Identify And Assessing Airside Information/Data That APOC Receives for Operational Planning

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Abstract

This thesis investigates the intricacies of information exchange and collaboration among key stakeholders at Amsterdam Airport Schiphol, focusing on the roles and data interactions of Schiphol APOC, KLM, and LVNL. Central to this research is the exploration of the efficacy and quality of data exchange processes and their impact on operational planning and decision-making within the airport's ecosystem.

The study reveals critical gaps in the availability and quality of airside information at Schiphol APOC, underscoring the need for improved data sharing mechanisms among stakeholders. Through a comprehensive analysis of various airside data sources, such as runways, taxiways, and aprons, the research emphasizes the importance of data accuracy, reliability, timeliness, and consistency in effective operational planning. Furthermore, the thesis identifies LVNL as a foundational source of information, essential for real-time operational conditions and air traffic management.

The findings of this research highlight the need for Schiphol APOC to adopt more integrated data-sharing systems and advanced technologies like AI and machine learning for real-time data analysis. Enhanced security measures for data exchange, including blockchain technology and advanced encryption methods, are recommended to ensure data integrity and security. Additionally, the research suggests strengthening collaboration mechanisms with other airport stakeholders and aligning data-driven operational improvements with sustainability goals.

Overall, this thesis contributes to the theoretical and practical understanding of data quality and sharing in airport operations. It offers actionable strategies for enhancing efficiency, safety, and collaborative decision-making, thus providing valuable insights for Amsterdam Airport Schiphol and the broader field of aviation management and operations.

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List of Abbreviations

Abbreviation	Definition
AAS	Amsterdam Airport Schiphol
A-CDM	Airport Collaborative Decision Making
AFOS	Airport Forecasting System
ALDT	Actual Landing Time
ANSP	Air Navigation Service Provider
AOP	Airport Operational Plan
APOC	Airport Operations Center
ASRT	Actual Start-up Request Time
ATC	Air Traffic Control
ATOT	Actual Take-Off Time
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
CISS	Central Information Schiphol System.
CIAO	Collaboration Interface Aircraft Operators
CMA	Capacity Management
CPDSP	Collaborative Pre-Departure Sequence Planning
DCB	Demand and Capacity Balancing
DST	Decision Support Tool
EFS	Electronic Flight Strips
EIBT	Estimated In-Block Time
ELDT	Estimated Landing Time
EOBT	Estimated Off-Block Time
FMPC	Flow Management Planning Coordinator
FUM	Flight Update Messages
KDC	Knowledge and Development Centre
KPI	Key Performance Indicator
KNMI	Koninklijk Nederlands Meteorologisch Instituut
LVNL	Luchtverkeersleiding Nederland
METAR	Meteorological Aerodrome Report
MGHA	Main Ground Handling Agent
MMT	Minimum Turnaround Time
NM	Network Manager
NOP	Network Operations Plan
OHD	Operational Helpdesk
OSD	Operational Support and Development
SOBT	Scheduled Off-Block Time
SUP	Support Unit Plan
TAF	Terminal Aerodrome Forecast
TAM	Total Airport Management
TSAT	Target Start-Up Approval Time
TTOT	Target Take Off Time
TOBT	Target Off-Block Time

TOT	Take-Off Time

Summary

The thesis provides a comprehensive analysis of information exchange and collaboration dynamics among the key stakeholders at Amsterdam Airport Schiphol, focusing on Schiphol APOC, KLM, and LVNL. The research highlights the transformative role of technology in enhancing communication, thereby improving operational planning's speed, accuracy, and reliability.

The study identified operational misalignments and a lack of Collaborative Decision Making (CDM). Solutions include developing automated systems for for data updates, integrating CDM tools, and establishing clear communication protocols.

The research includes interviews with stakeholders, an assessment of information exchange using KPIs, and a comparison of data sources among stakeholders to evaluate information alignment.
There is a notable deficiency in the timely sharing of information from LVNL's dataset with stakeholders, hindering effective decision-making. The research emphasized the importance of data accuracy, reliability, timeliness, and consistency, which are fundamental for effective operational planning and smooth airport operations. It highlighted the role of LVNL as a foundational information source and suggested a more integrated approach to information sharing and data exchange protocols.

Challenges faced by Schiphol APOC include last-minute gate changes, delays in the Apron process, and insufficient information exchange between stakeholders. Potential solutions involve introducing direct communication channels, integrating systems for enhanced data sharing, analyzing root causes behind delays, and investing in infrastructure and collaborative frameworks.

The research identified the Central Information Schiphol system (CISS) as a critical data source for APOC. CISS acts as a central repository for operational data, essential for decision-making and operational control at Schiphol APOC. The data includes flight schedules, aircraft turnaround data, gate assignments, baggage handling information, weather conditions, and more.

The research concludes with recommendations for enhancing information exchange and collaboration. These include the development of robust data-sharing protocols, advancing analytics and AI, improving security measures for data exchange, enhancing stakeholder collaboration, and conducting comparative global analysis.

1.Introduction

In the dynamic landscape of aviation, collaborative endeavors among key stakeholders such as Schiphol APOC, KLM (Royal Dutch Airlines), and Air Traffic Control the Netherlands (LVNL) are instrumental. These entities actively engage in the Knowledge and Development Centre (KDC), recognizing the paramount importance of effective information exchange in operational planning. To enhance this collaborative space, the KDC has undertaken a research initiative to closely monitor and understand the evolving dynamics within this alliance.

1.1 Background information

KDC stakeholders are connected to each other's operations, relying heavily on processes conducted by their partner organizations and the communication among them.
Therefore, it is needed to provide better information to all parties involved, whereas effective communication is vital in operation planning to ensure safety, efficiency, collaboration, and planning. While technology integration plays a key role in enabling this communication, making it faster, more accurate, and more reliable. It is an essential component of operations planning.
For this, they are actively developing and enhancing essential decision-support tools. Decision-support tools play a crucial role in making operations plan safer, more efficient, and more sustainable while improving the overall passenger and stakeholder experience. They provide real time information, optimize flight routes, fuel consumption, and resource allocation, help in managing air traffic flow and reducing delays and assist in long-term planning and forecasting.
Specially, the Airport Operations Centre play a pivotal role in the efficient and safe functioning of airport Schiphol. The primary objective of Schiphol's APOC is to make airport operations more predictable, flexible, and efficient and shorten recovery time after disruptions. This is done by forecasting and manage airport operations both in the immediate future and further ahead. This mission is underpinned by the collaborative efforts of all stakeholders within the airport ecosystem.
Challenges can arise when companies are unaware of decisions made by other entities, particularly when these decisions directly impact their own operations and are revealed shortly before implementation. (KDC, n.d.)
The core issue addressed in this research pertains to the unavailability of complete airside information to the Airport Operations Centre (APOC). Having access to reliable information is a critical determinant for APOC in making informed decisions.

1.2 Problem statement and research question

The core issue addressed in this research is that Schiphol APOC does not have all information needed available for operational planning.

Information Quality: The quality of data received by Schiphol APOC from partner organizations could be in question, specifically in terms of instance its accuracy, reliability, timeliness, and consistency.

Data Sharing Mechanisms: There is a concern about the mechanisms of data sharing among the stakeholders. It is unclear how new data is transferred among these organizations.

Ultimate Goal: The ultimate goal of addressing these issues is to determine whether the new information gathered by APOC is complete and suitable for planning purposes, thereby improving the efficiency and safety of Schiphol airport operations.

In essence, the problem statement revolves around the availability and the quality of information that the APOC relies on from its partner organizations, which directly impacts its ability to make informed decisions and efficiently manage airport operations.

Main Research Question:
The central inquiry driving this research is, **"What available data do stakeholders possess that APOC requires, and what constitutes the most valuable data for operational planning and decision-making processes at Amsterdam Airport Schiphol?"**

In essence, this research seeks to unravel the intricacies of information exchange among stakeholders, focusing on the data quality received by APOC from key stakeholders and the mechanisms governing data sharing.

1.3 Objectives of the study

The research aims to identify the airside data sources (Runways, Taxiways and Aprons) and comparing the sources that APOC receives from stakeholders. It will be assessed the quality of new and existing information used by Schiphol APOC from partner organizations and evaluated what is the most valuable data for APOC. It is proposed to measure the quality of data by evaluating its accuracy, reliability, and timeliness and consistency. In addition, it will also identify the data-sharing mechanisms among stakeholders, i.e., data transferring ways.

In return this research will provide insight into what is beneficial to all partners. APOC is likely to use the outcomes of the research to make informed decisions, enhance collaboration with stakeholders, and improve the quality of data used in airport operations planning, ultimately leading to improve insight in operational planning, traffic prediction accuracy, reduced delays, and recovery times at Schiphol Airport.

1.4 Significance of the study

This research addresses critical issues related to incomplete and inaccurate information, with potential consequences for operational decisions. By enhancing the APOC's access to reliable data, the study aims to improve operational planning, traffic predictions, and reduce delays and recovery times at Schiphol Airport, ultimately contributing to the safety and efficiency of airport operations.

1.5 Scope and limitations

The scope of this study encompasses a thorough examination of airside data sources, specifically focusing on runways, taxiways, and aprons at Amsterdam Airport Schiphol. While the research aims to provide comprehensive insights, certain limitations may arise, including the dynamic nature of aviation operations, potential confidentiality constraints, and limitations in data-sharing agreements among stakeholders.

1.6 Research Methodology

To achieve the research objectives, a methodology will be employed, the following chapter indicate what will be done and how this can be achieved, involves a combination of data collection, analysis, modelling, and evaluation.

Phase 1. Knowledge, this phase is included:

- Analyzing the planning process for APOC.

- Understand which data do APOC need through define the objectives of the research.
- Reviewing the literature to understand the existing research and understand the different roles and activities for the stakeholders regarding operational preparation. As well the key terms frequently referenced, including A-CDM, TAM, APOC, and AOP will be reviewed.
- The necessary data sources will be Identified and collected, that could be for example:

  Air traffic data (flight plans, radar data)
  Airport data (runway configurations, gate availability)
  Airlines data (schedules, aircraft types)
  Ground handlers' data (handling capacity, turnaround times)
  Weather data.
  Regulatory data.
  This can be done firstly with defining the definitions of the concepts investigated such as A-CDM, TAM and APOC and AOP and secondly by interviews with representatives of the stakeholders. Next step will be validated and pre-process the collected data to ensure accuracy.

