

Planning inefficiencies within the overall planning system of Mainport Schiphol

An analysis of alignment issues between the major stakeholders in the Dutch aviation sector, causing planning inefficiencies in the inbound and turnaround phase

Thesis



KDC Mainport Schiphol – Centre of Excellence
A collaboration with the Aviation Academy, Amsterdam University of Applied Sciences

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Thesis

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Preface

This thesis is created as the final product of my bachelor studies, in order to obtain my bachelor's degree in aviation Operations, with a specialization in Logistics, at the Amsterdam University of Applied Sciences (AUAS). The subject of the thesis, planning inefficiencies within the overall planning system of the Mainport Schiphol, resulted out of a fascination I have for planning and the collaboration between the many different stakeholders involved in the dynamic aircraft process at Amsterdam Airport Schiphol. The research was conducted in the commission of the Centre of Excellence department, as a part of the research agenda of the Knowledge and Development Centre. I have been working on the research from February of 2019 until August of 2019.

During the research, I received much guidance from both my AUAS thesis advisor, Frenchez Pietersz, as well as my thesis advisor provided by the KDC, Coen Vlasbom, the representative of KLM Royal Dutch Airlines within the KDC management team. I want to thank them, especially for their contribution and support during this research. I am thankful that both were willing to invest a significant amount of time and effort in guiding me through this project in the last couple of months.

Furthermore, I would like to thank all other people involved with the KDC, i.e. Boudewijn Lievegoed, Evert Westerveld, Catya Zuniga and Alina Zelenevska for offering their guidance and feedback, as well as the operational experts apart from the KDC that have contributed to this research.

Lastly, I would like to thank my fellow graduation interns at the KDC – CoE for their moral support in the last couple of months, the many brainstorm sessions we hold concerning our researches that would often end way off-topic, but most of all for the countless fun moments we experienced, both in and outside office hours. I am grateful to get to know all of them a lot better and even create new friends in the final stage of my studies.

I would like to end this preface with one of the favorite quotes I learned from fellow KDC – CoE graduation student Kyara Metz, which proved to be very useful in the last couple of months.

Appel, Peer, Banaan,
Laat het los, laat het gaan! (K. Metz., personal communication, 2019)

F. Mollema

Schiphol, 14 August 2019

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Abstract

Within the Dutch aviation industry, many stakeholders are involved in the aircraft process. Each stakeholder can influence a part of the aircraft process, for which they create their planning. The main stakeholders within the industry suspected that each stakeholder is merely focused on their own process(es) and individual planning and is not aware how certain decisions within their part of the aircraft process might affect other stakeholders and their planning. It was unsure if specific alignment issues between the stakeholders, causing unnecessary planning inefficiencies, existed. The objective of this research was to find these alignment issues and the corresponding planning inefficiencies, thereby also measuring their impact on the overall planning system. Different methods were used in order to achieve this objective, including literature research on both alignment and planning, interviews were held with different operational experts to determine the alignment issues and planning inefficiencies and data was analyzed to determine the impact on the overall planning system. The planning inefficiencies and their corresponding effect and impact are stated below.

- Aircraft enter the FIR boundary earlier than planned, resulting in a change in the inbound planning. Of all flights measured, 24% are early entries.
- An average taxi-in time is used in flight plans, which can cause a change in the inbound planning. Of all movements measured, 24% of the planned taxi-in time is incorrect when considering a buffer of 2 minutes.
- The term OTP is used in different ways, which confuses stakeholders. When compared, both OTP's counteract each other.
- A 5-minute TOBT interval is used within the outbound planning, which results in an inaccurate indication for the outbound planning. The interval is used by all airlines, to some extent.
- Last-minute updates are made regarding the TOBT, resulting in last-minute changes to the outbound planning. Results vary per airline per month from 23% to 62% of all updates being made within the final 5 minutes before the initial set TOBT.
- TSAT expires due to an inaccurate TOBT, which affects the outbound planning. Results vary per airline per month from 3% to 18% of all TSAT's being expired.

It is essential to minimize the impact of these inefficiencies in order to improve the efficiency of the overall planning system at Amsterdam Airport Schiphol, which could eventually benefit the capacity issue. However, more in-depth research on all inefficiencies must be performed since this research only provides a more explorative and general indication.

Keywords: planning, inefficiencies, aircraft process, alignment, OTP, TOBT, Amsterdam Airport Schiphol.

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List of abbreviations

A

AAS	Amsterdam Airport Schiphol
A-CDM	Airport Collaborative Decision Making
AIBT	Actual In-Block Time
ANSP	Air Navigation Service Provider
AOBT	Actual Off-Block Time
APOC	Airport Operations Centre
ATM	Air Traffic Management
AUAS	Amsterdam University of Applied Sciences

C

CoE	Centre of Excellence
-----	----------------------

E

EIBT	Estimated In-Block Time
ELDT	Estimated Landing Time
ETA	Estimated Time of Arrival
EXIT	Estimated Taxi-In Time

F

FSC	Full Service Carriers
FIR	Flight Information Region

G

GH	Ground Handler
----	----------------

I

IAF	Initial Approach Fix
IATA	International Air Transport Association
IB	In-Block
IL&T	Human Environment and Transportation Inspectorate
IS	Information Systems
IT	Information Technology

K

KDC	Knowledge and Development Centre
KLM	Koninklijke Luchtvaart Maatschappij (Royal Dutch Airlines)

L

LCC	Low-Cost Carrier
LVNL	Luchtverkeersleiding Nederland (Air Traffic Control the Netherlands)

N

NM	Network Manager
----	-----------------

O

OB	Off-Block
OCC	Operations Control Centre
OPL	Outbound Planner
OTP	On-Time Performance

P

PAX	Passengers
PI's	Planning Inefficiencies

R

RWY	Runway
-----	--------

S

SIBT	Scheduled In-Block Time
SOBT	Scheduled Off-Block Time
SQ	Sub-research Question

T

TOBT	Target Off-Block Time
TSAT	Target Start-up Approval Time
TTOT	Target Take-Off Time

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Summary

Within the Dutch aviation industry, many stakeholders are involved in the aircraft process. Three of the main stakeholders are represented within the KDC: KLM, AAS and the LVNL. Each of these stakeholders can influence a specific part of the aircraft process, for which they create their planning. Other parts of the aircraft process, over which a stakeholder has no control, are influenced and planned on by the remaining stakeholders.

Since the aircraft process is a continuous cycle, all stakeholders involved are carrying dependencies on one another, which also influences the individual planning each stakeholder makes. A certain level of collaboration is required, to succeed both the overall aircraft process as well as the individual stakeholders' process. However, the KDC management team suspected that each stakeholder is merely focused on their own process and planning and is not aware how individual decisions for/within their part of the aircraft process might affect other stakeholders and their planning. It was uncertain if alignment issues between the stakeholders existed, causing unnecessary planning inefficiencies within the overall planning system at Mainport Schiphol. The following main research question was formulated to research this subject:

“Do planning inefficiencies amongst the major stakeholders at Amsterdam Airport Schiphol occur and, if so, what impact do they have?”

Qualitative and quantitative research was performed in order to analyze the above-stated question, including a literature review, interviews with operational experts and data analysis. Literature was reviewed mainly on the topics of alignment and planning, to gain insight into these topics. After that, operational experts were interviewed to determine planning inefficiencies that they currently encounter within the inbound and turnaround phases of the aircraft process. Six planning inefficiencies were determined, which are stated in the table below.

Planning Inefficiency (PI)	Effect on overall planning system	Impact
Aircraft arrive at entry earlier than planned.	Inbound planning changes due to early arrival.	24% of all flights are early entries.
Inaccurate representation of taxi-in time is planned on.	Inbound planning changes due to later or earlier arrival at in-block position than planned	24% of taxi-in time is incorrect when considering a buffer of 2 minutes.
Same OTP term is used but with a different meaning.	Confusion amongst stakeholders concerning the term OTP.	OTP's counteract one another.
A 5-minute TOBT interval is used within the planning.	Inaccurate indication for outbound planning.	Interval is used by all airlines, to some extent.
Last-minute updates are made regarding the TOBT.	Last minute changes to outbound planning.	Results vary from 23% to 62%.
TSAT expires too often, due to inaccurate TOBT.	TSAT expires too often which affects the outbound planning.	Results vary from 3% to 18%.

Data analysis was performed in order to measure the impact of all planning inefficiencies on the overall planning system. Of the total amount of flights measured, 24% entry the FIR boundary earlier than planned. Of these early entries, 54% occur within the 5 minutes before the planned entry. For the planned taxi-in time is measured that 27% of the total amount of taxi-in times are planned on correctly, considering a buffer of 30 seconds prior and 30 seconds after the planned time. When increasing this buffer to 2 minutes, the percentage increases to 76 %. The difference in OTP meaning cannot be measured in the same way as the other planning inefficiencies. Since one OTP is indicating the arrival performance, and the other is indicating the departure performance, the outcomes are very different when compared to each other. When comparing the outcomes of both OTP's, a trend can be noticed in where both KPI's seem to counteract one another. For the TOBT it was measured how often this planning-time ends on minute 0 or minute 5, indicating if airlines round off their TOBT to a 5-minute interval. The top 10 airlines at Amsterdam Airport Schiphol all show a relatively high percentage, the outcomes vary between 52% and 88%, indicating that all these airlines make use of the 5-minute interval to some extent.

For the same planning-time was measured how much of the total amount of TOBT updates are made in the final 5 minutes before the previous set TOBT. The lowest percentage measured is 23% per month; the highest percentages measured is 62% per month. The last planning inefficiency was measured by calculating the percentage of the TSAT's that have expired of the total TSAT's that were issued. The results vary from 3% to 18% per airline per month.

It is recommended that more awareness must be created amongst the stakeholders on the importance of collaboration and alignment within the overall planning system, even more since the lack of capacity at AAS has become an increasing problem. Stakeholders must be aware of the impact they practice on each other's operation and corresponding processes and how this eventually affects their operation in the continuous cycle of the aircraft process. It is recommended that general training regarding this topic is given regularly by an independent party. However, stakeholders must be willing to participate. Also, more and better communication is vital. The Airport Operations Centre (APOC) might be a good starting point to achieve more alignment and communication. The A-CDM system has already contributed to better alignment amongst the stakeholders. However, it is currently used as an outbound system. It is therefore recommended to use A-CDM as an inbound system as well since these two phases profoundly influence each other. Furthermore, it is recommended that the planning inefficiencies found concerning the TOBT planning-time should be prioritized when considering performing more research. These inefficiencies affect all stakeholders and showed the most significant impact of all planning inefficiencies measured regarding the numbers and figures. When the impact of these two inefficiencies is minimized, the TSAT will thereby automatically expire less due to a more accurate set TOBT. It is recommended that at least more often and explicit training regarding this subject is provided to ground handlers operating at AAS. Lastly, it is recommended to perform more research on how possible future solution designs for the planning inefficiencies can benefit the capacity issue at AAS.

1 Introduction

The international air traffic industry is expanding each year. “International Air Transport Association (IATA) expects 7.8 billion passengers to travel in 2036, a near doubling of the 4 billion air travellers expected to fly this year.” (IATA, 2017). This development will result in more air traffic in the future, which will affect Amsterdam Airport Schiphol (AAS) as well. Spierings (2019) found that AAS is already reaching the limits of the available capacity of the airport, without having the possibility of expanding their area of operations any further. Thus, other solutions for the capacity issue are needed. One of the approaches for this problem regards finding ways to make more efficient use out of the capacity that is currently available. Research concerning this topic are performed within the Centre of Excellence (CoE), a department within the Knowledge and Development Centre (KDC). The KDC is:

“The Knowledge & Development Centre (KDC) sets itself the task to find valuable and innovative solutions for the sustainable development of the Mainport Schiphol. In the KDC the Dutch aviation partners Royal Dutch Airlines (KLM), Amsterdam Airport Schiphol (AAS) and Air Traffic Control the Netherlands (LVNL) work together with universities and other research institutes to innovate the Schiphol operation.” (KDC, n.d.)

Within the Dutch aviation industry, many stakeholders are involved in the aircraft process, of which three of the main stakeholders are mentioned above. Each stakeholder can influence a specific part of the aircraft process, for which they create their planning. Other parts of the aircraft process, over which a stakeholder has no control, are influenced, and planned on, by the remaining stakeholders. Since the aircraft process is a continuous cycle, all stakeholders involved are carrying dependencies on one another, which also influences the planning each stakeholder makes. A certain level of collaboration is required to succeed both the overall aircraft process and thus, the individual stakeholders' processes. However, the KDC management team suspects that each stakeholder is merely focused on their own process and planning and is not aware how individual decisions for/within their part of the aircraft process might affect other stakeholders and their planning. It could be that specific alignment issues between the stakeholders exist, causing unnecessary planning inefficiencies.

Planning inefficiency (PI)

A specific instability within the overall planning system caused by an insufficient alignment between stakeholders due to different points of focus, resulting in a deviation from the planning or an affected performance of one or multiple stakeholders.

Even though the aviation industry is a very dynamic operation in which flexibility is necessary in order to continually adapt to changing circumstances, the stability of the overall planning system becomes more and more critical due to the growing amount of traffic and the decreasing amount of available capacity. If potential PI's could be determined and eliminated, this would contribute to the stability of the overall planning system. Eventually, this might even have a positive effect on the capacity problem of Amsterdam Airport Schiphol.

There are many reasons why deviations from the planning occur or why the performance of a stakeholder is affected. Often this is caused by certain or unforeseen variables. Some of the leading causes are listed below:

- Weather conditions
- Airport disruptions (i.e. a crash in a particular information system)
- Lack of resources
- Capacity limitations (i.e. implementation of electronic flight strips in ATC Tower)
- Increase in workload

Since these variables cannot be foreseen or eliminated, deviations caused by these variables will not be considered. This research will focus only on PI's, which can be eliminated or avoided and on which stakeholders can act upon, regardless if they are aware of the PI or not. In this chapter, the problem statement is stated and elaborated (paragraph 1.1), the relevance of the research is explained (paragraph 1.2), the main research question and the sub-research questions (SQ's) are stated (paragraph 1.3), the scope of the research is defined in paragraph 1.4, any assumptions, limitations and/or delimitations with regard to the research are stated in paragraph 1.5 and the structure of the research is explained in paragraph 1.6.

1.1 Problem statement

An inevitable topic within capacity management is the development and compliance of specific plans. Each stakeholder within the Dutch aviation sector creates, and operates on, their schedules and planning-times within the aircraft process. Due to Airport Collaborative Decision Making (A-CDM), a significant amount of definitions used for certain planning-times are already aligned through "milestones". However, since each stakeholder puts their focus on different parts of the process and therefore different milestones (planning-times), it could lead to inefficiencies amongst other planning-times along the aircraft process, which could affect the performance of other stakeholders within the sector. The problem, as defined above, will not benefit the already limited capacity of Amsterdam Airport Schiphol. It has not yet been researched if inefficiencies indeed arise due to the factor explained above; it is only assumed by the stakeholders involved. Therefore, the following problem statement is formulated.

It is unknown if planning inefficiencies arise between stakeholders due to the focus on only the stakeholders' individual planning, instead of the overall planning of the system.

1.2 Research relevance/significance

This research regards every main stakeholder within the Dutch aviation sector. If PI's do occur and they are eliminated, this will create more alignment, stability and inefficiency in the overall planning system, which may eventually even benefit the capacity issue. Therefore, this research is relevant for every stakeholder involved in the aircraft process. If this research is not performed, it will remain unsure whether PI's occur or not and if more alignment can be achieved. When this research is not performed, this may have consequences for the stakeholders involved since they might be collaborating inefficiently and are unconsciously negatively affecting the already limited capacity of Amsterdam Airport Schiphol.

1.3 Research questions

The main research question, which is derived from the problem statement, is stated first in subparagraph 1.3.1. After that the SQ's are stated in subparagraph 1.3.2, in which the background questions are stated as well.

1.3.1 Main research question

As explained in paragraph 1.1 and paragraph 1.2, the proposed problem is that it is unknown if PI's arise due to the focus on different processes and planning-times between stakeholders, while these are interdependent. Therefore, the most crucial objective is to determine if PI's indeed arise due to the factors as explained above. However, to determine which planning-times are affected and how much these are affected, the PI's are linked to deviations found within the inbound and turnaround process. The impact of the PI's can then be analyzed, and it is clear which inefficiencies are the most important to try to eliminate. All factors mentioned above are included in the main research question:

“Do planning inefficiencies amongst the major stakeholders at Amsterdam Airport Schiphol occur and, if so, what impact do they have?”

1.3.2 Sub-research questions (SQ's) and background questions

To be able to answer the main research question, multiple sub-research questions (SQ's) are created. Given that the main research question is too comprehensive and complex to answer at once, the question is broken down into four sub-research questions which are stated below. The first SQ focusses on alignment concerning planning between the stakeholders. The second SQ will focus on the planning within the inbound and turnaround processes of the different stakeholders involved. The third SQ focusses on what planning inefficiencies occur within these processes. The final SQ focusses on the impact of the inefficiencies found. For every SQ, multiple background questions are determined as well. These background questions will help to answer the SQ in a step by step manner gradually. This way, it is clear which approach is chosen.

SQ 1: How can alignment issues concerning planning between the stakeholders in the Dutch aviation industry be identified?

- a) What is alignment?*
- b) What types of alignment exist?*
- c) How can alignment be applied; i.e. what methods are used?*
- d) What is the current situation on alignment concerning planning between the stakeholders in the Dutch aviation industry?*

SQ 2: Within the inbound and turnaround phase, which stakeholder plans on what processes and how?

- e) Who are the main stakeholders?*
- f) What is the process (journey) of an aircraft?*
- g) What defines the inbound and turnaround process?*
- h) What are the most critical planning-times used within the inbound and turnaround process?*

SQ 3: Where in the inbound and turnaround phases can planning inefficiencies be identified?

- i) What is the definition of a planning inefficiency?*
- j) Which planning inefficiencies can be found in the inbound and turnaround process according to operational experts?*
- k) How are the planning-times and KPI's defined by each stakeholder? Are there different definitions for the same planning-times?*
- l) Are the planning-times dependent on each other and, if so, in what way?*
- m) Do these inefficiencies only impact one stakeholder or multiple stakeholders?*

SQ 4: What is the impact of the identified planning inefficiencies?

- n) Which data is needed?*
- o) Where can this data be found?*
- p) In which part(s) of the aircraft process occur deviations?*
- q) What causes these deviations?*
- r) How often do these deviations occur?*

1.4 Research scope

First, this research will only consider PI's caused by controllable variables. PI's which cannot be avoided or controlled will not be elaborated. Only the tactical planning phase, which is the most up-to-date planning, is considered during this research. Preliminary planning phases, such as strategic or pre-tactical, are not considered. All the main relevant stakeholders of Amsterdam Airport Schiphol are considered during the research; however, since there is not a specific ground handler represented within the KDC management team, this stakeholder is elaborated from a general perspective. The flights that are analyzed within the data analysis are from the summer of 2018 (from March 2018 until October 2018). This season has been chosen because of multiple reasons. The first reason is that this provides relatively up-to-date data, in which Airport Collaborative Decision Making (A-CDM) was already implemented. In the year before, this was not the case. Also, the summer was chosen rather than the winter since there are fewer days which must be filtered out due to bad weather (disruptions). This decision also means, however, that a process such as de-icing is not considered in this research. Furthermore, the research will only focus on the inbound and turnaround process. The outbound process itself is left out of scope. Also, only airside processes are analyzed, landside processes are not considered. Furthermore, this research analyzes which PI's arise amongst the overall planning system of stakeholders at AAS. If any possible PI's are found, possible solutions can be proposed. However, the solutions may not be elaborated into detail and cannot be tested in real-life operations. Further research must be performed into the effectiveness of the proposed solutions.

1.5 Assumptions, limitations, and delimitations

Two assumptions are made during this research. As explained in sub-chapter 1.4, the focus lies on the inbound process and the turnaround process. Definitions of both processes may differ per source; therefore, an assumption was made for both processes regarding the beginning and ending from the perspective of where the aircraft is located. The inbound process is assumed to begin when aircraft enter the Flight Information Region (FIR) and end when aircraft reach their In-Block (IB) position. This is the moment when the inbound process alternates with the turnaround process. The inbound process begins when aircraft are IB and ends when aircraft are Off-Block (OB). No significant limitations or delimitations were determined before or during the research. Therefore, this will not be elaborated further.

1.6 Thesis structure

The structure of the thesis is stated below in table 1. Chapter 2 will elaborate on the methodology used during the research, both quantitative and qualitative. Chapter 3 and 4 explain the literature that was reviewed for this research, which is focused on inter-organizational alignment and planning, respectively. Chapter 5 and 6 contain the analysis regarding the planning inefficiencies. Chapter 3 until 6 is divided into different phases, which are elaborated in chapter 2. Following the analysis, the findings are stated in chapter 7. The findings will lead to conclusions in chapter 8 and the discussion in chapter 9. Finally, the recommendations are given in chapter 10.

Table 1. *Thesis structure.*

Chapters	
1.	Introduction
2.	Methodology
3.	Literature on alignment
4.	Literature on planning
5.	Inefficiencies in planning
6.	Impact of PI's
7.	Research findings
8.	Conclusion
9.	Discussion
10.	Recommendations
11.	List of references
12.	List of appendices

2 Methodology

To answer the SQ's, as stated in paragraph 1.3, different methods are used. For each SQ, at least one method must be applied. Sometimes multiple methods are needed to be able to perform the analysis. The methods applied can either be categorized as qualitative analysis or quantitative analysis. First, the research phases are explained by using Blooms' Taxonomy in paragraph 2.1. The method(s) and instruments used per SQ are elaborated after that in paragraph 2.2. Regarding the data analysis that is performed, an explanation is given regarding the data sample in paragraph 2.3, how and wherefrom the data is collected in paragraph 2.4 and how the data analysis is performed in paragraph 2.5.

2.1 Research phases

The research is divided into multiple phases, as visualized in the workflow in figure 1. Every phase aligns with the stated SQ's respectively and is determined according to Bloom's Taxonomy Verbs. According to the University of Arkansas (2018): *"Bloom's Taxonomy provides a list of action verbs based on each level of understanding."* The levels of understanding include:

- a) Remember
- b) Understand
- c) Apply
- d) Analyze
- e) Evaluate
- f) Create

The corresponding verbs for each level can be used when creating specific objectives, as is done below for four different phases. The verbs used, according to Bloom's Taxonomy, are highlighted in bold. The first objective is to identify how the plans of the stakeholders are currently aligned

The first objective is to identify which processes are included in the inbound and turnaround phase and classify per stakeholder how they plan these processes. These first two verbs are categorized within the remembering level, and the understand level, respectively. Subsequently, it must be examined where the process planning inefficiencies occur, and these inefficiencies must be illustrated. These second two verbs are categorized within the application level, and the analyze level, respectively. Furthermore, the impact of the inefficiencies must be analyzed as well, which is also categorized within the analyze level. Lastly, possible solutions can be proposed within the recommendations to minimize the impact of the planning inefficiencies, which is categorized within the evaluate level. The answer to the main research question will summarize all research findings, which is part of the creation level, according to Bloom (University of Arkansas, 2018).

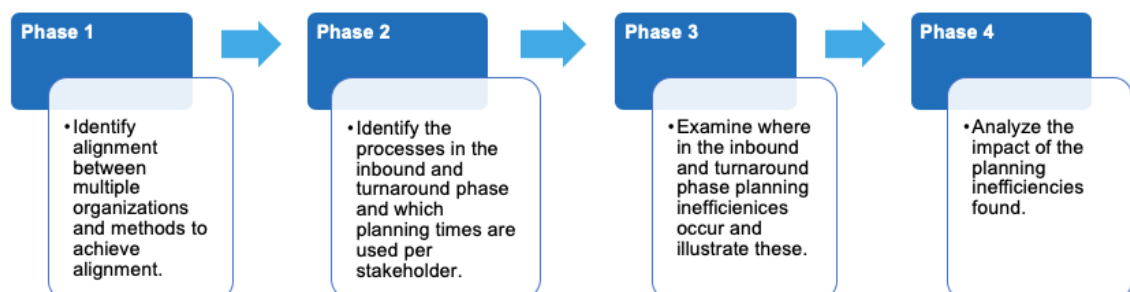


Figure 1: Research divided by phases.

2.2 Research design

Different methods are used to answer the SQ's, which finally will conclude in answer to the main research question. The chosen research methodologies are stated per SQ. Every SQ has been given a title which shortly expresses the main subject of the question. The same titles are used during the analysis (chapter 3 until chapter 6). The methods applied for this research either consist of desk-research, conducting interviews or data analysis. Both desk-research and interviews are qualitative research, while data-analysis is quantitative research.

The framework that is considered during the research is the e3alignment framework and method created by Pijpers, Gordijn & Akkermans (2009), which is elaborated in the literature in chapter 3. According to the e3alignment method, the first step to create alignment is the identification of alignment issues. After that, the alignment solution(s) are designed. The impact analysis of the solutions, which is considered as the final step within the e3alignment method, is not considered in this research due to time limitations. Within the framework of the e3alignment method, the focus is put on the interaction between organizations in a networked value constellation, in which four different perspectives on interaction are considered. By using conceptual modelling techniques, each perspective on interaction is analyzed. The focus of this research will mainly lie on the process interaction, but other interactions are considered as well. The strategic interaction was not considered in the original case study performed by Pijpers et al. (2009) since the stakeholders had indicated that their interest did not include this interaction.

2.2.1 SQ 1: alignment

- *How can alignment issues concerning planning between the stakeholders in the Dutch aviation industry be identified?*

The methods that are applied to answer this question is desk research. In the existing literature, it must be found what alignment is, how alignment is achieved when multiple organizations are involved, what methods exist in order to increase alignment and how this is applicable to the Dutch aviation industry. Since an insufficient alignment between stakeholders causes planning inefficiencies due to different points of focus, literature research must first be performed in order to determine the past and the current status on alignment in general and on alignment between the stakeholders, preferable concerning the overall planning system. Methods on alignment must also be researched since these methods might provide a framework for this research. Studies on this topic must be able to be found in either online academic databases or libraries.

2.2.2 SQ 2: stakeholders' planning

- *Within the inbound and turnaround phase, which stakeholder plans on what processes and how?*

The primary method that is applied in order to answer this SQ is desk-research. Information regarding the planning-times used by the main stakeholders must be found in order to create a clear visualization of the inbound and turnaround (planning) process per stakeholder. Also, it must be researched what these times stand for and what the interdependencies between the times are (also per stakeholder). This information is found in online documentation and documentation of KLM, AAS and LVNL. Other resources that are used to answer the more general background questions are (online) research articles or books, where information is found concerning the different needs of the stakeholders involved, the process (journey) of an aircraft and how to define the inbound and turnaround process of aircraft.

2.2.3 SQ 3: inefficiencies in planning

- *Where in the inbound and turnaround phases can planning inefficiencies be identified?*

Two methods are applied to answer this question. The first method is desk research. The visualizations of the planning processes per stakeholder created for SQ2 are combined in a UML activity diagram divided in swim lanes, which is a conceptual modelling technique as proposed by the e3alignment method, to be able to see the interdependencies and systematic loops of the planning-times between the stakeholders. Also, literature is sought to gain insight into the dependencies amongst the different planning-times used by each stakeholder. Secondly, interviews are held with operational experts of KLM, AAS, LVNL and a ground handling organization, who contain knowledge regarding the planning process and planning-times, to determine which inefficiencies they encounter from their perspective. The goal is to create an overall visualization of the planning-times used, including the interdependencies, and thereby to analyze the possibilities of inefficiencies that occur in the current overall planning process.

2.2.4 SQ 4: impact of PI's

- *What is the impact of the identified planning inefficiencies?*

The method that is applied to answer this question is quantitative data analysis. Existing data of planned and actual times, which is available in the database of LVNL and AAS, is sought of the summer season of 2018 (from 1st of March until 31st of October), to measure the impact of the inefficiencies. This impact is indicated by measuring the difference between planned time and actual time (ΔT), or the impact is indicated by measuring how often a specific deviation occurs. The planning-times used for this analysis are the planning-times found at SQ2 and SQ3. Data of disrupted days are filtered out, meaning deviations that are linked to other causes, such as bad weather, airport disruptions and extraordinary circumstances. This way, only the remaining deviations that could not be linked to any cause will remain.

2.3 Data sample

For this research, a selection is made of a specific set of data that is analyzed and a specific group of operational experts that is targeted for an interview. A selection must be made in order to be able to adhere to the time that is available to carry out this research. How this selection is made and how this resulted in a sample is explained hereafter.

For the quantitative data analysis, multiple data sets are used. Each set, however, contains data from the summer season of 2018, meaning from March until October. Why (only) this season was chosen is explained in the scope of the research in paragraph 1.4. Half of the sets are A-CDM data containing all the milestones that are used and measured at AAS. Not all the milestones are analyzed, only the ones which are applicable for this research. Which planning-times are applicable is determined by the second and third SQ, which are analyzed and elaborated in chapter 4 and 5 of this research. The other half of the sets concerns data from the LVNL, in which the times of aircraft are planned to arrive at the FIR boundary, IAF waypoint and the runway, and when they arrived at these points. For all the data sets the same filters were applied. Days in which any form of disruptions occurred are filtered out. These disrupted days are determined by eliminating days in which the On-Time Performance (OTP) of AAS was below 60%. Within the summer season of 2018, 44 days had an OTP below 60%. These days are stated in Appendix II. After filtering these days, the data set regarding the milestones indicates 134,071 flights and the data set regarding the arrival information showed 144,205 flights.

