017). *Airport CDM Implementation .* Brussels: Eurocontrol .

Eurocontrol. (2018). *European Wake Turbulence Categorisation and Separation Mininma on Approach and Departure.* Brussels: Eurocontrol .

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2012). *Seeking Qualitative Rigor in Inductive Research: Notes on the Gioia Methodology.* Pennsylvania: Penn State University Park.

Government of the Netherlands. (2022, 06 24). *Government limits flight movements at Amsterdam Schiphol Airport* . Retrieved from Government News: https://www.government.nl/latest/news/2022/06/24/government-limits-flight-movements-at-amsterdam-schiphol-airport#:~:text=This%20means%20Amsterdam%20Schiphol%20Airport,maximum%20of%20440%2C000%20a%20year.

Hayes, B. K., Heit, E., & Swendsen, H. (2010). *Inductive reasoning .* New Jersey: John Wiley & Sons, Ltd.

IVAO. (2022). *Classification of Airspace* . Retrieved from IVAO: https://xz.ivao.aero/aviation-handbook/2-general/2-3-classification-of-airspace/

Karapetyan, D., Atkin, J. A., Parkes, A. J., & Castro-Gutierrez, J. (2015). *Lessons from building an automated pre-departure sequencer for airports.* New York: Springer Science, Business Media.

Leech, B. L. (2002). *Aksing Questions: Techniques for Semistructures Interviews .* New Jersey: Rutgers University .

MovingDot. (2020). *RECAT-EU for Departures at Schiphol.* Hoofddorp: October .

Nosedal, J., Piera , M. A., Ruiz, S., & Nosedal , A. (2014). *An efficient algorithm for smoothing airspace congestion by fine-tuning take-off times.* New Mexico : Univesity of New Mexico .

Schiphol Airport . (2019). *Schiphol CDM Operations Manual.* Amsterdam: Schiphol Airport .

Single European Sky ATM Research . (2015). *Calculated Take-Off Time (CTOT) And Target TIme of Arrival*. Retrieved from Single European Sky ATM Research Joint Undertaking : https://www.sesarju.eu/node/2222

Single European Sky ATM Research. (2014). *Pre-Departure Sequencing Supported by Route Planning*. Retrieved from SESAR Joint Undertaking: https://www.sesarju.eu/node/2237

Verkerk, M. (2018). *Improving the information position of the turnaround coordinator in managing the Target Off Block Time.* Delft: Delft University of Technology .

# Appendix I Interview Transcript LVNL Outbound Planner

Interviewee: Outbound Planner LVNL Fabiënne Nieuwlaat (R)

Interviewer: Mees Nijsten (I)

Date: November 1, 2022 at 4:00 PM

Location: LVNL Headquarters

R: I actually have 2 jobs within LVNL, I have a very special role. My basic job is outbound planner on the tower. That way I am more than familiar with TSAT expired and CDM. Aircraft must of course call in the TSAT window, if they don't then the TSAT window expires and the flight becomes expired. I've been doing that for about 8 years now and was looking for a new challenge. In this way, I started at the capacity management department on April 1, 2022 and from that department I joined the CDM working group. In that way I know Yiannis and I became even more involved in the CDM process. My role in that working group is to approach it from 2 ways, from an operational point of view as an outbound planner and the experiences you gain there. What works and what doesn't. And I'm actually trying to make a link to that, what can we do with it at head office to improve your performance and to make the entire CDM process run better.

I: that is an interesting combination of roles and different processes.

R: Yes, sure

I: The research is actually about how the runway capacity can be used better, by reducing TSAT expired. Then it is really about the use of the runway capacity and not the runway capacity in general. The largest part of the research consists of interviews with the various stakeholders. That will be LVNL, Schiphol and KLM. In addition, all handling agents such as Swissport, Viggo and Aviapartner are included. In this way I want to approach this research from all perspectives, with everyone who is part of the CDM process. This will mainly be through interviews, with people who are involved in the operation on a daily basis. In this way I try to get a better picture of what the biggest pitfalls are, why TSAT works.

I: How does CDM play a role in your daily work as an outbound planner.

R: As an outbound planner you can no longer ignore CDM. When I first started in this work, we worked with the principle of first come first serve. Schiphol distributed the slots a year in advance and everyone got their place on that basis. The airlines drew up its schedules based on that. The EOBTs follow from those schemes. Everyone has an EOBT, otherwise not tuned to who comes at what time. We have 2 busy peaks in a day, 1 in the morning and 1 in the evening. Every peak came as a surprise that from a box or 8/9 the delay started to increase. And that was very random who got that delay, when and how long that delay was. That worked out fine for us because it was a lot of fun working that way. You had a very full and busy frequency at those moments. At the same time, however, the various stakeholders, and KLM in particular as a major consumer, wanted to gain more predictability and insight into the ATC delay process. As a result, the CDM concept has also been introduced at Schiphol. Where we used to look at how many EOBTs we have in a certain period of

time, it is now time to add a 2nd runway. Is it now the sequencer (CPDSP) that proposes a pre-planning and that already shows where there are many delay minutes. Based on this, we can determine when a 2nd runway will be used. In the past, planning was based on EOBT, which had to be updated less often. These days the schedule is going on TOBT, which should be a purer time that can also jump up and down, both forward and backward. That's something EOBT can't do. It's 30, if you finish earlier then it's a shame.

I: Did they have to wait until it was EOBT time?

R: They were allowed to shout, because you had a certain amount of leeway in that. But TOBT can also really set you back. That way we should also have a much better idea of what traffic we can expect in the coming period. What became a very important new element in our work is that chests were not allowed to shout but they had to shout in TSAT window. And TSAT window is the window of +- 5 minutes around TSAT time. And TSAT time is determined by the sequencer by looking at the number of TOBTs at any given time that results in a particular track record. So he's basically spreading it all over the track already. So some chests get a delay in this and some chests don't. They take the taxi time from that again, you get a TSAT from that. And the difference between TSAT and TOBT is basically your ATC delay. Which we normally gave ad hoc.

I: that also includes the variables of WTC, SIDs and runway capacity.

R: Yes exactly, that's what the sequencer itself includes. And with that, the work has become very different. It is now usually quieter on the frequency because not everyone is allowed to shout. You can only call when you are in TSAT window. But another element has also been added to our work. Namely, that's what your research is also about, there's a certain club of fliers that may call out at a time. Because for them there is a piece of track reserved, namely the TSAT window in which they can leave. Everyone else behind that is not allowed to leave because they are not in TSAT window yet. So what we regularly see in the operation is that crates that should be ready, are not ready. But don't pass that on.

I: And those other boxes behind that can't take that spot in the row. That is also the core of the problem, because TSAT expired is not a problem in itself. But it's more that no replacement box can jump in to take over that capacity. And that you then do not make optimal use of your job capacity.

I: From your experiences as an outbound planner, are there things that go wrong that you are doing every day, why the TSAT time is not met? Then you have to think about whether there are certain situations where the TSAT is not met?