Phase 2 Comprehension, this phase is included:

- Mapping the current preparation efforts undertaken by the involved partners.
- Identifying individual stakeholder expectations and wishes.
- Stakeholder perspectives will be gathered through interviews with their representatives.
- Analysing their existing planning procedures.
- Clarifying how preparatory roles are distributed among stakeholders and the resources they use for operational preparation.

Phase 3 Application, this phase is included:

- Process mapping techniques will be used to create timelines, outlining preparation steps, information sources, and deliverables.
- Identifying what information is considered individually and collectively relevant for stakeholders and how the current preparation processes are structured.
- Compare, categorize, and contrast information received from stakeholders.
- Measure the data quality that APOC receives, there are four key metrics will be autonomously monitor regularly. Which is completeness, timeliness, consistency and accurancy. It's important to check that each piece of data conforms to the correct type and format of data required.
- Conducting a gap analysis to identify discrepancies between the data currently received and the data required for optimal APOC operations.
- Analyzing the reasons behind the gaps, such as differences in data sources or lack of standardized data sharing protocols.
- The outcome includes timelines detailing the operational preparation processes of stakeholders.
- Research will be done to determine how this data sharing ahead of operations can lead to associated benefits.
- Defining and use appropriate performance KPI. Key Performance Indicators (KPIs) allow for near-real-time monitoring of data sharing principles. As a result, multiple performance indicators will be developed to assess the achievement of established parameters and standards.

Phase 4: Finalizing, this phase is included:

- Summarizing the findings and discuss where improvements lie for operational preparation of stakeholders and will be discussed the extent to which the planning schedules of the stakeholders can be merged and coordinated.
- Given that stakeholders utilize different data sources, there is a necessity to assess both similarities and distinctions concerning the sources of information and their respective quality. This follows to compare data sources and analyse what are the best sources for forecasting. Based on this analysis recommendations will be provided.
- Compiling the research findings and methodology into a well-structured report, ensuring clarity and proper documentation of the approach.
- Preparing a presentation to communicate the findings and methodology to stakeholders, colleagues, or the academic community.
- Properly documenting the data sources, models, and references in accordance with academic standards.

The methodology outlines a systematic approach to investigate the benefit in sharing information and simulations for capacity management, allowing for a comprehensive and rigorous analysis of the research topic.

1.7 Research Relevance

The relevance of this research extends beyond academic inquiry, directly impacting the operational landscape of Amsterdam Airport Schiphol. By addressing the identified issues, the study aims to offer practical insights that can be utilized by APOC, LVNL, KLM, and other stakeholders involved in airport operations. The research outcomes have the potential to inform strategic decisions, enhance collaboration, and contribute to the overall improvement of operational planning, traffic prediction accuracy, and the reduction of delays at Schiphol Airport.

1.8 Reading Guide

In navigating the intricacies of this thesis, the following reading guide is designed to provide a roadmap for readers to explore the key chapters and their contents. Each chapter unfolds a distinct aspect of the research, contributing to a comprehensive understanding of the subject matter.
This report begins in Chapter 1 with an introduction that explains the background information, problem statement and research question, objectives of the study, significance of the study, scope and limitations, research methodology, and research relevance. Chapter 2 unfolds a comprehensive exploration of the theoretical framework. Chapter 3 analysis the comprehensive stakeholder within Schiphol APOC and explores the Airport Collaborative Decision Making (A-CDM) framework at Schiphol APOC. Chapter 4 describes the current operational preparation at Schiphol APOC. Chapter 5 delves into the daily operational processes of KLM, LVNL and Schiphol APOC. Chapter 6 overviews the result of the interviews with the stakeholders and the bottlenecks they face and give potential solutions and shows the common bottlenecks which stakeholders intersect. After that, measure and evaluate various processes through the establishment of Key Performance Indicators (KPIs). Chapter 7 identify the data source of APOC Schiphol and provide an example of comparison in the EIBT and AIBT information between LVNL, KLM and APOC Schiphol for present the extent of information matching between stakeholders. Chapter 8 proposed a collaborative strategy between Schiphol APOC, KLM and LVNL. Chapter 9 present a discussion in a logical and organized manner, focusing on the most salient points. Chapter 10 present the conclusion, including interprets the findings, relates them to the research questions an objective, and discusses their implications. Chapter 11, provide the recommendation focuses on providing suggestions for action or further steps based on the findings of the study.

2.Theoretical Framework

This chapter unfolds a comprehensive exploration of the theoretical framework governing airport operations. Delving into critical concepts such as the Airport Operational Plan (AOP), Airport Operations Center (APOC), Total Airport Management (TAM), Airport Collaborative Decision Making (A-CDM), Central Information Schiphol System (CISS), Terminal Aerodrome Forecast (TAF), Eurocontrol, Performance-Based Management and the Network Operations Plan (NOP), this chapter illuminates the fundamental principles shaping the intricate of aviation management. Through these theoretical underpinnings, we aim to unravel the complexities that drive the efficiency, safety, and collaboration within airport ecosystems.

2.1 Airport Operation Center (APOC)

The Airport Operations Center (APOC) is a central hub within the aviation infrastructure, dedicated to overseeing and managing the day-to-day operational activities of an airport. This specialized center plays a pivotal role in ensuring the smooth functioning of various processes, both on the ground and in the air. (Eurocontrol, 2018)
The primary goal of the APOC is to maintain a high level of operational efficiency and safety throughout the airport. Unlike the Airport Operational Concept (AOP), which focuses on the collaborative and long-term planning aspects, the APOC is more immediate in its scope. It concentrates on the day-of-operation, actively coordinating and responding to real-time events and challenges.

In the dynamic environment of aviation, the APOC serves as the nerve center for communication and decision-making. It collaborates closely with various stakeholders, including airlines, ground handlers, air traffic control, and security, to address operational issues promptly and effectively. The APOC utilizes the latest technologies and real-time data to monitor and manage activities such as aircraft movements, gate assignments, and resource allocation.

The APOC's responsibilities extend beyond the day-of-operation, encompassing the medium and short-term planning phases. It works in tandem with stakeholders to contribute to the development of conflict-free, well-balanced, and executable plans that align with the overall objectives of the airport.

By maintaining a focus on immediate operational concerns, the APOC plays a critical role in minimizing disruptions, optimizing resources, and enhancing the overall passenger experience. It is a key component in the intricate web of airport operations, ensuring that the complex ballet of activities unfolds seamlessly and safely each day.

2.2 Airport Operational Plan (AOP)

The Airport Operational Concept (AOP) is a comprehensive and collaborative plan designed to ensure the efficient and effective functioning of an airport. The primary goal of the AOP is to provide a unified and continually updated blueprint for airport operations. This plan is a result of collective agreements among various stakeholders, including airlines, ground handlers, air traffic control, security, border control, and the airport itself.

At its core, the AOP serves as a rolling plan, incorporating data and contextual information about the airport's status on a given day (D-0). It strives to be conflict-free, well-balanced, and executable through continuous monitoring by the Demand and Capacity Balancing (DCB) process. The DCB process relies on information provided or updated by the different stakeholders at the airport.

The AOP undergoes constant scrutiny and the progress in plan execution is measured, and corrective measures are implemented to mitigate the impact of any deviations from the plan. This dynamic approach ensures adaptability and resilience in the face of changing circumstances.

A crucial aspect of the AOP is its role in providing the most accurate representation of the day-of-operation (D0) scenario, offering a common situational awareness to all stakeholders involved. The Airport Collaborative Decision Making (A-CDM) process plays a significant role in feeding information into the AOP. A-CDM focuses on airside operations, including turn-around processes, and its information is vital for the Network Operations Plan (NOP). (SESAR, n.d.)

Ultimately, the AOP contributes to the overall efficiency and safety of airport operations. It facilitates collaboration and informed decision-making among stakeholders, leading to a well-coordinated and streamlined airport experience. Whether addressing the immediate concerns of the operational day or participating in mid and short-term planning phases, the AOP, in collaboration with stakeholders, aims to create a conflict-free, well-balanced, and executable operational plan.

2.3 Airport Collaborative Decision Making (A-CDM)

Airport Collaborative Decision Making (A-CDM) is a system aimed at improving airport operations' efficiency and resilience. It achieves this by promoting transparency and collaboration among key stakeholders, including airport operators, aircraft operators, ground handlers, and air traffic control. These stakeholders exchange timely and accurate information, with a focus on streamlining aircraft turnaround and pre-departure processes. Additionally, A-CDM facilitates the exchange of precise departure information with the European Air Traffic Flow and Capacity Management network, enhancing en-route and sectoral planning for improved aviation efficiency. (Eurcontrol, n.d.)

2.3.1 A-CDM Parameters

The Airside Airport Collaborative Decision-Making (A-CDM) process involves various parameters that contribute to the efficient and coordinated management of airside operations. Some of the key parameters could include:

Departure Sequencing:
Coordinated decision-making on the departure sequence of flights to optimize runway usage and minimize taxiing times.

Surface Movement Planning:
Planning and coordination of surface movements, including taxi routes and gate access, to prevent congestion and ensure smooth aircraft flow on the ground.

Stand Allocation:
Efficient allocation of parking stands to arriving aircraft, ensuring a systematic approach to gate assignments, and reducing turnaround times.

Turnaround Coordination:
Collaboration in planning and executing aircraft turnarounds, involving ground services, baggage handling, and other processes to enhance turnaround efficiency.

Runway Operations:
Coordinated decision-making on runway usage and scheduling to optimize the sequencing of arrivals and departures, considering factors such as weather conditions and air traffic demand.

Collaborative Decision-Making (CDM) Systems:
Utilization of CDM systems for real-time information exchange among stakeholders, supporting collaborative decision-making processes and improving overall situational awareness.

Information Sharing:
Timely sharing of critical information, including aircraft movements, expected arrival and departure times, and operational constraints, to facilitate informed decision-making.

Predictability and Planning:
Emphasis on enhancing the predictability of airport operations through accurate and up-to-date information, allowing stakeholders to plan and adapt their activities effectively.