For the qualitative analysis, a diverse group of operational experts is interviewed in which all stakeholders are represented, meaning the airport, the air traffic control, the airlines and the ground handling organizations. Some of the conversations are actual interviews which are recorded, other more informal conversations and observations. The most crucial objective of the qualitative analysis is to gain insight in the planning inefficiencies that each main stakeholder in the Dutch aviation sector is experiencing, and to determine who is affected, either directly or indirectly, by these inefficiencies.

2.4 Data collection and ethical considerations

Data is collected from both literature resources as well as operational experts within the AAS sector to perform the qualitative analysis. The literature used is collected from relevant reports and scientific articles via Google Scholar, or via official websites from organizations related to the AAS sector such as Eurocontrol, Schiphol Airport, the KDC-CoE, IATA and To70. Operational experts representing all main stakeholders were interviewed, either formal or informal, to obtain insight into the planning inefficiencies they encounter daily.

The data that is used for the quantitative analysis is gathered from AAS as well as LVNL. The data from AAS is collected via Mr. J. Schäfer, an Airport Operations Analyst who is currently involved in the performance measure of A-CDM and the corresponding milestones. Another data set is collected via Mr. F. Dijkstra, an ATM expert at KDC-CoE specialized in arrival management. The final dataset is retrieved from a database called NEST. Access to this database is granted via the LVNL. How the participants and the corresponding data they provide are secured is explained below.

The 10 ethical guidelines stated below are followed during the performance of this research. These guidelines are followed to guarantee participants of the research the required level of confidentiality, for both personal as well as company information. The participants are approached professionally. The information given by the participants, which can either be in the form of data or information given during interviews, is carefully stored and secured on the company computer at the LVNL in files which can only be accessed using a password, which is only available to the researcher. The information itself is thoughtfully incorporated into the research, meaning that it is first considered how the entire sector will respond to this information if it is made public. If the information can negatively affect one or multiple stakeholders, this is discussed before publication.

1. Research participants should not be subjected to harm in any ways whatsoever.
2. Respect for the dignity of research participants should be prioritized.
3. Full consent should be obtained from the participants before the study.
4. The protection of the privacy of research participants must be ensured.
5. An adequate level of confidentiality of the research data should be ensured.
6. The anonymity of individuals and organizations participating in the research must be ensured.
7. Any deception or exaggeration about the aims and objectives of the research must be avoided.
8. Affiliations in any forms, sources of funding, as well as any possible conflicts of interests must be declared.
9. Any type of communication in relation to the research should be done with honesty and transparency.
10. Any misleading information, as well as the representation of primary data findings in a biased way must be avoided.

2.5 Data analysis

What techniques and tools are used to perform the quantitative data analysis is elaborated is determined beforehand. All data used for the purpose of this research is analyzed using Microsoft Excel. The purpose of the quantitative data analysis is to measure the impact of a certain inefficiency. The measuring is partly done by calculating the deviation between planned times and actual times, resulting in a difference in time. This results in the following formula, in which ΔT stands for the deviation in time:

$$\Delta T = \text{Planned Time} - \text{Actual Time}$$

The ΔT will either result in a negative time, meaning that a specific process or waypoint is reached earlier than planned, or a positive time, meaning that a specific process or waypoint is reached later than planned. The results are presented in a histogram, in which the distribution of the deviations is visibly divided per time range. This distribution gives a clear indication of how significant the impact of a planning inefficiency is.

The second approach of analyzing planning inefficiencies is by comparing two variables to another. This type of measuring is used when the same term is used to indicate two different variables or planning-times. When both variables are visualized within one figure, this can indicate the difference between the two. This type of measuring is not expressed in one specific formula.

Another approach of analyzing a planning inefficiency is by measuring how often a certain inefficiency occurs by counting. This can be expressed in a figure in various ways, by number or by percentage, divided per specific categories or not. However, this approach cannot be expressed in one single formula as well.

3 Literature on alignment challenges

Chapters 3 until 6 will elaborate on both the qualitative and quantitative analysis performed, divided per SQ, as stated in paragraph 1.3.2. The literature discussed in this chapter, applicable to SQ1, will mainly focus on alignment between various organizations carrying dependencies on each other with regard to (planning) processes, with the focus on the Dutch aviation industry. The (main) stakeholders in this industry are bound to collaborate on multiple levels in order to succeed in the overall aircraft process. However, it is assumed that the alignment regarding the planning process between the stakeholders may still require some improvements. Research is performed on how better alignment is achieved. Therefore, the focus lies on (inter-organizational) alignment and models and tools which are used to reach (more) alignment. The findings are useful to gain insight into inter-organizational alignment on multiple levels and some of the models, theories and frameworks could be applicable to the situation in the aviation sector under research. Literature concerning the processes within the overall aircraft process, which stakeholder is involved with which processes, planning and planning-times are elaborated in the analysis of the second SQ in chapter 4.

To determine how alignment is achieved between multiple organizations, alignment within one single organization will first be elaborated (paragraph 3.1). After that, the focus lies on supply chain alignment (paragraph 3.2). Inter-organizational alignment, which provides another insight concerning alignment, is elaborated subsequently (paragraph 3.3). The conceptual modelling technique that is used to achieve inter-organizational alignment is elaborated as well (paragraph 3.4). The second part of the literature review will mostly focus on the Dutch aviation industry. First, it is determined what kind of alignment issues this industry has faced (paragraph 3.5). Furthermore, it is explained how part of these issues was reduced due to A-CDM (paragraph 3.6). A conclusion regarding all literature reviewed is ultimately given (paragraph 3.7).

3.1 Alignment in a single organization

It is crucial to determine what alignment implies, in the context in which it is proposed in this literature review. According to the Cambridge Dictionary (n.d.), alignment is:

“an agreement between a group of countries, political parties or people who want to work together because of shared interests or aims”

The process of alignment is not an unknown topic within an organization. In modern-day company's, alignment is often referred to as business-IT alignment. In a way, this can also be interpreted as an “agreement”. As explained by Poelen (2017), in the early year's business-IT alignment concerned “the fit between the business plan and the IT plan” (p.12). Business-IT alignment is currently defined as the following by Juneja (n.d.):

“IT business alignment is defined as the dynamic actualization of organizational goals and objectives and the operationalization of the IT strategies according to those objectives.”

According to Pijpers, Gordijn & Akkermans (2009), process alignment, in which the planning process is an essential factor, is also incorporated into the business-IT alignment process. Therefore, business-IT alignment is discussed in this review. In the case study regarding the e3alignment method (which is elaborated further in this review) is used to explore inter-organizational alignment issues in the Dutch aviation industry, Pijpers et al. (2009) mention that many studies on business-IT alignment were conducted and alignment methods and frameworks were created. However, as stated by Pijpers et al. (2009), these studies only refer to alignment within a single organization. Less research has been done concerning alignment between multiple organizations, thus inter-organizational alignment. Pijpers et al. (2009) have introduced a specific method which is used to discover alignment issues amongst multiple organizations, in which the interaction between these organizations are the central point of attention. Since this method may be utilized as a tool in the analysis of SQ2 and primarily SQ3 of this research, it is elaborated in paragraph 3.4.

3.2 Supply chain alignment

Within the aircraft process, organizations collaborate on creating value for the same customer. This collaboration is similar to a supply chain, in which multiple actors must work together to create a functional chain. Therefore, alignment from a supply chain management perspective is illustrated as well. As mentioned by Stadler (2009), when actors collaborate in a supply chain, they generally face the “problem of information asymmetry, members having their own objectives and constraints which may be in conflict with those of the other members” (p.3). Stadler (2009) also states that “activities have to be aligned in such a way that the supply chain as a whole stay or becomes competitive while each member wins by cooperating.” (p.3). With regard to supply chain alignment, Lennox, Penake & Schechter (2004) do not mention the term alignment issues like Pijpers et al. (2011) but instead refer to disconnects between organizations within a supply chain. Either social or technical factors create these disconnects, and they might prevent proper alignment between organizations. In order to create alignment, these disconnects must be avoided.

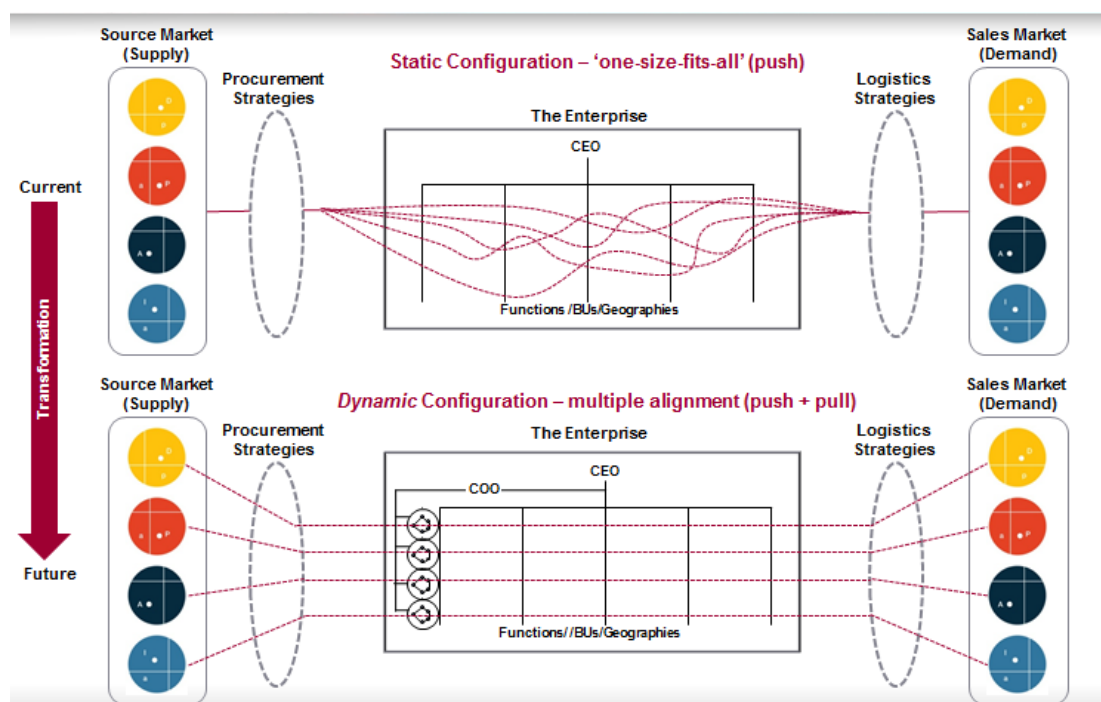


Figure 2: Dynamic Supply Chain Alignment created by Gattorna. (2012)

Gattorna (2012) created a concept concerning dynamic supply chain alignment. The illustration created by Gattorna with regard to this concept is stated in figure 2. According to Miles (2012), the most different about the concept of Gattorna is the fact that different internal organizational structures are used to address the need for different supply chains to satisfy the different markets most effectively. From figure 2, all the supply chains that are operated are coordinated by one Chief Operating Officer (COO), and the same supply chains are aligned with the supply market as well as the demand market (Miles, 2012).

3.3 Inter-organizational alignment

To detect and research inter-organizational alignment issues, Pijpers et al. (2009) have developed a method called *e3alignment*. This method was tested by performing numerous case studies in different industries, for example, the Spanish electric power industry, the Dutch mobile telecom industry and the Dutch aviation industry. The *e3alignment* method is explained by Pijpers et al. (2009) as the following:

With *e3alignment* they created alignment between organizations operating in a networked value constellation -which is a set of organizations who jointly satisfy a customer need - by (1) focusing on the interaction between the organizations in the networked value constellation, (2) considering interaction from four different perspectives, and (3) utilizing conceptual modeling techniques for each perspective. By creating inter-organizational alignment between the actors in a networked value constellation *e3alignment* ultimately contributes to a sustainable and profitable networked value constellation. To create alignment, *e3alignment* iteratively takes three specific steps: (1) identification of alignment issues, (2) alignment solution design, and (3) impact analysis. (p.59)

As mentioned above, *e3alignment* focuses on the interaction between organizations in the networked value constellation. This term is explained by Zarvic & Daneva (2006): “Networked value constellations are networked businesses that focus especially on how economic value is created and exchanged within a network of actors” (p.123). Thus, organizations collaborate on creating value for the same customer, which is vital for all actors to take in mind.

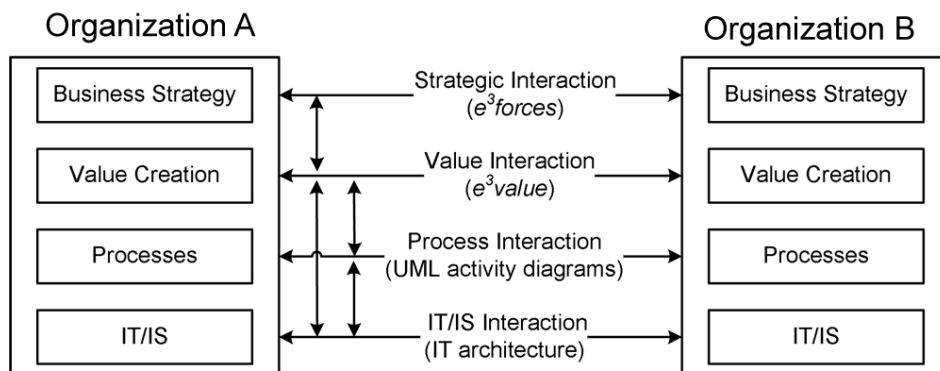


Figure 3: *e3alignment* framework created by Pijpers et al. (2009)

The framework for the *e3alignment* method is explained in figure 3 (Pijpers et al., 2009, p.576). The horizontal lines represent the interaction between the organization; these interactions between organizations occur when one organization is influenced by another. In the case of the Dutch aviation industry, these interactions vary from exchanging flight information, information regarding processes in the turnaround phase and payments between actors (Pijpers et al., 2009). According to the *e3alignment* method, the focus must be on the interaction between the organizations. In the framework, four different perspectives on interaction are considered. These perspectives concern the business strategy, value creation, processes, and information technology/information system (IT/IS). The interactions of each of these perspectives are analyzed using a conceptual modelling technique. (Pijpers et al., 2009) The different techniques used are stated in figure 3, below the type of interaction (e.g.: *e3forces* is a conceptual modelling technique used to analyzed strategic interaction).

For the purpose of this research, only the process interaction is elaborated further, since this interaction is bound to be connected to the planning process of the stakeholders within the Dutch aviation industry. According to Pijpers et al. (2009), the physical transfer of objects (interactions) and their corresponding activities between organizations and the sequence of these interactions are analyzed within the process perspective in which time is also considered. Within the aviation industry, and especially within the planning process, this is a critical factor considering the number of processes carrying interdependencies on processes of other organizations. Pijpers et al. (2009) found multiple alignment issues between the stakeholders of the Dutch Aviation industry, which also corresponds with the objective of this research.

3.4 Conceptual modeling technique

Pijpers et al. (2009) mentioned that conceptual modelling techniques are used to analyze interactions for the different perspectives in the e3alignment framework. The conceptual modelling technique that is used to analyze the process interaction between the stakeholders is a Unified Modeling Language (UML) activity diagram. According to Eshuis & Wieringa (2004): “Activity diagrams are flowchart-like notations with constructs to express sequence, choice and parallel execution of activities.” Creating an activity diagram is an effective manner to create an overview of all activities that are related to one another. However, when multiple stakeholders are involved in the same diagram, it is best to categorize the activities per stakeholders using swim lanes. When using swim lanes, vertical lines are incorporated within the activity diagram to indicate which activity belongs to which stakeholders. This way, it is adequately visualized how the stakeholders hold interdependencies towards one another with regard to their activities. The activity diagram created by Pijpers et al. (2011) for the case study is listed in figure 4 to provide an example (p. 218).

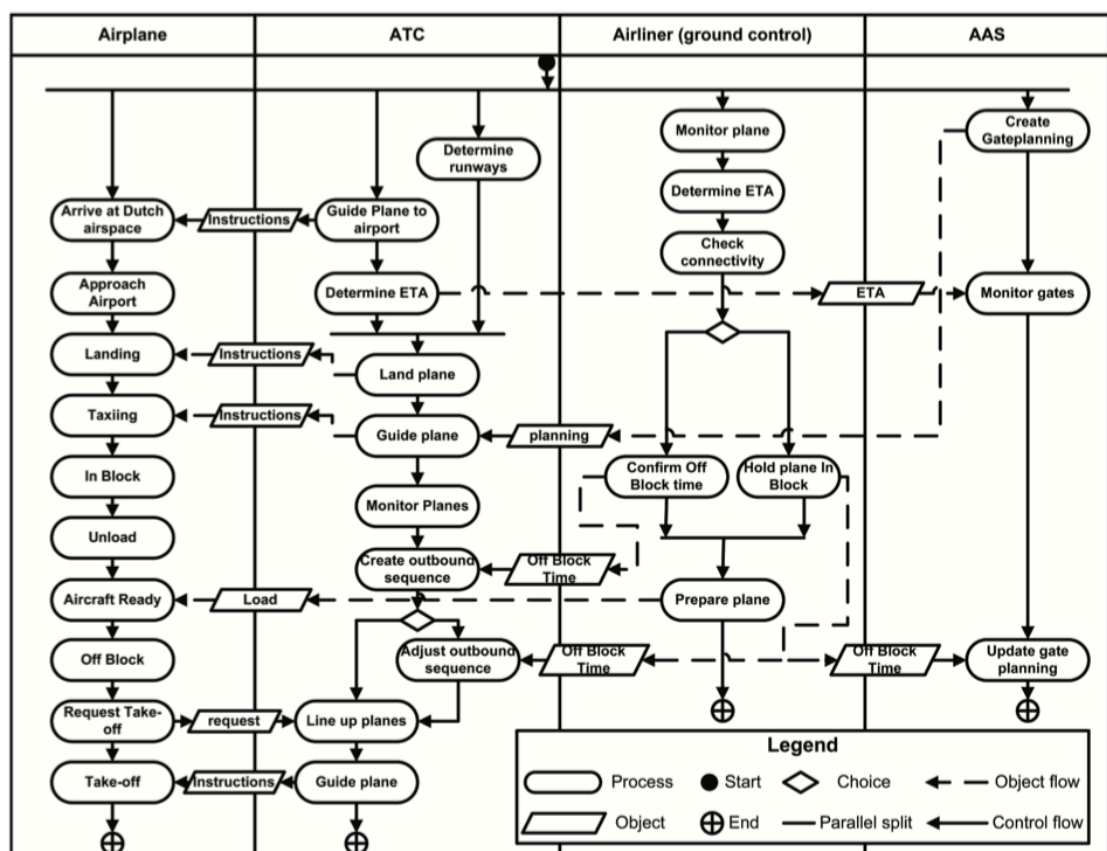


Figure 4: Activity diagram created by Pijpers et al. (2010)

3.5 Alignment issues in the Dutch aviation industry

According to the case study performed by Pijpers et al. (2009), two main alignment issues were determined between the stakeholders of the Dutch aviation industry with the help of the e3alignment method. The first issue concerns the order in which processes of stakeholders are conducted and in which last-minute information is exchanged between stakeholders. The corresponding time frame that remains for stakeholders of which processes are affected by these last-minute changes is small, which indicates that the order of the processes is not optimal. An example proposed by Pijpers, De Leenheer, Gordijn & Akkermans (2011): “if KLM holds a plain “In Block,” then the new “Off Block Time” is shared with ATC after ATC has made an outbound sequence for the departing airplanes.”

The second alignment issue that was found regards the different language that is used amongst the stakeholders. The different language can refer to a completely different terminology that is used (different terms used to declare in which condition the aircraft is located), but it can also refer to the terminology having different meanings for different stakeholders, even when the terminology itself is the same. Pijpers et al. (2011) mention the term Estimated Time of Arrival (ETA) as an example. This term can either refer to the moment when an aircraft lands on the runway, the moment when an aircraft arrives at the gate, or the moment when passengers depart from the aircraft. “As a result, the arrival time of an airplane varies per actor, which can lead to confusion between the actors.” (Pijpers et al. (2011). After analyzing the alignment issues, two solutions were created to resolve these issues. The first solution regards the creation of one central point in which all relevant information regarding the processes of stakeholders is collected. In this central point, one of the stakeholders must gather this information in time and distribute up-to-date information to the other stakeholders (Pijpers et al., 2011). The second solution concerns the milestone approach, in which a common terminology is used between all stakeholders to point out the different states of an aircraft. The valuation of these different states must also be similar to each of the stakeholders (Pijpers et al., 2011). This approach has, ever since this case study has been conducted, already been fully implemented at AAS in 2018 through Airport Collaborative Decision Making (A-CDM) for the turnaround process. If the alignment issues as proposed above have thereby been fully resolved in practice has not yet been researched; however, A-CDM can be considered as a tool which is used in order to create more alignment between stakeholders. The contribution that A-CDM has already brought towards this subject is explained in the following paragraph.

3.6 Contribution of A-CDM to alignment amongst stakeholders

Since May of 2018, A-CDM has been fully implemented at Amsterdam Airport Schiphol, and therefore, the airport has now officially achieved the status of CDM Airport (To70, 2018). A-CDM is said to be beneficial for not only the airport itself but for all stakeholders involved as well. A general explanation of A-CDM is firstly given: “Airport CDM is a concept that promotes intense collaboration between partners, using improved quality of information and more timely exchange of information, which is interpreted in the same way by all partners.” (Airports Council International, Eurocontrol, & International Air Transport Association, 2006, p.1-2). An example mentioned by Eurocontrol (2009), which is solved by using A-CDM is the meaning and interpretation of Estimated Time of Arrival (ETA), which differed per stakeholder. It could either be the moment of touchdown on the runway, the in-block time, the shutdown of the engines or the arrival at the stand (p. 4). By implementing milestones that are used to indicate where a particular aircraft is at a specific moment, which is interpreted by all stakeholders in the same way, this problem is eliminated. Due to better collaboration between stakeholders and by using and exchanging information that is interpreted in the same way a more and better alignment between stakeholders is achieved by implementing A-CDM. This improved alignment generates multiple benefits for all parties involved in the aircraft process. The local benefits, as explained by Eurocontrol (2016) in the A-CDM Impact Assessment Final Report (p. ii), are:

- Average taxi-out time savings between 0.25 and 3 minutes per departure.
- Average schedule adherence improvements between 0.5 and 2 minutes per flight.
- Reduction in push-back delays after start-up approval.
- Increased ATFM slot adherence despite increased traffic demand and ATFM regulation volumes.
- Improved ground handling resource utilization.
- Reduction in the number of late stand and gate changes.
- Improved management of and recovery from periods of adverse conditions.
- Reduction in Flight Activation Monitoring suspensions.
- Increased peak departure rates at the runway.
- Dramatically improved take-off time predictability – typically by as much as 85% during adverse conditions.

3.7 Conclusions

Currently, alignment is an essential factor in organizations. Many studies regarding the topic of business-IT alignment have been performed; however, research on alignment between (multiple) organizations has not been performed on a large scale. Therefore, the e3alignment method was created by Pijpers et al. (2009), which is used to determine and analyze alignment issues amongst multiple organizations.

According to the e3alignment method, the focus of inter-organizational alignment must lie on the interaction between different actors as seen from four different perspectives. Within the e3alignment framework, mainly the analysis of the process interaction is applicable for this research, primarily for SQ 3. The value perspective and the IS perspective provide knowledge that is valuable to use within the analysis performed for SQ 2.

With the help of the e3alignment method, Pijpers et al. (2011) were able to determine multiple inter-organizational alignment issues within the Dutch aviation industry, which cause planning inefficiencies as well. Therefore, these issues are considered during the research; however, these issues were determined ten years ago. The full implementation of A-CDM at AAS in 2018 has brought a decrease in the number of alignment issues, for instance, by using the milestone approach. Thus, it must first be researched which issues do still occur after having implemented A-CDM. Also, the research does not indicate what impact the alignment issues have because this is not measured. This factor is included in this research within the analysis of SQ4.

The case study performed by Pijpers et al. (2011) is mainly focused on the identification of alignment issues and solution designs. However, the impact analysis of solutions, as mentioned in the case study as the third and final step within the e3alignment method, is not elaborated. Thus, the impact of the solutions created with the help of the e3alignment method remains unsure. This uncertainty must be considered during the research if the method is applied. The literature concerning supply chain alignment might be considered for the research as well since it provides a different approach towards alignment than the one that Pijpers et al. (2011) proposed, which can stimulate to think 'out of the box' during the analysis phase of the research.

4 Literature on planning

The analysis performed with regard to SQ 2 is elaborated in this chapter. The focus of this first part of the analysis is to gain insight into the processes and planning per stakeholder in the Dutch aviation sector. By performing desk research, it is determined who the main stakeholders are (paragraph 4.1) and in which processes they are involved (paragraph 4.2). Furthermore, it is determined which planning-times within the inbound and turnaround process are worked with within the Dutch aviation sector (paragraph 4.3). Lastly, it is determined which stakeholder is concerned with which planning-times based on the processes they are involved in (paragraph 4.4).

4.1 The stakeholders

The main stakeholders within any aviation sector include the airlines, the Air Navigation Service Provider (ANSP), the airport itself and the ground handlers. In the case of the Dutch aviation sector, two of these stakeholders are AAS and LVNL, representing the airport and air traffic control, respectively. KLM will mostly represent the role of the airline as a stakeholder in this research. KLM, which according to their Schedule Planning Manager W. van Miltenburg operates their worldwide hub-network using AAS as their home base, has the highest amount of flights arriving and departing from the airport (personal communication, 12th of April 2019). According to Van Woerkom (2018), the airline is followed by Low-Cost Carriers (LCC) easyJet and Transavia, respectively. As presented by Schiphol (2019), there are 92 airlines currently operating at the airport. All these airlines are handled in the turnaround process by one of the ground handlers available at AAS. Since there is not one specific ground handler (GH) represented within the KDC, this stakeholder will not be explicitly elaborated. The Network Manager (NM), who operates the air traffic management network on a large scale, is also considered as one of the stakeholders. In the case of the Dutch aviation sector, Eurocontrol provides the role of the NM (Eurocontrol, 2019). All these stakeholders collaborate and interact with each other, and plan amongst each other in order to succeed the overall aircraft process. However, all stakeholders carry dependencies on each other since all processes within the overall aircraft process are connected. When something changes in one process, this will likely influence a subsequent process as well. The planning each stakeholder makes is also based upon these processes. The interdependencies between all plans are even greater since any changes made with regard to one planning can not only cause a change in the planning of a subsequent process but in the planning of a previous process as well. The interdependencies between the stakeholders are visualized in figure 5.

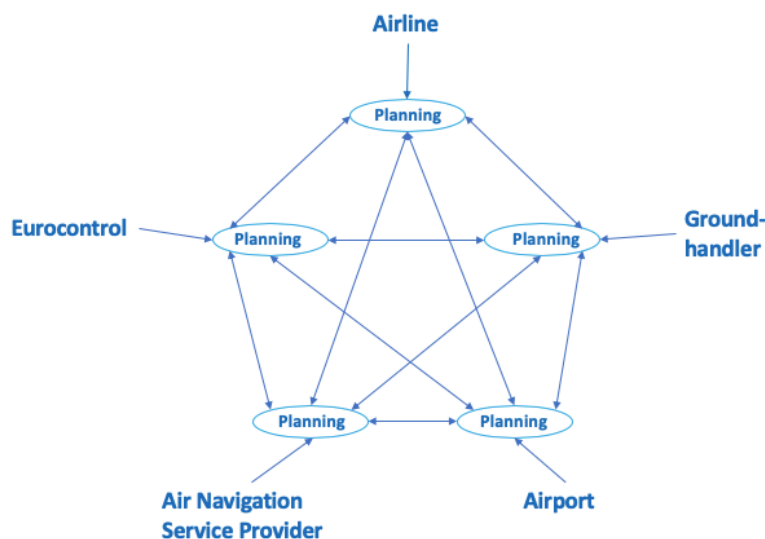


Figure 5: Planning Interdependencies.

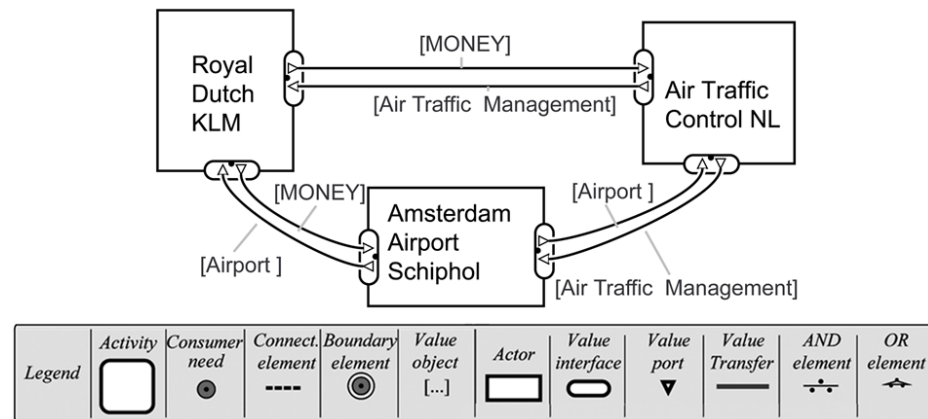


Figure 6: Value perspective according to e3value created by Pijpers et al. (2009)

A part of the Aviation case study concerning the e3alignment method created by Pijpers et al. (2009) is elaborated to gain a better understanding of the interactions between the stakeholders. Within this case study, only KLM was considered from the airline perspective since it is the biggest airline operating at AAS. Figure 6 indicates how each of the main stakeholders adds value to one another, either in the form of money, services or facilities. This interaction remained unchanged over the years but is still important to consider since it may give insight into the origin of the planning inefficiencies that may arise.