R: I am now going to tell my experiences that I have gained over the past six months from that CDM working group and I am going to make a distinction between them. We used to think that TSAT window was not met, and so chests became TSAT expired, because ground handling tended to settle in the ATC delay. Since the TSAT time is divided far in advance, they can of course see when they should call. Then they say, for example: I'm ready on the hour, but ATC has given me another fifteen minutes delay. If I'm done within 15 minutes, I won't update but I'll just guess. Then it's my turn right away, so I don't have to wait. In addition, they do not have to register a delay code. Because every update of TOBT is also written on their own record. So that used to be my view very much. They want to hold their spot and they don't want to give up that spot and be moved even further back. It is true that this summer, because the disruptions at Schiphol are so great, that all kinds of peripheral problems also arise. And that some working groups have been set up to see how this can be done. In 1 of those working groups we compared the outbound process of LVNL with the turnaround process

of the airline. Then you see that the outbound planning process of LVNL takes place about an hour before TTOT. We look about an hour ahead. Between 45 minutes and an hour we make a choice to start from 1 or 2 jobs at that time. If you look at the turnaround process of point-to-point flights in particular, they have a turnaround time of 50 minutes. So the moment we look at how many jobs we need, it could just be that the box that should be in that spot on the 2nd runway has not even landed yet or has just landed. If you have an inbound delay, you will arrive later, but a piece of inbound delay will be passed on to CDM. There is something of communication about inbound times with respect to TOBT theorem. But that process is not completely watertight. Let's say that the inbound just made it, then he is at Schiphol and his turnaround begins. With the current problems that Schiphol has with the departure process, and that is simply about the security shortages. When will my passengers be at the gate or not? It is difficult for an airline to estimate whether or not they will close their doors on time. The moment they check whether or not they are going to get TOBT, they do that 10 minutes before TOBT. Airlines have no indication of where their passengers are at the airport, because that is information that the airport sometimes has, but not everywhere. Because you need contact points to register whether people are there or not and nowadays you can check in online so it is not clear where they are exactly. The first moment of contact is to scan your boarding pass. But then you don't know yet whether or not they are past security. That's a very difficult trade-off, because you don't want any extra delay if it's not necessary. But at the same time, you don't know at that moment whether you're going to make it. The airline only knows when you didn't make it, that you didn't make it.

I: So that time information comes in way too late.

R: So you see in the way we plan as LVNL, there really is no other way and I think it can't be shorter either. Another factor at LVNL is that we coordinate outbound and inbound flow. So there just has to be a certain amount of time in between to be able to send that. You have to go somewhere at some point and can say, here we close it and then we open it there again. You can't do that a few minutes in advance. So what the outbound process stands or falls with, and therefore also your TSAT expired, that is the predictability of the departure process. That is the most important thing, you can roughly estimate how long each element of your process will take. If you say yes to that, then your TOBT is reliable. If the answer is no, then just do something.

I: then it is passing on for the sake of passing on.

R: then everyone is indeed doing their best, but some things you just don't know.

I: Was there before the problem, so also with covid, were the same problems to be seen there for the crowds and problems?

R: I think before covid, the ATC delay was used to make settlements. Especially because there the passenger process was fairly predictable. You can spend 15 minutes on security or 40 minutes once, but that you will stand in a line for 4 hours and therefore miss your plane, that was never seen before.

I: those are indeed the challenges that have made it difficult lately to set a correct TOBT.

I: Picking up on that first part of the problem, using the ATC delay to make up for time during your checkout. Do you see short-term solutions for that yourself?

R: That's hard to say, because my image has changed. I only looked at KLM, but if you look at how they deal with TOBT theorem there. Is that very neat and do they try to pass on the information as

best as possible. I don't know how that goes with other handlers, so I can't say anything about it. Which I do think might have influence and that's something we can explore as well. Now we really send on TSAT time, they call in TSAT window. While if you look at standard CDM implementation at other airports, TOBT is called there. Then you also have a much more TOBT-minded operation. As a tower, we do not have the tools to check whether a chest that calls out TOBT is actually ready. But the airport could facilitate that.

I: yes, there are camera systems that automatically look at what is around the aircraft in order to get an image of the turnaround.

R: They are working on that. Then you have another problem. At the moment the pushback direction is sent to TSAT. So there's your last link, because then they call out TOBT and they are ready, but then they don't have a pushback truck yet. That cycle also has to be arranged and that also requires a different working method for KLM.

I: is that due to crowds on airside or the peripheral roads, or too few trucks?

R: I don't know the answer to that question.

# Appendix II Interview Transcript KLM Hub Coordinator

Interviewee: Manager HUB coordination KLM Stijn Gommers (R)

Interviewer: Mees Nijsten (I)

Date: November 3, 2022 at 10:00 AM

Location: KLM HUB

I: What is your current position here at KLM HUB and what are your daily activities?

R: I am the HUB coordination manager. That means I am the manager of the HCC, the HUB control centre. Which is the control of Ground Services, so the handling agent KLM. I manage the HCC hierarchically and functionally. Hierarchically the Duty Turnaround Managers (DTM), so the ones who actually have to monitor the turnaround and who have to set the TOBT. And functionally the other flow managers also have their own supervisor. Because they are also part of the control system, we only control them functionally. In addition, we are the designated crisis managers of the operation when a serious disruption occurs.

I: And what exactly does that mean, what does that mean for your position?

R: Then we are the main operational point of contact, I am not talking about management leadership, but the point of contact for the operation during a crisis.

I: Just a little about the research. The aim of the research is to reduce expired by means of TSAT, and to make better use of the runway capacity. At the moment, part of the runway capacity is not used because the TSAT is missed. I try through interviews with all the different parties in this process. By including all parties in this I try to find out where the points for improvement lie with regard to TSAT expired reduction.

I: In general, how does CDM play a role in your daily work?

R: We mainly come into contact with TOBT and TSAT, the rest of CDM is rarely discussed. To begin with, the TOBT, why do I say little? Because we have our own KLM programming, in which we work a lot and in which we ultimately set the times. In the HCC specifically the TOBT. We are of course also dependent on the TSAT, especially because of the pushback management. That direction is here and is also controlled from Ground Services. The aircraft allocators do use a lot of CDM in connection with the VOP availability and the planning of the VOPs, they are continuously in there.

R: I think you have a core problem right there. We have CDM, but it's not really super permeated into the HCC. We all know what CDM is and we know we need to work towards a TOBT, but it's not a very integral thing. Then I think KLM is still doing reasonably well compared to other handling agents.

I: What information flows do you have at your disposal to arrive at a TOBT statement?

R: in principle, we have or, data-technical insight into all processes that the handling agent KLM carries out here for the purpose of a turnaround. We don't have everything digital and we also have a lot of qualitative feedback. This qualitative feedback is one of the major issues from a KLM perspective, why it is not always possible to focus the TOBT in time.

I: what exactly does qualitative feedback mean?

R: that is from the team coordinator who is under the wing, he has a central role in the handling. You do need it sometimes because of course you are not physically in the operation here and where you are here on Topside, if something is not going well or if there is something known why a program can get disrupted during processing. Then we have to transfer it over the phone here from the HCC. Then we can adjust the TOBT from here. Adjusting TOBT is done integrally. We have 3 parties that depend on this. We have the gate agent who secures the passenger domain at flight level above the wing. We have a team coordinator who does that under the wing. Then you have the Duty Turnaround Manager. Together they form the operational triangle that must monitor the turnaround.

I: Suppose below or above the wing notice that they are not going to make the TOBT. Who is ultimately responsible for adjusting the TOBT?

R: the Duty Turnaround Manager is ultimately responsible, but he/she has a leading role in this. If he gets the information from the gate agent or the team coordinator, he finally makes the decision. This decision is made in consultation with our OCC. Up to 15 minutes they can make the decision themselves to move the TOBT backwards. If it is longer than 15 minutes, we will endanger our network in such a way that we always have to consult with the OCC.

I: Is it possible that 15 minutes have to be passed, but the OCC sees that this is going to be a problem for the network. Is it possible that the OCC says they want to keep that TOBT within 15 minutes?

R: suppose there is a choice, then we would like to do that, suppose we miss 6 passengers. Then we decide not to wait and close the doors. Sometimes you have other circumstances, for example a car broken on the plane. Then the OCC can jump high and low but that is not possible. We have also agreed guidelines in that, under 5 passengers, doors are always closed anyway. Above 5 passengers it is always in consultation. The same goes for suitcases. Under 25 suitcases always close doors, above 25 suitcases it is in consultation.

I: That is clear, otherwise you could indeed say if we do not pick up the passengers or luggage, then you have a good chance that you will go over those 15 minutes.