Slot Allocation:
Collaborative efforts in slot allocation to manage the demand for departure and arrival slots, contributing to organized and efficient use of airport capacity.

Weather Considerations:
Integration of weather information into decision-making processes to anticipate and plan for weather-related disruptions, ensuring operational resilience.

Emergency Response Coordination:
Provisions for emergency response coordination to enable swift and effective responses to unforeseen events or disruptions on the airside.

Air Traffic Flow Management (ATFM) Integration:
Integration with ATFM systems to align airside operations with broader air traffic management initiatives, promoting overall network efficiency.

These parameters collectively contribute to the success of A-CDM at any Airport, fostering a collaborative and coordinated approach to airside activities. Active participation and information exchange among airlines, airport operators, air traffic control, ground handlers, and other relevant entities play a crucial role in optimizing operational efficiency and minimizing delays.

2.3.2 Facilitating Effective Information Exchange

At the core is the principle that sharing relevant data and timely information, pivotal for enhancing aircraft flight safety and efficiency, should be a collaborative effort among stakeholders. However, it's not mandatory for stakeholders to disclose all their data universally; instead, there should be a collective agreement to selectively share data and information based on specific needs and benefits.

Informed decision-making relies on stakeholders having access to precise and timely information, along with a shared understanding of current and anticipated constraints. The essence of A-CDM lies not only in internal information exchange within organizations but also in fostering collaboration among all stakeholders. Effectively implementing this concept poses a considerable challenge, as stakeholders may express reluctance to share information or data due to concerns regarding organizational security or economic considerations.

Overcoming this initial challenge becomes a primary objective for any group aiming to integrate A-CDM into their operations. Stakeholders must work together to identify available data, recognize the benefits achievable through shared awareness, and understand the sensitivities associated with the data. Subsequently, they should establish procedures to ensure appropriate processing, anonymization, and safeguarding of the data to protect the interests of individual stakeholders.

2.4 Total Airport Management (TAM)

The Total Airport Management (TAM) project, part of SESAR 2020 research, focuses on addressing airport complexity at various levels. It aims to develop cost-effective solutions that provide benefits not only to local airports but also to the broader European air network. This project also considers societal concerns by including environmental mitigation measures and assessing their impact on airport performance. (Eurocotrol, n.d.)
To integrate airports effectively into the broader air traffic management (ATM) network, the TAM project emphasizes the importance of timely information sharing. This involves exchanging information between the Network Operations Plan and individual airport Operation Plans to enhance coordination and efficiency within the aviation system.

Maximizing the effectiveness of collaborative performance management using the TAM approach is particularly advantageous at Schiphol, a bustling hub airport. Enhanced communication between the airport and the Network Manager can yield advantages not only at the local level but also within the broader aviation network.

By relying on more dependable information and conducting more thorough assessments of decision impacts, airport decision-making will improve. Consequently, airport operations should become more predictable, flexible, and efficient, and they'll also recover more quickly to normal operations, enhancing overall resilience.

2.5 Eurocontrol

The European Organization for the Safety of Air Navigation plays a central and pivotal role in managing and coordinating air traffic across Europe. Operating the Network Manager (NM), Eurocontrol oversees the European air traffic network and actively participates in the development and implementation of the Network Operations Plan (NOP). (Eurocontrol, n.d.)

The organization facilitates collaboration among stakeholders, including air navigation service providers, airlines, airport operators, and civil aviation authorities, to develop a comprehensive NOP. Facilitating the exchange of crucial information among aviation stakeholders, Eurocontrol ensures effective data sharing for optimal decision-making. This information exchange covers areas such as weather forecasts, airport capacities, and air traffic flow, proving integral to the development and execution of the NOP.

Eurocontrol provides crucial information to the air traffic control as part of the collaborative efforts to manage and coordinate air traffic. Some key types of information that Eurocontrol provide:

- Air Traffic Flow Management (ATFM) Information.
- Collaborative Decision-Making Information.
- Weather Information.
- Airport Capacity Information.
- Air Traffic Data and Performance Monitoring.
- Strategic Planning Information.

In summary, Eurocontrol serves as a key organization in the management and coordination of air traffic in Europe. By facilitating collaboration, data sharing, and strategic planning, Eurocontrol contributes to the safety, efficiency, and sustainability of air travel across the European continent.

2.6 Terminal Aerodrome Forecast (TAF)

The Terminal Aerodrome Forecast (TAF) is a crucial meteorological tool. TAF provides weather forecasts specifically tailored for the needs of aviation, focusing on conditions around airports and aerodromes. TAFs are essential for flight planning and aviation operations, offering detailed weather forecasts that cover a 24 to 30-hour period. They provide critical information about expected weather conditions at the terminal area, including factors like wind speed and direction, visibility, cloud cover, and significant weather phenomena. (Aviationweather, n.d.)

TAFs present concise and standardized information in a coded format. Pilots and aviation professionals are trained to interpret this format to gather precise details about the weather.
Elements covered include forecast periods, expected wind conditions, visibility, significant weather phenomena (such as thunderstorms or precipitation), and any temporary variations.

The forecasts are specific to individual airports or aerodromes, tailoring the information to the unique conditions and challenges of each location. The forecasts contribute to enhanced safety by allowing pilots and operators to anticipate and prepare for changing weather conditions.

TAFs are integrated into the broader aviation planning process, facilitating decision-making for flight departures, arrivals, and en-route operations. They are one of the key meteorological tools that contribute to the overall safety and efficiency of air travel.

2.7 Performance-Based Management

Performance-based management refers to an approach that emphasizes measurable outcomes and results in various aspects.
KPIs such as on-time performance, turnaround time, and baggage handling efficiency are crucial for measuring the efficiency of airline and airport operations. These indicators help in optimizing resource allocation, scheduling, and process management.
By using this approach, KPIs provide a quantifiable measure of performance against desired outcomes. They enable the stakeholders to assess whether they are on track to achieve their strategic and operational goals. Stakeholders can use KPI data to make informed choices that align with their strategic objectives.
KPIs help in identifying areas of success and areas needing improvement. By focusing on these areas, organizations can enhance their operational efficiency and effectiveness.

Furthermore, KPIs can be used to monitor risk factors and trigger alerts when metrics fall outside of acceptable ranges, allowing for timely intervention to mitigate risks. In Chapter 7 of this research four key performance indicators will identify that provide a clear basis for measuring success.

3. Schiphol APOC

This chapter delves into the comprehensive stakeholder analysis within Schiphol APOC, outlining the critical roles and responsibilities of entities such as the Air Navigation Service Provider (ANSP), airlines, ground handlers, meteorological services, security teams, and the Air Traffic Management (ATM) Network. Additionally, it explores the Airport Collaborative Decision Making (A-CDM) framework, elucidating its benefits and pivotal role in promoting collaborative decision-making for improved airport operations.

3.1 Stakeholders Analysis of Schiphol APOC

This analysis provides insights into the pivotal roles and collaborations among stakeholders that collectively enhance the efficiency, safety, and coordination within Schiphol APOC.

Air Traffic Control (LVNL - Luchtverkeersleiding Nederland)
LVNL is integral to Schiphol APOC, LVNL ensures the safety and efficiency of air traffic by managing the movement of aircraft on the ground and in the airspace around the airport. This includes coordinating arrivals, departures, and movements on the ground to ensure safe and efficient operations, coordinating with the APOC for real-time information, and monitoring weather conditions. In emergencies, LVNL collaborates on crisis management. Serving as a communication hub, LVNL facilitates seamless information exchange, maintains critical infrastructure, and optimizes air traffic flow. Its constant coordination with the APOC enhances overall operational efficiency and safety at Amsterdam Airport Schiphol. LVNL supply Schiphol APOC with information on available airspace and runway capacities. This data assists the APOC in planning and optimizing the use of resources to accommodate the demand for air traffic. (LVNL, n.d.)

Airlines
KLM Royal Dutch Airlines, being one of the major carriers operating at Amsterdam Airport Schiphol, has several roles and responsibilities within Schiphol APOC. (KLM, n.d.)

Here are key roles that KLM play within the APOC Schiphol:
- KLM is responsible for the coordination of its flight operations at Schiphol. This includes managing the departure and arrival schedules, ensuring efficient turnaround times, and coordinating with ground services for various operational needs.
- KLM provides and receives real-time information through the APOC. This includes updates on flight status, weather conditions, air traffic flow.
- KLM manages its crew operations within the APOC. This involves coordinating crew schedules, ensuring compliance with regulations, and communicating relevant information to flight and ground crews.
- KLM is involved in coordinating the turnaround of its aircraft at Schiphol. This includes managing boarding and deplaning processes, fueling, catering, and other activities to minimize ground time and optimize operational efficiency.
- In the event of disruptions such as delays, diversions, or cancellations, KLM works within the APOC to manage and mitigate the impact on its operations. This involves making decisions on rerouting, rebooking, and communicating with affected passengers.

KLM, in collaboration with the APOC, ensures the implementation of safety and security measures for its flights. This includes adherence to safety protocols, security checks, and coordination with relevant authorities.

Apron control:
Apron Control manages aircraft movements on the apron, assigning gates, and coordinating ground handling services for efficient turnaround. It ensures safety by monitoring vehicle and personnel movements, communicates with pilots and ground crew, and integrates with other APOC sections for seamless coordination. Apron Control plays a key role in emergency response and considers environmental factors in apron management. Its responsibilities include gate assignments, resource optimization, and contributing to overall operational efficiency.

Ground Handlers
Ground handlers at Schiphol APOC manage aircraft turnarounds, handling tasks like baggage and cargo loading, cleaning, and servicing. They coordinate with the APOC to align activities with overall airport operations, ensuring efficient and safe ground handling. Responsibilities include passenger services, de-icing operations in adverse weather, and compliance with safety and security standards. Ground handlers communicate with airlines and authorities, providing information on aircraft status and turnaround processes. Their integral role contributes to the smooth and timely functioning of ground operations at Amsterdam Airport Schiphol.