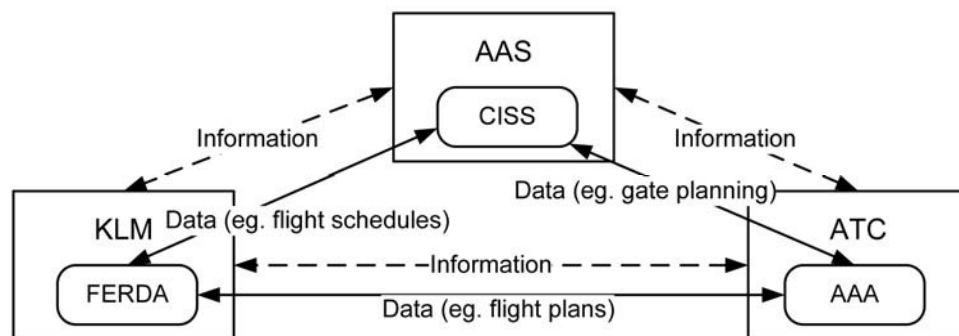


Figure 7: Information system perspective created by Pijpers et al. (2009)

Figure 7 visualizes how the interaction proceeds from the information system perspective. For every stakeholder is stated which information system is used (FERDA, CISS and AAA) and what type of information is shared. The information that is shared also concerns the different plans that are made, for instance, flight plans and gate planning. This interaction remained unchanged as well and is still essential to consider since this gives insight into what kind of information is shared with regard to planning and thus planning-times.

4.2 The processes and planning

Within the overall aircraft process, all stakeholders previously mentioned in paragraph 4.1 are involved within one or multiple processes. The flow of the aircraft process is visualized in figure 8 (McDonnell et al., 2014).

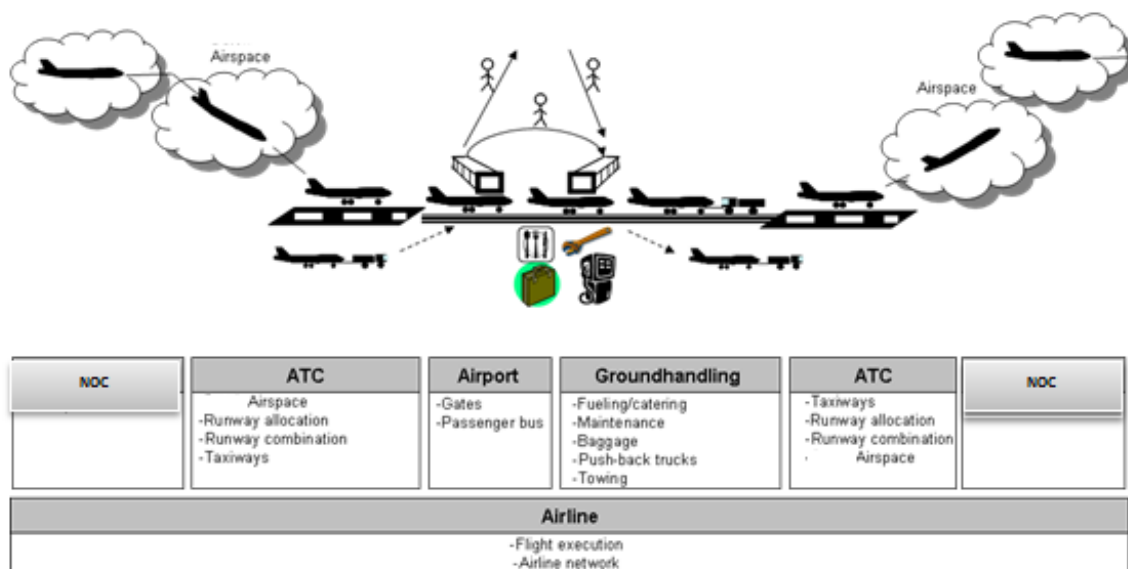


Figure 8: Aircraft process flow.

The airline is continuously involved with every process, since the airline is the owner of the aircraft. The aircraft is almost always in operation. When a flight is en-route, the NM (NOC as presented in figure 8) provides air traffic services to the airline. When approaching the destination, the ANSP (or ATC as mentioned in the figure) guides the aircraft to a runway determined by them and thereafter, guides the aircraft via the taxiways to a particular gate or stand. In case a remote stand is used, passenger busses are used to bring all passengers to the terminal. The airport controls the gates, the corresponding gate assignee and the passenger busses. Upon arrival at the gate, the ground handler can start all the turnaround processes to make sure that the aircraft is ready for departure again. When the aircraft ready for departure, the ANSP will guide the aircraft back to an allocated runway via the taxiways and after that guide the aircraft through the Dutch airspace onto the following destination until the NM takes over the guidance. In figure 9 is visualized what the primary decision points are for every process and how these points are located in relation to each other (McDonnell et al., 2014).

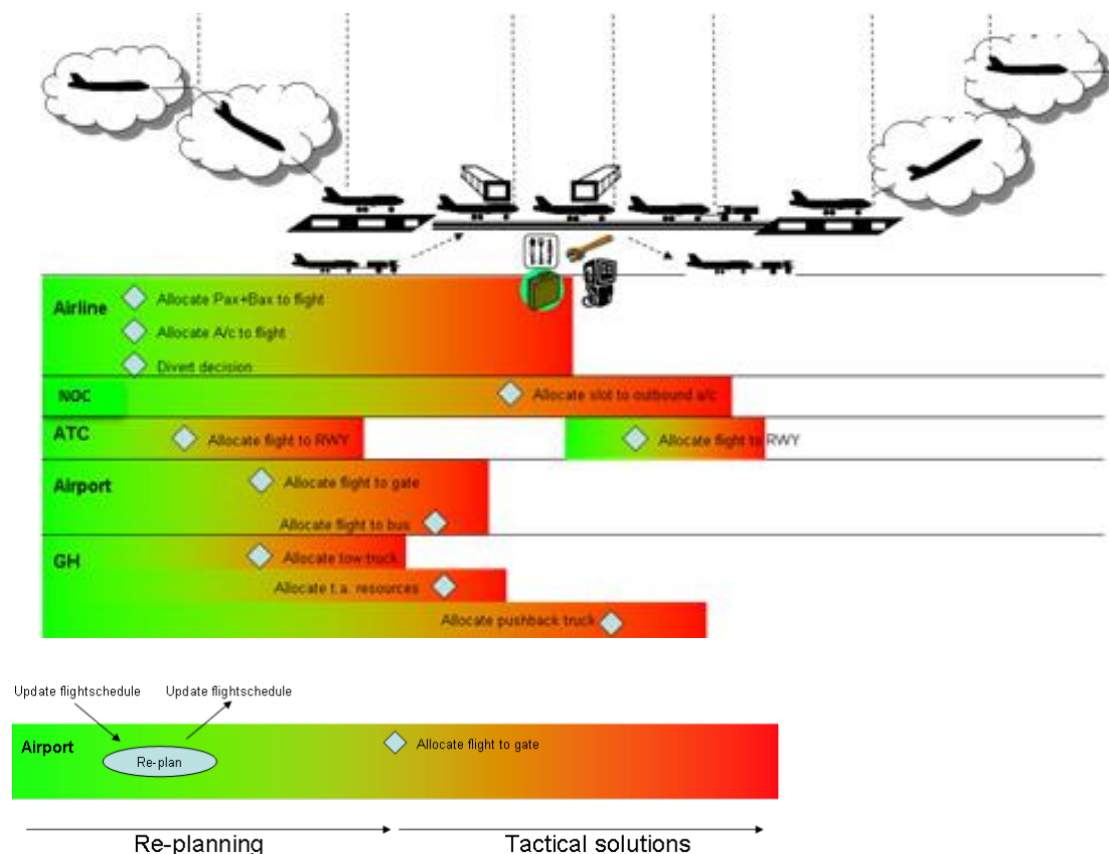


Figure 9: Decision points per process.

Every stakeholder creates a planning that is based on the processes in which they are involved. The airline (i.e. KLM), creates a flight plan for each flight they operate, resulting in a complete schedule and network planning. The planning of the Network Manager (Eurocontrol) concerns the capacity of the European airspace and the ATM network. The ANSP/ATC (LVNL) creates a planning concerning the capacity of the Dutch airspace and the runways. The planning of the airport (AAS) regards the gate capacity and allocation. The ground handler creates a planning regarding all the resources in order to complete the turnaround processes they are involved with. All these plans are made multiple times, within different phases. Eurocontrol has determined three different phases of planning, which are listed below (Eurocontrol, n.d.).

- The strategic phase, which takes place between 12 months until 7 days before operation.
- The pre-tactical phase, which takes place between 6 days until 1 day before operation.
- The tactical phase, which takes place on the day of the operation.

This research will focus on the tactical phase of planning. Since this phase takes place on the day of operation, it is assumed that this planning is the most up to date. Any inefficiencies found within the most up to date planning are essential to analyze because it indicates that these instabilities thereby cannot be avoided by trying to update the planning most accurately, the issue must be caused by structural issues within the alignment between stakeholders.

4.3 The inbound and turnaround phases

In the different plannings that are used within the Dutch aviation industry, certain planning-times were created to estimate the time an aircraft is at a particular waypoint and thereby be finished with a specific process to be able to continue with a different process. Every aircraft arriving and departing at AAS will go through the same processes. These processes are explained by means of the milestones or planning-times that are worked with, for both the inbound phase (subparagraph 4.3.1.) and the turnaround phase (subparagraph 4.3.2).

4.3.1 The inbound phase

Within the inbound process, the first waypoint aircraft encounter is upon arrival at the Dutch airspace, the Amsterdam FIR. From there, aircraft set course to one of the three IAF waypoints, SUGOL, RIVER or ARTIP. Which IAF waypoint is chosen is mostly dependent on where aircraft are entering the FIR and the capacity that is available at the IAF waypoints at that specific time. Figure 10 (LVNL, n.d.-a.) visualizes where the FIR and the three IAF waypoints are located. The IAF waypoints, SUGOL, RIVER and ARTIP, are the three black triangles in the middle of the figure, indicated by the red circles. The outermost grey line indicates the FIR.

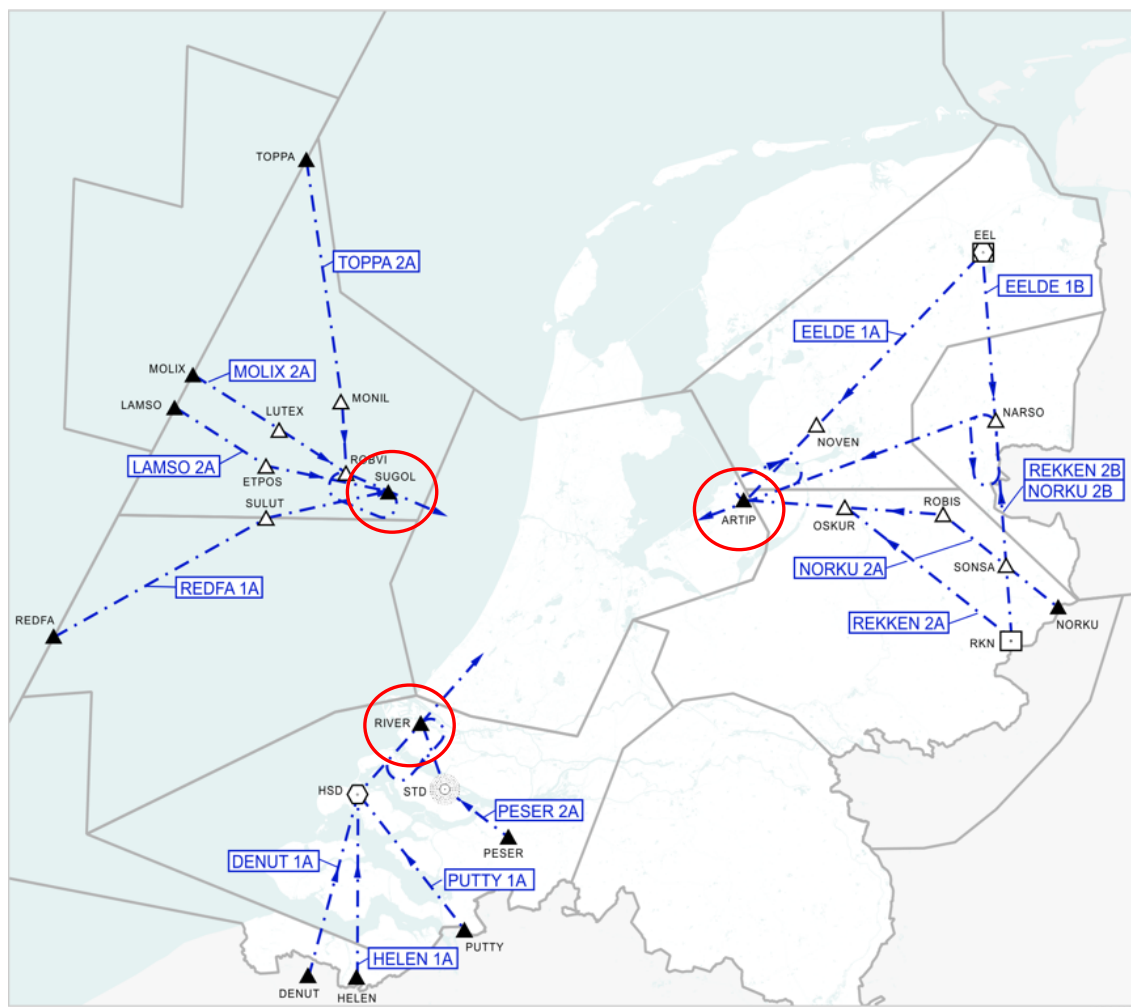


Figure 10: FIR and IAF waypoints within the Dutch airspace.

The FIR and IAF waypoints are the first vital planning-times that are used within the inbound process, considering that plans of following processes are based upon these times. Both the FIR and the IAF waypoints are planned based upon the last filed flight plan. Following the IAF waypoint, aircraft are lined up for a particular runway which is determined by the designated approach controller.

4.3.2 The turnaround phases

The landing time is the first A-CDM milestone within the inbound process, which is considered a planning-time and accepted by all stakeholders. In figure 11 (Schiphol, n.d.) the milestones that are used at airports for the planning of processes upon implementing A-CDM are visualized. The first milestone concerns the Estimated Landing Time (ELDT). When an aircraft has landed, the taxi process to the gate starts. An estimation of the duration of this taxi time is also presented as a milestone, namely the Estimated Taxi-In Time (EXIT). In contrast to other milestones, this planning-times indicates how much time the process itself will take, instead of indicating at what time the aircraft is at a specific waypoint. The EXIT is calculated by subtracting the ELDT from the Estimated In-Block Time (EIBT). When the aircraft has completed the taxi process and has reached the gate or stand, this is called the In-Block position. From thereon, the turnaround process begins. During this process, a Target Off-Block Time (TOBT) must be set and be maintained up-to-date. According to Schiphol (n.d.), the TOBT is the planned time of an aircraft to go Off-Block and start the outbound process. Based upon the TOBT, an estimation is made of the Target Take-Off Time (TTOT). The TTOT is the planned take-off time. Based upon the TTOT, a Target Start-up Approval Time (TSAT) is calculated. This is the planned time that the pilot of an aircraft will receive approval to start up. The pilot may request this approval within a 10-minute window, 5 minutes before TSAT and 5 minutes after TSAT. The TSAT is the final planned time that is used within the turnaround process.

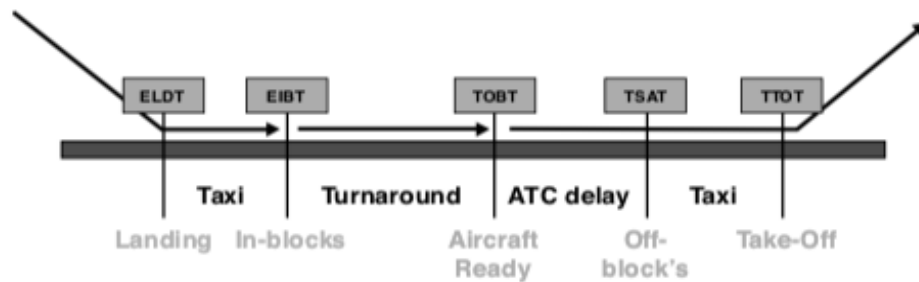


Figure 11: A-CDM Milestones.

4.4 Planning-times

In figure 12, all planning-times mentioned in paragraph 4.3 are visualized within the order of the processes in which they are involved. This visualization is based upon the information given in paragraph 4.1, 4.2 and 4.3. The planning-times are stated on the left side of the figure. The black arrows point out at what point of the sequence the planning-times are used. The blue-colored words stated at the top of the figure indicate all the states that the aircraft can be at, meaning the FIR boundary, the IAF waypoint, the runway (RWY), the gate, or the Off-Block (OB) position. The three different blue-colored rectangles represent the inbound process, taxi-in process and turnaround process, respectively. Figure 12 visualizes in what part of the process the stakeholders are involved in, and thus which planning-times they put their focus on. The dashed part of every line indicates when a stakeholder is in a planning phase, the continues lines indicate when the process is happening.

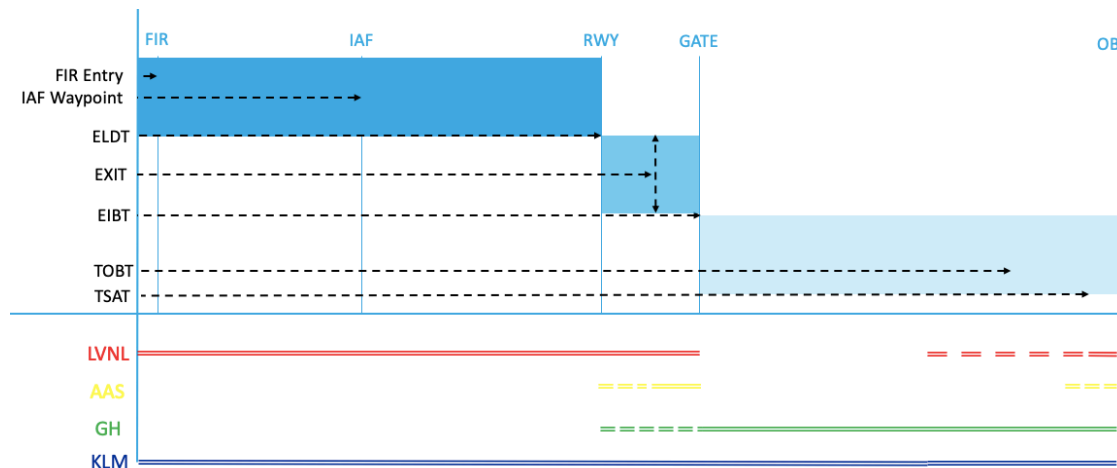


Figure 12: Inbound and turnaround process per stakeholders with planning-times .

The LVNL is mostly focused on the inbound process and the taxi-in process. From the moment when an aircraft reaches the gate, the involvement of the LVNL will end. This involvement will return when an aircraft reaches the TOBT. This planning-time influences the outbound sequence, which is created by the LVNL. The process in which AAS is involved mainly concerns the gate planning. This planning is created one day in advance, and the gate planning system will continue to update from that moment forward. However, from the moment that an aircraft is on the ground, it is specified which gate is available and most convenient to use. When an aircraft reaches the OB position, this will release a gate which will then become available. Thus, this will influence the gate planning as well. The ground handler (GH) is involved with the turnaround process. The ground handler must plan on to which gate their staff and equipment must be sent. This is certain from the moment that an aircraft lands and the exact gate is assigned. When the exact gate is assigned, and the staff, handling equipment and aircraft are present, the handling process of the aircraft can begin. This process will end when an aircraft reaches the OB position. The airline, in this case, represented by KLM, is involved with the complete inbound and turnaround process, and thus all the planning-times mentioned are an important indication. However, since KLM measures their OTP based on IB times and not on OB times, it is assumed that the focus of the airline initially lies on the inbound process. An essential reason for KLM to do so is because KLM has a significant amount of transfer passengers having a connecting flight at AAS. If the airline arrives at their IB position later than planned, the chances of a passenger missing their connecting increases.

4.5 Conclusions

The main stakeholders within the Dutch aviation industry are all connected and add value to each other's organization in some way. The stakeholders all carry dependencies on others concerning their specific planning since the processes on which the planning is based are all connected within the continuous aircraft process. The stakeholders share information regarding their planning with each other. Depending on the processes a stakeholder is involved with, this will determine which part of the overall aircraft process they will put their focus on and which they plan on. For every planning, certain planning-times are used. The most critical planning-times within the inbound phase and the turnaround phase are the FIR entry time, the IAF waypoint, the ELDT, the EXIT, the EIBT, the TOBT and the TSAT. The airline will focus on all these planning-times since they are involved with all the processes in the inbound and turnaround phase. The ANSP also focusses on all these planning-times, since they are involved within the inbound phase and outbound phase. The TOBT and TSAT are generated in the turnaround process; however, they are determining for the outbound sequence planning. The airport is mostly focused on the EIBT and the TBOT since this is determining for the gate planning. The ground handler is mostly focused on the EIBT, the TOBT and the TSAT since these planning-times are determining for the resource planning.

5 Inefficiencies in planning

This chapter focusses on alignment issues within the inbound and turnaround process that causes planning inefficiencies. This analysis is based on the opinions and experiences of operational experts in the Dutch aviation sector. A quantitative analysis was done by interviewing each of these experts, which is elaborated first (paragraph 5.1). From these interviews, a set of planning inefficiencies is derived from alignment issues amongst the stakeholders, which are stated after that (paragraph 5.2). The planning inefficiencies are visualized in an activity diagram (paragraph 5.3).

5.1 Interviews

The objective of this analysis is to determine if planning inefficiencies occur amongst the main stakeholders of the Dutch aviation industry and, if so, wherein the aircraft process these occur and why. The definition of a planning inefficiency is:

Planning inefficiency (PI)

An instability within the overall planning system caused by an insufficient alignment between stakeholders due to different points of focus, resulting in a deviation from the planning, or an affected performance, of one or multiple stakeholders.

To analyze if PI's occur amongst the stakeholders, by which alignment issues these are caused, and what effect this has on the operation, multiple conversations took place with operational experts. Some of these conversations are in the form of an official interview, these are included in the appendices, whilst others are in the form of an informal conversation. Most of the informal conversation took place in the early phase of the research. Some of the conversations even included a low-level observation to gain a better general understanding of how the overall aircraft process and overall planning system works. Since these conversations and observations are not officially recorded or documented, they cannot be listed in the appendix. However, since these conversations and/or observations did contribute in the early exploring stage of the research and thus the analysis of planning inefficiencies, the persons that were spoken to are listed below. The company and function of the operational expert are listed; names are provided only in consultation with the person in question:

- Flow Controller at KLM.
- Mr. F. Dijkstra. President owner FerWay, specialized in Arrival Management.
- Continuous Improvement Manager, Schiphol Group.
- Approach Controller at LVNL.
- Supervisor LVNL.
- Flow Management Position Controller LVNL.

After the exploring stage, interviews were held with multiple operational experts. By conducting these interviews, most of the planning inefficiencies, as proposed in paragraph 5.2, were identified. All interviews are listed in the appendices. The most crucial objective of the interviews was to determine which planning inefficiencies each of the operational experts could identify from their perspective. This will, therefore, be the recurring subject of the interview. By determining planning inefficiencies, the first part of the main research question can be answered. The findings derived from these interviews are elaborated in the following paragraph. The operational experts who were interviewed are listed below.

- Mr. M. Reijndorp, Outbound Planner in training at LVNL.
- Mr. J. van Leeuwen, Loading Supervisor at Swissport.
- Mr. F. Steevens, Gate Planner at Schiphol Group.
- Mr. J. Schäfer, Airport Operations Analyst at Schiphol Group.

5.2 Planning inefficiencies determined through interviews

The interviews that were held with the operational experts provided a clear insight into some of the current alignment issues between the stakeholders in the Dutch aviation sector. It could be determined that planning inefficiencies do occur within different processes of the overall aircraft process, mainly at times when processes overlap, as is indicated in figure 13. The planning inefficiencies that could be determined are elaborated below, within the order of occurrence within the overall aircraft process. After that, all PI's will also be stated in table 2, in which the planning time/KPI, the alignment issue causing the PI, the impact of the PI and the affected stakeholders are stated. Why these stakeholders are affected is visualized in the activity diagram in paragraph 5.3

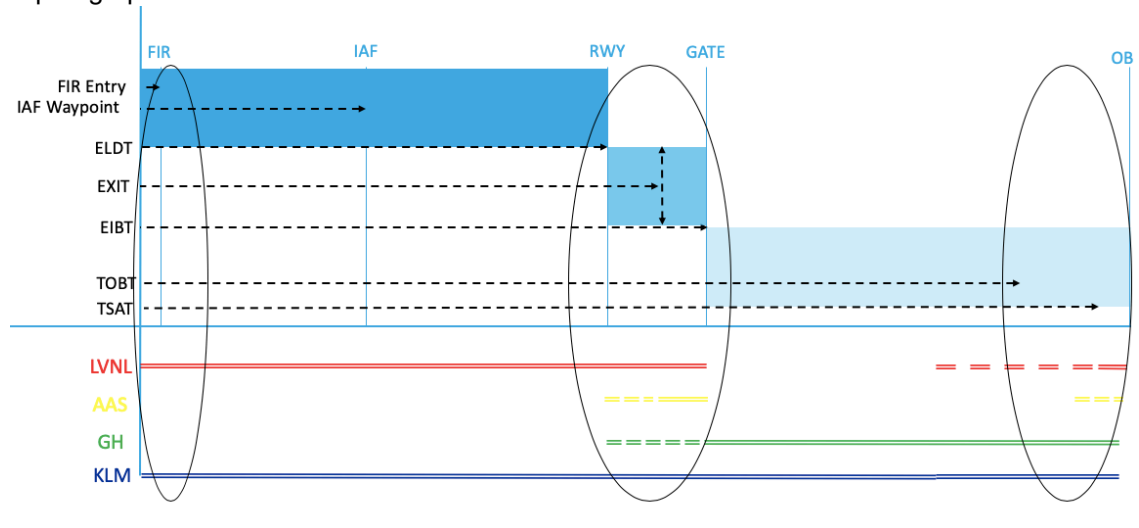


Figure 13: Inbound and turnaround process per stakeholder indicating alignment issues.

The first PI regards the early entry of aircraft at the FIR boundary. This PI was mentioned by Mr. F. Steevens (Appendix V) and affirmed by Mr. J. Schäfer (Appendix VI). He mentioned that it still often occurs that aircraft arrive earlier than planned, which influences the gate planning that is made since this planning is made one day in advance and is based on the flight plan filed by the airlines. If this planning inefficiency occurs early in the morning, the gate capacity is still enough in order to accommodate these early entries. However, if an aircraft arrives earlier than planned and thereby arrives in a peak hour, the airport is not always able to accommodate this, and thus aircraft may have to wait on a remote stand or taxiway. This causes extra workload for the LVNL since more traffic is present on the taxiways. The ground handler is also affected since the resources required to complete the turnaround process are needed earlier than planned. The airline might not be aware what the effect of an early arrival could mean to other stakeholders. It might even be possible that airlines stimulate early arrivals amongst their crew staff since this will increase the satisfaction of their customer, the passengers.

The second PI is the inaccurate representation of taxi-in time that is planned on by airlines, due to the average taxi-in time that is presented in the flight plan. This PI was first brought up by KLM Flight OPS, which indicated that the taxi-in times are not always in accordance with the planned runway and average runway times. After that, during an observation at the KLM Operations Control Centre (OCC), a Flow Controller could confirm that these the taxi-in times are indeed estimated times. An estimation is made because the runway configuration used at Amsterdam Airport Schiphol often changes, which LVNL can confirm:

“The use of runways has a major influence on taxiing times, the occupation of parking spaces and the system of taxiways.” (LVNL, n.d.-b.).

Therefore, it cannot be determined in a flight plan which runway an aircraft will land on and how long the distance between the runway and the gate is. The Flow Controller does observe the runways that are in use on the day itself using Flightradar. However, the plannings have already been created by that point. When the actual taxi-in times significantly deviate from the planned taxi-in time, this could affect the OTP of KLM, as well as the gate and ground handling planning.

The third PI concerns the term OTP, which is a KPI used by both KLM and AAS. However, KLM measures their OTP based on if they arrive on time at their in-block position, while AAS measures their OTP based on the off-block position of aircraft. The contrast between these two different meanings is significant, which may confuse the stakeholders when OTP is the subject of discussion. The OTP itself might not be a planning time; however, it does provide an indication on which planning-times the stakeholders are focused the most. KLM shall probably be focused on arriving at the in-block position on time since this increases their OTP. Schiphol shall probably be focused on aircraft going off-block in time because this increases their OTP. This may cause the stakeholders to take a particular decision which could benefit their operation, but negatively affect the performance of others (i.e. the early FIR entry). This PI was indicated by Mr. S. Kuiper, a fellow KDC graduate intern, who researched the operational plan stability of AAS. Within his research, the PI, as mentioned above, was one of the main subjects. Mr. J. Schäfer confirmed the finding as stated above (Appendix VI). He also added that airlines also measure their OTP not only for arrival but for departure as well. However, the way this OTP is calculated can differ significantly per airline. This process is not aligned between stakeholders as well.