R: yes that's right, but this is the process on paper. In practice we run into a lot of problems.

I: What are the problems why this doesn't work in practice?

R: The TOBT and TSAT discussion has been going on for some time, of course, but since COVID, the problems at Schiphol but also our own problems in terms of staff shortages. You see that every flight gets disrupted. As a result, you notice that sometimes you physically lose the overview. A team coordinator can do 2 flights at the same time, but does not always know exactly what a potential risk is for the departure time of a flight. He sees that too late. The DTM has so many disrupted flights that its programming doesn't really help in determining which flight has the highest priority. That's problem 1.

R: You also suffer from a cultural problem. The casino effect that makes working as a DTM a lot of fun. What the DTM does, what is not allowed, they also sometimes gamble in the TSAT window. They think if we still save the settlement, then they will not adjust the TOBT and they assume that they can achieve the settlement in the TSAT window. That is what the DTM does, which thinks it has achieved for KLM as a company. Besides what the DTM does, you also see this happening at the

flight service, which thinks: don't put my TOBT away because then my TSAT will slide far back.

I: on the one hand also understandable, of course, this is a problem that occurs with many handlers. The time between your TOBT and TSAT can of course also be quite considerable, so it is logical that they want to gamble on that. Only if you look at the big picture, this does not yield any profit for the entire operation.

R: The disadvantage of that is also that you create the culture that we always want to try this. Because we think it's profit. While in the end it would give us much more peace of mind as a handler to provide a realistic and stable TOBT. Because of course we plan all our handling processes with the exception of pushback, which is planned on TSAT, on end of handling or TOBT. There you also immediately have a problem to deal with. At the moment we still have too many different times, which really creates some confusion in the systems. One controls TOBT, the other controls the doors-closed performance, the other at a different time. There is, of course, a difference.

I: then because of all the different times, at a given moment you no longer know which time should really be leading.

R: No, that's right, then you come back to a problem from earlier in this conversation. We are not yet fully CDM-minded. Because we also work with our own times.

I: Of course we already have a lot of problems to deal with, what solutions do you see yourself?

R: we are already starting an intensive improvement process. With us it goes into three categories: that's here at the HCC, how can we change the culture in the HCC that we get rid of that casino effect. That we start from the idea that every minute we win with 1 plane is a profit for KLM, that is not the case at all.

R: In addition, we need the tooling that uses the dark cockpit principle, so that the focus of the DTM is really on that flight where it is necessary at that moment. In this, the tooling supports the correct prediction, in the future perhaps an automatic TOBT theorem based on processes that have not yet been completed. That tooling can then help to look at how many extra minutes you realistically need to complete this handling.

R: the 2nd category wherever we look, but it is very broad because TOBT is of course the endgame of ground handling. So we also look at how we can help the team coordinator and the gate agent, how can we make it much clearer for them what the consequences of their actions are. They are very active at flight level, but they do not oversee the entire sector. So they feel like they're doing a really good job, or what's the matter with those few minutes of delay. So we think it helps a lot to make the consequences visible and create a culture there that they have to inform in a timely manner.

I: Are there ways you are already thinking about making those consequences clear, or is this still in the early stages.

R: no, this is really still in the early stages. We do have tooling that already indicates something, but it is still in the early stages. What you should really think about is how you bring this. You do not want the interpretation to come from, yes okay if 10 passengers miss the return flight, that's not so bad as long as we put the TOBT correctly. That is why we are really thinking about expressing it in costs, that is what triggers people the most. Then you create an image of what it will cost if you do not close your flight now while it is intended.

R: the third category is in consultation with the OCC. Basically, we see that things are not going well at the arrival level. So if we don't make sure that all our flights are secured with the minimum ground time on arrival, then of course you put extra pressure on the controls here because you need the adjustment. The moment the chest arrives at the VOP, make sure that the base plate is in the right position. That also brings peace.

I: just before the imaging, suppose you have a half hour delay on an incoming flight. I think it's 50 minutes for you to turn around for European flights. That flight is immediately moved back that half hour.

R: Yes you should actually put that minimum ground time back. You shouldn't try to squeeze, because that essentially leads to you eventually having to fix something at the back. Then you run the risk of this happening too late.

I: that putting the TOBT backwards so that you keep the minimum ground time is not happening yet?

R: yes, a lot is, but you can see that there is still a lot of optimisation. I think that that move can mainly be made by looking during the final approach. There is also a lot going on at Schiphol itself. Read: landing on the Polderbaan or taking a connection that is actually not realistic at all. But if you show the operational players we accept this affiliation. Then they will wait for that, that is in your mind. At the HCC we don't know. Or we have something like that that you can wait but within your process time and if you run v -10 procedure you have to unload, but you see that operational players don't do that.

I: that part of culture is of course very interesting for my research. A lot has been written about work cultures. There are, of course, different ways to convey the importance of CDM. It is indeed important to do this in such a way that everyone also sees its value and that they also get to work with it.

R: also for the operational player there is tooling that supports them, it is of course the trend to handle more flights with fewer personnel. That is not so much just at KLM, but it happens everywhere. So how can we put the qualitative feedback, by means of tooling, off the side a bit more. Then we can determine the TOBT more based on data.

I: and how is that arranged at the VOP?

R: Yes the turnaround coordinator does something for the TOBT, the average gate agent doesn't know what you are talking about when you start talking about TOBT. That is already a problem that you actually have to tackle. The TC does look reasonably at the TOBT, but it is not always on the VOP. A pilot is of course on the VOP all the time, who is literally looking straight at the TOBT and TSAT. So the TOBT is not very much present in its activities for the TC. There too the cargo door is closed time instead of the CDM time TOBT.

I: That CDM is still mixed a lot with its own internal times. Then you're going to mix up a lot of different things.

R: also the awareness, they all see the TOBT, but the TOBT is also only a time. For a TC, the consequence is not clear if I don't pass the TOBT. This makes it very easy to say: I need another 10 minutes. And they often call that to the HCC, but then they don't really understand what that does to the TSAT at the back.

I: no exactly, because a pilot knows, for example, where his TSAT window is located in which he can call. The TOBT is known on the ground, but the consequences for TSAT are not known there.

R: no, that's right.

R: bringing forward is also disruptive. You also mainly see TCs and our flight ops organization that put a lot of pressure on advance. While we as handlers say, an advance and a delay are both a disruption. You prefer to just fly on your schedule, as you have set it up optimally. You also want to focus your ground handling on that. The pressure is being increased to move forward, I think that is also a realistic problem. Then we bring the TOBT forward, so that the TSAT also moves forward, but the pushback is not yet present. As a result, the TSAT expired again, while if we hadn't done anything it would have gone well.

# Appendix III Interview Transcript Schiphol Gate Planner

Interviewee: Gate Planner Schiphol Timo van der Wal(R)

Interviewer: Mees Nijsten (I)

Date: November 9, 2022 at 10:00 AM

Location: Schiphol Tower Center

I: what is your position here at Schiphol?

R: I am a gate planner. In addition, I am also an operational expert for project groups, so I also participate in that. My main job is as a gate planner.

I: So you are also part of that CDM working group?

R: Yes, right.

I: Then I will briefly explain the research. I want to reduce this by means of finding out the reasons why TSAT expired. If you miss TSAT, you miss a piece of runway capacity. I want to do that by reducing practical, short-term solutions. The main question of the research is therefore: how can runway capacity be better used by reducing TSAT expired.

I: then I have three sub-questions, which are about the interview side of this research. The research contains a piece of theory, a piece of data and then, of course, a piece of interviews that I am currently working on. These questions are mainly about how the TOBT is updated. That is of course essential for a good TSAT. I mainly look at things that are seen by handlers on the platform, which are also implemented in the TOBT updates. How and when these updates come about and what role you play in them. And whether CDM is understood by all parties involved.