Meteorological Services
KNMI, the Royal Netherlands Meteorological Institute, plays a vital role within Schiphol APOC by providing accurate weather forecasts, real-time monitoring, and advisory services. Their meteorological information supports decision-making for optimal runway usage, air traffic flow management, and responses to adverse weather conditions. KNMI collaborates with stakeholders, issuing special weather reports when necessary, and assesses the environmental impact of weather phenomena. Integration with APOC systems ensures seamless access to meteorological data, contributing to the safety and efficiency of Amsterdam Airport Schiphol operations. In summary, KNMI's services are integral to informed decision-making and proactive measures in response to dynamic weather conditions at Schiphol airport. (KNMI, n.d.)

Security Services
Security services at Schiphol APOC are responsible for assessing and addressing potential threats, coordinating with law enforcement, and ensuring access control and perimeter security. They employ advanced surveillance technologies, respond to security incidents, and manage passenger and baggage screening processes. The team conducts security drills to test emergency response procedures, shares information collaboratively, and addresses cybersecurity concerns. Compliance with national and international aviation security regulations is a priority, emphasizing a comprehensive and integrated security approach. The overall goal is to safeguard airport operations, infrastructure, and the safety of passengers and personnel.

Air Traffic Management (ATM) Network:
The ATM Network at Schiphol APOC manages and optimizes air traffic flow, coordinating with stakeholders and integrating with air traffic control services. It provides real-time monitoring and decision support, ensuring timely and informed responses to operational challenges. The ATM Network plays a vital role in capacity planning, arrival/departure sequencing, and addressing disruptions. Collaboration with airlines, ground handlers, and air traffic control enhances overall operational efficiency. Information sharing, communication, and contingency planning are key functions, contributing to the safe and coordinated movement of air traffic at Amsterdam Airport Schiphol. (Schiphol, n.d.)

3.2 Airport collaborative decision-making (A-CDM) at Schiphol APOC

Collaborative Decision Making (CDM) at Schiphol APOC is a framework designed to enhance the exchange of operational information, fostering more informed decision-making. The A-CDM data encompasses various information elements, encompassing details about flights and A-CDM milestones. The initiation of data for each flight typically occurs several hours before the scheduled arrival or departure, with subsequent lines generated after each modification. Each specific flight is associated with approximately 26 separate lines of data. (Schiphol, n.d.)

Facilitating a streamlined operational environment entails the seamless exchange of critical data among stakeholders involved in airside processes, spanning approach, turnaround, and take-off phases. This practice is essential for fostering a collective understanding of the operational landscape and promoting collaborative decision-making among diverse participants.

Through the real-time sharing of pertinent data, stakeholders can collectively adopt a synchronized perspective based on consistent and optimal information. This collaborative approach positively influences reliability, timeliness, fuel efficiency, environmental sustainability, and resource utilization within the operational framework.

Airport collaborative decision-making main benefits

Airport Collaborative Decision Making (A-CDM) yields significant benefits through collaborative decision-making among key stakeholders, including Airport Operators, Aircraft Operators, Ground Handlers, De-icing companies, Air Traffic Control (ATC), and the Network Manager. The main advantages include cost reductions, environmental benefits, capacity optimization, and improved efficiency.

Cost Reductions

A-CDM significantly cuts costs through streamlined operations. It reduces idle times for aircraft, minimizing fuel consumption and saving airlines money. A-CDM's process improvements eliminate waiting periods, optimizing aircraft utilization, and lowering operational expenses. The system fosters stable flight schedules by improving communication, reducing the need for costly last-minute adjustments. Efficiency gains, achieved through collaboration and data sharing, lead to cost reductions in handling irregular operations. A-CDM's role in resource optimization ensures cost-effective use of airport resources, from gates to ground services. Overall, A-CDM's impact on operational efficiency directly contributes to airlines' financial sustainability in the aviation industry.

Environmental Advantages

A-CDM delivers environmental benefits by optimizing operations and reducing fuel consumption. Streamlined ground processes lead to decreased idle times, lowering emissions and enhancing fuel efficiency. A-CDM minimizes waiting periods by providing real-time data, preventing unnecessary fuel burn. Improved air traffic management and route optimization further reduce fuel consumption during flights. The system's enhanced predictability decreases the need for last-minute adjustments, minimizing additional fuel burn and emissions. A-CDM's efficiency gains contribute to environmentally friendly operations by reducing resource waste. Overall, A-CDM aligns with aviation industry efforts to enhance environmental sustainability.

Capacity Optimization

A-CDM enhances cost-effective capacity optimization by improving coordination and resource allocation. Real-time information sharing enables efficient gate assignments, reducing the need for last-minute adjustments and enhancing overall resource utilization. A-CDM minimizes operational disruptions by identifying weaknesses and collaboratively developing solutions, reducing associated costs. It supports strategic planning for capacity expansion, allowing stakeholders to explore cost-effective infrastructure enhancements. Streamlining ground operations through improved coordination reduces turnaround times, optimizing capacity and increasing aircraft movements. A-CDM's impact on minimizing delays and waiting times contributes to lower operational costs associated with fuel consumption, crew scheduling adjustments, and passenger inconvenience. Overall, A-CDM fosters collaboration, enhances communication, and improves efficiency, creating a more sustainable and cost-effective aviation environment.

Improving Efficiency

A-CDM enhances operational efficiency through improved communication and collaboration. Real-time information sharing improves predictability, enabling stakeholders to plan efficiently and anticipate disruptions. A-CDM empowers proactive planning and scenario development, allowing the creation of solutions before crises occur, leading to optimized resources and improved efficiency. Enhanced understanding of operational constraints and cohesive team approaches enable stakeholders to address challenges collectively, fostering more efficient operations. Integration with network management provides accurate departure times, minimizing slot losses in congested airspace and optimizing traffic flow for improved efficiency. Overall, A-CDM's impact on predictability, proactive planning, collaborative problem-solving, and integrated network management contributes to streamlined operations and enhanced operational efficiency.

4. The Current Operational Preparation at Schiphol APOC

In this chapter, the operational dynamics of Schiphol Airport are explored, with a comprehensive examination of the Airport Operation Centre (APOC). Paragraph (4.1) emphasis is placed on the creation of the Airport Operations Plan (AOP), covering planning phases and the integration of data sources. In paragraph (4.2) the team structure and responsibilities of the APOC are detailed.

4.1 AOP within Schiphol APOC

The primary output of Schiphol APOC is the Airport Operations Plan (AOP). This section presents an overview of the AOP concept, its current state, and its future evolution, along with insights into the essential data sources used in its creation. (Schiphol, n.d.)

The AOP serves as a dynamic and consistently accurate source of information, which all Schiphol airport stakeholders, including the APOC, rely on. It functions as a conflict-free and executable database with multiple validation procedures to ensure data accuracy and consistency from various sources.
The Airport Operational Plan (AOP) is crafted using Microsoft Power BI, creating an interactive dashboard format. This setup allows users to filter parameters or navigate through text messages. For distribution to external partners beyond Schiphol, the plan is converted into a static PDF format, typically extending to about 33 pages. The length of the AOP can vary, sometimes including sections void of data, dependent on the input from various sources. The plan is organized into several chapters, encompassing numerical data, textual information, graphical representations, and maps.

Integral Overview	Chapters
Aircraft	In- & Outbound APC (Apron Planning & Control) NOP Maintenance Memo’s
Passengers	Action Plan Departure Hall Departure Filters Transfer Filters Arrival Filters Capacity Forecast Maintenance Long-term Maintenance Assets in Failure Memo’s
Landside	Action Plan Capacity & Demand Maintenance Long-term Maintenance Memo’s
Baggage	Action Plan Forecast Baggage T-1 T2/E D

	T3 Maintenance Long-term Maintenance Memo's
Weather Forecast	

Table 1: The content of the AOP within Schiphol APOC

The assembly of the AOP is overseen by the APOC team, which includes four key positions dedicated to the daily creation of this plan. At the forefront is the day coordinator, who oversees daily operations and oversees presenting the airport plan to the D2D department. Supporting the day coordinator are three cluster leads, each specializing in different areas. Their role involves integrating predictive data based on their expertise and addressing any anticipated capacity challenges for the upcoming day. Alongside this group is a development team, assigned to enhance the AOP with new features and manage the configuration of the APOC at Amsterdam Airport Schiphol. Figure (1) present a page of the AOP showing the number of the in & outbound aircrafts as an example.

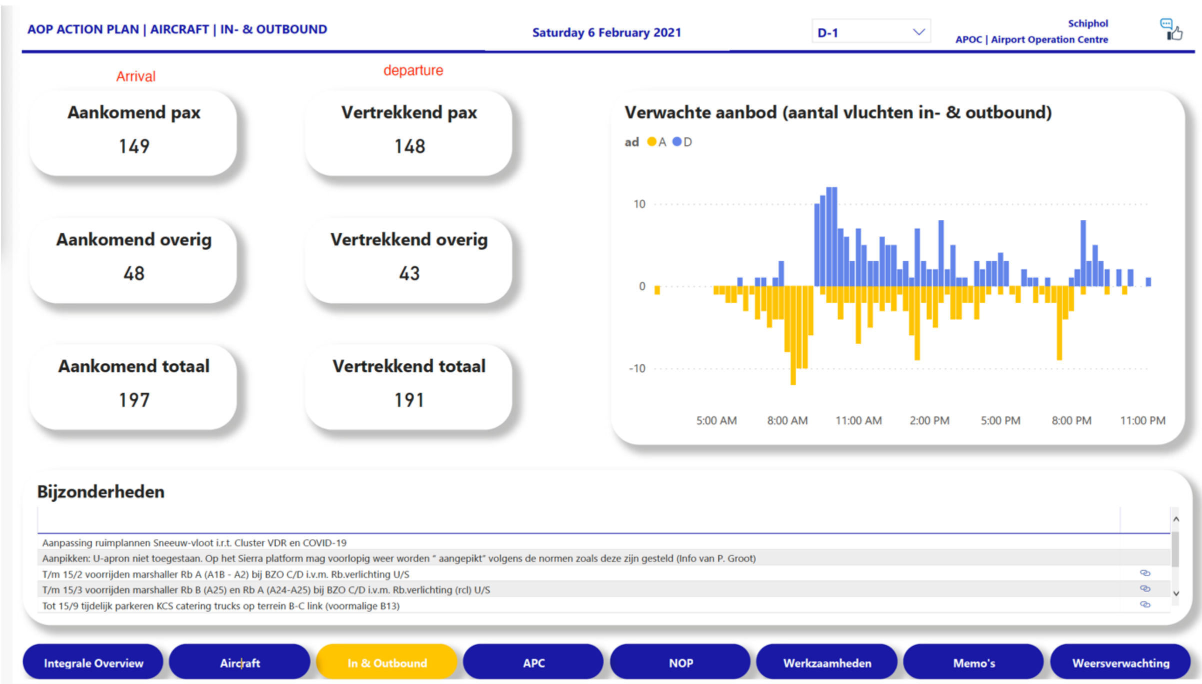


Figure 1: Page from the APOC Schiphol's AOP

The AOP operates as a "rolling plan" that is continuously updated and enriched with new data. Its effective timeframe spans from (D-7) to post-operation analysis (D+1 onwards). It assimilates all turnaround information on the airside and passenger flow information on the landside to provide a comprehensive view of airport operations.