The fourth PI is the 5-minute interval that is regularly used for the TOBT, meaning that the TOBT is either planned on a time ending on minute-0 or minute-5 (i.e. 12:00 or 12:05). This indicates that the TOBT is rounded to a particular minute, instead of using the accurate time an aircraft could be TOBT. The ground handlers at AAS set a TOBT for every aircraft. This time is leading for the outbound sequence, which is created by the A-CDM system and then optimized by the outbound planner at LVNL. If multiple aircraft have a TOBT set on 12:05, but the accurate TOBT of one aircraft is actual 12:03, another on 12:04 and another on 12:06, this is not visible within the A-CDM system, and thus it cannot be considered within the outbound sequence. Thereby, optimizing the sequence will also be more difficult for the outbound planner. This PI was indicated by Mr. J. van Leeuwen (Appendix IV), a Loading Supervisor at Swissport, and confirmed by Mr. M. Reijndorp (Appendix III), an Outbound Planner in training. The fifth PI regards the last-minute updates that are made regarding the TOBT. As mentioned before, the TOBT is leading for the outbound sequence. When this time is updated within the last minutes of the turnaround process, this will have a significant effect on the outbound sequence, which is not desired. This PI was indicated by Mr. M. Reijndorp as well. He stated that the TOBT must be set as soon as possible, as accurate as possible, to be able to create the most efficient outbound planning. However, both the 5-minute interval used and the last-minute updates made for the TOBT are not contributing to this statement. When the outbound planning sequence is not optimal, this will affect not only the LVNL but all other stakeholders as well. The inefficiencies amongst the TOBT are likely to be caused due to the lack of knowledge concerning the procedure of how the TOBT must be dealt with. According to Mr. M. Reijndorp (Appendix III), the TOBT must be set as soon as possible and as accurate as possible. This is not properly aligned amongst the involved stakeholders, as is proved by the 5-minute interval that is used for the TOBT and the many last-minute TOBT that are made. As indicated by Mr. J. Schäfer (Appendix VI), training courses are given to ground handlers on how the A-CDM milestones and primarily the TOBT must be dealt with, since the ground handlers are responsible for setting the TOBT. However, because the staff working at handling companies often only works there for a short amount of time, a lot of the information that is passed on in these training courses get lost.

The sixth and final PI concerns the TSAT that is not met and was indicated by Mr. M. Reijndorp as well (Appendix III). This is mainly caused due to the TOBT not being set accurately. The TSAT is calculated within the A-CDM system based on the TOBT. This pilot is permitted to ask for start-up approval within the 10-minute TSAT window, which is 5 minutes prior, and 5 minutes after TSAT. When the TOBT is set inaccurate, the TSAT will also be set inaccurate. When the TSAT thereby expires, a new TOBT must be set. This will probably cause an outbound delay since the aircraft will then be placed in the back of the outbound sequence. This delay will affect all main stakeholders.

Table 2: Planning inefficiencies overview.

Planning Time/KPI	Alignment Issue	Planning Inefficiency (PI)	Impact	Affected stakeholders
FIR-Entry	Airlines either try arriving early or don't intervene when arriving early by chance.	Aircraft arrive at entry earlier than planned.	Inbound planning changes due to early arrival.	AAS. GH. LVNL.
Taxi-In Time	An average taxi-in time is used in flight plans.	Inaccurate representation of taxi-in time is planned on.	Inbound planning changes due to later or earlier arrival at in-block position than planned	AAS. GH. KLM.
OTP	Airlines measure OTP on the in-block position of aircraft whilst AAS measure OTP on off-block position of aircraft.	Same OTP term is used but with a different meaning.	Confusion amongst stakeholders concerning the term OTP.	AAS. KLM.
TOBT	Unclear procedure and utility of TOBT.	A 5-minute TOBT interval is used within the planning.	Inaccurate indication for outbound planning.	All main stakeholders.
TOBT	Unclear procedure and utility of TOBT.	Last-minute updates are made regarding the TOBT.	Last minute changes to outbound planning.	All main stakeholders.
TSAT	TSAT window is not met (due to inaccurate TOBT).	TSAT expires too often.	TSAT expires too often which affects the outbound planning.	All main stakeholders.

5.3 Activity diagram

To confirm and visualize the planning inefficiencies determined by the operational experts, an activity diagram is created (see figure 14). The activity diagram is a type of a conceptual modelling technique. Within the activity diagram, multiple swim lanes are visible, in which the processes of the stakeholders are visible in chronological order. This diagram indicates how the particular processes of every stakeholder are linked to another, what influence each stakeholder has on processes in which other stakeholders are involved in, and what the effect is on each stakeholders' planning. The symbols used within the activity diagram are explained in appendix VII.

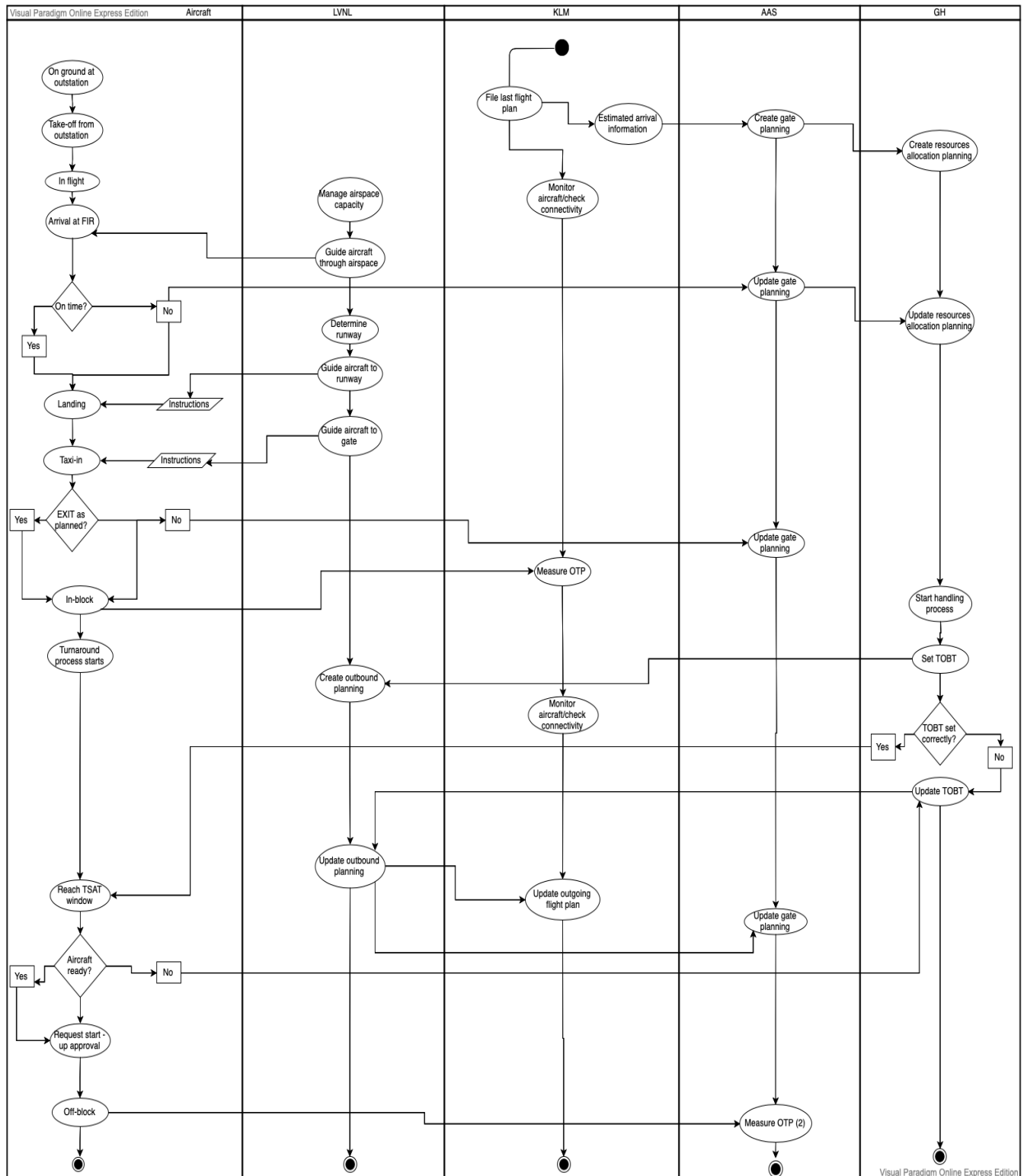


Figure 14: Activity diagram of inbound and turnaround phase.

5.4 Conclusions

By interviewing multiple operational experts, it is determined that planning inefficiencies occur within the inbound phase and the turnaround phase, as a result of insufficient alignment between the main stakeholders at Amsterdam Airport Schiphol due to different points of focus. These inefficiencies often occur when the processes of stakeholders are overlapping each other, or when a process of one stakeholder merges into the process of another stakeholder. These inefficiencies affect the planning-times corresponding to these processes and thus the different plans.

In total, six planning inefficiencies could be identified. These inefficiencies all have different effects on different stakeholders. The inefficiencies found in the turnaround phase, concerning the TOBT and the TSAT planning-times, have the most significant impact considering the number of stakeholders that are affected according to the activity diagram.

6 Impact of PI's

Multiple planning inefficiencies have been identified. Therefore, a data analysis can be performed in order to measure the impact of these PI's. In table 3, all planning inefficiencies are listed per planning-time or KPI in chronological order of the aircraft process. The data analysis method used is elaborated per planning inefficiency. The data analysis is elaborated further within every paragraph. Each analysis is measured over the summer season of 2018.

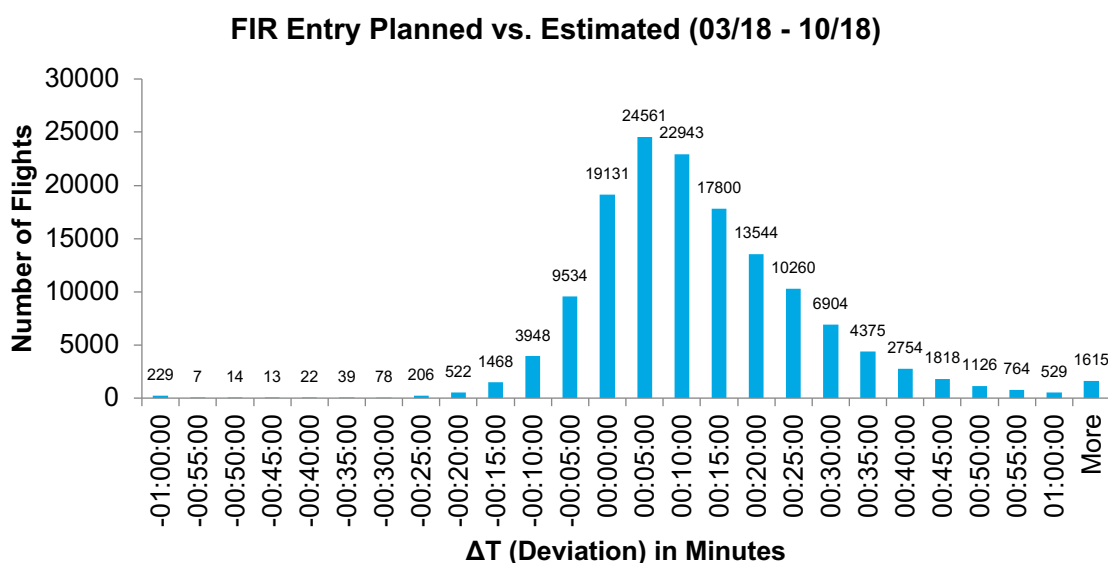
Table 3: Data-analysis per PI.

Planning Time/KPI	Planning Inefficiency	Data-analysis
FIR-Entry	Aircraft arrive at entry earlier than planned.	Planned FIR entry vs. actual FIR entry.
Taxi-In Time	Inaccurate representation of taxi-in time is planned on.	EXIT vs. AXIT.
OTP	Same OTP term is used but with a different meaning.	OTP Arrival vs. OTP Departure.
TOBT	A 5-minute TOBT interval is used within the planning.	Percentage of 5-minute interval used, for all airlines.
TOBT	Last-minute updates are made regarding the TOBT.	Percentage of TOBT updates in final 5 before previous TOBT, for all airlines.
TSAT	TSAT expires too often.	Percentage of TSAT expired, for all airlines.

The early FIR entry is measured first (paragraph 6.1), thereafter, the average taxi-in time (paragraph 6.2). The data-analysis of these two inefficiencies are similar since a ΔT is calculated between the planned time and the actual time at that milestone. The two different measurements of OTP (paragraph 6.3) are compared as well; however, a ΔT will not be calculated. The last three PI's, meaning the TOBT 5-minute interval (paragraph 6.4), the TOBT last-minute updates (paragraph 6.5) and the TSAT expiration (paragraph 6.6), are measured in a similar way. For each of these planning inefficiencies is measured how often they arise; thus, the impact these inefficiencies will have. The percentage of the TOBT 5-minute interval is measured per airline over the complete summer season of 2018 at once (March until October). The TOBT last-minute updates and the TSAT expiration are measured over the same period, but the calculations are made per month.

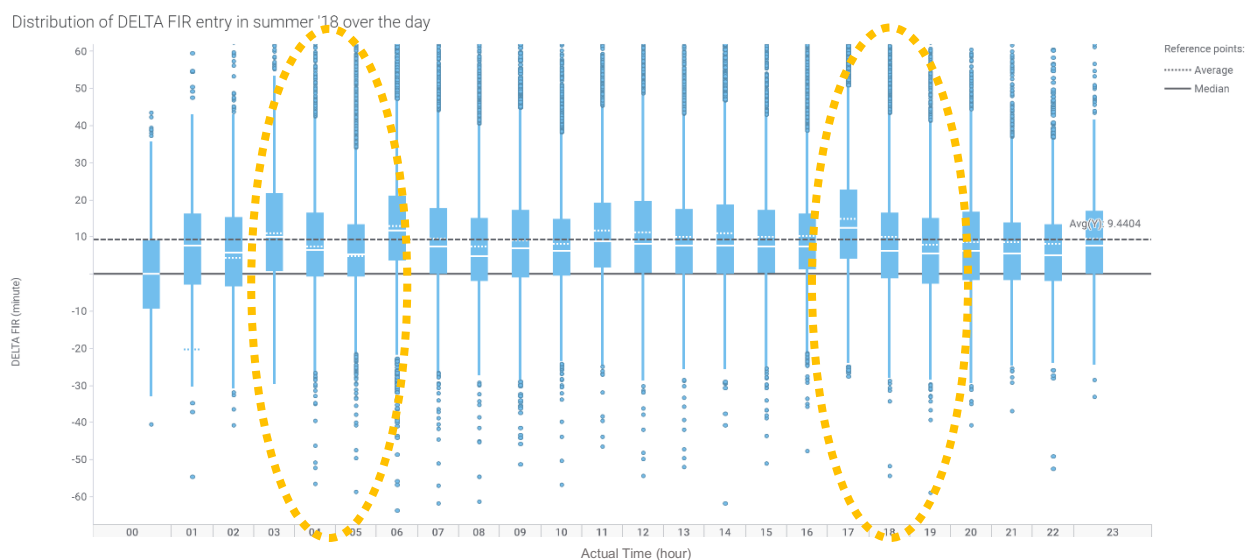
6.1 PI 1: Early FIR-entry

The amount of early FIR entry is measured by comparing the time an aircraft is planned to enter the FIR boundary of the Dutch airspace, to the actual time this aircraft is passing the FIR boundary. The planned entry time is based upon the last filed- flight plan, thus the most updated planning possible. All flights are grouped within a timeframe of 5 minutes deviating from the planned time. The amount of flights entering the Dutch FIR within that timeframe is listed within graph 1. In total around 144,204 flights were analyzed, of which 35,211 early entries. This means that 24% of the total amount of flights entry the FIR earlier than planned, considering the most updated flight planning to be used. Of these early entries, 54% occur within the 5 minutes before the planned entry. The impact of these early entries on other stakeholders is smaller because the deviations caused by these entries in the other plans are minimal. The 'more' category in graph 1, as stated in the x-axis time base, indicates more than 01:00:00.



Graph 1: FIR entry planned vs. estimated.

How these early entries are distributed over the day is visualized in graph 2. Since most of the entries occur later than planned, all the boxplots (except for the boxplot that visualizes) are mostly placed above the median. Especially during the night hours, more early entries occur, which is likely due to the significantly smaller amount of air traffic. A great number of outliers are noticeable, which are pointed out by the dots, due to the large dataset that was used for this analysis. The graph also indicates a small “wave” trend over the day. What is interesting to see, is that the early entries occur more often during peak-hours, as indicated by the orange ellipses. This may indicate that airlines are anticipating towards busy airspace and plan on this within their flight planning too much. An early entry at the FIR could be prevented by, for instance reducing the speed of the aircraft or by vectoring/buffering. However, it must be considered what the environmental impact is when these measures are taken.

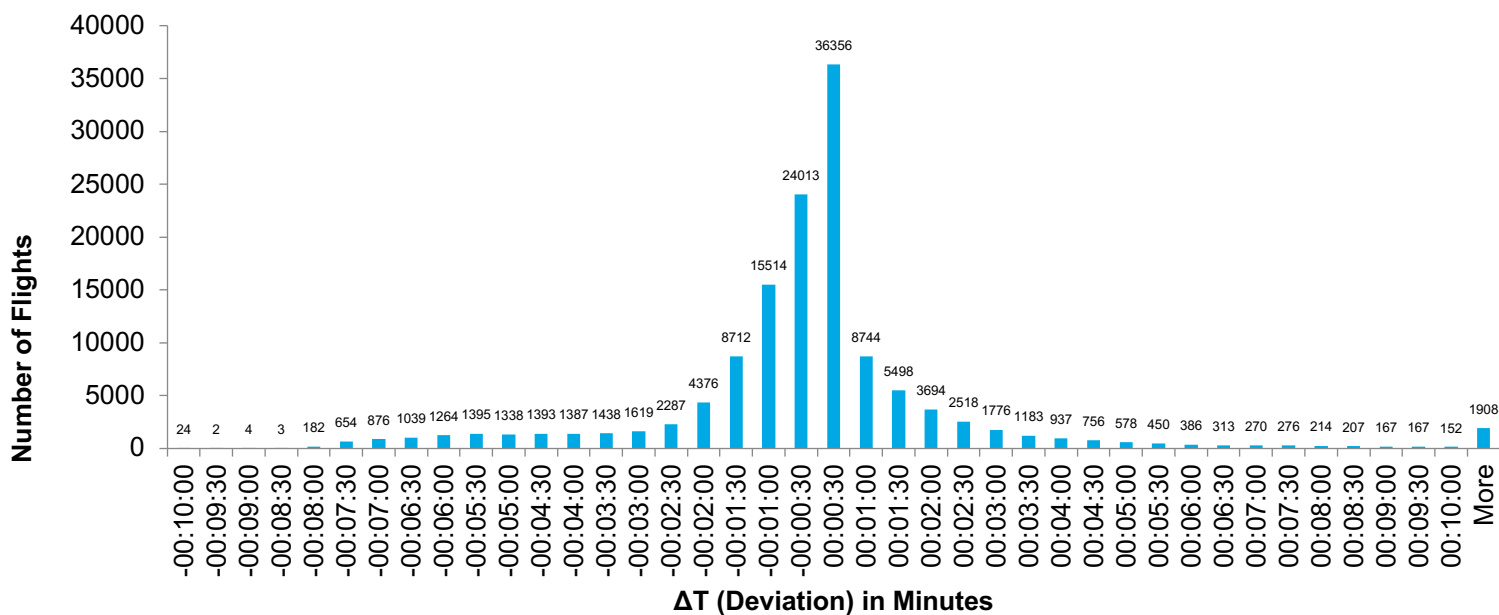


Graph 2: Distribution of Δ FIR entry time over the day.

6.2 PI 2: Average taxi-in time

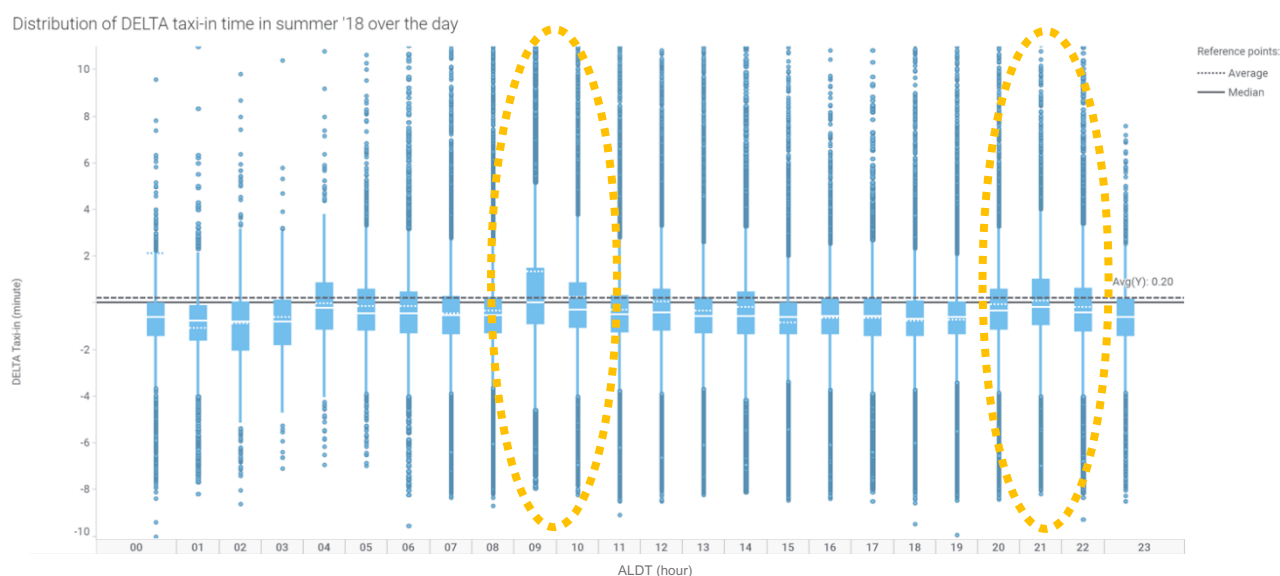
The impact of an average taxi-in time being used within the planning is measured by calculating a ΔT between the EXIT and the AXIT. Both milestones are the result out of the difference between the ELDT and the EIBT, and the ALDT and the AIBT respectively. The outcomes are visualized in graph 3. The 'more' category in this graph, as stated in the x-axis time base, indicates more than 01:00:00. All flights are grouped within a timeframe of 30 seconds deviating from the planned time. Compared to graph 1, a much smaller timeframe was chosen because the deviations for the taxi-in times are generally much smaller than the deviations of the FIR entry time. This is due to the simple fact that the taxi-in process is shorter than the flight process, and this leaves less room to deviate. In total 134,071 aircraft movements were analyzed, of which 36,356 movements are grouped within the 30 seconds prior and 30 seconds after the planned time. This is 27% of the total movements measured. 102,531 movements are grouped within 2 minutes prior and 2 minutes after the planned time, which is 76%. The average taxi-in time used within flight planning is caused by the fact that, due to weather circumstances, it cannot be determined in an early stage which runway is used for landing. The taxi-in time is mostly determined by the distance between the runway on which the aircraft has landed and the gate which has been assigned to the aircraft. Since AAS has six runways, the chance of the runway configuration to be changed (due to the weather) is relatively high compared to other airports.

Estimated Taxi-In Time vs. Actual Taxi-In Time (03/18 - 10/18)



Graph 3: Taxi-in time planned vs. estimated.

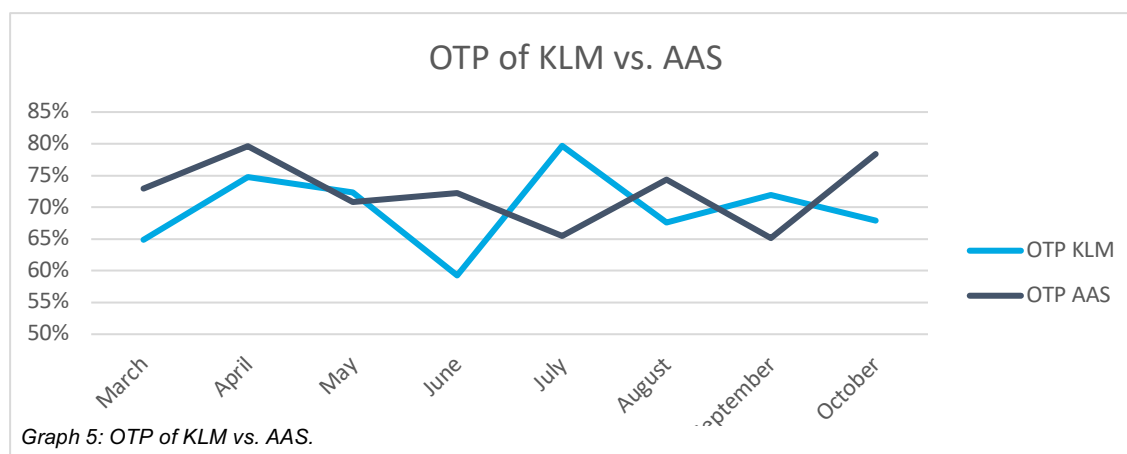
The distribution of the planned versus taxi-in time deviations is visualized in graph 4. The deviations are mostly distributed evenly over the day. A small increase is noticeable during the peak hours; the boxplots indicate that more deviations on the upper top part of the graph occur in comparison to other hours of the day, meaning that the duration of the taxi-in time is longer than planned. This is likely to be caused by the increase in traffic making use of the taxiways. What is interesting to see is that according to this graph, for almost every boxplot, more than 50% and sometimes even up to 75% of the movements the taxi-in time takes less time than planned. However, the average deviation is around +12 seconds, thus longer than planned. This indicates that there must be a significant amount of heavily longer than planned taxi-in times that have increased the average deviation. An explanation for this finding could be that these aircraft were planned on landing on one of the five runways situated around the airport but actually landed on runway 18R/36L, also known as the "Polderbaan". Since this runway is situated significantly further from the airport than the other runways, this would cause a high deviation between the planned taxi-in time and the actual taxi-in time.



Graph 4: Distribution of Δ taxi-in time over the day.

6.3 PI 3: Difference in OTP meaning

The impact of this inefficiency cannot be measured in the same way the other PI's are measured. Since one OTP is indicating the arrival performance and the other OTP is indicating the departure performance, the performances cannot be compared due to this significant difference. In graph 5, the OTP of KLM and AAS (in which all airlines and flights are considered) are plotted against each other. The OTP of KLM was calculated by measuring the difference between the Actual In-Block Time (AIBT) and the Scheduled In-Block Time (SIBT). The OTP of AAS was calculated by measuring the difference between the Actual Off-Block Time (AOBT) and the Scheduled Off-Block Time (SOBT). For both calculations, a buffer of 15:59 minutes was considered in which aircraft are still on time since this is the standard used by AAS. The difference between the two OTP's is significant, and they seem to counteract one another, especially in the busy summer months as seen in graph 5. This indicates that if both stakeholders are trying to improve their OTP, this can cause inconvenience for the other stakeholder. However, this cannot easily be changed since these KPI's are relevant for their strategies. As illustrated in figure 6, the airport receives money from the airline, to make use of its resources. Thus, the airline is a customer of the airport. The lower the outbound OTP, the fewer customers the airport can accommodate. The airport wants as many customers as possible. In the same figure is visualized that the airline pays money to both the ATC and the airport, meaning that their customer must be someone else, namely the passenger. The inbound OTP is an essential performance measurement for the airline, since customer satisfaction increases when the OTP increases, thus leading to more customers.



Graph 5: OTP of KLM vs. AAS.

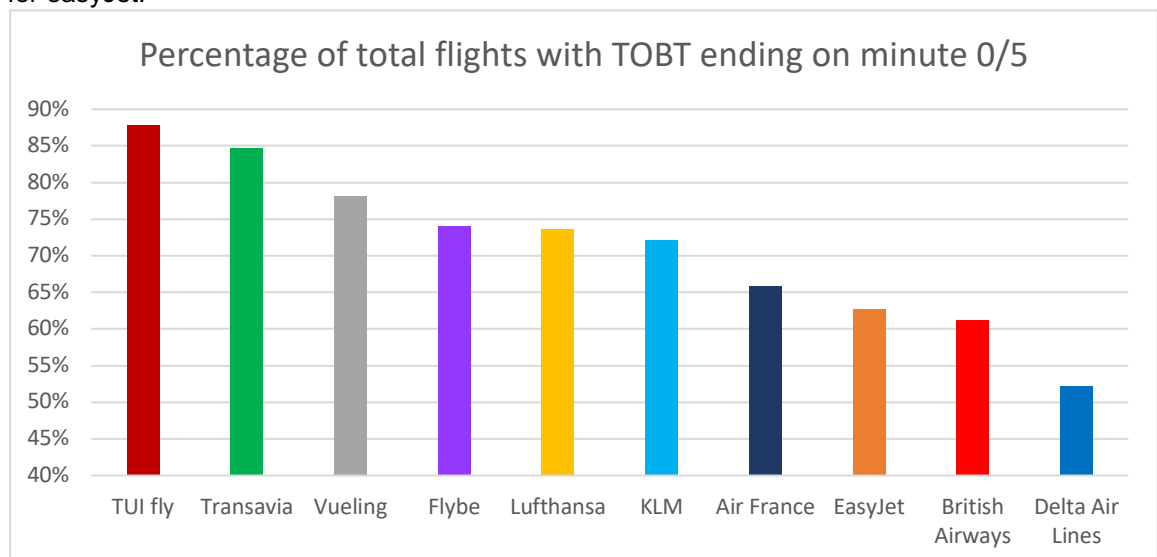
6.4 PI 4: TOBT 5-minute interval

This planning inefficiency is measured by calculating the amount of TOBTs per airline that ends on minute 0 or minute 5. This calculation is made for all airlines operating at Amsterdam Airport Schiphol, and the outcome is presented in a percentage. The outcomes for all airlines are stated in appendix VIII. In the appendix, only airlines with 64 flights or more are considered. Other airlines with fewer flights at Schiphol might give an incorrect indication, so they are left out of scope. In this analysis, only the top-10 airlines with the highest amount of flights from AAS are highlighted. These airlines are listed in table 4, and the outcomes are visualized as well in graph 6. The airlines are ranked from highest percentage to lowest. Not for all the TOBT's set on minute 0 or 5 can be considered that an interval of 5 minutes was used. However, it is assumed that the higher the amount of TOBT's ending on these numbers, the higher the chance of a 5-minute being used. If an even distribution was considered, the amount of TOBT's ending on minute 0 and 5 would be 20%.