I: How does CDM play a role in your daily work?

R: Actually with every flight. We use a standard application that must be pre-provided. For us it is essential to check the status of the TOBT and ultimately the TSAT.

I: You also check the status of the TOBT on the day of the operation?

R: yes, that's right

I: How does that work if you see that there are deviations with a certain flight?

R: mainly via the CISS, then we sometimes have the CDM. So actually I have to say that CISS is really leading. Because we can see the TOBT theorem in that. And whether that 5-minute overflow is feasible. And that TSAT automatically follows through. CDM is actually a kind of 2nd screen. Actually, CISS is leading.

I: and then what is the difference between CISS and CDM?

R: At CISS we actually see the flight number, type, route and a few more things but mainly TOBT and TSAT, they are next to each other. At the CDM it is very extensive. That in itself is fine because you can then look specifically at the reason for each flight. But at the CISS it's ideal to have the two side

by side. As a result, we can also see that a particular flight has not updated its TOBT and therefore fails to achieve its TSAT.

I: what do you do with that information if you already see it in advance. Can you already do something proactive?

R: normally you then call the handlers. Then you say that the TOBT needs to be adjusted. The problem we are now facing is that they don't have it in order, so there is no clear working method for us anymore. We should really just call every flight. It's getting better now, but during the summer it was really unbearable.

I: the problems above the wing were then so enormous that the handler under the wing could finish everything, but then you were still waiting for boarding. That is of course a problem that falls outside the influence of CDM.

R: yes, that's right, but there should be more communication between the handler and the person who is in the office of the handler.

I: yes, because he ultimately sets the TOBT, the person who is not in the operation, but that is always in consultation with the person on the platform.

R: Yes, KLM has it well organized. But that is also because they have their own OCC for handling.

I: In terms of gate planning, you are often a day in advance (D-1). Do you then set the EOBT on D-1? How exactly does that work?

R: That's all on schedule arrival and schedule departure. We don't actually look at EOBTs and TSAT and TOBT there. It's purely on schedule. We are also working on looking more at history, to look at flight 692 comes 9 out of 10 times an hour earlier. That you look at that a little more. But it's still a chance, and that history isn't hard facts.

I: It is therefore difficult to start planning for this in advance, because then you run the risk that it will not happen anyway.

I: So when you look at the operation now, where do you think the biggest problems are right now in terms of the TSAT? Or why the TOBT is probably not being updated properly.

R: Ultimately, and I try to make everyone believe that, it's just because the handlers don't have it right. That's the problem. I understand that it is partly force majeure, in the sense of no staff. But at the same time, the way of working, I have during my studies at Swissport. That went okay at the time, but there is a certain atmosphere / new working method came. In combination with too few people. As a result, it is no longer up to date.

I: yes, of course there is that busyness. There has been an investigation at Brussels Airport. A TC employee there indeed said that updating the TOBT is only 1 percent of his duties. So that can partly be explained, of course. But it's a shame that you don't get a good TSAT position because of that.

R: no, that's right, we've tried it with LVNL as well, specifically with one handler. To try and trigger that. You actually do that by giving the ready status, while you can give a flight ready, while it is not ready. What happens then is that you give a flight ready. Flight is not ready in practice. Which causes TOBT to expire completely, TSAT to expire completely. You will eventually end up in line. It's been done and tested but it doesn't work. They are of no further interest. The handlers don't even see it. So we ended up with ourselves with it. The flight comes to the back of the queue, our system is

going to clash. You get conflicts there. But it is a certain thing that makes you want to wake them up, of note you have to adjust your TOBT. I think it can be done, but it needs to be sorted out first.

I: yes, that's why the third sub-question actually, about how is the CDM process understood. Also talked to other handlers who said if you ask a gate agent what is TOBT and TSAT then they have no idea. So I do think that a large part is also an awareness of the process. Because what TOBT is may be obvious, but there's so much more to the process front and back. Then not all 16 milestones need to be known, but the part around the turnaround is of course important. Then they also get an insight into what happens when they change a TOBT. I think there is a lot of room for improvement there.

R: yes, I think they should indeed be better informed. Ultimately, there is also added value for the handlers themselves.

I: yes, that's right, because they ultimately have their own process in order.

I: Do you think there is still room for improvement on your front end on the planning side? Which might make things go better on the day of surgery?

R: No on the schedule, neither TOBT nor TSAT. It is also almost impossible to do on the day of surgery. Yes, it sounds very annoying, but in the end the handler has to do better. We shouldn't want to do everything ourselves. They have to do it. I think that's where the most profit can be made. I have already said that to colleagues in the APOC. That's where you have to take your chance. Now also get handlers involved.

I: yes, it is the intention to include the handlers in the APOC.

R: yes that's right, from 15 November officially I believe. Swissport comes first. And that's great, I see the opportunities there.

I: yes sure. Then of course there is also a difference between the people who are on the APOC and the people who are in the operation.

R: yes it always makes me itchy. Then I think, I see so many things, I would prefer to do everything. But at the same time I can't and there are people in front of it.

I: the most difficult thing about CDM is of course all the interests involved. It really is a collaboration between all parties. And it is of course very difficult to represent all interests there.

R: You really have to show those parties the benefits, that is purely about information.

I: if you indeed look at the profit for the people in the operation, then you put it another step on the task list for the employees on the platform.

I: Do you see problems with crates arriving early? So chests that advance their TOBT that that is not rewarded that the TSAT then still jumps back. Does that happen often in your experience?

R: It really depends on what time you do it. It is now 10:37, let's say you have a TSAT of 10:45 and you think I can set it to 10:40. This is advantageous for the TSAT. If you now set it to 10.40 instead of 10.45, the TSAT will really go forward. Of course it depends on job usage. So always adjust TOBT.

I: yes the handlers said that from their experience little is done because then the TSAT either

remains the same or even jumps backwards. That is of course strange because then you will be punished for something good.

R: It really shouldn't. That shouldn't be possible. The only thing I can think of is that a box will get in line earlier, so it will give itself a priority spot. Then he wants to leave earlier, but if it is busy you will get a later TSAT. But then I would leave the TSAT as it is but update the TOBT.

# Appendix IV Interview Transcript Viggo Lead Coordinator

Interviewee: Lead Coordinator Viggo Wouter van der Voort (R)

Interviewer: Mees Nijsten (I)

Date: November 7, 2022 at 4:15 PM

Location: Schiphol office

I: What is your role at Viggo and what are your daily activities?

R: I started at Viggo in Eindhoven and we have been at Schiphol for 1.5 years now. Here we started handling Transavia. I myself started out in the role of coordinator. A coordinator is actually the center of the entire operation. It controls both the passage and ramp section and monitors towing movements. Then, after 8 months, I progressed to the position of project officer for the coordination department. I was responsible for improving and optimizing processes. At Schiphol, of course, we started out kind of bare. Many processes that we had simply set up in the beginning have been adapted and further developed over time. Now I am lead coordination, there I am responsible for the entire coordination department. Then I am responsible for the people who are there, but also for the processes they manage and also responsible for the contact with external parties with whom we deal.

R: I participate in the CDM working group.

I: Yiannis is indeed known through there. Do you notice that if you start working there with all parties that it has an influence?

R: Yes, I have been involved for half a year and this working group has been silent for a long time. Yiannis started that up again. Not all parties participate in this working group. So I am the only representative of a handler from that group. Swissport, Menzies, Dnata, are all not included. What I notice is that the participants in that group do have the will to do things, but it has to be done as a unit. You can see that everyone still works from their own interests. So it is often wrestling with the question of what is best for the whole. That's a tricky one. But we have now started a roadmap of what we are going to do in the next two years. What are concrete actions we can take?

I: The biggest stumbling point of CDM is of course when one party drops out.