The primary goals of the AOP at Schiphol APOC

The primary goals of the AOP are as follows:

- Increase Situational Awareness: The AOP enhances situational awareness from seven days before operation (D-7) up to the day of operation (D-0).
- Enable Data Analytics: The data within the AOP, known as "actuals," is used for data analytics, which supports decision-making.

The AOP serves as a valuable resource for a wide range of local stakeholders due to its comprehensive nature and its role in ensuring the efficient, safe, and coordinated functioning of an airport, including airport operators, LVNL, airlines, ground handlers, emergency services, and MET (Meteorological) providers.

4.2 Schiphol APOC Operational Planning Process

Schiphol APOC plays a vital role in facilitating communication for airspace and airport users in cases of capacity issues or disruptions. It coordinates the resolution of issues outlined in the Airport Operations Plan (AOP), ensuring awareness of the impact of disruptions, and participating in the decision-making process and what-if assessments. It takes proactive measures to reduce the impact of AOP alerts and warnings and plays a role in post-operations analysis, generating post-operation reports. Additionally, it hosts the APOC supervisor, responsible for communication among airport stakeholders, including the network manager. The picture below (Figure 2) was taken at Schiphol APOC office.

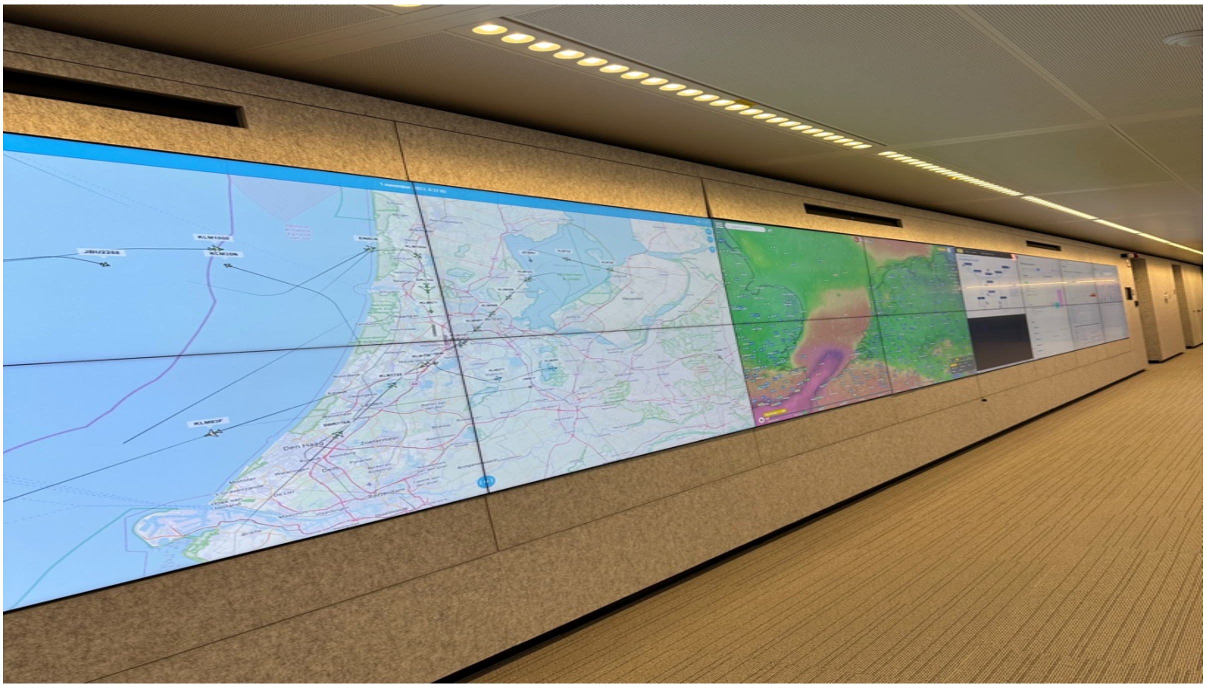


Figure 2: Schiphol APOC Office

The APOC forms the foundation for strategic planning within Total Airport Management (TAM), encompassing ground access, landside, and airside sectors. Each of these sectors involves various stakeholders who work at an operational level of detail. The APOC's role is to host as many relevant stakeholder representatives as possible to facilitate agile changes in planning considerations.

Other responsibility:

- Facilitate communication during capacity issues or disruptions.
- Coordinate issue resolutions in the AOP.
- Stay informed about disruption impacts.
- Coordinate and facilitate decision-making as necessary.
- Make decisions to mitigate AOP alerts/warnings.
- Play a role in post-operation analysis and report generation.
- The APOC evaluates its performance the day after operation (D+1).
- Multiple scenarios are prepared for the scheduled day of operation, considering numerous factors that may impact airport capacity.

4.3 Schiphol APOC Systems

In this paragraph, the most important systems used by Schiphol APOC during its operational operation will be presented. Which are, IRIS system, Wilbur system and Power BI system.

4.3.1 The IRIS system

The IRIS system, crafted by Schiphol and provides information from D-7 to D-1 and offers valuable data related to network, terminal, and baggage handling, flight Information, aircraft movement, passenger Information, air Traffic Control integration, runway and taxiway usage, and environmental monitoring. These data could be in form of maps, charts, and diagrams depicting the layout of the airport, runway and taxiway configurations and gate assignments.

This system serves as a tool for understanding pre-tactical capacity and predicting the supply for the operational day. This proprietary system presents a visual representation that effectively clarifies issues related to supply and demand, as well as capacity challenges. Users can delve into different facets of the processes through interactive features, enhancing the overall analytical experience. Figure (3) shows a look at the content of the IRIS system.

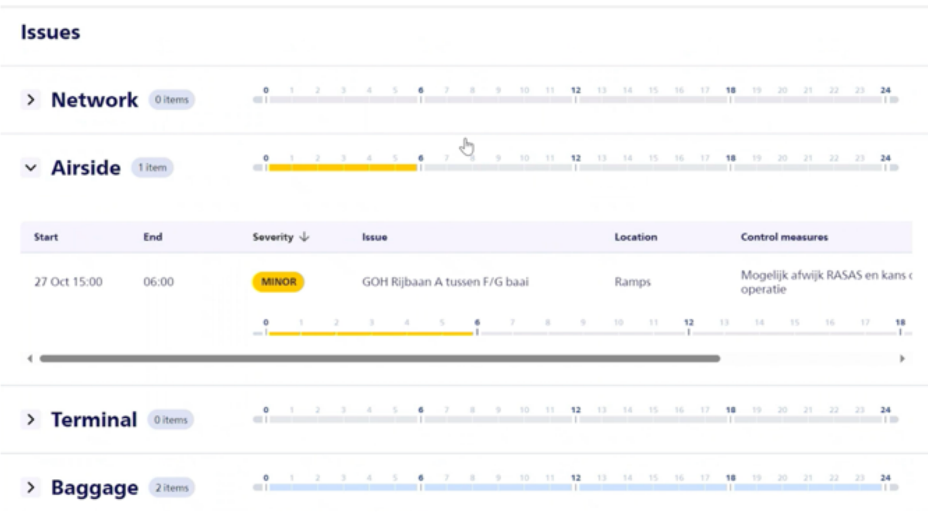


Figure 3: Slide from the IRIS system

4.3.2 The WILBUR system

The WILBUR system, designed by Schiphol, functions as a live dashboard utilized within the APOC on the operational day D-0. This system captures and presents data including air traffic control, airlines, ground services, and other relevant data streams, enabling the airport to anticipate various airport processes up to 4 hours in advance. Through its data-driven methodology, it establishes a singular data truth and promotes shared situational awareness

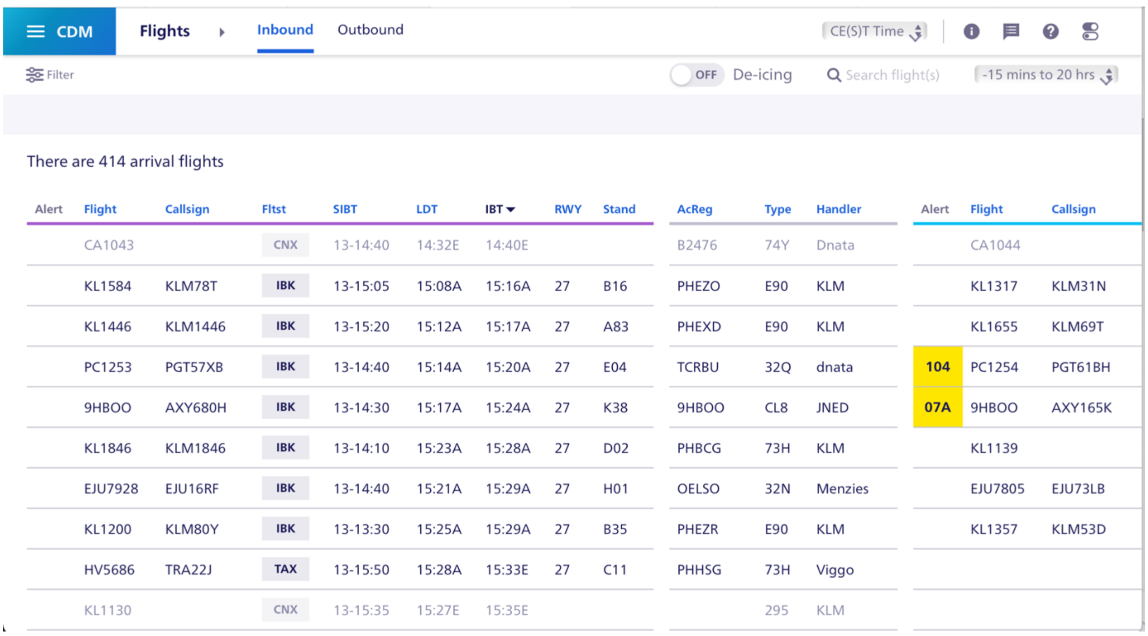
Wilbur plays a pivotal role in fostering collaborative decision-making among diverse stakeholders. By acting as a communication hub, it seamlessly connects individuals within the APOC, enabling effective information sharing during both routine daily operations and unforeseen events.