Table 4: Percentage of flights with TOBT ending on minute 0/4 per airline.

Airlines	Ground Handler	Total amount of flights	Percentage of TOBT's ending on minute 0/5
TUI fly	Swissport	3,649	88%
Transavia	KLM Ground Services	12,488	85%
Vueling	Aviapartner	3,711	78%
Flybe	Aviapartner	3,644	74%
Lufthansa	Aviapartner	2,721	74%
KLM	KLM Ground Services	82,507	72%
Air France	KLM Ground Services	3,202	66%
easyJet	Menzies	11,981	63%
British Airways	Aviapartner	3,586	61%
Delta Air Lines	KLM Ground Services	4,431	52%

The percentages of all airlines are significantly higher than the 20% that would be expected. This indicates that all the airlines regularly use the 5-minute interval for the TOBT, some more than others. However, the TOBT is set by the ground handler organization that is handling the aircraft; thus, these are also incorporated in table 4. An interesting finding is that Delta Air Lines, the only airline amongst these 10 that is not based within Europe and thus is the least familiar with A-CDM and the milestones of which TOBT is one, scores the lowest percentage. However, Delta Air Lines is handled by the same ground handler as KLM, Air France and easyJet, which score a significantly higher percentage. When comparing the outcomes per handler, it is determined that, based on these 10 airlines, there is no significant difference in performance. Swissport does score the highest percentage, but there is only one outcome for this airline, which is not representative. When comparing business models, the top half airlines scoring the highest percentage are all LCC's, and the bottom half airlines are all Full-Service Carriers (FSC), except for easyJet.



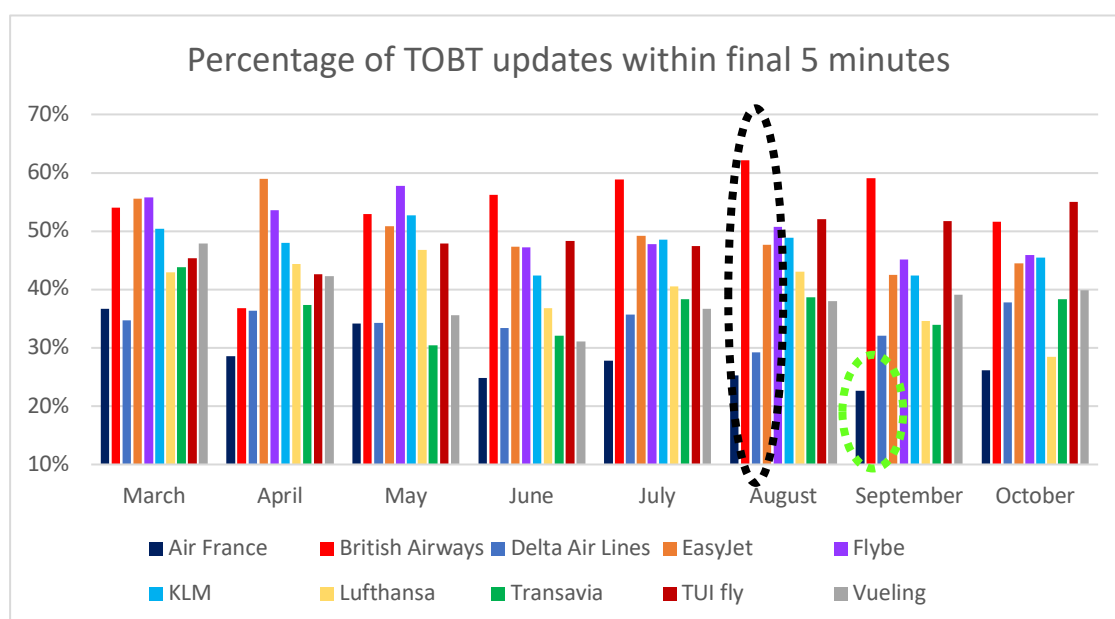
Graph 6: Percentage of flights with TOBT ending on minute 0/5 per airline.

6.5 PI 5: TOBT last-minute updates

This planning inefficiency is measured by calculating the percentage of the TOBT updates that are made within the final 5 minutes before the initial set TOBT. This calculation is made for all airlines operating from Amsterdam Airport Schiphol, per airline and per month. The complete list is incorporated within Appendix IX. For this analysis, the same 10 airlines are highlighted as in the previous paragraph.

As indicated by Mr. M. Reijndorp, it is essential that the TOBT is set as soon as possible and as accurate as possible in order to create the most efficient outbound sequence as possible. Thus, the lower the percentage of updates within the final 5 minutes of the initial TOBT, the more efficient the outbound sequence will be. In graph 7, the percentage is indicated per airline and per month. The airline with the lowest percentage is Air France (23% in September, pointed out by the green ellipse), followed by Delta Air Lines. British Airways has one of the highest percentages in every month (62% in August, pointed out by the black ellipse). Flybe, easyJet and KLM also have relatively high scores.

Similar to the previous analysis, there is not one particular ground handler performing better or worse than the others regarding the percentage of TOBT updates within the final 5 minutes. The outcomes per ground handler are evenly distributed. A significant difference between LCC's and FSC's can neither be determined. Again, Delta Airlines is one of the 'better' performing airlines amongst the 10 that are presented.



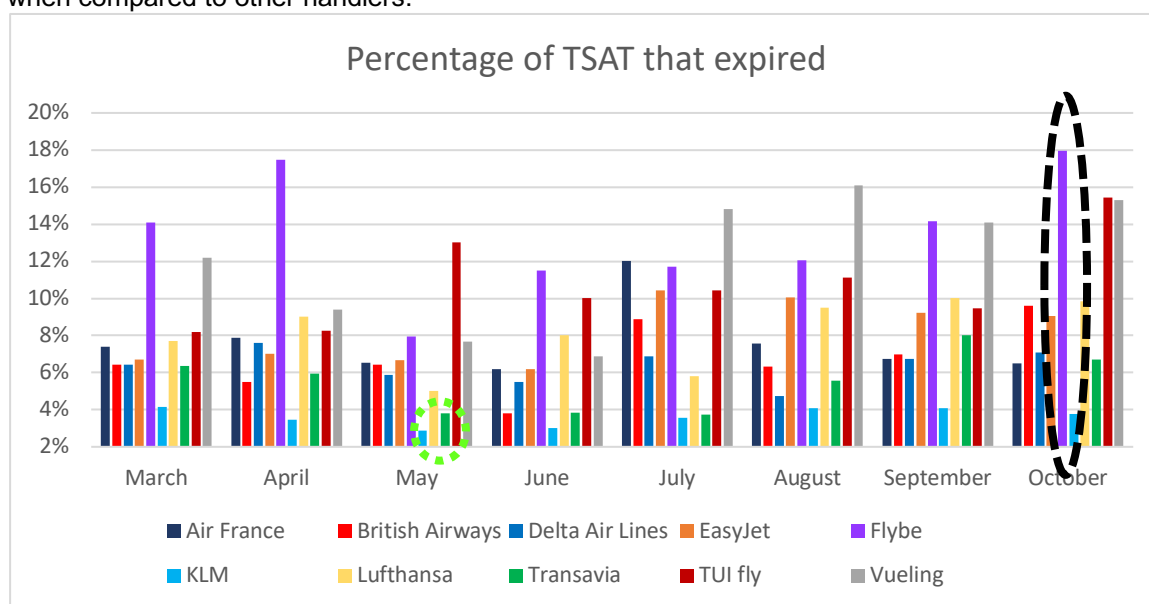
Graph 7: Percentage of TOBT updates within final 5 minutes.

6.6 PI 6: TSAT expired

This planning inefficiency is measured by calculating the percentage of the TSAT's that have expired of the total TSAT's that were issued. This calculation is made for all airlines operating from Amsterdam Airport Schiphol, per airline and per month. The complete list is incorporated within Appendix X. For this analysis, the same 10 airlines are highlighted as in the previous paragraphs 6.4 and 6.5.

As explained in paragraph 5.2 regarding planning inefficiencies, the TSAT is determined by the TOBT that is set. When the TOBT is not set accurately, and an aircraft is not ready within the TSAT-window they have been issued, TSAT will expire, and the aircraft must set a new TOBT. The aircraft will then be put in the outbound sequence again; however, a delay is then already established. Thus, the lowest amount of expired TSAT's is desired by all stakeholders. In graph 8, the percentage of TSAT's that have expired are visualized. The airline with the lowest percentage is KLM, which is remarkable since this airline has a significantly higher amount of flights than the other airlines. One would expect that the amount of TSAT's expired would thereby also be higher compared to other airlines. Flybe, TUI fly and Vueling all score significantly higher than other airlines, almost double in some cases. All these airlines are considered as LCCs. The results vary from 3% (KLM in May, indicated by the green circle) to 18% (Flybe in October, indicated by the black ellipse).

KLM, Delta Air Lines, Transavia and Air France all score a relatively low percentage every month compared to other airlines. All these airlines are handled by KLM Ground Services, which indicates that this ground handler performs as one of the best regarding this topic. Both Flybe and Vueling are handled by Aviapartner, which indicates that this ground handler performs poorly when compared to other handlers.



Graph 8: Percentage of TSAT that expired.

6.7 Conclusions

All the planning inefficiencies have been measured in a way that indicates how often they occur within the day to day operation and thus how big the impact is that the inefficiencies have. Since all of the planning inefficiencies are different and also have a different effect, the impact they have cannot be compared to one another. It can, however, be determined that all the planning inefficiencies cause instabilities within the overall planning system and thus must be avoided.

7 Research findings

During the analysis, multiple findings were done in accordance with the main research question and the sub-research questions. These findings are stated and elaborated in this chapter in the same order as the sub-research questions.

The following findings were done with regard to SQ 1: **How can alignment issues concerning planning between the stakeholders in the Dutch aviation industry be identified?** During the analysis, it was found that inter-organizational alignment can be applied to the Dutch aviation industry, on multiple perspectives. It was established that in the past, alignment issues occurred amongst the main stakeholders, especially concerning the order of processes and the different planning used per stakeholder. The implementation of A-CDM tackled some of these issues. With the implementation of this new system, new planning-times and procedures were introduced. However, it remained unsure if new alignment issues occurred due to this new system.

The following findings were done with regard to SQ 2: **Within the inbound and turnaround phase, which stakeholder plans on what processes and how?** All of the main stakeholders within the Dutch aviation industry are dependent on one another since the processes they are involved in are all part of the continuing aircraft process. Therefore, they influence each other's processes and corresponding planning. By using planning-times, also called milestones, each stakeholder is able to plan on when an aircraft will pass a certain point or are in a particular state. Since the stakeholders are involved in different parts of the overall aircraft process, each stakeholder put their focus one or multiple of these planning-times. The most critical planning-times defined in the inbound and turnaround process are the FIR entry, the IAF waypoint, the ELDT, the EXIT, the EIBT, the TOBT and the TSAT. The order of these times, and in which part of the process, the stakeholders are involved is visualized in figure 15.

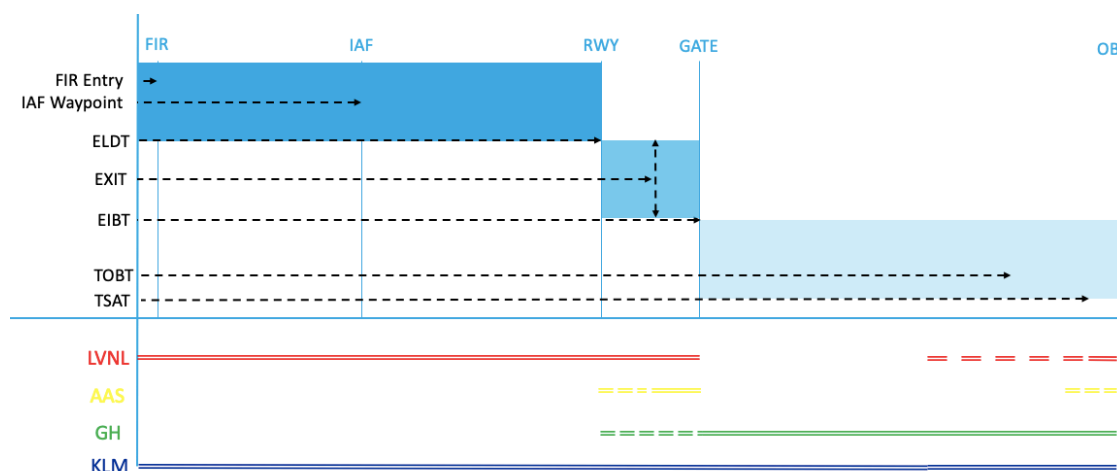


Figure 15: Inbound and turnaround process per stakeholders with planning-times .

After the literature research, more findings were done through interviews, considering SQ 3: **Where in the inbound and turnaround phases can planning inefficiencies be identified?** Within the processes in the inbound and turnaround phase, as visualized in figure 15, multiple alignment issues could be determined with the help of operational experts. Due to this insufficient alignment as a result of different points of focus, planning inefficiencies are caused within the overall planning system at Mainport Schiphol. The planning inefficiencies result in a deviation from the planning, or an affected performance of one or multiple stakeholders. The planning inefficiencies mostly concern the planning-times found, as stated in figure 15 and are listed subsequently.

- Early entry at FIR
- Average taxi-in time is used in airlines' flight plans
- The term OTP is used in different ways.
- A 5-minute TOBT interval is used within the planning.
- Last-minute updates are made regarding the TOBT.
- TSAT expired due to inaccurate TOBT.

After identifying which planning inefficiencies arise within the inbound and turnaround phase, it was analyzed how often these occur and thus the impact on the overall planning system at Mainport Schiphol, thus with regard to SQ 4: **What is the impact of the identified planning inefficiencies?** The impact is discussed per planning inefficiency below.

Of the total amount of flights measured, 24% entry the FIR earlier than planned. Of these early entries, 54% occur within the 5 minutes before the planned entry. The impact of these early entries on other stakeholders is smaller because the deviations caused by these entries to the other plans are minimal.

For the planned taxi-in time is measured that, in reality, 27% of the total amount of taxi-in times are planned on correctly, considering a buffer of 30 seconds prior and 30 seconds after the planned time. When increasing this buffer to 2 minutes, the percentage increases to 76 %. Thus in 24% of the time, the total amount of taxi-in times used within the flight plans is either too long or too short by a minimal 2 minutes.

The difference in OTP meaning cannot be measured in the same way as the other planning inefficiencies. Since one OTP is indicating the arrival performance and the other OTP is indicating the departure performance, the performance can indicate very different outcomes when comparing these to each other. This is the main problem since this can confuse practice concerning which definition of OTP is meant. Also, when comparing the outcomes of both OTP's, a trend can be noticed in where both KPI's seem to counteract one another.

For the TOBT it was measured how often this planning-time ends on minute 0 or minute 5, indicating if airlines round off their TOBT to a 5-minute interval. The top 10 airlines with the highest amount of flights arriving and departing from Amsterdam Airport Schiphol all show a relatively high percentage of TOBT's ending on minute 0 or minute 5. The outcomes vary between 52% (Delta Air Lines) and 88% (TUI fly), indicating that all these airlines make use of the 5-minute interval to some degree.

For the same planning-time was measured how much of the total amount of TOBT updates are made in the final 5 minutes before the previous set TOBT. The same 10 airlines were considered. The outcomes show that, even though the exact results differ per month, overall, the airlines score the same concerning the place in the ranking. The airline with the lowest percentage is Air France (23% in September), followed by Delta Air Lines. British Airways has one of the highest percentages in every month (62% in August). Flybe, easyJet and KLM also have relatively high scores.

The last planning inefficiency was measured by calculating the percentage of the TSAT's that have expired of the total TSAT's that were issued. The results vary from 3% (KLM in May) to 18% (Flybe in October). KLM, Delta Air Lines. Transavia and Air France all score a relatively low percentage every month compared to other airlines (all handled by KLM Ground Services) Both Flybe and Vueling score relatively high compared to the other airlines (both handled by Aviapartner).

8 Conclusions

In this chapter, the main research question, as formulated in the begin of the research, is answered according to the analysis performed for all sub-research questions combined. The main research question is stated below. The first part of the main research question is answered by SQ1, SQ2 and SQ3, in which qualitative research was applied by means of reviewing the literature and conducting interviews with operational experts.

“Do planning inefficiencies amongst the major stakeholders at Amsterdam Airport Schiphol occur and, if so, what impact do they have?”

- **SQ1: How can alignment issues concerning planning between the stakeholders in the Dutch aviation industry be identified?**

The e3 alignment method provided insight into how previous alignment issues between the main stakeholders of the Dutch aviation industry were determined. Solutions were created for these alignment issues, which were applied when A-CDM was implemented ten years later. With the full implementation of A-CDM in May of 2018, more alignment is achieved between the stakeholders, for instance, by the introduction of milestones. Since the arrival A-CDM caused a change within the over planning system at Amsterdam Airport Schiphol, the situation on alignment needed to be re-evaluated. The e3 alignment method was partly applied again in this research.

- **SQ2: Within the inbound and turnaround phase, which stakeholder plans on what processes and how?**

To be able to analyze possible alignment issues in the overall planning system, the stakeholders and how they are connected, the processes, the planning and the planning-times used by the main stakeholders had to be determined first. With the help of literature research, the inbound phase and the turnaround phase could be visualized, including all processes and most essential planning-times. Each main stakeholder is involved with one or multiple of these processes and therefore focusses most on these in their individual planning. Since these processes are all connected to one another within the overall aircraft process, the stakeholders carry each other concerning their individual planning. The most critical planning-times determined within the inbound phase and the turnaround phase are the FIR entry time, the IAF waypoint, the ELDT, the EXIT, the EIBT, the TOBT and the TSAT. The airline is involved with all these planning-times since they are involved with all the processes of the aircraft. The LVNL is also involved with all planning-times but is not involved with the turnaround process itself. However, the TOBT and the TSAT are essential indicators for the outbound sequence and are generated within the turnaround process. AAS is mostly involved with the EIBT and the TOBT since these times indicate how long a certain gate or stand is occupied. The ground handler is concerned with the EIBT, TOBT and the TSAT since these times are critical indicators to the ground handlers' resource planning.

- **SQ3: Where in the inbound and turnaround phases can planning inefficiencies be identified?**

After the inbound phase and turnaround phase had been visualized, including all processes and planning-times, it was researched if any alignment issues and thus planning inefficiencies could be identified. Operational experts were interviewed regarding their thoughts and experiences on alignment issues and planning inefficiencies, after which an activity diagram was created as proposes by the e3alignment method. Six planning inefficiencies could be identified. Therefore, the first part of the main research question could be answered. The planning inefficiencies are stated below.

- Early entry at FIR
- Average taxi-in time is used in airlines' flight plans
- The term OTP is used in different ways.
- A 5-minute TOBT interval is used within the planning.
- Last-minute updates are made regarding the TOBT.
- TSAT expired due to inaccurate TOBT.

The second part of the main research question concerns the impact of the identified planning inefficiencies. The impact was measured by applying different data-analysis methods per inefficiency. The impact will, therefore, be discussed per inefficiency as well.

- **SQ4: What is the impact of the identified planning inefficiencies?**

The amount of early FIR entry was measured by comparing the time an aircraft is planned to enter the FIR boundary of the Dutch airspace, to the actual time this aircraft is passing the FIR boundary. Of the total amount of flights measured, 24% entered the FIR boundary too early, of which 54% of flights enter within the 5 minutes prior to the planned entry. When an aircraft arrives too early, this will affect the planning of the following processes and thereby the other main stakeholders as well, especially when this occurs in peak hours. Thus, the impact is relatively high. The data-analysis showed that early entries occur even more often during peak-hours, indicating that airlines consider a too large buffer within their planning during these times.

The impact of an average taxi-in time being used within the planning is measured by calculating a ΔT between the EXIT and the AXIT. Of the total amount of movements measured, 27% of the taxi-in times are correctly planned upon when considering a 30-second buffer. When considering a 2-minute buffer, the percentage of correctly planned times increases to 76%; thus, the impact seems relatively low. The fact that airlines use an average taxi-in time within their flight planning is considered as a planning inefficiency, but in practice, most of the estimations made are accurate. A small increase in the ΔT is noticeable during peak hours, due to more traffic on the taxiways. The distribution of the ΔT shows that the actual taxi-in time often takes less time than what is planned; however, the average ΔT is approximately 12 seconds. This is likely to be caused by a high number of outliers, likely to be caused by the unexpected use of runway 18R/36L, significantly increasing the actual taxi-in time.

The official impact of the different ways the term OTP is used cannot be measured; however, it could be indicated how different the outcomes of the KPI are when comparing them to each other. With the implementation of A-CDM, milestones were introduced in order to make sure that every stakeholder is working with the same definitions. However, airlines generally base their OTP on their in-block position, and AAS base their OTP on the off-block position. This results in different outcomes, which even seem to counteract each other for most of the months measured.

The impact of the 5-minute interval used to set the TOBT is indicated by measuring how often the TOBT is set on minute 0 or minute 5. The analysis shows that all airlines, some more than others, apply the 5-minute interval. For the 10 airlines highlighted in this research, the percentages vary between 52% and 88%. This results in an inaccurate representation of the TOBT, which impacts the efficiency of the outbound sequence. Since this planning inefficiency occurs for all airlines, the impact is relatively high.

The impact of the TOBT, last-minute updates, is measured by calculating the percentage of the TOBT updates that are made within the final 5 minutes before the initial set TOBT. Updates must preferably be made as soon as possible to ensure an efficient outbound sequence. However, the data analysis shows that, considering the 10 highlighted airlines, in the best-case scenario, 23% of the updates for one month are made in the last 5 minutes before the previous TOBT. In the worst-case scenario, this is 62%. The impact of this inefficiency can be considered high as well since all stakeholders are affected when the efficiency of the outbound sequence is affected.

The impact of the last inefficiency was measured by calculating the percentage of the TSATs that have expired of the total TSATs that were issued. When the TSAT expires, the outbound sequence and thus, all stakeholders are affected. The results vary between 3% to 18% per month. The impact of this planning inefficiency is very dependent on the airline; therefore, the impact is seen as moderate.

It can be determined that all planning inefficiency negatively impact the overall planning system and thus preferably need to be minimized or eliminated by creating more alignment, in order to improve the efficiency of the overall planning system.

9 Discussion

Before the research, only a few assumptions had to be made. However, there were a couple of assumptions that arose during the research, mainly considering the causes of the identified planning inefficiencies. Therefore, this chapter is merely focused on the fourth and final SQ. Since these causes could not be proven, they are not included in the conclusion of this research but elaborated in this chapter as points of discussion. These points are stated according to the sequence of the planning inefficiencies. More general points of discussion are mentioned after that.

Literature research was the chosen method to analyze the first two sub-questions. The first regarded SQ1: **How can alignment issues concerning planning between the stakeholders in the Dutch aviation industry be identified?** Even though suitable literature was determined, meaning the e3alignment method concerning inter-organizational alignment, not many other sources concerning this topic could be found. The e3alignment method proved to be helpful during this research; however, not many other literature studies on alignment were discussed. This can be included in future research, to provide a broader approach to this topic. The other literature research regarded SQ2: **Within the inbound and turnaround phase, which stakeholder plans on what processes and how?** Afterward, this analysis proved to be somewhat general, since it did not provide new information. However, it was essential to elaborate on since it provides crucial background knowledge regarding the research subject.

The following analysis regarded SQ3: **Where in the inbound and turnaround phases can planning inefficiencies be identified?** To analyze which planning inefficiency could be determined, it was chosen to perform multiple interviews with operational experts, and create an activity diagram. The interviews held were sufficient to determine six planning inefficiencies; however, more operational experts could have been interviewed to determine even more inefficiencies and to provide different opinions regarding this topic. This could be provided by performing further research. The activity diagram proved to give a clear visualization of the problems defined, as was already determined by the e3alignment method.

The following points of discussion regard SQ4: **What is the impact of the identified planning inefficiencies?** The points are listed per planning inefficiency.

Multiple factors could cause an early entry at the FIR. Either the airlines are purposely trying to arrive as early as possible by flying faster than planned or needed, or the weather conditions (i.e., wind conditions) are better than expected, and the crew does not intervene when this causes an earlier arrival than planned. This could be explained by the fact that airlines measure their OTP based on their arrival at the in-block position; thus, the earlier an aircraft arrives, the higher the chance of a high OTP. Customer satisfaction also increases when arriving earlier than is expected.

The large ΔT 's found between the EXIT and the AXIT could be caused by the unexpected use of runway 18R/36L for the landing; however, this is only suspected and could not be determined from the available data. Further research is required regarding this subject.

The last three inefficiencies are all situated amongst A-CDM milestones, namely the TOBT and the TSAT. The inefficiencies amongst the TOBT are likely to be caused due to the lack of knowledge concerning the procedure of how the TOBT must be dealt with. This can be caused by the short amount of time that employees tend to work at handling companies, causing the information to be lost. Another cause could also be that handlers are still not used to the A-CDM way of working since it has only fully implemented since May of 2018. Mr. J. Schäfer also indicated that it might be possible that ground handlers misinterpret the A-CDM manual, by reading that they are only allowed to update the TOBT in the last 5 minutes while instead, it reads that the TOBT may be set upon (intervals of) 5 minutes. However, it was not researched which of these factors cause the inefficiencies; more in-depth research must be performed concerning this topic.

The expiration of the TSAT is likely often to be caused by an inaccurately set TOBT. Other factors causing the TSAT to expire could be the fact that airlines are hesitant to update the TOBT since it will cause change within the outbound sequence. Therefore, the TOBT is kept unchanged in order to remain the specific desired spot within the outbound sequence. However, if this TOBT is not reachable, it will cause the TSAT to expire. Again, these causes are all based on assumptions and not determined.

Different methods were applied per planning inefficiency to analyze the data. Even though the methods were simplistic, the outcomes proved to provide sufficient general insight into the impact of the planning inefficiencies. However, more detailed findings and therefore, recommendations could have been given if the analysis would have been more detailed. To achieve this, a less simplistic method would, therefore, had to been chosen from the starting point of the data analysis.

It is assumed that the identified planning inefficiencies negatively affect the already limited capacity at Amsterdam Airport Schiphol. Since most of the PI's result in deviations within the planning, the efficiency of having a planning gets lost. When less planning inefficiencies occur, this will lead to more plan stability, which is currently needed more than ever at Amsterdam Airport Schiphol due to the limited amount of capacity left. However, no research was performed on how the planning inefficiency directly affects the capacity. Therefore, this cannot be stated as a fact.

This research was mainly focused on researching if planning inefficiencies occur, thus explorative. Since multiple inefficiencies were found, a more general quantitative analysis was performed to provide insight on the impact. More in-depth research should be performed on all the planning inefficiencies to provide an in-depth analysis per planning inefficiency, which must also focus on the solution design and impact analysis of the solutions.

10 Recommendations

After analyzing the planning inefficiencies, the subject is to minimize the impact of these inefficiencies or eliminate the alignment issue causing the inefficiency. Possible solutions will, therefore, be provided as a recommendation in this chapter.

A-CDM has contributed to better alignment amongst the main stakeholders, as stated within the analysis concerning SQ1: **How can alignment issues concerning planning between the stakeholders in the Dutch aviation industry be identified?** However, it is only focused on the outbound process. Inbound and outbound are so dependent on each other, which is also pointed out by Mr. J. Schäfer. It would make sense conduct research into the implementation of A-CDM not only as an outbound system but as an inbound system as well. This could be a new opportunity to create even more alignment but must first be thoroughly researched and cannot be implemented in the short term.

This research focusses only on the inbound phase and turnaround phase, which are explained within the analysis of SQ2: **Within the inbound and turnaround phase, which stakeholder plans on what processes and how?** It is recommended for further research to be conducted on the outbound phase as well. Also, not all processes were considered in this research, although they could be interesting to analyze with regard to planning inefficiencies. Examples could be the de-icing process, terminal/passenger processes. This can be executed in a short-term basis.