I: then briefly about the research. I'm trying to find out what are the main reasons why TSAT expires at Schiphol. If you miss TSAT at Schiphol, you miss a piece of runway capacity that you don't use. On bad days this can be as much as 50 percent. By identifying the causes, this study aims to bring back the TSAT expired. I talk to a lot of parties for this. With as many handlers as possible, in addition you have LVNL and I also work partly at Schiphol. As a result, all interests and all perspectives are included in the research.

I: To what extent do you come into contact with CDM in your work as a coordinator?

R: When I was in the execution myself of course daily. Now in my leading role a little less. But it does come up everywhere.

I: To what extent do you have the resources to manage the entire process so that it also runs according to CDM rules?

R: We have two people. One of them looks very much at resource planning and the other is actually constantly looking and steering, what is happening at flight level and are there certain flights that need adjustment. So it also does the TOBT theorem. What you do see in practice, we have a kind of foreman on the platform. This is very important because it must supply the information from the VOP. Based on this information, the coordination adjusts the TOBT. You can see that sometimes it gets difficult. Information exchange must be proactive, which is often not the case at the moment.

I: no, what you often find sick at other airports in the data is correct, that the last minutes before the TOBT are updated a lot. You obviously have a problem there.

I: Where do you think, in your experiences, where things sometimes go wrong with regard to TSAT or TOBT theorem.

R: I think there are many reasons. Information that must come from the VOP to coordination. In addition, security. You are going to close your flight, but you find out that passengers are still missing due to the queues at security. Then you find out at the last minute that the flight is going to run late.

R: if at some point you have a peak with all sorts of flights and you have a limited pushback capacity. Then you often find out last minute that you don't have pushback available for a flight. People are reluctant to update the TOBT because that can of course result in a later TSAT. So they prefer to wait until the last minute and then take action.

I: Of course you hear that very often indeed, that even in the time between TOBT and TSAT there is still handling. I hear this one in all the interviews. Do you see a solution to this problem?

R: The tricky part is that the person who adjusts the TOBT often does not have the knowledge of the effect of an adjustment that is too late. This of course has an effect on the entire process, but the person who carries it out does not have that overview.

I: Is there a difference between that knowledge, under or over the wing?

R: I don't think there's a difference there, it's about a lot of people in the implementation who don't know what CDM is. The term CDM is well known, but we have no idea what it means. We have a flight officer, a kind of foreman, who keeps an eye on both above and below the wing.

I: Are those responsible for this not trained on CDM?

R: No, that's not actually happening. It is explained what the TOBT entails and that they have to adjust it, but they are not taught exactly what that does in the large CDM process.

I: There will be some catching up to do there. It may not be necessary to explain all 16 milestones, but the milestones related to the turnaround process may be useful and valuable to know for such a flight officer.

R: The tricky part is, and we also discussed this in the CDM working group, that this position is almost always held by young people. They grow to another position or you have outflow. So you regularly have a new team of people. So it is a challenge to keep giving all those new people that information all the time. We now have such an E-learning. That could help, the only question is to what extent does someone take such an E-learning seriously. It is often seen as a kind of school work

and you can basically just click through it.

I: yes, I made the Eurocontrol E-learning from my studies. Many group members clicked through it indeed and I did take it seriously. You really notice a difference in knowledge. So that is indeed the second question of E-learning is available and you can also make it available, but does it have the desired effect?

I: Are you affected by flights that have to be brought forward? So if a TOBT can be brought forward, it is often not done. Or you did, but it then has the same effect as a delay on the sequencing process.

R: yes, we do have regular flights that are ready earlier. Especially when we enter the winter season, passenger numbers are lower. Then you handle planes faster. But we also see that if we bring forward a TOBT and nothing happens to your TSAT after that, then if you leave it and then you immediately see the consequence of a later TSAT.

I: yes I asked because an early TOBT can result in a later TSAT. Of course, that shouldn't be the intention

R: yes then you will actually be punished for finishing the handling faster.

R: If you update a TOBT too late now, it will have no consequence beyond a later TSAT. As a handler, I can delay my flight and that will affect all other flights, but I don't notice it myself. I myself receive a report with a score every month, but in the end nothing is done with that score.

I: yes, that score is indeed visible, a way of thinking should actually be created for that CDM process.

R: you should actually have someone that you have someone who updates a TOBT too late, that you then get a call from a very annoying person who makes you aware of it.

I: So you also notice a lot of updates towards the TOBT time?

R: yes, that happens all the time, people are also busy in the process and especially with their own thing. Then little information comes from the VOP to our coordination. Then suddenly a lot of updates come in during the completion. Because then they have a good view of the process. That is also because boarding only closes on V-10. That's just too late if you still have to close everything. I have noticed that at other airports that I fly through myself, boarding simply closes 20 or even 30 minutes in advance. Then you will have insight much earlier whether or not you are going to make it.

R: As an airport, you could impose the requirement that boarding must be completed 20 minutes in advance.

I: where do you get that extra time?

R: That doesn't matter in itself, downstairs the process will run as it always does. At the top you would then bring the process forward a bit. But for your gate agents, for example, it doesn't matter. You actually just shift them in terms of time, but you don't need more of that.

# Appendix V Interview Transcript KLM Cityhopper Captain

Interviewee: KLM Cityhopper Captain Ritsaart Kreiken (R)

Interviewer: Mees Nijsten (I)

Date: November 3, 2022 at 2:00 PM

Location: Online Microsoft Teams

I: I am researching TSAT expired reduction at Schiphol. This is a graduation research that is part of the Aviation Operations study. In this I try to explore the main reasons why TSAT expired. If there are ways to reduce this, the available runway capacity at Schiphol can be better used.

I: You are of course captain at KLC, that speaks for itself. Do you also have any additional tasks?

R: I do indeed fly on the Embrear and as an additional position I am in the Flight Safety department. That was first owned by Cityhopper, only that eventually merged with KLM. We do security checks there. That's how I came to your internship supervisor, we are doing an investigation. We see an increase in actions performed without ATC clearance. We are looking at what contributes to that. One of the things we heard a lot from pilots is that many pilots suffer from the fact that the TSAT jumps up and down continuously. Which means that you have to switch from a calm situation to we have to go now. That is sometimes forgotten to ask for start-up and pushback clearance.

I: That fits in well with this research then.

I: This research is mainly conducted by conducting interviews with all stakeholders involved.

I: How do you feel about the CDM process as a pilot?

R: We have a very small dot on the iPad, where we can see what the TSAT is and what the TOBT is. Often they match and sometimes the TSAT is later than the TOBT. We can see when exactly we are in the TSAT window +-5 minutes. You can therefore already make calls from 5 minutes before you are in the TSAT window. Only 30 seconds before that, LVNL usually accepts it.

I: Is there a difference between the airports you fly to?

R: yes sure. At Schiphol we can monitor our TSAT time on the iPad. If you look at Frankfurt, for example, they also have CDM there. When you park your aircraft, you have a Visual Docking Guidance System (VDGS). There the TSAT time is projected. At other airports I can't remember that time jumping back and forth a lot. If you are ready much earlier, ask the handler if he wants to bring the TOBT forward. This almost always jumps your TSAT forward as well. There you look outside to see what time is on that board and then you call. I don't often have an outstation that you can't go right away. You often have that at Schiphol. Even if you are in the window, you call and then you can't go.

I: They also have that VDGS at Schiphol, don't they?

R: yes, but we with Cityhopper we are almost always on the platform or we are on B16 to B36, you don't have VDGS there. Recently, since corona, we are also occasionally on the Delta pier.

I: If you look at facilities, there is something you can do with that. Do you benefit from being able to watch a VDGS out your window.