In its multifaceted functionality, Wilbur extends its support to the meticulous management of vital airport resources, including gates, runways, and ground services. This strategic resource allocation aims to optimize operational efficiency, minimize disruptions, and streamline processes, thus contributing to the overall enhancement of airport operations.

Beyond mere resource management, Wilbur is designed to analyze vast datasets in real-time, generating insightful reports for airport authorities and operators. These reports serve as valuable tools for making informed decisions, identifying areas for improvement, and establishing a foundation for a culture of continuous enhancement.

As a guardian of safety and security, Wilbur stands vigilant, contributing to the identification and response to safety-related events within airport operations. Its adaptability to changes, whether in air traffic volume, weather conditions, or unexpected disruptions, ensures a dynamic and resilient response to the evolving operational landscape.

The overarching goal of Wilbur is to enhance the airport's overall operational efficiency. This goal manifests through the reduction of delays, optimization of resource utilization, and the establishment of a proactive system that thrives on adaptability, collaboration, and continuous improvement. Wilbur embodies a cutting-edge approach to airport management, providing not just a system but a strategic ally in the pursuit of operational excellence at Schiphol Airport. Figures (4 &5) are show slides from WILBUR system.



Alert	Flight	Callsign	Fltst	SIBT	LDT	IBT	RWY	Stand	AcReg	Type	Handler	Alert	Flight	Callsign
	CA1043		CNX	13-14:40	14:32E	14:40E			B2476	74Y	Dnata		CA1044	
	KL1584	KLM78T	IBK	13-15:05	15:08A	15:16A	27	B16	PHEZO	E90	KLM		KL1317	KLM31N
	KL1446	KLM1446	IBK	13-15:20	15:12A	15:17A	27	A83	PHEXD	E90	KLM		KL1655	KLM69T
	PC1253	PGT57XB	IBK	13-14:40	15:14A	15:20A	27	E04	TCRBU	32Q	dnata	104	PC1254	PGT61BH
	9HBOO	AXY680H	IBK	13-14:30	15:17A	15:24A	27	K38	9HBOO	CL8	JNED	07A	9HBOO	AXY165K
	KL1846	KLM1846	IBK	13-14:10	15:23A	15:28A	27	D02	PHBCG	73H	KLM		KL1139	
	EJU7928	EJU16RF	IBK	13-14:40	15:21A	15:29A	27	H01	OELSO	32N	Menzies		EJU7805	EJU73LB
	KL1200	KLM80Y	IBK	13-13:30	15:25A	15:29A	27	B35	PHEZR	E90	KLM		KL1357	KLM53D
	HV5686	TRA22J	TAX	13-15:50	15:28A	15:33E	27	C11	PHHSG	73H	Viggo			
	KL1130		CNX	13-15:35	15:27E	15:35E				295	KLM			

Figure 4: The last update runway capacity in WILBUR system

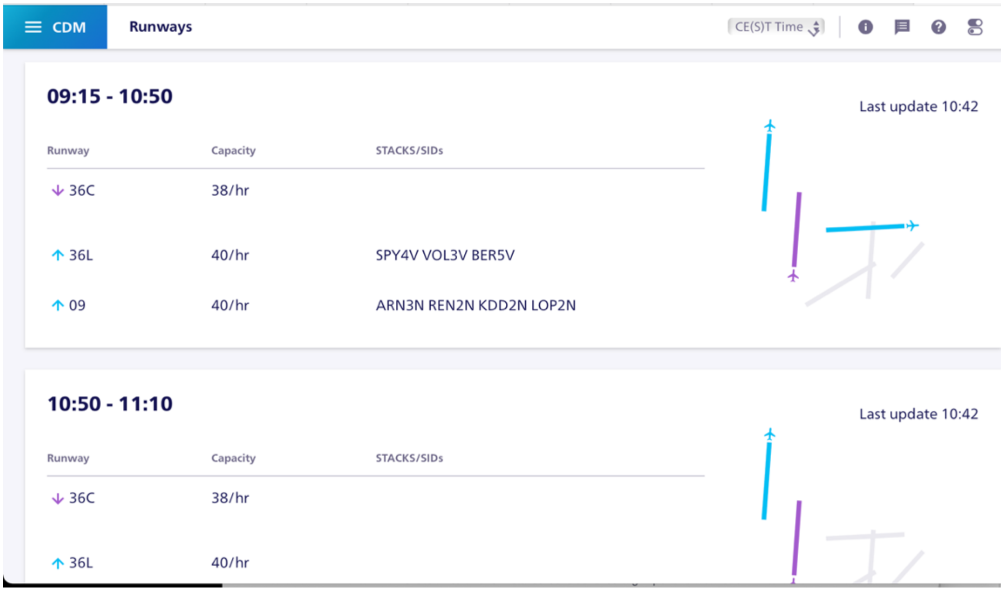


Figure 5: The situation of the inbound flights in WILBUR system

4.3.3 Power BI

Power BI, a business intelligence tool crafted by Microsoft, empowers the APOC Performance Manager and analysts to visually interpret and scrutinize data. This versatile application facilitates the extraction of data from diverse origins, transforming, modeling, and conducting analyses before presenting it through interactive dashboards, reports, and visualizations.

Within the tool, an array of visualization choices, including graphs, tables, maps, and KPIs, offer an engaging and insightful presentation of data. Furthermore, the software incorporates advanced analytical functionalities to delve into data intricacies.

A pivotal attribute of Power BI lies in its capability to dynamically update data in real-time, allowing seamless sharing with collaborators. The application seamlessly establishes data connections to various repositories, such as databases and datasets. The APOC Performance Manager and analysts leverage the Power BI application, establishing a linkage with the CISS. Figure (6) shows an example of some available datasets in Power BI.

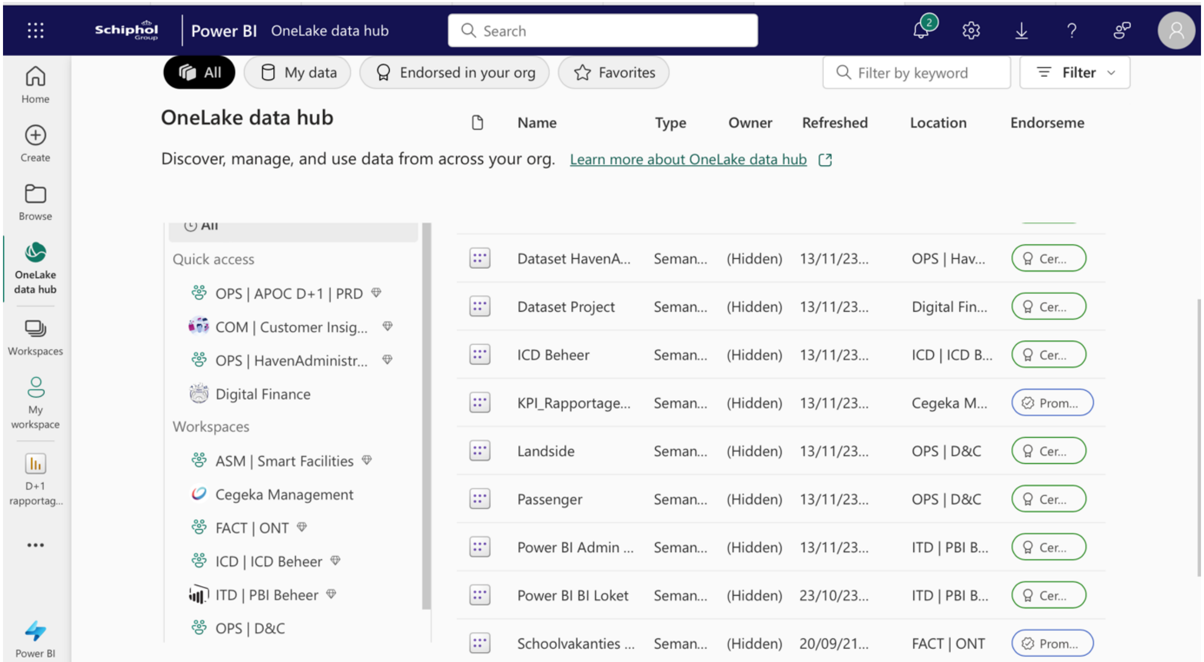


Figure 6: Slide from Power BI system

5.Daily Operational Process

This chapter delves into the daily operational processes of the key stakeholders. The chapter begins with a detailed exploration of the team structure at APOC Schiphol and description of the process that takes place in one day (5.1). Transitioning to LVNL in paragraph (5.2), the OPS plan preparation process is examined, showcasing collaborative efforts between LVNL departments and the utilization of data sources. In paragraph (5.3) KLM's continuous evaluation approach for individual flights, supported by decision-support tools, is also explored.

5.1 Schiphol APOC Daily Process

The preparation of AOP at APOC Schiphol involves a dedicated team with specific roles assigned to ensure a comprehensive and well-coordinated plan. (Schiphol, n.d.)

The key responsibilities are distributed among the following roles:

Day Coordinator

The daily activity of the Day Coordinator within Schiphol Airport Operations Center (APOC) involves a series of tasks and responsibilities that are crucial for the smooth functioning of the airport. These activities are dynamic and can vary based on the day's specific requirements, but generally include the following:

The Day Coordinator starts by reviewing the flight schedule and any planned airport activities for the day. This involves assessing resource availability, checking for any potential issues or conflicts in the schedule, and understanding the overall operational outlook for the day.