How planning inefficiencies arise and result out of alignment issues was elaborated in the analysis of SQ 3: **Where in the inbound and turnaround phases can planning inefficiencies be identified?** Multiple recommendations are made regarding this subject. It is recommended that more awareness is created amongst all stakeholders on the importance of collaboration, open communication and alignment concerning planning and performance, even more since the lack of capacity at AAS has become an increasing problem since this can minimize the impact of the planning inefficiencies. Every stakeholder tends to focus only on their operations and processes, and the bigger picture of the overall aircraft process is under-exposed. The stakeholders must be made aware of the importance of reducing the impact of planning inefficiencies, how this can benefit the overall planning system and eventually, the individual stakeholders. After analyzing the inefficiencies, it is determined that better alignment between stakeholders is possible to achieve. It is recommended that training regarding this topic is given regularly by an independent party. However, stakeholders must be willing to participate. A more general solution regarding all PI's is to achieve more and better communication. Stakeholders must be aware of the impact they practice on each other's operation and corresponding processes. More and better communication is vital. The Airport Operations Centre (APOC) might be a good starting point to achieve more alignment. "The concept document developed by NM at the request of operational stakeholders describes the principles behind setting up a successful local collaboration that enables transparent and collaborative operations at and around airports." (Eurocontrol, 2018). This concept is not yet implemented at Amsterdam Airport Schiphol.

Multiple planning inefficiencies regarding the TOBT were identified. After the identification, it could be determined that the impact of these inefficiencies is relatively high within the analysis of SQ 4: **What is the impact of the identified planning inefficiencies?** The solution to this inefficiency, however, could be quite straightforward. More often and clear training must be given to ground handling employees on what the consequences are of the TOBT not being set correctly and on-time. This research shows that the inefficiencies concerning the TOBT affect all main stakeholders. Therefore, it could be determined that these inefficiencies have priority with regard to a solution. Training concerning A-CDM is already given to employees, but this research shows that in practice planning, inefficiencies still occur. Therefore, a solution must be sought on how the training concerning this topic could be better communicated. It must, however, first be researched if this can be arranged, also when considering the costs of these training courses.

Lastly, every planning inefficiency must be analyzed in a more in-depth manner. This research was conducted on an exploratory level; thus, the inefficiencies could not be researched into detail. Further research into the solution design and the impact of the solutions can be conducted, according to step 2 and step 3 in the e3alignment method. Also, more research must be conducted on how these solutions can benefit the capacity issue at Schiphol. This can be executed on a short-term basis if desired by the stakeholders.

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Planning inefficiencies within the overall planning system of Mainport Schiphol

An analysis of alignment issues between the major stakeholders in the Dutch aviation sector, causing planning inefficiencies in the inbound and turnaround phase

Appendices

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Appendix I Reflection

During the complete duration of this final chapter of my bachelor studies, I have learned a lot. Not only am I referring to the subject of my thesis, but the work environment and personal growth as well. Therefore, this chapter is divided into two categories: knowledge, in which I will reflect on matters that are related to the actual research, both skills and subject, and experiences, in which I will reflect on more general matters concerning the work environment, social aspects and my personal growth.

• Knowledge

When I started the internship, I found that there was no clear scope of the research. It was more a general subject in which a scope had to be made. However, I assumed for too long that there had to be a very specific outcome or a goal to be achieved. After a few months, I finally accepted that I had to define a clear scope for the research myself; otherwise, I would be stuck at the same point, and no results could be achieved. I found this one of the most challenging things to do since I am more the type of person to follow a clear, specific and set-out assignment, instead of determining all the steps. Even though this gave me enough stress during the last couple of months, I am proud that I have eventually succeeded in this task, with the help of my thesis advisor. This will be very helpful during the phase of writing my master thesis.

The research I conducted was related to many stakeholders within the aviation industry. During my bachelor studies, I already learned a great deal concerning the operation of most of these stakeholders and all the processes they are involved in. However, I quickly learned that air traffic control was underexposed during the bachelor compared to other stakeholders. I was missing essential information that I needed for my research. Therefore, I had to learn a lot about air traffic control in a short amount of time. Luckily, this research was conducted in the office of the air traffic control, and thus, I was able to ask the questions I had directly to experts within the field. Luckily, many of the other research topics were focused on mainly the LVNL. Therefore, I could learn together with and from the other KDC graduation students, which proved to be very helpful as well.

The research conducted by the other KDC graduation students, which were all aviation students as well, were all related to the topic of capacity management at Amsterdam Airport Schiphol. At the beginning of the internship, it was often told that our assignments were firmly related to each other; however, I found myself having trouble to find the connections and seeing the bigger picture. Afterwards, it was much easier to find and understand the similarities and connections, which I found disappointing because we did not get to collaborate in a team on a substantial level that often. If I ever would be in a similar position, I would like to handle this differently from the beginning.

During the quantitative analysis of the research, I had to analyze different datasets concerning planning-times and A-CDM milestones. Even though the analysis was not typically tricky, I found myself having trouble to perform the data analysis and work with Microsoft Excel. I received help from my fellow interns, for which I was very grateful, and I learned a lot from them. I found that I was far more interested in this subject that I thought I would be.

• Experience

Even though the graduation internship is performed individually, I really enjoyed working together with all the people involved within the KDC, both students, as well as the stakeholders and the AUAS advisors. I learned a lot about how to work in an environment with different kind of people, how to communicate on different levels and adapt to certain situations I was not familiar with. In the beginning, I was often stressed because of the different working methods, approaches and the way of communicating of others. In the end, I figured that I could not change others, but I was able to change the way how I was handling it, and I could adapt more easily to others.

During the first couple of months, scrum meetings and sprint reviews were held, which is a part of working in an agile manner. I believe that this would have had a much more positive effect if all the interns would have worked on one big project in a real team, for which the scrum meeting and sprint reviews are actually meant. For me, personally, this method had a negative effect since I found myself heavily stresses during the meetings and presentations. However, I did become slightly more relaxed with presenting and speaking for groups of people as the weeks went by, which is a highly appreciated skill.

Appendix II OTP of AAS below 60% dates

Table 5: All dates in the summer season of 2018 when the OTP of AAS was below 60%.

Number of days	Date
1	26-03-2018
2	05-04-2018
3	09-04-2018
4	25-04-2018
5	29-04-2018
6	30-04-2018
7	01-05-2018
8	20-05-2018
9	27-05-2018
10	29-05-2018
11	30-05-2018
12	31-05-2018
13	01-06-2018
14	02-06-2018
15	03-06-2018
16	04-06-2018
17	05-06-2018
18	07-06-2018
19	08-06-2018
20	10-06-2018
21	22-06-2018
22	26-06-2018
23	28-06-2018
24	29-06-2018
25	01-07-2018
26	15-07-2018
27	16-07-2018
28	27-07-2018
29	28-07-2018
30	29-07-2018
31	09-08-2018
32	10-08-2018
33	13-08-2018
34	15-08-2018
35	25-08-2018
36	04-09-2018
37	05-09-2018
38	06-09-2018
39	11-09-2018
40	12-09-2018
41	14-09-2018
42	21-09-2018
43	23-09-2018
44	01-10-2018

Appendix III Summary interview Mr. M. Reijndorp

Table 6; Interview information Mr. M. Reijndorp.

Name of interviewee	Mr. M. Reijndorp
Name of interviewer	Mrs. F. Mollema
Job title of interviewee	Outbound Planner (in training) at LVNL
Date	10-04-2019
Place	Amsterdam Airport Schiphol, The Netherlands

- **What is your function as an outbound planner?**
 - An outbound planner has multiple responsibilities. The outbound planner (OPL) creates a time-based sequence for all the outbound traffic at Schiphol. The A-CDM system automatically generates a sequence for the outbound flow, which can be optimized by the OPL who can thereby regulate the outgoing traffic. The OPL also provides the route-clearances.
- **What is the most important factor within the creation of an accurate outbound planning?**
 - For every aircraft a target off-block time, TOBT, needs to be set by the ground handling company. This is one of the most important factors within the A-CDM system because based on these TOBT's, an outbound planning is created. After the TOBT is set, a target take-off time, or TTOT, can be set as well when adding up the taxi-out time and maybe even an ATFM delay, or calculated take-off time, which is called a CTOT, as well. From the TTOT a target start-up approval time or TSAT is calculated. This is the time calculated within the A-CDM system that indicates the most suitable moment for a pilot to ask permission from ATC to start-up. There is a ± 5 window surrounding the TSAT. Because there are so many times dependent on the TOBT, the most important factor is that this TOBT is set as accurate as possible, and as soon as possible within the turnaround process. This will provide an accurate outbound planning because the A-CDM system can calculate a more accurate outbound sequence.
- **What is, according to you, the biggest inefficiency within the outbound planning process?**
 - The biggest inefficiency is when the TOBT is not being set soon enough, accurate enough or both. There are a lot of last-minute updates for the TOBT but that makes it more difficult for the A-CDM system, which works the best with as accurate times as possible, to create an accurate outbound sequence, and thereby my job as OPL gets more difficult as well. It can also happen that, if the TOBT is not set accurately, the TSAT will expire because the aircraft is not ready yet. Then they have to wait and set a new TOBT which costs a lot of time. This is probably the biggest inefficiency in the outbound planning.

Appendix IV Summary interview Mr. J. van Leeuwen.

Table 7: Interview information Mr. J. van Leeuwen.

Name of interviewee	Mr. J. van Leeuwen
Name of interviewer	Mrs. F. Mollema
Job title of interviewee	Loading Supervisor at Swissport
Date	10-04-2019
Place	Amsterdam Airport Schiphol, The Netherlands

- **What is your function as a Load Supervisor at Swissport?**
 - I am a Load Supervisor, which means that, on the ramp, I have the final responsibility about the turnaround process of an aircraft. The loading and unloading of cargo, general cargo or dangerous goods, mail and luggage. Furthermore, I have to keep close contact with the gate agents, for PAX, load controllers, which create the loading while respecting the rules of the airline, IATA and IL&T, and finally the duty operations department. The last-mentioned are important for you to keep in mind, because they keep record of all the flights handled by the ground handler which flights have which TOBT's.
- **From your perspective as a Load Supervisor, how do ground handlers currently work with the A-CDM procedures?**
 - When a flight is planned by an airline, they apply for a certain slot and they pass on a standard schedule, that's when we take over. We receive up to-date schedules on the day itself, and we put that in CISS. We adjust the EOBT and the TOBT on the basis of the flight schedule, in case there are certain delays for the inbound flight, we update the TOBT. While working on the ramp, if I know that for some reason a delay will arise, I will report this to the department so that the TOBT can be adjusted as soon as possible and the TSAT can be calculated as accurate and favorable as possible. Most of the time, the TOBT does not get updates if the delay is less than 5 minutes.
- **According to your experience as a Load Supervisor, are there any planning inefficiencies within the ground handling process that may require attention?**
 - I think improvements can be made concerning the TOBT process. In my opinion, it should either be possible for the Load Supervisor to update the TOBT directly, naturally, they should first receive proper training on how to do this. Or, the TOBT must be updated earlier, even when there is less than a 5-minute change in the planning. You will also prevent the problem that A-CDM will randomly arrange the outbound sequence when for instance 10 flights are departed at 15:20. If there is another flight with an interval of 5 minutes that gets delayed is then also ready to depart at 15:20, this aircraft are at the bottom of the priority list. If the TOBT is set accurately to the minute, the A-CDM system is able to make a more accurate calculation of the reality. This is the next point of improvement, in the briefing the ground handlers receive, I don't know if this counts for KLM as well, it isn't indicated that the TOBT should be set per minute accurately. I don't know if this is the case because in this way, KLM gains benefit for being the only one to do this. But this inefficiency causes the planning to be less accurate and the TSAT can therefore be assigned in a better and more accurate way.

Appendix V Summary interview Mr. F. Steevens

Table 8: Interview information Mr. F. Steevens.

Name of interviewee	Mr. F. Steevens
Names of interviewers	Mr. S. Kuiper and Mrs. F. Mollema
Job title of interviewee	Asset Manager Gate Planning at Schiphol Group
Date	12-04-2019
Place	Amsterdam Airport Schiphol, The Netherlands

*note: this interview was held in cooperation with Mr. S. Kuiper, fellow KDC graduation intern, due to the fact that he needed the same information for his research regarding operational plan stability at Amsterdam Airport Schiphol. The interview was recorded and thereafter summarized by Mr. S. Kuiper, thus the summary below concerns a copy of his summary (citation). The same summary can also be found in his thesis (Kuiper, 2019, p.83-84) and all credits for the summary of the interview below belong to him only.

- **According to which restrictions is the gate planning made?**
 - *During the planning flights are subjected to certain restrictions regarding the type of passengers on board, type of aircraft, origin or destination, ground time etc. When planning the flights, the planners try to cluster the flights, which means that the planners try to keep in mind that if an aircraft is handled by a certain ground handler, the next aircraft at that stand preferably is handled by the same handler, reducing vehicle movement on the airport and optimizing workhours of the ground handler. There are regulations in place which tell the planners which restriction is more important. For example, the restriction determining which flight are handled on a remote buffer when there are too little connected stands available is the number of passengers, the flight with the least passengers is handled remote to have the lowest impact on the passenger flows.*
- **When is the planning made?**
 - *The planning is made the day before and changes in the flight plans can be given to the gate planners until 17:00 hours LT the day before. So, all changes afterwards are no longer considered in the planning. Changes that occur later on are done by the gate control center of the airport and are based upon the original planning that was made.*
- **How far ahead do the gate controllers start changing the planning?**
 - *It really depends on the deviation. In the planning we already have some buffer margins so if the deviation is within the margins we do not change anything.*
- **If it is needed and a flight is delayed, when do they start changing the planning?**
 - *The information from the CDM and the ground handlers needs to be updated first. When this is done the system starts updating. So, it is dependent on the moment that the information becomes available.*
- **Wouldn't it be beneficial to have a system which predicts the flights for the whole day instead of only the current flights that share ACDM data?**
 - *Not necessarily, it would only be if it was very accurate, which is almost impossible because there are so many variables. In that case you really have to watch what you are doing because you do not want to create some kind of apparent reality. What you also see when things become really uncertain, during bad weather for example, is that airlines keep telling that their departure time is still as planned. They do this to show their passengers they are flying and to keep their slot times they originally received. Even though we as planners can see that the planning of the flight has become completely unrealistic. Which causes problems in the planning and then we as planners have to ask the ground handlers and airlines to update the data so it becomes realistic again.*

- **At which point do you switch the gates to a flight around if this leads to an inbound delay?**
 - *Smaller delays of 5 minutes are not enough because switching it around causes problems as well. The ground handler might already be waiting at the gate, passengers inside the terminal need to change position, etc. All this higher the change of something going wrong on the next flight, for example missing passengers or bags causing further delays. However, when a delay becomes too high, let's say 30 minutes then we will start deviating from the original plan because the effects on the inbound flight are too high.*
- **What do you see currently as the biggest challenge to the current operation?**
 - *The lack of management based on the available ground infrastructure. Everyone mostly look at the landing capacity, while this is not always the most restrictive. Sometimes it is the stand capacity. By doing this we create an increase in pressure on the ground infrastructure and because it becomes busier we will see it much more often that there are waiting traffic in the field awaiting a free stand.*
- **Do you think outbound holding would be an option to release some pressure on the gate capacity?**
 - *Yes absolutely, specifically these flights which have an outbound delay of around 15 minutes often happen and cause problems for the following inbound flights. However not all the airlines like to do it because it means they have to wait in the field. Very recently they started doing it with smaller aircraft, until cat-4 (737) however we lack the infrastructure (remote holding stands) to do it on a structural basis. When we would be able to use it structurally this would definitely create the planning space we would like to have.*
- **Does it happen often that flights arrive too early causing you to change your gate planning?**
 - *Yes, however it really depends on the moment of the day what the impact is. The first arriving flights of the day mostly do not have another flight on their stand before they arrive. So, when they arrive too early, it will not create a problem. This is done by airlines because this creates extra connection time for their passengers, which creates a higher chance that the connection flight leaves on time. Thereby does it increase passenger satisfaction because they have unexpectedly more time at their destination or during the connection. The problem arises on the flights arriving later than the first arrivals. Here the gates are already occupied demanding the gate planners to change the planning and look for other options to handle the aircraft. In this case we have an aircraft on the ground which we realistically cannot always accommodate.*
- **Could it be an idea to create special slots that will tell an airline that the airport is not able to accommodate an early arrival on that slot. If they do arrive early they are handled remote or maybe even be buffered until gate capacity is available?**
 - *Yes, only problem is, once again, you need to have that buffer space. Nevertheless, indeed there should be more communication between the airlines and the airport about the possibilities.*

(Kuiper, 2019, p.83-84)

Appendix VI Summary interview Mr. J. Schäfer

Table 9: Interview information Mr. J. Schäfer.

Name of interviewee	Mr. J. Schäfer
Name of interviewer	Mrs. F. Mollema
Job title of interviewee	Airport Operations Analyst at Schiphol Group
Date	15-05-2019
Place	Amsterdam Airport Schiphol, The Netherlands

- The first inefficiency that I found was the average taxi-in time that is planned upon. In almost half of the time the taxi-in times used within the flight plan is not correct. However, my calculations did not exclude any disruption days. How do you determine, for the A-CDM performance manual, which data is filtered out due to disruptions?**

 - The OTP is a good indicator for this. When the OTP is extremely low, this will give an indication of some sort of disruption at the airport and then we can decide not to include this in the performance calculations.
 - It has never been officially agreed upon between all parties what defines a disrupted day.
 - We do not measure the taxi-in times because it is not an official A-CDM process, but it definitely is an important airport process. I also think that inbound is an under-exposed process, so it is a good thing that someone is researching into this instead of only focusing on outbound.
- I agree, because the performance of the outbound process is also dependent on the inbound process, right?**

 - Yes, exactly. We are currently performing a research into the entire chain, from landing time till take-off time, calculating what is influencing the outbound punctuality, which delay minutes are buildup in which process. We see a lot of reactionary delay, which is outbound delay caused by inbound delay. An important factor in that case which we can influence are the taxi-in times, so it is important to look into that. By improving the inbound process, the outbound process performance improves as well.
- The next inefficiency regards the earlier than planned entry of aircraft at the FIR, which can cause problems for the gate planning especially when the aircraft then arrives in a peak hour. I received the data for this part from the LVNL but I still also have to filter out the disruption moments, which I think should be the same days that are filtered out for the other inefficiencies data sets?**

 - Yes, I think that for the happy flow of the analysis that is important. This inefficiency is also interesting, Early inbound are a hot topic for us because we experience a lot of difficulties due to this in the terminal. And we do not have any data regarding the FIR entry ourselves.
- Regarding the OTP inefficiency, I am not sure if this is measurable. It seems to me that it is more of a strategic choice that differs per organization based on what they want to measure?**

 - The thing is that airlines generally do measure how they perform on off-block times but in a different way, which is even trickier. We talk about in- and off-block times when the red line is passed with the transponder, thus physically leaving or entering an aircraft stand. Airlines have 1001 different ways of measuring this via they aircraft system, for instance when breaks are released, when the aircraft is lifted by the pushback truck, when the bridge is disconnected, when all doors are closed etc.

- **Does that difference in how they are measuring also result in any miscommunication between the parties?**
 - Yes. I once received a question of an airline which asked why one of their flights had a taxi time to the polderbaan of 1.5 hours. I analyzed the data and it just so happened to be that we just had radar data available which allowed use to see the tracks and the times on ground. I saw that the aircraft had been taxiing for only 20 minutes, which is very normal, from the B-pier to the polderbaan. The airline had a totally different AOBT, much more similar to the TOBT which was way earlier due to a CTOT. Either way, because they had measured it differently the OCC of the airline thought the taxi-process was way longer than it should be and was wondering if the aircraft would have enough fuel to complete the flight.

- **The last inefficiencies are more related to what you are measuring with regard to A-CDM. What are your thoughts on these inefficiencies regarding the TOBT?**
 - There are a lot of misconceptions regarding the usage of the TOBT. One of the things that I have heard is that some ground handlers tell airlines that the TOBT can only be adjusted in the last final 5 minutes of the previous TOBT. That is the exact opposite of what we want because the TOBT should already be long adjusted by that point. It took us a lot of time to try to repair that misconception but I still think it is not 100% clear. If the TOBT is updated that late then you will probably end up in the back of the sequence that is made by LVNL and thus be delayed.
 - Concerning the interval of 5 minutes that is used with regard to the TOBT, it does state in the A-CDM manual that this is accepted. It may be set more accurately on the minute, like KLM does very efficiently. Especially the foreign non-European airlines have less knowledge on how the TOBT works. The ground handler is their only source of information regarding this topic. We provide training to handlers concerning A-CDM which is very useful. The downside is that the personal working at handling companies often work there for only a short amount of time, thus the knowledge that we provide gets lost very easily. But we do try to inform them as much as possible. Now that I think of it, it may also be the case that handlers misinterpret the manual, by reading that they are only allowed to update the TOBT in the last 5 minutes while instead it actually reads that the TOBT may be set upon (intervals of) 5 minutes. I might look into that further.

- **The final inefficiency is the TSAT that still happens to expire in some cases. What are your thoughts on this?**
 - The most difficult part is that there are airlines which call out of their TSAT window. These will mostly be rejected by the LVNL, but the amount of flights which call out of their TSAT window are not measured. It is only measured how many of the flights calling out of their TSAT window are still accepted by the LVNL. Thus, the performance of the outbound planner is measured. However, the amount of expired TSAT's is an important aspect of the outbound process

Appendix VII Activity diagram legend

Symbol	Description
	Start Symbol
	End Symbol
	Activity/Process Symbol
	Decision Symbol
	Yes/No Symbol
	Information Symbol

Appendix VIII TOBT interval

Table 10: Percentage TOBT ending on minute 0 or 5 per airline at AAS.

Airline	Total amount of flights in the summer season of 2018	Percentage of flights with TOBT ending on minute 0 or 5
Air Astana	144	92,36%
Corendon Dutch Airlines	1227	91,61%
Qatar Airways	245	91,43%
Georgian Airlines	70	91,43%
Eva Air	105	90,48%
Skywork Airlines	134	90,30%
Air Mauritius	71	90,14%
Garuda Indonesia	211	90,05%
China Airlines	136	88,97%
Bulgaria Air	244	88,93%
TUI fly	3649	87,80%
Corendon Airlines	411	87,59%
Turkish Airlines	1217	86,11%
Cathay Pacific	235	85,96%
Transavia	12488	84,76%
Adria Airways	203	84,73%
Air Serbia	335	84,48%
Iranair	70	84,29%
Surinam Airways	129	83,72%
Egypt Air	247	83,40%
Etihad Airways	247	83,40%
Royal Air Maroc	414	82,85%
Iberia Express	476	82,77%
Ukraine Int. Airlines	259	82,63%
Singapore Airlines	245	82,45%
Xiamen Airlines	100	82,00%
KLM Cityhopper	119	81,51%
Air Canada	222	81,08%
Finnair	487	80,90%
Atlasglobal	245	80,82%
Air Malta	272	80,51%
SunExpress	371	80,32%
EI AI	403	80,15%
China Southern Airlines	483	80,12%
China Eastern Airlines	139	79,86%
TAP Portugal	945	79,58%
Pegasus Airlines	868	78,92%
Arkia	80	78,75%
United Airlines	963	78,71%
Small Planet Airlines	256	78,52%
Scandinavian Airlines	1874	78,39%

Vueling	3711	78,23%
Tunisair	64	78,13%
airBaltic	946	78,12%
Croatia Airlines	265	78,11%
Emirates	487	77,82%
Aeromexico	240	77,50%
American Airlines	384	77,08%
Air Europa	485	75,05%
Jet Airways	974	75,05%
Flybe	3644	74,07%
Lot Polish Airlines	943	74,02%
Lufthansa	2721	73,65%
Tarom	477	73,38%
Alitalia	1168	73,20%
KLM	82507	72,19%
Icelandair	412	72,09%
Aer Lingus	1239	70,94%
Royal Jordanian Airlines	139	70,50%
Aegean Airlines	241	69,71%
Swiss International Airlines	951	69,51%
Air Arabia Maroc	356	68,82%
Austrian Airlines	913	68,67%
Onur Air	102	68,63%
Belavia	235	67,23%
WOW Air	420	66,90%
Air Transat	153	66,67%
Aeroflot	749	66,49%
Norwegian Air Shuttle	595	66,05%
Air France	3202	65,90%
Transavia France	153	64,05%
EasyJet	11981	62,72%
Korean Air	182	61,54%
British Airways	3586	61,27%
easyJet Switzerland	488	59,02%
Czech Airlines CSA	457	58,86%
Kenya Airways	275	58,55%
Ryanair	1134	58,38%
Jet2.com	230	53,04%
Delta Air Lines	4431	52,22%
Eurowings	751	51,00%
Norwegian Air International	326	42,33%

Appendix IX TOBT updates list of airlines

Table 11: Percentage of TOBT updates in the final 5 minutes.

Month-year	Airline	TOBT updates in the final 5 minutes	Amount of flights
Mar-18	Adria Airways	74%	28
Mar-18	Aegean Airlines	38%	31
Mar-18	Aer Lingus	52%	151
Mar-18	Aeroflot	56%	93
Mar-18	Aeromexico	45%	29
Mar-18	Air Arabia Maroc	34%	45
Mar-18	Air Astana	33%	24
Mar-18	Air Canada	55%	18
Mar-18	Air Europa	54%	61
Mar-18	Air France	37%	466
Mar-18	Air Malta	35%	32
Mar-18	Air Mauritius	50%	2
Mar-18	Air Serbia	44%	34
Mar-18	AirBaltic	74%	122
Mar-18	airBaltic	71%	122
Mar-18	Alitalia	45%	145
Mar-18	AlMasria Universal Airlines	50%	2
Mar-18	American Airlines	48%	27
Mar-18	Arkea	40%	8
Mar-18	Atlasglobal	83%	32
Mar-18	Austrian Airlines	51%	110
Mar-18	Belavia	30%	27
Mar-18	British Airways	54%	489
Mar-18	Bulgaria Air	67%	31
Mar-18	Cathay Pacific	50%	30
Mar-18	China Airlines	48%	18
Mar-18	China Eastern Airlines	86%	17
Mar-18	China Southern Airlines	52%	62
Mar-18	Corendon Airlines	55%	13
Mar-18	Corendon Dutch Airlines	58%	32
Mar-18	Croatia Airlines	25%	31
Mar-18	Czech Airlines CSA	39%	53
Mar-18	Delta Air Lines	35%	403
Mar-18	EasyJet	56%	1407
Mar-18	EasyJet Switzerland	50%	80
Mar-18	easyJet Switzerland	54%	80
Mar-18	Egypt Air	53%	34
Mar-18	El Al	39%	45
Mar-18	Emirates	48%	63
Mar-18	Etihad Airways	45%	31

Mar-18	Eurowings	41%	91
Mar-18	Eva Air	40%	14
Mar-18	Finnair	82%	63
Mar-18	Flybe	56%	499
Mar-18	Freebird Airlines	50%	3
Mar-18	Garuda Indonesia	57%	27
Mar-18	Georgian Airlines	100%	9
Mar-18	Iberia Express	50%	60
Mar-18	Icelandair	68%	32
Mar-18	Iranair	53%	9
Mar-18	Jet Airways	57%	121
Mar-18	Jet2.com	35%	31
Mar-18	Kenya Airways	55%	31
Mar-18	KLM	50%	9585
Mar-18	Korean Air	50%	17
Mar-18	Lot Polish Airlines	49%	121
Mar-18	Lufthansa	43%	350
Mar-18	Norwegian Air International	42%	34
Mar-18	Norwegian Air Shuttle	44%	52
Mar-18	Pegasus Airlines	50%	91
Mar-18	Qatar Airways	39%	31
Mar-18	Royal Air Maroc	62%	33
Mar-18	Royal Jordanian Airlines	63%	18
Mar-18	Ryanair	48%	137
Mar-18	Scandinavian Airlines	61%	244
Mar-18	Singapore Airlines	37%	31
Mar-18	Skywork Airlines	65%	18
Mar-18	Small Planet Airlines	24%	28
Mar-18	SunExpress	45%	22
Mar-18	Surinam Airways	40%	16
Mar-18	Swiss International Airlines	36%	121
Mar-18	TAP Portugal	49%	118
Mar-18	Tarom	50%	60
Mar-18	Transavia	44%	1150
Mar-18	Transavia France	10%	18
Mar-18	TUI fly	45%	231
Mar-18	Tunisair	48%	9
Mar-18	Turkish Airlines	57%	157
Mar-18	Ukraine Int. Airlines	39%	46
Mar-18	United Airlines	56%	113
Mar-18	Vueling	48%	396
Mar-18	WOW Air	50%	31
Mar-18	Xiamen Airlines	44%	10
Apr-18	Adria Airways	53%	25
Apr-18	Aegean Airlines	26%	29