R: I'm not 100 percent sure I'll benefit from that. In any case, I think it's nice that the time that is set is also fixed at other airports. If you're not ready yourself and that's why you don't pass your TSAT, everyone will understand why. What's frustrating is when you're almost in your TSAT window and at once it goes back 20 minutes. You notice that much more at Schiphol than at other fields. So where I get my information from I don't find that interesting in itself, I find it more interesting that it remains consistently the same.

I: could you think of reasons why it is possible to maintain that TSAT time in other fields and not at Schiphol?

R: At Schiphol, the TSAT now jumps mainly because the TOBT changes. So in other words, our handler feeds the CDM system with TOBT. Because it is now a mess at Schiphol, you notice that passengers are still missing or the luggage has not yet been loaded. Then you do not reach your own set TOBT, the TSAT responds to that. I can imagine that if you are at an outstation, you are the only KLM flight there at that moment. The handler who handles us is hired for this, so he has more priority to achieve our TOBT. That's more of an assumption, I'm not 100 percent sure.

I: no exactly, I'm just looking for other insights into where things could go wrong. In recent months, we have had some problems at Schiphol, which disrupted this process.

I: if you notice that you are ready for your TOBT, you can bring it forward. I have heard from superiors that if you move early at Schiphol. That you often still get a later TSAT. Is that also your experience?

R: I have to be honest, I can't remember the last time I thought we were going to see him could advance. Imagine that you think you are ready on time, then you could still leave 5 minutes before the scheduled departure time. Sometimes at an outdoor station you are just lucky, the day before yesterday we went to Düsseldorf. On the way there we only had about 20 passengers, on the way back it was a full flight. But because you only have so few on the way there, cleaning the plane is done much faster. You can then turn around much faster. But if you fly to Schiphol you often don't have that, so I have not really had the experience that we could really leave from Schiphol significantly earlier than the scheduled departure time.

I: Have certain agreements or procedures been made with pilots regarding TOBT and TSAT?

R: usually it is reasonably sharp and you see that it often cannot be made true. As a result, you are in your TSAT window, but you are not ready yet, so you cannot leave. What you can do is ask the TLO employee if he can call to adjust the TOBT. Some do it on their own and some let you know. I think they are pretty much on top of that. I think they are over-focusing the TOBT rather than not noticing when the TOBT has expired. Usually when the TOBT has expired you will see a minute later that the TSAT window jumps. There is someone who is watching this process.

I: Yes at KLM Ground Services they were talking about a triangle. You have the gate agent over the wing, you have someone under the wing and you have someone on KLM HUB. The three of them actually determine the TOBT. They can adjust this freely within fifteen minutes, if it is longer than fifteen minutes then they must contact the OCC because it may have consequences for the network.

I: So you have no influence on that yourself?

R: we can't set it somewhere but we can contact the TLO'er, the team coordinator.

I: Where do you think, from your position, where the opportunities lie to improve this process.

R: you mean specifically on the TSAT?

I: yes correct, or in relation to TOBT theorem. The two are often linked together.

R: First of all, you notice that there are so many shortages at the moment. Not only at Schiphol Airport, but also at KLM. There are shortages of colleagues who load luggage. There are shortages of TLO employees. In the past, 1 TLO'er, the one who manages all the ground staff, had 2 or 3 boxes at the same time. Now they do 5 at a time. They have to ensure that 5 aircraft are loaded and unloaded, refueled and catered. As a result, everything actually ends. It's a perfectly oiled machine, until one thing goes wrong and then the whole house of cards collapses. Then you can no longer cope with disturbances. Then you immediately see that the stated TOBTs cannot be met. Once that happens, it often becomes a mess. So that's the first point, that's purely for Schiphol and KLM, there just needs to be more staff.

R: The second is that they go to the DMAN at LVNL. What you now notice is that the TSAT now jumps back and forth every 10 minutes. The TOBT remains the same but the TSAT changes. For example, if the LVNL removes 1 job. Then everything shoots back and forth, which also makes sense. But when another job is added fifteen minutes later, everything shoots back and forth. If somehow some kind of damping could be made in that system. Then that would be very nice. Sometimes you will see the TSAT jump back and forth a few times within a minute. You should be able to filter that out.

I: That the TSAT only jumps when necessary? With the new DEMAN 2.0 they want to create a TOBT window. So you can actually dampen those jumps a bit.

R: Whatever strikes me, I think airlines are allowed to exchange slots. Only you are not allowed to exchange TOBT.

I: slots, as in take-off slots?

R: yes exactly. Imagine we have a lock at 12.00 and a box after us at 12.15. we are not ready but those after us are then you can swap those two. But that is not possible for TOBTs. if you see that one chest is ready 20 minutes later and the other one is waiting, you could swap those two.

I: yes, that is exactly why you lack job capacity in this case. At Schiphol you all wait at the gate, you have no buffer for the runway anywhere. And so if you miss your TSAT, there's no one there to jump into that hole unless they're ready for the pushback right away. If you can make a grouping there in advance that there is an X number of chests ready, if one misses the TSAT then there are others that are ready there.

R: yes that would be great, because pushback is sent to your TOBT I think. What you often see is that you are in your window and you are ready, but there is no pushback. Then you look next to you, then you see an aircraft that is not ready yet, but it is a pushback.

I: yes what I was told, the pushback will be sent to TSAT. With that new DMAN So they want to create that group. They can then exchange them in that sequence.

R: How does it work then? Suppose you have 10 chests in a row, if 1 isn't ready to go, wouldn't you

say it's the next one's turn? Is it then that there is no pushback truck ready there?

I: That may be the case. The same goes for the algorithm, which takes all different variables into account. That algorithm creates a digital “queue, at some airports they make that queue physical.

I: How is CDM embedded within the programme? Will it be in briefings or training afterwards?

R: That's funny you say that. We have an Ipad from work, you get all kinds of handouts about anything and everything. But we never had any training about it. And on the Schiphol site there is quite an extensive training. I encountered them for this research, but otherwise I have never seen them anywhere or heard anyone about them. So no, we haven't had any training on that.

R: TOBT and TSAT, of course, you cooperate on a daily basis. But otherwise that is not in a training afterwards?

I: No, not that I know of anyway.

# Appendix VI Interview Transcript Aviapartner Supervisor Operations

Interviewee: Operations Supervisor Aviapartner Sven Pots (R)

Interviewer: Mees Nijsten (I)

Date: November 16, 2022 at 1:00 PM

Location: Aviapartner Schiphol office

I: What is your position here at Aviapartner.

R: My position is Operations Supervisor. Actually, I am responsible for the turnaround supervisors and the flight watch team. The turnaround supervisors monitor the turnaround themselves. The flight watch team is the group that manages the CDM part with regard to the TOBT and TSAT.

I: The research in brief. I am researching the main reasons why the TSAT expires. By reducing that, we actually want to increase the use of runway capacity. If you now miss TSAT, a piece of runway capacity will not be used. We want to reduce that by means of practical, short-term solutions. The research consists of 3 parts, a theoretical part, a data part. The third and also the largest part is through interviews. In it I have three sub parts. The first concerns whether what is seen on the platform during the turnaround is actually passed on to the TOBT. The second part is how and when this happens. You can now see that the closer you get to the TOBT, the more updates there will be. The third, which is about a culture piece, how is the CDM process and theory understood by the people who work with it. Those are actually the three parts in the interview piece.

I: How does CDM play a role in your daily work?

R: If I'm not in the operation then CDM doesn't play a role. If I do run in the operation then I am the one who implements the TOBT updates.

I: On what basis do you implement those updates?

R: based on information. It comes from the gate or the person standing on the platform, by telephone.

I: and do you feel for yourself that you can make an accurate TOBT statement through that information flow?

R: well, the surprise is always in the end of the turnaround. You can't predict that. No matter how beautiful it looks on paper. There are always passengers who don't show up, or luggage is also a difficult story lately. At the beginning of the summer, of course, we had security problems. Then it's just Murphy's law, the domino effect. If my colleague who is outside says, I need another 10 minutes, then it will be an update. But this will not take place earlier than 15 minutes before departure.