The coordinator prepares the daily airport plan, which outlines the operational strategy, including flight schedules, resource allocation, and any special considerations or events. This plan is then submitted to the Day-to-Day (D2D) department for approval and dissemination.

The coordinator often participates in or leads coordination meetings with various departments and stakeholders. These meetings are crucial for ensuring that everyone is aligned with the day's plan and understands their roles and responsibilities.

Throughout the day, the Day Coordinator actively monitors the progress of operations against the planned schedule. This involves staying updated on flight arrivals and departures, passenger flow, baggage handling, and other critical operational aspects.

The coordinator is responsible for addressing any issues that arise during the day. This requires quick decision-making and problem-solving skills, often under pressure. The coordinator must efficiently handle disruptions, such as delays, cancellations, or emergencies, and implement contingency plans as needed.

The coordinator ensures that all operations comply with regulatory requirements and safety standards. They keep a close eye on any safety or security concerns and take necessary actions to mitigate risks.

Overall, the daily activities of the Day Coordinator at Schiphol APOC are centered around ensuring that the airport operates efficiently, safely, and effectively. They play a critical role in managing the complexities of daily airport operations and responding to the dynamic nature of the aviation industry.

Topic-Specific Cluster Lead

The daily activities of a Topic-Specific Cluster Lead within Schiphol APOC revolve around specialized tasks within their area of expertise, focusing primarily on forecasting and addressing capacity issues. Their role is critical in ensuring the smooth and efficient functioning of specific operational aspects of the airport.

One of the primary tasks is to analyze various data sets and trends related to their specific domain, such as passenger flow, baggage handling, aircraft movement, or security processes. They use this data to forecast potential capacity issues and operational challenges that might arise in the near future, typically focusing on the next day's operations. After analyzing and forecasting, the Cluster Lead inputs this forecasted data into the relevant systems or communicates it to the necessary departments. This data is crucial for strategic planning and resource allocation.

They closely monitor capacity levels within their domain, identifying areas where capacity might be exceeded or underutilized. This involves assessing the availability of resources like personnel, equipment, and facilities, and ensuring they are aligned with the forecasted demand. The Cluster Lead proactively identifies potential issues that may impact capacity or efficiency within their area. They work on developing solutions or contingency plans to address these issues before they escalate.

They maintain regular communication with stakeholders relevant to their domain, such as airline representatives, ground handling agents, or security personnel, to inform them of any anticipated changes or challenges and to gather feedback. Based on their analysis and forecasts, the Cluster Lead implements strategies and adjustments to manage capacity effectively. This might involve reallocating resources, adjusting schedules, or implementing new procedures.

They prepare reports and documentation related to capacity planning, forecasting accuracy, and operational performance. These reports are crucial for continuous improvement and strategic decision-making.

In essence, the daily activities of a Topic-Specific Cluster Lead at Schiphol APOC are centered around specialized analysis, forecasting, and capacity management within their domain. Their role is vital in preemptively addressing challenges and ensuring that their specific operational area contributes effectively to the overall success and efficiency of the Schiphol airport's operations.

Development Team

The Development Team within Schiphol APOC focuses on the technological and operational enhancement of the Airport Operational Plan (AOP) and the overall functionality of the APOC. Their daily activities involve a blend of software development, system integration, and operational planning.

The team starts by identifying areas within the AOP and APOC systems where new functionalities could be added, or existing ones could be enhanced. This involves collaborating with operational teams to understand their needs and challenges.

A significant part of their day is dedicated to developing new software functionalities and tools. This includes writing code, designing user interfaces, and creating data management systems that will be integrated into the AOP and APOC systems.

The team works on configuring the APOC systems to meet the specific operational needs of the airport. This might involve customizing software to handle unique scenarios or operational requirements.

Once new features are developed, the team integrates them into the existing AOP framework. This process requires careful planning to ensure compatibility and seamless operation with other system components. After integrating new features, the team conducts thorough testing to ensure that these additions function as intended. They also perform quality assurance checks to identify and fix any bugs or issues.

Ongoing monitoring of the systems is necessary to ensure they are functioning optimally. The team also performs regular maintenance and updates to the software and systems. The Development Team needs to stay informed about the latest trends and advancements in technology and airport operations. This knowledge helps them in developing innovative solutions that keep the APOC at the forefront of operational efficiency.

This collaborative structure ensures that each aspect of the AOP is addressed with specialized attention. The Day Coordinator provides overarching coordination, while the Topic-Specific Cluster Leads contribute domain-specific insights. The APOC Team focuses on the daily assembly, and the Development Team works on continuous improvement and the incorporation of new functionalities into the AOP and APOC configuration. Together, these roles form a well-rounded team dedicated to the effective preparation and enhancement of the AOP at APOC Schiphol.

Figure (7) is a description of the process that takes place in one day.

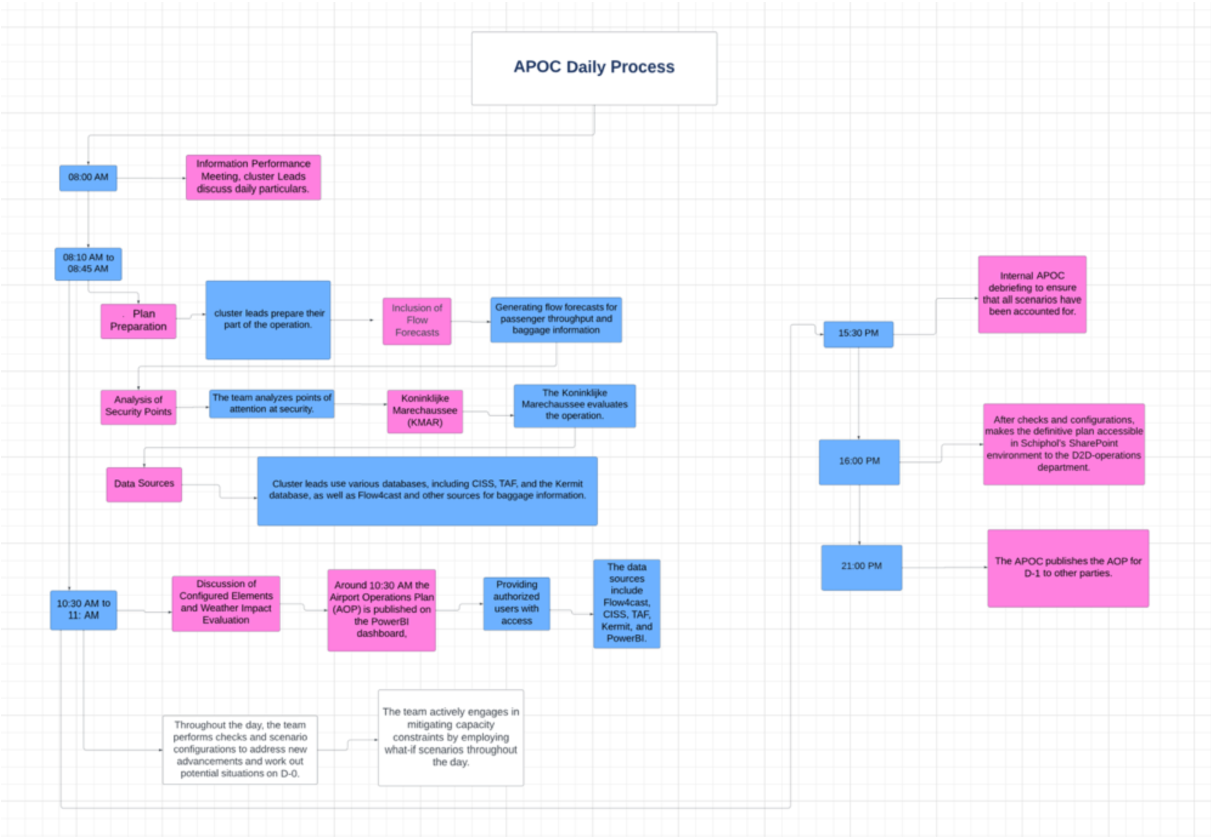


Figure7: Schiphol APOC Daily Process

The flow chart illustrates the daily process of the Schiphol APOC for compiling the Airport Operational Plan (AOP). The process unfolds as follows:

8:00 AM: An Information Performance Meeting takes place where cluster leads discuss the particulars of the day.
08:10 AM to 08:45 AM: This is the Plan Preparation phase, where cluster leads prepare their respective parts of the operation, including the analysis of security points and inclusion of flow forecasts.
Data Sources: Cluster leads utilize various databases like CISS, TAF, and the Kermit database, as well as Flowcast and other sources for baggage information.
10:30 AM to 11:00 AM: Discussions of Configured Elements and Weather Impact Evaluation occur.
Around 10:30 AM, the AOP is published on the Power BI dashboard, and authorized users are provided with access.
Throughout the day: The team conducts checks and scenario configurations to address new advancements and works out potential situations for D-0. They actively engage in mitigating capacity constraints by employing 'what-if' scenarios throughout the day.
15:30 PM: There is an internal APOC debriefing to ensure that all scenarios have been accounted for.
16:00 PM: After checks and configurations, the definitive plan is made accessible in Schiphol's SharePoint environment to the D2D-operations department.
21:00 PM: Finally, the APOC publishes the AOP for D-1 (the next day) to other parties.

Presently, the team's primary emphasis lies in foreseeing upcoming events and orchestrating activities within a confined timeframe. This involves strategic planning for a maximum of seven days. However, an ideal conceptual implementation aims for a more expansive planning horizon, stretching back even before the 180th day of operation. This envisioned approach would provide a more comprehensive and forward-looking perspective for effective operational management.

5.2 LVNL Daily Operational Planning Process

This section sheds light on the daily operational planning process at LVNL (Luchtverkeersleiding Nederland), specifically the OPS plan generation for the next day's air traffic operations. The OPS plan is an essential component of managing air traffic at Amsterdam Airport Schiphol and ensures smooth and efficient operations.

The OPS plan is prepared one day in advance, making it a D-1 plan.