Apr-18	Aer Lingus	56%	154
Apr-18	Aeroflot	69%	89
Apr-18	Aeromexico	42%	28
Apr-18	Air Arabia Maroc	48%	39
Apr-18	Air Astana	33%	17
Apr-18	Air Canada	48%	29
Apr-18	Air Europa	42%	59
Apr-18	Air France	29%	367
Apr-18	Air Malta	38%	35
Apr-18	Air Mauritius	17%	9
Apr-18	Air Serbia	52%	42
Apr-18	Air Transat	100%	2
Apr-18	AirBaltic	49%	112
Apr-18	airBaltic	49%	112
Apr-18	Alitalia	43%	147
Apr-18	American Airlines	64%	27
Apr-18	Arkia	54%	10
Apr-18	Atlasglobal	42%	30
Apr-18	Austrian Airlines	35%	113
Apr-18	Belavia	24%	26
Apr-18	British Airways	37%	443
Apr-18	Bulgaria Air	72%	30
Apr-18	Cathay Pacific	66%	30
Apr-18	China Airlines	63%	16
Apr-18	China Eastern Airlines	44%	18
Apr-18	China Southern Airlines	59%	59
Apr-18	Corendon Airlines	32%	51
Apr-18	Corendon Dutch Airlines	43%	126
Apr-18	Croatia Airlines	40%	30
Apr-18	Czech Airlines CSA	43%	51
Apr-18	Delta Air Lines	36%	546
Apr-18	EasyJet	59%	1472
Apr-18	EasyJet Switzerland	38%	77
Apr-18	easyJet Switzerland	41%	77
Apr-18	Egypt Air	60%	30
Apr-18	El Al	39%	46
Apr-18	Emirates	40%	60
Apr-18	Etihad Airways	49%	31
Apr-18	Eurowings	41%	95
Apr-18	Finnair	74%	60
Apr-18	Flybe	54%	433
Apr-18	Garuda Indonesia	47%	26
Apr-18	Georgian Airlines	67%	9
Apr-18	Iberia Express	62%	58
Apr-18	Icelandair	86%	39

Apr-18	Iranair	80%	9
Apr-18	Jet Airways	46%	118
Apr-18	Jet2.com	51%	42
Apr-18	Kenya Airways	44%	29
Apr-18	KLM	48%	10145
Apr-18	KLM Cityhopper	40%	4
Apr-18	Korean Air	58%	17
Apr-18	Lot Polish Airlines	42%	118
Apr-18	Lufthansa	44%	326
Apr-18	Norwegian Air International	38%	39
Apr-18	Norwegian Air Shuttle	51%	59
Apr-18	Onur Air	23%	6
Apr-18	Pegasus Airlines	38%	84
Apr-18	Qatar Airways	41%	30
Apr-18	Royal Air Maroc	49%	39
Apr-18	Royal Jordanian Airlines	36%	17
Apr-18	Ryanair	39%	142
Apr-18	Scandinavian Airlines	54%	231
Apr-18	Singapore Airlines	38%	30
Apr-18	Skywork Airlines	45%	24
Apr-18	Small Planet Airlines	49%	26
Apr-18	SunExpress	48%	24
Apr-18	Surinam Airways	53%	16
Apr-18	Swiss International Airlines	39%	118
Apr-18	TAP Portugal	45%	110
Apr-18	Tarom	44%	58
Apr-18	Transavia	37%	1255
Apr-18	Transavia France	27%	24
Apr-18	TUI fly	43%	345
Apr-18	Tunisair	60%	8
Apr-18	Turkish Airlines	59%	149
Apr-18	Ukraine Int. Airlines	31%	30
Apr-18	United Airlines	53%	120
Apr-18	Vueling	42%	454
Apr-18	WOW Air	44%	36
Apr-18	Xiamen Airlines	55%	13
May-18	Adria Airways	82%	26
May-18	Aegean Airlines	31%	30
May-18	Aer Lingus	63%	158
May-18	Aeroflot	88%	93
May-18	Aeromexico	38%	31
May-18	Air Arabia Maroc	34%	38
May-18	Air Canada	33%	26
May-18	Air Europa	54%	62
May-18	Air France	34%	398

May-18	Air Malta	33%	33
May-18	Air Mauritius	44%	8
May-18	Air Serbia	76%	43
May-18	Air Transat	31%	21
May-18	AirBaltic	70%	117
May-18	airBaltic	70%	117
May-18	Alitalia	43%	150
May-18	American Airlines	55%	56
May-18	Arkia	30%	8
May-18	Atlasglobal	73%	29
May-18	Austrian Airlines	37%	118
May-18	Belavia	43%	31
May-18	British Airways	53%	467
May-18	Bulgaria Air	70%	31
May-18	Cathay Pacific	53%	27
May-18	China Airlines	37%	16
May-18	China Eastern Airlines	53%	17
May-18	China Southern Airlines	57%	61
May-18	Corendon Airlines	28%	59
May-18	Corendon Dutch Airlines	31%	192
May-18	Croatia Airlines	46%	35
May-18	Czech Airlines CSA	40%	52
May-18	Delta Air Lines	34%	576
May-18	EasyJet	51%	1512
May-18	EasyJet Switzerland	50%	68
May-18	easyJet Switzerland	51%	68
May-18	Egypt Air	39%	31
May-18	El Al	22%	50
May-18	Emirates	56%	60
May-18	Etihad Airways	46%	31
May-18	Eurowings	40%	95
May-18	Eva Air	30%	14
May-18	Finnair	96%	62
May-18	Flybe	58%	458
May-18	Garuda Indonesia	69%	26
May-18	Georgian Airlines	50%	8
May-18	Iberia Express	50%	63
May-18	Icelandair	77%	62
May-18	Iranair	50%	9
May-18	Jet Airways	47%	128
May-18	Jet2.com	40%	32
May-18	Kenya Airways	60%	31
May-18	KLM	53%	10493
May-18	KLM Cityhopper	100%	4
May-18	Korean Air	40%	18

May-18	Lot Polish Airlines	60%	120
May-18	Lufthansa	47%	337
May-18	Norwegian Air International	35%	38
May-18	Norwegian Air Shuttle	53%	82
May-18	Onur Air	31%	17
May-18	Pegasus Airlines	56%	111
May-18	Qatar Airways	37%	32
May-18	Royal Air Maroc	52%	28
May-18	Royal Jordanian Airlines	36%	17
May-18	Ryanair	40%	144
May-18	Scandinavian Airlines	70%	250
May-18	Singapore Airlines	42%	31
May-18	Skywork Airlines	70%	21
May-18	Small Planet Airlines	42%	37
May-18	SunExpress	37%	43
May-18	Surinam Airways	60%	16
May-18	Swiss International Airlines	48%	119
May-18	TAP Portugal	38%	120
May-18	Tarom	36%	61
May-18	Transavia	30%	1666
May-18	Transavia France	59%	24
May-18	TUI fly	48%	475
May-18	Turkish Airlines	55%	152
May-18	Ukraine Int. Airlines	44%	29
May-18	United Airlines	53%	122
May-18	Vueling	36%	472
May-18	WOW Air	60%	61
May-18	Xiamen Airlines	75%	13
Jun-18	Adria Airways	55%	24
Jun-18	Aegean Airlines	35%	31
Jun-18	Aer Lingus	51%	152
Jun-18	Aeroflot	65%	96
Jun-18	Aeromexico	43%	30
Jun-18	Air Arabia Maroc	31%	39
Jun-18	Air Astana	25%	18
Jun-18	Air Canada	55%	28
Jun-18	Air Europa	45%	60
Jun-18	Air France	25%	381
Jun-18	Air Malta	46%	34
Jun-18	Air Serbia	59%	43
Jun-18	Air Transat	61%	30
Jun-18	AirBaltic	65%	111
Jun-18	airBaltic	67%	111
Jun-18	Alitalia	27%	146
Jun-18	American Airlines	65%	60

Jun-18	Arkia	33%	9
Jun-18	Atlasglobal	71%	30
Jun-18	Austrian Airlines	35%	114
Jun-18	Belavia	26%	32
Jun-18	British Airways	56%	439
Jun-18	Bulgaria Air	57%	30
Jun-18	Cathay Pacific	39%	27
Jun-18	China Airlines	44%	18
Jun-18	China Eastern Airlines	67%	17
Jun-18	China Southern Airlines	52%	59
Jun-18	Corendon Airlines	48%	52
Jun-18	Corendon Dutch Airlines	52%	168
Jun-18	Croatia Airlines	14%	33
Jun-18	Czech Airlines CSA	39%	55
Jun-18	Delta Air Lines	33%	566
Jun-18	EasyJet	47%	1458
Jun-18	EasyJet Switzerland	32%	68
Jun-18	easyJet Switzerland	36%	68
Jun-18	Egypt Air	38%	30
Jun-18	El Al	53%	53
Jun-18	Emirates	63%	62
Jun-18	Etihad Airways	43%	30
Jun-18	Eurowings	37%	90
Jun-18	Eva Air	38%	13
Jun-18	Finnair	75%	60
Jun-18	Flybe	47%	441
Jun-18	Garuda Indonesia	63%	26
Jun-18	Iberia Express	42%	57
Jun-18	Icelandair	66%	60
Jun-18	Iranair	32%	8
Jun-18	Jet Airways	55%	120
Jun-18	Jet2.com	48%	24
Jun-18	Kenya Airways	41%	30
Jun-18	KLM	42%	10306
Jun-18	Korean Air	35%	26
Jun-18	Lot Polish Airlines	45%	119
Jun-18	Lufthansa	37%	339
Jun-18	Norwegian Air International	41%	42
Jun-18	Norwegian Air Shuttle	48%	79
Jun-18	Onur Air	20%	16
Jun-18	Pegasus Airlines	35%	104
Jun-18	Qatar Airways	26%	30
Jun-18	Royal Air Maroc	67%	31
Jun-18	Royal Jordanian Airlines	22%	18
Jun-18	Ryanair	35%	141

Jun-18	Scandinavian Airlines	54%	225
Jun-18	Singapore Airlines	42%	30
Jun-18	Skywork Airlines	30%	23
Jun-18	Small Planet Airlines	55%	31
Jun-18	SunExpress	34%	52
Jun-18	Surinam Airways	38%	14
Jun-18	Swiss International Airlines	34%	118
Jun-18	TAP Portugal	51%	113
Jun-18	Tarom	24%	59
Jun-18	Transavia	32%	1613
Jun-18	Transavia France	12%	25
Jun-18	TUI fly	48%	463
Jun-18	Tunisair	55%	8
Jun-18	Turkish Airlines	64%	154
Jun-18	Ukraine Int. Airlines	57%	31
Jun-18	United Airlines	55%	120
Jun-18	Vueling	31%	469
Jun-18	WOW Air	55%	59
Jun-18	Xiamen Airlines	62%	13
Jul-18	Adria Airways	55%	24
Jul-18	Aegean Airlines	23%	31
Jul-18	Aer Lingus	63%	162
Jul-18	Aeroflot	65%	96
Jul-18	Aeromexico	43%	31
Jul-18	Air Arabia Maroc	55%	54
Jul-18	Air Astana	100%	15
Jul-18	Air Canada	47%	31
Jul-18	Air Europa	55%	62
Jul-18	Air France	28%	388
Jul-18	Air Malta	30%	36
Jul-18	Air Mauritius	63%	13
Jul-18	Air Serbia	47%	44
Jul-18	Air Transat	61%	33
Jul-18	AirBaltic	63%	123
Jul-18	airBaltic	63%	123
Jul-18	Alitalia	35%	155
Jul-18	American Airlines	64%	62
Jul-18	Arkia	31%	14
Jul-18	Atlasglobal	63%	31
Jul-18	Austrian Airlines	39%	115
Jul-18	Balkan Holiday Airlines	58%	7
Jul-18	Belavia	29%	30
Jul-18	British Airways	59%	421
Jul-18	Bulgaria Air	56%	31
Jul-18	Cathay Pacific	33%	31

Jul-18	China Airlines	38%	17
Jul-18	China Eastern Airlines	43%	18
Jul-18	China Southern Airlines	49%	61
Jul-18	Corendon Airlines	45%	60
Jul-18	Corendon Dutch Airlines	50%	204
Jul-18	Croatia Airlines	42%	36
Jul-18	Czech Airlines CSA	62%	58
Jul-18	Delta Air Lines	36%	601
Jul-18	EasyJet	49%	1458
Jul-18	EasyJet Switzerland	61%	31
Jul-18	easyJet Switzerland	63%	31
Jul-18	Egypt Air	28%	31
Jul-18	El Al	53%	59
Jul-18	Emirates	47%	61
Jul-18	Etihad Airways	45%	32
Jul-18	Eurowings	38%	98
Jul-18	Eva Air	25%	13
Jul-18	Finnair	71%	62
Jul-18	Flybe	48%	440
Jul-18	Garuda Indonesia	93%	26
Jul-18	Georgian Airlines	40%	9
Jul-18	Iberia Express	33%	63
Jul-18	Icelandair	68%	58
Jul-18	Iranair	40%	9
Jul-18	Jet Airways	65%	123
Jul-18	Jet2.com	52%	18
Jul-18	Kenya Airways	38%	37
Jul-18	KLM	49%	10629
Jul-18	KLM Cityhopper	50%	4
Jul-18	Korean Air	69%	27
Jul-18	Lot Polish Airlines	42%	120
Jul-18	Lufthansa	41%	351
Jul-18	Norwegian Air International	39%	54
Jul-18	Norwegian Air Shuttle	47%	80
Jul-18	Onur Air	43%	18
Jul-18	Pegasus Airlines	29%	119
Jul-18	Qatar Airways	34%	31
Jul-18	Royal Air Maroc	51%	91
Jul-18	Royal Jordanian Airlines	44%	17
Jul-18	Ryanair	39%	145
Jul-18	Scandinavian Airlines	62%	210
Jul-18	Singapore Airlines	58%	32
Jul-18	Skywork Airlines	57%	26
Jul-18	Small Planet Airlines	42%	36
Jul-18	SunExpress	37%	63

Jul-18	Surinam Airways	29%	17
Jul-18	Swiss International Airlines	24%	122
Jul-18	TAP Portugal	59%	123
Jul-18	Tarom	37%	61
Jul-18	Transavia	38%	1824
Jul-18	Transavia France	38%	9
Jul-18	TUI fly	47%	625
Jul-18	Tunisair	39%	9
Jul-18	Turkish Airlines	58%	153
Jul-18	Ukraine Int. Airlines	63%	32
Jul-18	United Airlines	57%	120
Jul-18	Vueling	37%	489
Jul-18	WOW Air	51%	61
Jul-18	Xiamen Airlines	70%	13
Aug-18	Adria Airways	43%	26
Aug-18	Aegean Airlines	20%	31
Aug-18	Aer Lingus	53%	159
Aug-18	Aeroflot	50%	93
Aug-18	Aeromexico	47%	31
Aug-18	Air Arabia Maroc	45%	54
Aug-18	Air Astana	42%	18
Aug-18	Air Canada	52%	40
Aug-18	Air Europa	60%	62
Aug-18	Air France	25%	411
Aug-18	Air Malta	35%	35
Aug-18	Air Mauritius	46%	14
Aug-18	Air Serbia	55%	45
Aug-18	Air Transat	71%	29
Aug-18	AirBaltic	57%	125
Aug-18	airBaltic	57%	125
Aug-18	Alitalia	34%	128
Aug-18	American Airlines	74%	62
Aug-18	Arkia	62%	14
Aug-18	Atlasglobal	75%	31
Aug-18	Austrian Airlines	36%	115
Aug-18	Balkan Holiday Airlines	33%	9
Aug-18	Belavia	29%	31
Aug-18	British Airways	62%	436
Aug-18	Bulgaria Air	86%	31
Aug-18	Cathay Pacific	36%	31
Aug-18	China Airlines	31%	17
Aug-18	China Eastern Airlines	58%	18
Aug-18	China Southern Airlines	46%	62
Aug-18	Corendon Airlines	25%	73
Aug-18	Corendon Dutch Airlines	47%	204

Aug-18	Croatia Airlines	25%	35
Aug-18	Czech Airlines CSA	48%	65
Aug-18	Delta Air Lines	29%	594
Aug-18	EasyJet	48%	1489
Aug-18	EasyJet Switzerland	46%	30
Aug-18	easyJet Switzerland	46%	30
Aug-18	Egypt Air	20%	31
Aug-18	El Al	41%	56
Aug-18	Emirates	60%	62
Aug-18	Etihad Airways	43%	32
Aug-18	Eurowings	36%	102
Aug-18	Eva Air	11%	13
Aug-18	Finnair	83%	62
Aug-18	Flybe	51%	462
Aug-18	Garuda Indonesia	67%	27
Aug-18	Iberia Express	65%	62
Aug-18	Icelandair	69%	62
Aug-18	Iranair	50%	9
Aug-18	Jet Airways	65%	125
Aug-18	Jet2.com	30%	17
Aug-18	Kenya Airways	44%	44
Aug-18	KLM	49%	10544
Aug-18	KLM Cityhopper	75%	8
Aug-18	Korean Air	51%	26
Aug-18	Lot Polish Airlines	44%	118
Aug-18	Lufthansa	43%	337
Aug-18	Norwegian Air International	39%	45
Aug-18	Norwegian Air Shuttle	50%	82
Aug-18	Onur Air	32%	17
Aug-18	Pegasus Airlines	34%	128
Aug-18	Qatar Airways	27%	31
Aug-18	Royal Air Maroc	35%	101
Aug-18	Ryanair	42%	146
Aug-18	Scandinavian Airlines	61%	238
Aug-18	Singapore Airlines	41%	31
Aug-18	Skywork Airlines	44%	22
Aug-18	Small Planet Airlines	29%	35
Aug-18	SunExpress	38%	61
Aug-18	Surinam Airways	36%	17
Aug-18	Swiss International Airlines	28%	118
Aug-18	TAP Portugal	47%	123
Aug-18	Tarom	39%	60
Aug-18	Transavia	39%	1854
Aug-18	Transavia France	8%	8
Aug-18	TUI fly	52%	632

Aug-18	Tunisair	50%	8
Aug-18	Turkish Airlines	40%	155
Aug-18	Ukraine Int. Airlines	81%	32
Aug-18	United Airlines	79%	126
Aug-18	Vueling	38%	482
Aug-18	Wind Rose Aviation	14%	1
Aug-18	WOW Air	59%	60
Aug-18	Xiamen Airlines	100%	13
Sep-18	Adria Airways	40%	26
Sep-18	Aegean Airlines	45%	30
Sep-18	Aer Lingus	57%	150
Sep-18	Aeroflot	53%	89
Sep-18	Aeromexico	36%	30
Sep-18	Air Arabia Maroc	49%	46
Sep-18	Air Astana	53%	17
Sep-18	Air Canada	42%	30
Sep-18	Air Europa	39%	60
Sep-18	Air France	23%	390
Sep-18	Air Malta	47%	34
Sep-18	Air Mauritius	50%	8
Sep-18	Air Serbia	59%	42
Sep-18	Air Transat	56%	25
Sep-18	AirBaltic	33%	120
Sep-18	airBaltic	33%	120
Sep-18	Alitalia	30%	151
Sep-18	American Airlines	79%	61
Sep-18	Arkia	43%	8
Sep-18	Atlasglobal	46%	33
Sep-18	Austrian Airlines	34%	111
Sep-18	Belavia	23%	29
Sep-18	British Airways	59%	430
Sep-18	Bulgaria Air	73%	30
Sep-18	Cathay Pacific	38%	29
Sep-18	China Airlines	38%	17
Sep-18	China Eastern Airlines	100%	17
Sep-18	China Southern Airlines	57%	59
Sep-18	Corendon Airlines	54%	55
Sep-18	Corendon Dutch Airlines	43%	182
Sep-18	Croatia Airlines	25%	34
Sep-18	Czech Airlines CSA	26%	65
Sep-18	Delta Air Lines	32%	600
Sep-18	EasyJet	42%	1570
Sep-18	EasyJet Switzerland	29%	67
Sep-18	easyJet Switzerland	29%	67
Sep-18	Egypt Air	45%	30

Sep-18	El Al	54%	42
Sep-18	Emirates	64%	59
Sep-18	Etihad Airways	47%	30
Sep-18	Eurowings	40%	88
Sep-18	Eva Air	14%	13
Sep-18	Finnair	69%	58
Sep-18	Flybe	45%	446
Sep-18	Garuda Indonesia	86%	27
Sep-18	Georgian Airlines	50%	8
Sep-18	Iberia Express	55%	56
Sep-18	Icelandair	80%	58
Sep-18	Iranair	33%	9
Sep-18	Jet Airways	56%	119
Sep-18	Jet2.com	38%	28
Sep-18	Kenya Airways	44%	43
Sep-18	KLM	42%	10378
Sep-18	KLM Cityhopper	18%	50
Sep-18	Korean Air	47%	26
Sep-18	Lot Polish Airlines	44%	118
Sep-18	Lufthansa	35%	341
Sep-18	Norwegian Air International	32%	38
Sep-18	Norwegian Air Shuttle	41%	79
Sep-18	Onur Air	19%	15
Sep-18	Pegasus Airlines	30%	119
Sep-18	Qatar Airways	32%	30
Sep-18	Royal Air Maroc	40%	51
Sep-18	Royal Jordanian Airlines	22%	18
Sep-18	Ryanair	32%	140
Sep-18	Scandinavian Airlines	66%	232
Sep-18	Singapore Airlines	49%	30
Sep-18	Small Planet Airlines	55%	34
Sep-18	SunExpress	30%	55
Sep-18	Surinam Airways	45%	16
Sep-18	Swiss International Airlines	26%	118
Sep-18	TAP Portugal	57%	118
Sep-18	Tarom	33%	60
Sep-18	Transavia	34%	1624
Sep-18	Transavia France	24%	21
Sep-18	TUI fly	52%	490
Sep-18	Tunisair	19%	7
Sep-18	Turkish Airlines	41%	149
Sep-18	Ukraine Int. Airlines	47%	29
Sep-18	United Airlines	62%	120
Sep-18	Vueling	39%	484
Sep-18	WOW Air	59%	58

Sep-18	Xiamen Airlines	56%	13
Oct-18	Adria Airways	56%	24
Oct-18	Aegean Airlines	30%	28
Oct-18	Aer Lingus	48%	153
Oct-18	Aeroflot	53%	100
Oct-18	Aeromexico	53%	30
Oct-18	Air Arabia Maroc	41%	41
Oct-18	Air Astana	67%	16
Oct-18	Air Canada	47%	20
Oct-18	Air Europa	53%	59
Oct-18	Air France	26%	401
Oct-18	Air Malta	37%	33
Oct-18	Air Mauritius	83%	8
Oct-18	Air Serbia	57%	42
Oct-18	Air Transat	42%	13
Oct-18	AirBaltic	53%	116
Oct-18	airBaltic	53%	116
Oct-18	Alitalia	39%	146
Oct-18	American Airlines	48%	29
Oct-18	Arkia	42%	9
Oct-18	Atlasglobal	100%	29
Oct-18	Austrian Airlines	24%	117
Oct-18	Belavia	26%	29
Oct-18	British Airways	52%	461
Oct-18	Bulgaria Air	60%	30
Oct-18	Cathay Pacific	44%	30
Oct-18	China Airlines	48%	17
Oct-18	China Eastern Airlines	44%	17
Oct-18	China Southern Airlines	53%	60
Oct-18	Corendon Airlines	44%	48
Oct-18	Corendon Dutch Airlines	51%	119
Oct-18	Croatia Airlines	18%	31
Oct-18	Czech Airlines CSA	17%	58
Oct-18	Delta Air Lines	38%	545
Oct-18	EasyJet	44%	1615
Oct-18	EasyJet Switzerland	26%	67
Oct-18	easyJet Switzerland	26%	67
Oct-18	Egypt Air	59%	30
Oct-18	El Al	43%	52
Oct-18	Emirates	53%	60
Oct-18	Etihad Airways	57%	30
Oct-18	Eurowings	25%	92
Oct-18	Eva Air	50%	13
Oct-18	Finnair	81%	60
Oct-18	Flybe	46%	465

Oct-18	Freebird Airlines	100%	1
Oct-18	Garuda Indonesia	23%	26
Oct-18	Iberia Express	35%	57
Oct-18	Icelandair	85%	41
Oct-18	Iranair	75%	8
Oct-18	Jet Airways	48%	120
Oct-18	Jet2.com	47%	38
Oct-18	Jetairfly	50%	6
Oct-18	Kenya Airways	42%	30
Oct-18	KLM	45%	10427
Oct-18	KLM Cityhopper	36%	45
Oct-18	Korean Air	40%	25
Oct-18	Lot Polish Airlines	49%	109
Oct-18	Lufthansa	28%	340
Oct-18	Norwegian Air International	41%	36
Oct-18	Norwegian Air Shuttle	46%	82
Oct-18	Onur Air	27%	13
Oct-18	Pegasus Airlines	38%	112
Oct-18	Privilege Style	80%	1
Oct-18	Qatar Airways	38%	30
Oct-18	Royal Air Maroc	57%	40
Oct-18	Royal Jordanian Airlines	33%	16
Oct-18	Ryanair	32%	139
Oct-18	Scandinavian Airlines	58%	244
Oct-18	Singapore Airlines	36%	30
Oct-18	Small Planet Airlines	45%	29
Oct-18	SunExpress	56%	51
Oct-18	Surinam Airways	28%	17
Oct-18	Swiss International Airlines	39%	117
Oct-18	TAP Portugal	60%	120
Oct-18	Tarom	45%	58
Oct-18	Transavia	38%	1502
Oct-18	Transavia France	24%	24
Oct-18	TUI fly	55%	387
Oct-18	Tunisair	13%	8
Oct-18	Turkish Airlines	53%	148
Oct-18	Ukraine Int. Airlines	70%	30
Oct-18	United Airlines	64%	122
Oct-18	Vueling	40%	465
Oct-18	WOW Air	59%	54
Oct-18	Xiamen Airlines	57%	12

Appendix X TSAT expired list of airlines

Table 12: Percentage of TSAT expired per airline.