I: that updates late, which is a problem, sometimes there is no other way.

R: never actually, unless you know housekeeping is still not there 30 minutes before departure. But even then I can continue it once for 10 minutes, but then you are still in the final phase of the

turnaround. Then an update can always take place.

I: yes, exactly. You say I update the TOBT, via what do you do that?

R: That is done through CISS.

I: if I go back to that turnaround coordinator on the platform, they have knowledge of CDM. Besides knowing what TOBT is, they know what the process around it entails.

R: They get information about that in the training, so they should know that.

I: What is going on a lot at the moment is that CDM is not understood. TOBT and TSAT are well known concepts. But not really.

R: Well, the problem is that not every aircraft has a turnaround coordinator. This is contractually agreed with the airline. That depends on what they are willing to pay for it. If you don't pay for it, you get an old-fashioned foreman, who just puts the suitcases in and takes them out. That is not the level at which they train. This is the same when passing. He is responsible for above the wing and a load officer under the wing. There is no one coordinating. For them, that box is ready when it is ready, so to speak. That is also something that matters. In the end, it all comes down to the resources and the tools you have. And it's not just security that's lacking.

I: yes, so you are really suffering from the shortage on the labor market?

R: Yes sure.

I: And before COVID and the tight labor market, did you see the same problems?

R: Then it was more stable, yes.

I: Things were more stable there, but things didn't go well there at times. What did you see as the reasons for that when the TSAT expired, or the TOBT was not set properly.

R: There is of course a part of the captains who do not call on time. If you are in your TSAT window and it has been busy for 2 minutes, then it has 3 minutes to call, then it is up to them. Then you cannot proactively continue the TOBT, which would be too late anyway. Because you don't want to because we're done. That's one of the factors.

R: On the other hand, part of our operation remains not covered with a turnaround coordinator, contractually. Then colleagues above the wing have other priorities in the latter phase of the turnaround. This also applies to the platform employees.

I: yes, that is indeed only a very small part of their work.

R: Given that we are indoors, they should be our eyes and ears of course. We have been advocating for cameras on the platform for a long time. But that is somehow privacy technically not possible.

I: yes, I've heard that more often in previous interviews. They are working on that. There is even a whole system for automatically recognizing in which phase of a turnaround a box is. But that is still a difficult story.

I: do you see solutions for this to improve this, it does not have to be so much from you. This can also be from other stakeholders. I am also talking to all stakeholders. Do you see solutions for this from any stakeholder? Let's disregard COVID and the security situation here.

R: At least that the tools would be sufficient. There has been talk for a long time about a process that should be able to automatically recognize the turnaround. In terms of luggage and cargo, I find that a bit debatable, because you don't know what the expectation is there. Sometimes we really have 10 to 15 departures in 20 minutes. We never have 10 to 15 pushbacks available. The final distribution is also a point that we run into. In addition, the space at Schiphol also plays a role. We are sometimes on Delta Bravo and Charlie pier, and Alpha platform.

I: You also have to deploy the already scarce resources in a very distributed manner. So you would also look at slot allocation. Putting you all together on 1 pier would make the job easier.

R: once you get a gate change from the Bravo, you go straight to the Charlie pier. With the resources that are available, certainly now, but also in general. We still have a competitive battle at Schiphol.

I: when you talk about resources, that is of course personnel, but do you also suffer from too little equipment?

R: It's mainly staff at the moment.

I: Do you feel that an advance of the TOBT is not rewarded in your TSAT time.

R: No, I don't feel that way. You will be regularly rewarded for this.

I: it was indicated to others that in that case the TSAT either remains the same or shifts backwards. Then you will be punished for something good.

R: no, it sometimes happens, but in general that TSAT just pops up.

I: We just talked about the pilots not calling in their TSAT window. To what extent do they influence the TOBT statement?

R: It's very hard to plan the minute when that door closes. Ultimately, the cabin crew themselves decide when they think that door can be closed. So if that is 1 minute after your TOBT time and your TSAT is the same as your TOBT. Then I'm not going to shift that TOBT time by 10 minutes. Then it will be indicated as a delay, then the airline will ask questions. That is all contractually arranged. In this example if the pilot calls within 4 minutes there is nothing to worry about. But then he has to do this. We also do not know to what extent they have completed their paperwork and other matters in the cockpit.

I: That is very difficult to coordinate that together?

R: yes exactly

I: Is there a difference between up and down the wing in terms of issues that you see passing by?

R: No, it doesn't matter that much. The advantage from above is that we can often monitor boarding ourselves. 5 minutes before departure you will be asked about the status of boarding. If 40 more people have to board then I know they won't make it in those 5 minutes. Then you will be within your 5 minutes for TOBT, again at the last minute.

I: Actually, you should already have a measuring point for that.

R: yes that's right. But that is impossible with crates that have a turnaround time of 35 to 45 minutes.

I: those short turnaround times make that a difficult story indeed.

R: yes exactly. Yes, as far as TOBT adherence is concerned, set a correct TOBT 20 minutes before time. That's nice for a KLM B777 going to Bangkok, but not for the aircraft we deal with.

I: Then I actually come to your procedures for advancing steps. But that is not technically possible because you have such short turnaround times. That is indeed what was seen as an idea. To bring forward the moment doors close. But you don't get that if you have such short turnaround times.

R: Close doors bring it forward?

I: Now the doors are often closed 5 minutes in advance. If you bring that moment forward, so start boarding earlier and close earlier. Then you also have a longer time to recognize delays and disruptions before you get within 5 minutes of that TOBT.

R: We also notice, apart from security, there is no communication with external parties at Schiphol. The fuel company has a lot of problems lately. So we don't get a good estimate. Fifteen minutes before time, we hear from the person at the gate that they are still waiting for the fuel truck. But the estimate from the fuel company does not come. So you keep updating the TOBT until the fuel arrives. There is an information gap between the third parties that influence our operation. That's about fueling and cleaning. These parties all influence our turnaround, of which we do not receive any concrete estimates.

I: you have no communication with those parties during a turnaround?

R: yes we can call them but the answer we always get is that they are on their way. That can be 5 minutes, but it can also take 15 minutes.

I: Then still 1 question or the culture piece. You are trained in that around the CDM process. Are there still improvements to be made?

R: Presentation is used that we got from the CDM group. The people who work operationally really know what a TOBT is. It's not about knowledge.

# Appendix VII Interview Transcript LVNL Ground Controller

Interviewee: Ground Controller and Outbound Planner LVNL Stefan de Jong (R)

Interviewer: Mees Nijsten (I)

Date: December 12, 2022 at 3:30 PM

Location: Online

I: What are your activities within LVNL?

R: I am Stefan de Jong. I am a ground controller and outbound planner. I have been working at LVNL for 25 years. I have worked as an operational expert in the Procedures department for 13 years. There I took over the baton of CDM from my college who has retired. For the past 1.5 years I have been working as an operational expert at the Strategy & Capacity Management department. And in that capacity I interfere with CDM.

I: So you also participate in the CDM working group?

R: yes, Fabienne Nieuwlaat is the one who participates from the office. I support her from the operation in that. Of all the people in the operation, I am the one who knows the most about CDM and how CDM works in the operation.

I: How does CDM play a role in your daily work?

R: as a ground controller you are indirectly involved in this. But I am always very aware of the C in CDM. That you really have to do it together. I saw the benefits of CDM from the first day of my course at Eurocontrol. I try to propagate that as much as possible. I am sometimes jokingly referred to as the CDM police on the tower. I see that there is still a lot to be achieved in the current operation.

I: Is CDM less popular with other colleagues than with you?