Month-year	Airline	TSAT expired	Amount of flights
Mar-18	Adria Airways	19,4%	28
Mar-18	Aegean Airlines	12,9%	31
Mar-18	Aer Lingus	11,7%	151
Mar-18	Aeroflot	7,6%	93
Mar-18	Aeromexico	6,7%	29
Mar-18	Air Arabia Maroc	27,7%	45
Mar-18	Air Astana	0,0%	24
Mar-18	Air Canada	0,0%	18
Mar-18	Air Europa	12,9%	61
Mar-18	Air France	7,4%	466
Mar-18	Air Malta	15,6%	32
Mar-18	Air Mauritius	0,0%	2
Mar-18	Air Serbia	8,8%	34
Mar-18	AirBaltic	8,2%	122
Mar-18	airBaltic	8,1%	122
Mar-18	Alitalia	3,3%	145
Mar-18	AlMasria Universal Airlines	0,0%	2
Mar-18	American Airlines	13,3%	27
Mar-18	Arkia	12,5%	8
Mar-18	Atlasglobal	6,5%	32
Mar-18	Austrian Airlines	3,6%	110
Mar-18	Belavia	14,8%	27
Mar-18	British Airways	6,4%	489
Mar-18	Bulgaria Air	6,5%	31
Mar-18	Cathay Pacific	12,5%	30
Mar-18	China Airlines	10,7%	18
Mar-18	China Eastern Airlines	11,8%	17
Mar-18	China Southern Airlines	11,3%	62
Mar-18	Corendon Airlines	21,4%	13
Mar-18	Corendon Dutch Airlines	4,9%	32
Mar-18	Croatia Airlines	12,9%	31
Mar-18	Czech Airlines CSA	5,7%	53
Mar-18	Delta Air Lines	6,4%	403
Mar-18	EasyJet	6,7%	1407
Mar-18	easyJet Switzerland	2,1%	80
Mar-18	EasyJet Switzerland	2,8%	80
Mar-18	Egypt Air	22,6%	34
Mar-18	El Al	11,4%	45
Mar-18	Emirates	11,4%	63
Mar-18	Etihad Airways	11,3%	31
Mar-18	Eurowings	8,4%	91

Mar-18	Eva Air	28,6%	14
Mar-18	Finnair	35,5%	63
Mar-18	Flybe	14,1%	499
Mar-18	Freebird Airlines	0,0%	3
Mar-18	Garuda Indonesia	3,7%	27
Mar-18	Georgian Airlines	11,1%	9
Mar-18	Iberia Express	6,3%	60
Mar-18	Icelandair	29,0%	32
Mar-18	Iranair	22,2%	9
Mar-18	Jet Airways	5,6%	121
Mar-18	Jet2.com	5,7%	31
Mar-18	Kenya Airways	3,2%	31
Mar-18	KLM	4,1%	9585
Mar-18	Korean Air	20,7%	17
Mar-18	Lot Polish Airlines	9,5%	121
Mar-18	Lufthansa	7,7%	350
Mar-18	Maleth-Aero	0,0%	1
Mar-18	Norwegian Air International	16,7%	34
Mar-18	Norwegian Air Shuttle	24,5%	52
Mar-18	Pegasus Airlines	20,2%	91
Mar-18	Qatar Airways	9,7%	31
Mar-18	Royal Air Maroc	9,1%	33
Mar-18	Royal Jordanian Airlines	5,3%	18
Mar-18	Ryanair	16,2%	137
Mar-18	Scandinavian Airlines	15,3%	244
Mar-18	Singapore Airlines	9,4%	31
Mar-18	Skywork Airlines	15,0%	18
Mar-18	Small Planet Airlines	25,0%	28
Mar-18	SunExpress	18,2%	22
Mar-18	Surinam Airways	13,0%	16
Mar-18	Swiss International Airlines	8,1%	121
Mar-18	TAP Portugal	7,2%	118
Mar-18	Tarom	9,7%	60
Mar-18	Transavia	6,3%	1150
Mar-18	Transavia France	5,6%	18
Mar-18	TUI fly	8,2%	231
Mar-18	Tunisair	44,4%	9
Mar-18	Turkish Airlines	14,8%	157
Mar-18	Ukraine Int. Airlines	16,7%	46
Mar-18	United Airlines	13,4%	113
Mar-18	Vietnam Airlines	0,0%	1
Mar-18	Vueling	12,2%	396
Mar-18	WOW Air	34,4%	31
Mar-18	Xiamen Airlines	0,0%	10
Apr-18	Adria Airways	28,0%	25

Apr-18	Aegean Airlines	13,3%	29
Apr-18	Aer Lingus	13,9%	154
Apr-18	Aeroflot	5,6%	89
Apr-18	Aeromexico	16,1%	28
Apr-18	Air Arabia Maroc	14,0%	39
Apr-18	Air Astana	0,0%	17
Apr-18	Air Canada	17,2%	29
Apr-18	Air Europa	8,3%	59
Apr-18	Air France	7,9%	367
Apr-18	Air Malta	8,6%	35
Apr-18	Air Mauritius	11,1%	9
Apr-18	Air Serbia	11,6%	42
Apr-18	Air Transat	0,0%	2
Apr-18	airBaltic	14,4%	112
Apr-18	AirBaltic	14,4%	112
Apr-18	Alitalia	4,0%	147
Apr-18	American Airlines	29,6%	27
Apr-18	Arkia	33,3%	10
Apr-18	Atlasglobal	6,7%	30
Apr-18	Austrian Airlines	6,0%	113
Apr-18	Belavia	7,4%	26
Apr-18	British Airways	5,5%	443
Apr-18	Bulgaria Air	10,0%	30
Apr-18	Cathay Pacific	6,0%	30
Apr-18	China Airlines	23,1%	16
Apr-18	China Eastern Airlines	0,0%	18
Apr-18	China Southern Airlines	8,0%	59
Apr-18	Corendon Airlines	19,2%	51
Apr-18	Corendon Dutch Airlines	7,8%	126
Apr-18	Croatia Airlines	13,3%	30
Apr-18	Czech Airlines CSA	15,7%	51
Apr-18	Delta Air Lines	7,6%	546
Apr-18	EasyJet	7,0%	1472
Apr-18	EasyJet Switzerland	4,0%	77
Apr-18	easyJet Switzerland	4,8%	77
Apr-18	Egypt Air	23,3%	30
Apr-18	El Al	6,5%	46
Apr-18	Emirates	5,7%	60
Apr-18	Etihad Airways	15,0%	31
Apr-18	Eurowings	10,8%	95
Apr-18	Eva Air	8,3%	12
Apr-18	Finnair	21,7%	60
Apr-18	Flybe	17,5%	433
Apr-18	Garuda Indonesia	3,8%	26
Apr-18	Georgian Airlines	0,0%	9

Apr-18	Iberia Express	8,3%	58
Apr-18	Icelandair	32,5%	39
Apr-18	Iranair	44,4%	9
Apr-18	Jet Airways	5,7%	118
Apr-18	Jet2.com	13,6%	42
Apr-18	Kenya Airways	0,0%	29
Apr-18	KLM	3,5%	10145
Apr-18	KLM Cityhopper	0,0%	4
Apr-18	Korean Air	19,2%	17
Apr-18	Lot Polish Airlines	7,4%	118
Apr-18	Lufthansa	9,0%	326
Apr-18	Norwegian Air International	17,1%	39
Apr-18	Norwegian Air Shuttle	16,7%	59
Apr-18	Onur Air	16,7%	6
Apr-18	Pegasus Airlines	11,9%	84
Apr-18	Qatar Airways	11,8%	30
Apr-18	Royal Air Maroc	28,2%	39
Apr-18	Royal Jordanian Airlines	0,0%	17
Apr-18	Ryanair	21,0%	142
Apr-18	Scandinavian Airlines	13,5%	231
Apr-18	Singapore Airlines	8,3%	30
Apr-18	Skywork Airlines	0,0%	24
Apr-18	Small Planet Airlines	33,3%	26
Apr-18	SunExpress	36,0%	24
Apr-18	Surinam Airways	5,3%	16
Apr-18	Swiss International Airlines	8,3%	118
Apr-18	TAP Portugal	15,0%	110
Apr-18	Tarom	21,7%	58
Apr-18	Transavia	6,0%	1255
Apr-18	Transavia France	20,8%	24
Apr-18	TUI fly	8,3%	345
Apr-18	Tunisair	37,5%	8
Apr-18	Turkish Airlines	3,2%	149
Apr-18	Ukraine Int. Airlines	6,7%	30
Apr-18	United Airlines	11,7%	120
Apr-18	Vueling	9,4%	454
Apr-18	WOW Air	16,7%	36
Apr-18	Xiamen Airlines	15,4%	13
May-18	Adria Airways	14,8%	26
May-18	Aegean Airlines	3,2%	30
May-18	Aer Lingus	9,4%	158
May-18	Aeroflot	3,2%	93
May-18	Aeromexico	6,5%	31
May-18	Air Arabia Maroc	10,5%	38
May-18	Air Astana	0,0%	19

May-18	Air Canada	19,2%	26
May-18	Air Europa	9,7%	62
May-18	Air France	6,5%	398
May-18	Air Malta	8,6%	33
May-18	Air Mauritius	12,5%	8
May-18	Air Serbia	13,6%	43
May-18	Air Transat	28,6%	21
May-18	AirBaltic	14,7%	117
May-18	airBaltic	14,7%	117
May-18	Alitalia	3,9%	150
May-18	American Airlines	18,6%	56
May-18	Arkia	10,0%	8
May-18	Atlasglobal	6,5%	29
May-18	Austrian Airlines	4,1%	118
May-18	Belavia	3,2%	31
May-18	British Airways	6,4%	467
May-18	Bulgaria Air	12,9%	31
May-18	Cathay Pacific	8,2%	27
May-18	China Airlines	0,0%	16
May-18	China Eastern Airlines	5,9%	17
May-18	China Southern Airlines	12,2%	61
May-18	Corendon Airlines	13,1%	59
May-18	Corendon Dutch Airlines	7,3%	192
May-18	Croatia Airlines	13,9%	35
May-18	Czech Airlines CSA	7,4%	52
May-18	Delta Air Lines	5,9%	576
May-18	EasyJet	6,7%	1512
May-18	EasyJet Switzerland	4,1%	68
May-18	easyJet Switzerland	4,9%	68
May-18	Egypt Air	12,9%	31
May-18	El Al	4,1%	50
May-18	Emirates	6,8%	60
May-18	Etihad Airways	8,3%	31
May-18	Eurowings	4,0%	95
May-18	Eva Air	0,0%	14
May-18	Finnair	11,3%	62
May-18	Flybe	7,9%	458
May-18	Garuda Indonesia	7,7%	26
May-18	Georgian Airlines	0,0%	8
May-18	Iberia Express	4,8%	63
May-18	Icelandair	39,7%	62
May-18	Iranair	10,0%	9
May-18	Jet Airways	3,2%	128
May-18	Jet2.com	12,5%	32
May-18	Kenya Airways	6,5%	31

May-18	KLM	2,9%	10493
May-18	KLM Cityhopper	25,0%	4
May-18	Korean Air	14,3%	18
May-18	Lot Polish Airlines	10,3%	120
May-18	Lufthansa	5,0%	337
May-18	Norwegian Air International	10,0%	38
May-18	Norwegian Air Shuttle	22,0%	82
May-18	Onur Air	11,8%	17
May-18	Pegasus Airlines	8,7%	111
May-18	Qatar Airways	6,9%	32
May-18	Royal Air Maroc	10,3%	28
May-18	Royal Jordanian Airlines	0,0%	17
May-18	Ryanair	20,0%	144
May-18	Scandinavian Airlines	11,4%	250
May-18	Singapore Airlines	7,3%	31
May-18	Skywork Airlines	3,8%	21
May-18	Small Planet Airlines	17,8%	37
May-18	SunExpress	8,2%	43
May-18	Surinam Airways	0,0%	16
May-18	Swiss International Airlines	9,5%	119
May-18	TAP Portugal	8,1%	120
May-18	Tarom	4,8%	61
May-18	Transavia	3,8%	1666
May-18	Transavia France	10,7%	24
May-18	TUI fly	13,0%	475
May-18	Tunisair	0,0%	7
May-18	Turkish Airlines	7,5%	152
May-18	Ukraine Int. Airlines	12,1%	29
May-18	United Airlines	8,9%	122
May-18	Vueling	7,7%	472
May-18	WOW Air	17,5%	61
May-18	Xiamen Airlines	0,0%	13
Jun-18	Adria Airways	20,0%	24
Jun-18	Aegean Airlines	0,0%	31
Jun-18	Aer Lingus	5,9%	152
Jun-18	Aeroflot	6,7%	96
Jun-18	Aeromexico	10,0%	30
Jun-18	Air Arabia Maroc	5,0%	39
Jun-18	Air Astana	0,0%	18
Jun-18	Air Canada	17,9%	28
Jun-18	Air Europa	10,0%	60
Jun-18	Air France	6,2%	381
Jun-18	Air Malta	8,8%	34
Jun-18	Air Mauritius	22,2%	9
Jun-18	Air Serbia	20,9%	43

Jun-18	Air Transat	13,3%	30
Jun-18	airBaltic	36,0%	111
Jun-18	AirBaltic	36,6%	111
Jun-18	Alitalia	3,3%	146
Jun-18	American Airlines	23,3%	60
Jun-18	Arkia	0,0%	9
Jun-18	Atlasglobal	0,0%	30
Jun-18	Austrian Airlines	6,1%	114
Jun-18	Belavia	3,3%	32
Jun-18	British Airways	3,8%	439
Jun-18	Bulgaria Air	13,3%	30
Jun-18	Cathay Pacific	12,2%	27
Jun-18	China Airlines	6,7%	18
Jun-18	China Eastern Airlines	0,0%	17
Jun-18	China Southern Airlines	11,5%	59
Jun-18	Corendon Airlines	14,5%	52
Jun-18	Corendon Dutch Airlines	7,4%	168
Jun-18	Croatia Airlines	2,9%	33
Jun-18	Czech Airlines CSA	9,1%	55
Jun-18	Delta Air Lines	5,5%	566
Jun-18	EasyJet	6,2%	1458
Jun-18	EasyJet Switzerland	3,1%	68
Jun-18	easyJet Switzerland	2,7%	68
Jun-18	Egypt Air	3,3%	30
Jun-18	El Al	1,9%	53
Jun-18	Emirates	5,7%	62
Jun-18	Etihad Airways	3,6%	30
Jun-18	Eurowings	6,2%	90
Jun-18	Eva Air	7,7%	13
Jun-18	Finnair	20,0%	60
Jun-18	Flybe	11,5%	441
Jun-18	Garuda Indonesia	3,8%	26
Jun-18	Georgian Airlines	0,0%	9
Jun-18	Iberia Express	3,3%	57
Jun-18	Icelandair	56,7%	60
Jun-18	Iranair	53,8%	8
Jun-18	Jet Airways	3,3%	120
Jun-18	Jet2.com	3,4%	24
Jun-18	Kenya Airways	6,7%	30
Jun-18	KLM	3,0%	10306
Jun-18	KLM Cityhopper	0,0%	4
Jun-18	Korean Air	8,8%	26
Jun-18	Lot Polish Airlines	4,2%	119
Jun-18	Lufthansa	8,0%	339
Jun-18	Norwegian Air International	18,6%	42

Jun-18	Norwegian Air Shuttle	25,6%	79
Jun-18	Onur Air	5,9%	16
Jun-18	Pegasus Airlines	5,7%	104
Jun-18	Qatar Airways	7,2%	30
Jun-18	Royal Air Maroc	6,3%	31
Jun-18	Royal Jordanian Airlines	5,6%	18
Jun-18	Ryanair	26,8%	141
Jun-18	Scandinavian Airlines	18,9%	225
Jun-18	Singapore Airlines	2,0%	30
Jun-18	Skywork Airlines	8,0%	23
Jun-18	Small Planet Airlines	14,3%	31
Jun-18	SunExpress	3,6%	52
Jun-18	Surinam Airways	0,0%	14
Jun-18	Swiss International Airlines	3,3%	118
Jun-18	TAP Portugal	11,7%	113
Jun-18	Tarom	6,7%	59
Jun-18	Transavia	3,8%	1613
Jun-18	Transavia France	4,0%	25
Jun-18	TUI fly	10,0%	463
Jun-18	Tunisair	44,4%	8
Jun-18	Turkish Airlines	9,1%	154
Jun-18	Ukraine Int. Airlines	26,7%	31
Jun-18	United Airlines	8,3%	120
Jun-18	Vueling	6,9%	469
Jun-18	WOW Air	26,7%	59
Jun-18	Xiamen Airlines	15,4%	13
Jul-18	Adria Airways	32,0%	24
Jul-18	Aegean Airlines	6,5%	31
Jul-18	Aer Lingus	20,5%	162
Jul-18	Aeroflot	11,7%	96
Jul-18	Aeromexico	3,2%	31
Jul-18	Air Arabia Maroc	24,1%	54
Jul-18	Air Astana	5,6%	15
Jul-18	Air Canada	29,0%	31
Jul-18	Air Europa	14,5%	62
Jul-18	Air France	12,0%	388
Jul-18	Air Malta	8,3%	36
Jul-18	Air Mauritius	23,1%	13
Jul-18	Air Serbia	15,9%	44
Jul-18	Air Transat	15,6%	33
Jul-18	airBaltic	28,2%	123
Jul-18	AirBaltic	28,2%	123
Jul-18	Alitalia	3,8%	155
Jul-18	American Airlines	34,9%	62
Jul-18	Arkia	29,4%	14

Jul-18	Atlasglobal	0,0%	31
Jul-18	Austrian Airlines	11,8%	115
Jul-18	Balkan Holiday Airlines	42,9%	7
Jul-18	Belavia	9,7%	30
Jul-18	British Airways	8,9%	421
Jul-18	Bulgaria Air	22,6%	31
Jul-18	Cathay Pacific	16,7%	31
Jul-18	China Airlines	10,3%	17
Jul-18	China Eastern Airlines	0,0%	18
Jul-18	China Southern Airlines	15,7%	61
Jul-18	Corendon Airlines	16,9%	60
Jul-18	Corendon Dutch Airlines	8,5%	204
Jul-18	Croatia Airlines	16,7%	36
Jul-18	Czech Airlines CSA	27,6%	58
Jul-18	Delta Air Lines	6,9%	601
Jul-18	EasyJet	10,4%	1458
Jul-18	easyJet Switzerland	5,7%	31
Jul-18	EasyJet Switzerland	6,1%	31
Jul-18	Egypt Air	3,2%	31
Jul-18	El Al	8,5%	59
Jul-18	Emirates	7,6%	61
Jul-18	Etihad Airways	23,1%	32
Jul-18	Eurowings	6,8%	98
Jul-18	Eva Air	0,0%	13
Jul-18	Finnair	22,6%	62
Jul-18	Flybe	11,7%	440
Jul-18	Garuda Indonesia	19,2%	26
Jul-18	Georgian Airlines	0,0%	9
Jul-18	Iberia Express	7,8%	63
Jul-18	Icelandair	35,5%	58
Jul-18	Iranair	55,6%	9
Jul-18	Jet Airways	3,9%	123
Jul-18	Jet2.com	16,7%	18
Jul-18	Kenya Airways	2,6%	37
Jul-18	KLM	3,6%	10629
Jul-18	KLM Cityhopper	0,0%	4
Jul-18	Korean Air	16,7%	27
Jul-18	Lot Polish Airlines	14,5%	120
Jul-18	Lufthansa	5,8%	351
Jul-18	Norwegian Air International	14,8%	54
Jul-18	Norwegian Air Shuttle	31,3%	80
Jul-18	Onur Air	16,7%	18
Jul-18	Pegasus Airlines	5,8%	119
Jul-18	Qatar Airways	7,1%	31
Jul-18	Royal Air Maroc	24,7%	91

Jul-18	Royal Jordanian Airlines	0,0%	17
Jul-18	Ryanair	31,5%	145
Jul-18	Scandinavian Airlines	22,5%	210
Jul-18	Singapore Airlines	11,8%	32
Jul-18	Skywork Airlines	7,4%	26
Jul-18	Small Planet Airlines	32,5%	36
Jul-18	SunExpress	3,2%	63
Jul-18	Surinam Airways	35,3%	17
Jul-18	Swiss International Airlines	8,1%	122
Jul-18	TAP Portugal	22,6%	123
Jul-18	Tarom	14,5%	61
Jul-18	Transavia	3,7%	1824
Jul-18	Transavia France	22,2%	9
Jul-18	TUI fly	10,4%	625
Jul-18	Tunisair	55,6%	9
Jul-18	Turkish Airlines	13,2%	153
Jul-18	Ukraine Int. Airlines	35,5%	32
Jul-18	United Airlines	15,3%	120
Jul-18	Vueling	14,8%	489
Jul-18	WOW Air	23,8%	61
Jul-18	Xiamen Airlines	15,4%	13
Aug-18	Adria Airways	35,7%	26
Aug-18	Aegean Airlines	16,1%	31
Aug-18	Aer Lingus	11,3%	159
Aug-18	Aeroflot	11,8%	93
Aug-18	Aeromexico	6,5%	31
Aug-18	Air Arabia Maroc	35,2%	54
Aug-18	Air Astana	5,0%	18
Aug-18	Air Canada	41,9%	40
Aug-18	Air Europa	19,4%	62
Aug-18	Air France	7,6%	411
Aug-18	Air Malta	17,1%	35
Aug-18	Air Mauritius	7,1%	14
Aug-18	Air Serbia	11,1%	45
Aug-18	Air Transat	13,8%	29
Aug-18	AirBaltic	29,0%	125
Aug-18	airBaltic	29,0%	125
Aug-18	Alitalia	4,6%	128
Aug-18	American Airlines	14,5%	62
Aug-18	Arkia	50,0%	14
Aug-18	Atlasglobal	6,3%	31
Aug-18	Austrian Airlines	5,0%	115
Aug-18	Balkan Holiday Airlines	44,4%	9
Aug-18	Belavia	9,7%	31
Aug-18	British Airways	6,3%	436

Aug-18	Bulgaria Air	9,7%	31
Aug-18	Cathay Pacific	20,4%	31
Aug-18	China Airlines	7,1%	17
Aug-18	China Eastern Airlines	16,7%	18
Aug-18	China Southern Airlines	18,5%	62
Aug-18	Corendon Airlines	9,0%	73
Aug-18	Corendon Dutch Airlines	10,3%	204
Aug-18	Croatia Airlines	17,1%	35
Aug-18	Czech Airlines CSA	17,2%	65
Aug-18	Delta Air Lines	4,7%	594
Aug-18	EasyJet	10,0%	1489
Aug-18	easyJet Switzerland	0,0%	30
Aug-18	EasyJet Switzerland	0,0%	30
Aug-18	Egypt Air	16,1%	31
Aug-18	El Al	8,3%	56
Aug-18	Emirates	10,1%	62
Aug-18	Etihad Airways	11,1%	32
Aug-18	Eurowings	14,4%	102
Aug-18	Eva Air	0,0%	13
Aug-18	Finnair	30,6%	62
Aug-18	Flybe	12,0%	462
Aug-18	Garuda Indonesia	11,1%	27
Aug-18	Georgian Airlines	0,0%	8
Aug-18	Iberia Express	19,4%	62
Aug-18	Icelandair	38,7%	62
Aug-18	Iranair	22,2%	9
Aug-18	Jet Airways	6,5%	125
Aug-18	Jet2.com	10,5%	17
Aug-18	Kenya Airways	6,8%	44
Aug-18	KLM	4,1%	10544
Aug-18	KLM Cityhopper	0,0%	8
Aug-18	Korean Air	11,4%	26
Aug-18	Lot Polish Airlines	12,8%	118
Aug-18	Lufthansa	9,5%	337
Aug-18	Norwegian Air International	23,9%	45
Aug-18	Norwegian Air Shuttle	39,8%	82
Aug-18	Onur Air	27,8%	17
Aug-18	Pegasus Airlines	4,7%	128
Aug-18	Qatar Airways	8,5%	31
Aug-18	Royal Air Maroc	26,7%	101
Aug-18	Royal Jordanian Airlines	0,0%	18
Aug-18	Ryanair	30,8%	146
Aug-18	Scandinavian Airlines	19,0%	238
Aug-18	Singapore Airlines	5,6%	31
Aug-18	Skywork Airlines	19,2%	22

Aug-18	Small Planet Airlines	24,3%	35
Aug-18	SunExpress	3,3%	61
Aug-18	Surinam Airways	0,0%	17
Aug-18	Swiss International Airlines	8,1%	118
Aug-18	TAP Portugal	13,7%	123
Aug-18	Tarom	14,5%	60
Aug-18	Transavia	5,6%	1854
Aug-18	Transavia France	0,0%	8
Aug-18	TUI fly	11,1%	632
Aug-18	Tunisair	44,4%	8
Aug-18	Turkish Airlines	8,8%	155
Aug-18	Ukraine Int. Airlines	45,5%	32
Aug-18	United Airlines	14,4%	126
Aug-18	Vueling	16,1%	482
Aug-18	WOW Air	21,0%	60
Aug-18	Xiamen Airlines	0,0%	13
Sep-18	Adria Airways	30,8%	26
Sep-18	Aegean Airlines	27,3%	30
Sep-18	Aer Lingus	9,8%	150
Sep-18	Aeroflot	11,1%	89
Sep-18	Aeromexico	6,7%	30
Sep-18	Air Arabia Maroc	13,0%	46
Sep-18	Air Astana	17,6%	17
Sep-18	Air Canada	20,0%	30
Sep-18	Air Europa	11,7%	60
Sep-18	Air France	6,7%	390
Sep-18	Air Malta	32,4%	34
Sep-18	Air Mauritius	12,5%	8
Sep-18	Air Serbia	21,4%	42
Sep-18	Air Transat	7,7%	25
Sep-18	AirBaltic	3,3%	120
Sep-18	airBaltic	3,3%	120
Sep-18	Alitalia	9,3%	151
Sep-18	American Airlines	20,0%	61
Sep-18	Arkia	12,5%	8
Sep-18	Atlasglobal	16,7%	33
Sep-18	Austrian Airlines	4,3%	111
Sep-18	Balkan Holiday Airlines	0,0%	2
Sep-18	Belavia	6,7%	29
Sep-18	British Airways	7,0%	430
Sep-18	Bulgaria Air	33,3%	30
Sep-18	Cathay Pacific	20,8%	29
Sep-18	China Airlines	15,4%	17
Sep-18	China Eastern Airlines	11,8%	17
Sep-18	China Southern Airlines	15,3%	59

Sep-18	Corendon Airlines	19,6%	55
Sep-18	Corendon Dutch Airlines	15,1%	182
Sep-18	Croatia Airlines	23,5%	34
Sep-18	Czech Airlines CSA	16,7%	65
Sep-18	Delta Air Lines	6,7%	600
Sep-18	EasyJet	9,2%	1570
Sep-18	EasyJet Switzerland	6,2%	67
Sep-18	easyJet Switzerland	6,2%	67
Sep-18	Egypt Air	30,0%	30
Sep-18	El Al	13,6%	42
Sep-18	Emirates	4,0%	59
Sep-18	Etihad Airways	10,7%	30
Sep-18	Eurowings	11,6%	88
Sep-18	Eva Air	15,4%	13
Sep-18	Finnair	15,0%	58
Sep-18	Flybe	14,2%	446
Sep-18	Garuda Indonesia	0,0%	27
Sep-18	Georgian Airlines	22,2%	8
Sep-18	Iberia Express	9,8%	56
Sep-18	Icelandair	32,8%	58
Sep-18	Iranair	22,2%	9
Sep-18	Jet Airways	5,8%	119
Sep-18	Jet2.com	17,9%	28
Sep-18	Kenya Airways	6,8%	43
Sep-18	KLM	4,1%	10378
Sep-18	KLM Cityhopper	2,0%	50
Sep-18	Korean Air	15,4%	26
Sep-18	Lot Polish Airlines	13,3%	118
Sep-18	Lufthansa	10,0%	341
Sep-18	Norwegian Air International	25,6%	38
Sep-18	Norwegian Air Shuttle	29,1%	79
Sep-18	Onur Air	29,4%	15
Sep-18	Pegasus Airlines	7,5%	119
Sep-18	Qatar Airways	10,1%	30
Sep-18	Royal Air Maroc	20,3%	51
Sep-18	Royal Jordanian Airlines	5,6%	18
Sep-18	Ryanair	28,4%	140
Sep-18	Scandinavian Airlines	17,1%	232
Sep-18	Singapore Airlines	13,5%	30
Sep-18	Small Planet Airlines	25,7%	34
Sep-18	SunExpress	12,7%	55
Sep-18	Surinam Airways	15,8%	16
Sep-18	Swiss International Airlines	7,5%	118
Sep-18	TAP Portugal	27,5%	118
Sep-18	Tarom	6,7%	60

Sep-18	Transavia	8,0%	1624
Sep-18	Transavia France	16,7%	21
Sep-18	TUI fly	9,5%	490
Sep-18	Tunisair	50,0%	7
Sep-18	Turkish Airlines	8,6%	149
Sep-18	Ukraine Int. Airlines	41,9%	29
Sep-18	United Airlines	16,7%	120
Sep-18	Vueling	14,1%	484
Sep-18	WOW Air	16,7%	58
Sep-18	Xiamen Airlines	15,4%	13
Oct-18	Adria Airways	37,0%	24
Oct-18	Aegean Airlines	22,6%	28
Oct-18	Aer Lingus	20,4%	153
Oct-18	Aeroflot	9,6%	100
Oct-18	Aeromexico	16,1%	30
Oct-18	Air Arabia Maroc	20,9%	41
Oct-18	Air Astana	0,0%	16
Oct-18	Air Canada	10,0%	20
Oct-18	Air Europa	16,1%	59
Oct-18	Air France	6,5%	401
Oct-18	Air Malta	24,2%	33
Oct-18	Air Mauritius	37,5%	8
Oct-18	Air Serbia	16,3%	42
Oct-18	Air Transat	23,1%	13
Oct-18	AirBaltic	3,2%	116
Oct-18	airBaltic	3,2%	116
Oct-18	Alitalia	7,0%	146
Oct-18	American Airlines	6,7%	29
Oct-18	Arkia	44,4%	9
Oct-18	Atlasglobal	12,9%	29
Oct-18	Austrian Airlines	7,5%	117
Oct-18	Belavia	13,3%	29
Oct-18	British Airways	9,6%	461
Oct-18	Bulgaria Air	12,9%	30
Oct-18	Cathay Pacific	23,9%	30
Oct-18	China Airlines	14,8%	17
Oct-18	China Eastern Airlines	0,0%	17
Oct-18	China Southern Airlines	14,4%	60
Oct-18	Corendon Airlines	16,4%	48
Oct-18	Corendon Dutch Airlines	11,9%	119
Oct-18	Croatia Airlines	12,5%	31
Oct-18	Czech Airlines CSA	15,0%	58
Oct-18	Delta Air Lines	7,1%	545
Oct-18	EasyJet	9,1%	1615
Oct-18	EasyJet Switzerland	5,6%	67

Oct-18	easyJet Switzerland	5,4%	67
Oct-18	Egypt Air	25,8%	30
Oct-18	El Al	15,5%	52
Oct-18	Emirates	10,9%	60
Oct-18	Etihad Airways	22,2%	30
Oct-18	Eurowings	7,8%	92
Oct-18	Eva Air	7,7%	13
Oct-18	Finnair	24,2%	60
Oct-18	Flybe	18,0%	465
Oct-18	Freebird Airlines	100,0%	1
Oct-18	Garuda Indonesia	0,0%	26
Oct-18	Georgian Airlines	0,0%	10
Oct-18	Iberia Express	20,7%	57
Oct-18	Icelandair	27,3%	41
Oct-18	Iranair	37,5%	8
Oct-18	Jet Airways	14,4%	120
Oct-18	Jet2.com	27,3%	38
Oct-18	Jetairfly	71,4%	6
Oct-18	Kenya Airways	3,2%	30
Oct-18	KLM	3,8%	10427
Oct-18	KLM Cityhopper	4,3%	45
Oct-18	Korean Air	10,8%	25
Oct-18	Lot Polish Airlines	18,3%	109
Oct-18	Lufthansa	9,8%	340
Oct-18	Norwegian Air International	21,1%	36
Oct-18	Norwegian Air Shuttle	24,4%	82
Oct-18	Onur Air	13,3%	13
Oct-18	Pegasus Airlines	3,5%	112
Oct-18	Privilege Style	100,0%	1
Oct-18	Qatar Airways	12,7%	30
Oct-18	Royal Air Maroc	18,2%	40
Oct-18	Royal Jordanian Airlines	0,0%	16
Oct-18	Ryanair	25,0%	139
Oct-18	Scandinavian Airlines	17,5%	244
Oct-18	Singapore Airlines	20,3%	30
Oct-18	Small Planet Airlines	32,5%	29
Oct-18	SunExpress	7,7%	51
Oct-18	Surinam Airways	20,0%	17
Oct-18	Swiss International Airlines	12,1%	117
Oct-18	TAP Portugal	21,1%	120
Oct-18	Tarom	1,6%	58
Oct-18	Transavia	6,7%	1502
Oct-18	Transavia France	3,7%	24
Oct-18	TUI fly	15,4%	387
Oct-18	Tunisair	0,0%	8

Oct-18	Turkish Airlines	9,7%	148
Oct-18	Ukraine Int. Airlines	35,5%	30
Oct-18	United Airlines	15,3%	122
Oct-18	Vueling	15,3%	465
Oct-18	WOW Air	19,0%	54
Oct-18	Xiamen Airlines	0,0%	12