R: I always feel that other colleagues see CDM as a necessary evil. While if it really worked well, I see the benefits of it. Then it makes the operation a lot easier and more predictable.

I: The benefits are of course enormous, provided everything works properly.

R: yes, what makes it difficult sometimes is that there are many conflicting interests. You would think everyone wants to get rid of as many planes as possible in the shortest possible time. Yet you see that whether the interests at the airport are different from those of the airlines. Or other combinations of stakeholders where interests collide. No one can object to getting rid of as many planes as possible. But one company wants its planes to leave first.

I: To what extent do you relate to the TOBT theorem? That is of course done, but to what extent do you have to deal with it.

R: Firstly, we see that reflected in the capacity we lose. When I look at the whole as a planner, you see, for example, that you can initially start with 2 jobs. TOBTs are then adjusted last minute, so you are not going to start 2 jobs anyway. You notice that because the TOBT is not accurate enough and

our sequencer can handle it very badly, you see that the planning lacks efficiency. As a result, we lose capacity.

I: How does the sequencer play a part in that?

R: Our sequencer is actually too efficient. At the time I took over from my lecture, the sequencer had already been made in-house. That sequencer was actually made in such a way that it could take over 1-on-1, exactly the task we had at the time as a start-up controller. That turned out to be a mistake. Our current sequencer actually ensures that a certain amount of delay is already generated. We are now trying to remove that with the new DMAN story. That has already been successful, but that is not yet in operation.

I: The delay generated by the sequencer is then the time difference between TOBT and TSAT?

R: Yes right. Normally you shouldn't lose capacity when you call inside the TSAT window. What our sequencer is doing right now: it gives you a spot based on TOBT + Taxi time. If you don't make it to that spot, you will by definition lose capacity. That also has to do with a combination of how the sequencer plans and what we as an outbound planner do again. So I'm going to change the schedule again at the last minute. This causes loss of capacity and instability for chests that are not yet in the TSAT window. So it is actually a combination of planning to the minute by the sequencer, how the outbound planner plans and the quality of the TOBT. Those three things together mean that we are losing capacity at Schiphol.

I: with the new DMAN you actually want to create a window for the TOBT. So you can exchange an x number of aircraft with each other as soon as someone is not exactly ready on their TOBT.

R: DMAN is not going to sequence to the minute. We divide the hour into blocks of 10 minutes. In those 10 minutes we will plan a number of aircraft. The order does not matter here. As long as you go airborne as an airplane in those 10 minutes. The advantage of this is that several aircraft can also have the same calculated TTOT. CPDSP does not plan all aircraft with a different TTOT. That construction already set a delay based on the capacity at the airport. That's where the first delay already starts.

I: So you create delays for planes that could actually leave, unlike others.

R: yes that's right. The current CPDSP puts 1 aircraft in 1 slot on the runway every time. If that plane doesn't make it to that slot, there are last minute changes. Then no other aircraft can enter that slot and then you lose capacity.

I: With the new DMAN, do you actually want several aircraft to wait on the runway?

R: That could be a consequence. You want the sequencer to offer a certain amount of aircraft to the operation. Our current sequencer does that with 1 plane at a time. With the new DMAN there are more. There is naturally a spread in that because one calls on TSAT - 5, the other TSAT +3. In addition, 2 aircraft can never call at the same time. If they were both ready at the same time, you can only have 1 on the radio. It automatically spreads. The system will ensure that every flight has the chance to reach its TTOT within that window -+5 minutes. As a result, we do not lose any capacity. If you call after your TSAT with our current CPDSP, you are already losing capacity. So not only TSAT expired, because that is by definition a loss of capacity. So you lose capacity if you haven't called your TSAT at the latest, and that won't matter with the new DMAN.

I: what effect does late updating of the TOBT have on the TSAT.

R: For the individual flight that doesn't really matter much. With the current sequencer it still gets the best TSAT. I always compare it a bit with putting your towel down on the beach. You are not going to use it yet, but you do have your towel ready. This way you can see through last-minute changes that you are constantly holding on to your spot. This prevents other chests from getting into their TSAT window. So you see that mostly in the TSAT of other chests. So they suffer from that. There you actually touch on a problem which is the basis of this whole story. A handler is charged by the airline on TSAT delay. That is not right. You cannot checkout a ground handler on TSAT delay. Because TSAT is a result of supply and capacity and a handler has no influence on either. The only thing you could address a handler on is the delay in handling. That is a very difficult problem to tackle.

I: then you should settle the handler on a TOBT delay instead of a TSAT delay?

R: Correct, I think yes.

I: What are the EXOT/EXIT based on?

R: That is seeing what the historical realization is there. With an expert judgment on top of that. Together with 2 colleagues, I recently reviewed that taxi times table. We had a taxi time table where you had, for example, A42 and A43, where the taxi time could just differ by 3 or 4 minutes. That is of course nonsense. If you are on a certain stand, you can therefore have more delays because there is also inbound traffic or other factors that may affect you. We got rid of all those things. You shouldn't actually look at that taxi times table historically, but you should especially look at the taxi time if you only have 1 flight. That, for example, 1 flight has 3 or 4 minutes extra taxi time, yes that is possible, but that is the operation. We will then determine that. You don't have to plan for that by default.

R: Those are things that we have been able to extract from it in recent years, but at first you saw very strange things in them. If you're talking about taxi times. We only have 1 taxi times table. If it is BZO then we still use the same table. Or if there is snow. Soon we will be able to do that with DMAN. For BZO we have a different taxi times table that takes this into account.

I: then you get the same principle that you now have for the runway capacity in different BZO phases?

R: Yes, Eurocontrol has already put that in their manual. As Schiphol, we thought we knew better. And now we find out that it would be useful if we had that. What we can also do is that you add a percentage to the standard taxi time.

I: Before the DMAN comes along, do you think there are things that could be tweaked in the near term to reduce the TSAT expired cases.

R: There are a number of issues. The handler now leaves the TOBT until the very last moment when they don't make it. We say do that in advance, if you're not sure if you're going to get your TOBT. You can say we will no longer focus on the TSAT, but we will focus on the TOBT. If, as a handler, you have your box ready within +-5 minutes of the TOBT, then you are doing well. Small TOBT updates (less than 5 minutes), we should stop doing that. Because each TOBT update can cause up to 9 TSAT updates of other aircraft. A Set n current time against the TOBT. Now we have compared the TOBT 20 minutes before departure with the TOBT 10 minutes before departure or against the previous TOBT. Basically you want to see what your last TOBT is compared to the Actual End of Ground

Handling Time. Then you can see how good the prediction of the TOBT is. The airport is also busy with deep learning. With those cameras around the platforms to monitor the turnaround. I think that will be a first step to ensure that we can also go from data analysis to the handlers and tell them that they should adjust the TOBT better.

R: As long as you haven't implemented all those things, it will be very difficult. You have to make the handler feel a nuisance that he is not doing a good job. Our current system does not. In fact, you can get your TOBT updated and still get the best TSAT.

I: That shouldn't be possible. The Eurocontrol manual also prescribes not to pass on adjustments to the TOBT for less than 5 minutes.

R: Basically everything we came up with to make it better is actually kind of in the DMAN story. What we do in DMAN everyone starts with the same priority. But if the handler is not predictable enough with the TOBT, you lose priority.

R: CDM always works very well at an airport that has no capacity problem. But you want CDM to work well at an airport where the supply exceeds the capacity. The DMAN will keep track when you update the TOBT. If you do that after TOBT -6, you will go back in priority. The moment you have to fight as a flight with other flights for a place in the sequence, you can be delayed so much. That should be an incentive for the handler.

I: So you want to attach a “punishment” to it so that they also see what the consequence is.

R: yes exactly, now it is: oh we won't make it but we'll just leave it. Soon it will be: let's update because then we won't get a lower priority.