The OPS plan is a collaborative effort involving two LVNL departments:
- Operational Support and Development (OSD). (LVNL, n.d.)
- Capacity Management (CMA). (LVNL, n.d.)

Together forming the Pre-tact Unit. During their meetings, the team discusses the plan, with much of the content being automatically generated. The KNMI (Royal Netherlands Meteorological Institute) plays a critical role in providing weather updates, which are vital for aviation operations.

Key Activities in the OPS Plan Preparation Process

Time	Activity
09:30-10:30	Preparing the discussion using source data
10:30-11:30	Joint internal discussion with OSD and CMA
11:00	Briefing with KNMI
11:30	Preparing the concept OPS plan in .pdf
13:30	Preparing the final OPS plan in .pdf
15:00	Automatic distribution to stakeholders
16:30	Forwarding OPS plan to the Support Unit Plan (SUP) and Flow Management Planning Coordinator (FMPC)

Table 2: OPS Plan Activities

Data Sources for OPS Plan

Data Sources	Purpose
Network Manager (NM) predict data	Forms the basis for traffic demand predictions
Capacity meeting decisions (LVNL QRC's)	Helps in capacity planning and addressing constraints
KNMI (Royal Netherlands Meteorological Institute)	Provides the latest weather forecast
Schiphol Kansverwachting (SKV)	Offers weather forecast probabilities for decision-making

Table 3: OPS Plan Data Sources

The OPS plan is generated using a combination of these data sources and analyzed to make accurate predictions. (Transport.ec.europa.eu, n.d.), (KDC, n.d.)

The OPS plan preparation involves rotating roles within the LVNL Pre-tact Unit, ensuring an efficient allocation of work. This team consists of three individuals, with one representative responsible for finalizing and distributing the OPS plan.

Content of the OPS plan

The OPS plan provides the following information:

- Expected traffic numbers, including arrivals and departures at AAS.
- Flight data for Amsterdam FIR boundary and EHAM runway.
- Distribution of traffic numbers throughout the day.
- Announcements of special events and relevant announcements from EUROCONTROL's Network Operations Portal.
- Maintenance planning (if applicable).
- Information from the Operational Helpdesk (OHD), such as survey flights or aeronautical events. (LVNL, n.d.)
- Regulation scenarios.
- Traffic distribution per stack and indications of bunching.

- Sector configurations and distribution throughout the day.
- Weather Information
- Runway use or configuration during peak and off-peak times.-
- Taxiway Assignments
- Air Traffic Flow Management
- Aircraft Movement Monitoring
- Coordination with Ground Services
- Emergency Response Coordination

This comprehensive OPS plan serves as a valuable resource for managing air traffic operations effectively.

Figure (8) and (9) provide slides from an OPS plan, displaying predicted inbounds for EHFIRAM, regulation scenarios, and other critical remarks for a specific date based on NM PREDICT data.

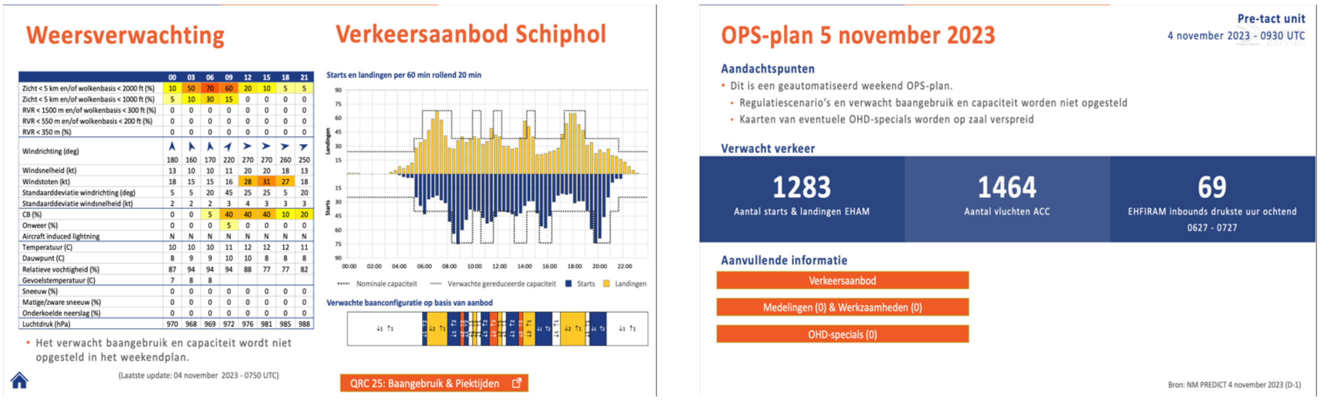


Figure 8 & 9: Slides from LVNL OPS plan

The OPS plan plays a crucial role in ensuring the smooth and efficient operation of air traffic at Amsterdam Airport Schiphol. By harnessing a variety of data sources, LVNL prepares detailed plans for each day, incorporating weather forecasts, traffic numbers, and important announcements. The collaborative effort of different LVNL departments ensures the accuracy and reliability of these plans, allowing for seamless air traffic management.

5.3 KLM Operational Planning Process

This section provides insights into KLM's flight preparation process, focusing on how they continuously evaluate and update their flight planning to reduce delays and ensure adherence to scheduled arrival times.

KLM does not prepare a daily comprehensive preparatory plan for airport operations. Instead, they continuously evaluate and update their flight planning for individual flights and regions containing multiple KLM flights. The primary goal is to minimize overall delays and ensure that flights adhere to their scheduled arrival times.

KLM relies on various decision-support tools to optimize individual aircraft movements and their collective network. These tools aid in managing and predicting the flow of aircraft within their network.

- Airport Forecasting System (AFOS): Predicts runway usage for the next 36 hours based on meteorological forecasts and LVNL's runway configuration data. (KDC, n.d.)

- EUROCONTROL Collaboration Interface Aircraft Operators (CIAO): Monitors en-route delays and allows for preemptive actions based on surrounding aircraft flight plans.

- Traffic Flow Management (TFM): Provides flight-specific data and assists in managing flights, particularly in the case of delays or cancellations.

KLM does not prepare a standard deliverable for operational preparation. Instead, they focus on individual flight planning, which includes various documents such as flight plans, passenger lists, load sheets, and crew planning. Additionally, they have access to scattered information like flight valuations and aircraft maintenance remarks. (Eurocontrol, n.d.)

Two primary teams are responsible for managing and preparing KLM flights:

- Flow Controllers: Comprising six members, this team monitors ATC delays across the network and maintains communication with EUROCONTROL.

- Dispatchers: A team of approximately fifteen dispatchers handles tasks like creating flight plans and mass & balance calculations. They also engage in route planning and aircraft preparation.

Preparation Timeline
The preparation timeline for KLM flights involves several key stages:

Timeline Stage	Description
Fourteen Days Prior	Check seat reservations to determine flight execution.
From 14 Days to D-1	Dispatch team prepares flight plan and paperwork.
D-1 (Day of Operation)	Flight is handed over to the flow control department.
Six hours before departure	Initial flight plan is filed to the Lido system.
Approximately three hours before departure	Weight and balance checks and en-route traffic analysis.
Roughly two hours before departure	Crew discussion on the flight plan. Approval or modifications requested.

Table 4: OPS Plan Timeline at KLM

Daily Activity
KLM conducts several daily briefing instances to coordinate and assess operations:

Time	Activity
04:15	Meeting with operational manager flight, approach control, ACC SUP, and KNMI to discuss foreseen operation.
9:15	Evaluation of the inbound peak at Schiphol Airport.
14:00	Assessment of operation status and anticipation of possible evening peak traffic.
21:30	Review of D-0's operation and examination of expected nighttime traffic.

Table 5: OPS Plan Daily Activity at KLM

Content of the OPS plan

The OPS plan provides the following information:

- Priority of flights
- Flight Schedules
- Aircraft Movement Data
- Gate Assignments
- Passenger Boarding and Deplaning
- Crew Operations
- Maintenance Activities
- Collaboration with Ground Services
- Aircraft Performance Data

By following this flight preparation process, KLM ensures effective management of their flights and minimizes disruptions, contributing to a smoother air travel experience.

6. Interviews with stakeholders

Interviews were conducted with representatives from various stakeholders to have an overview of the current situation and operations and an insight to uncover their challenges, requirements have been discussed. The primary goal was to identify specific improvement areas expressed by different stakeholders and compare these desires across the stakeholders.
Through conversations with various representatives of stakeholders, the bottleneck they face were deduced. In the following paragraph (6.1), the most common problems they face will be presented. While chapter (6.2) discuss and identify common intersections that highlight the importance of information exchange, and collaborative efforts among stakeholders, (6.3) measure and evaluate various processes through the establishment of Key Performance Indicators (KPIs).

6.1 Stakeholders Experience Bottleneck

This chapter delves into the bottlenecks faced individually by KLM, APOC Schiphol, and LVNL, shedding light on the challenges within early arriving aircraft, unstable take-off times, updating TOBT information, and DST information sharing.

6.1.1 Bottleneck Faced by KLM Airline

The bottelnecks in this paragraph was collected and analyzed based on an interview with one person, he works as ATM Regional Manager Netherlands at KLM airline.
At the end of each meetings, these bottelnecks were concluded, it was determined why this point is considered a problem, and potential solutions were presented in which these bottelnecks could be solved.

Early Arriving Aircraft:
KLM faces a significant challenge related to the early arrival of aircraft, leading to unforeseen fluctuations in airport capacity. This issue arises when flights land before their scheduled times, causing disruptions in the predetermined plans for specific gates. Ground services, encompassing refueling, cleaning, and boarding preparations, may not be adequately equipped to manage such premature arrivals.

Implications:
Early arrivals cause disruptions in ground operations, impacting gate plans and resource allocation.
Operational disruptions and delays in subsequent flights.
Complex resource allocation due to unpredictable shifts in demand.

Potential Solutions:
Improved communication and collaboration for proactive adjustments.
Advanced predictive tools for anticipating and managing early arrivals.
Investment in capacity planning to optimize ground operations.

Unstable Take-Off Time (TOT) Information:
Unstable Take-Off Time (TOT) refers to situations where there is inconsistency or unpredictability in the scheduled or expected time at which an aircraft is planned to take off from the runway. This instability can be attributed to various factors that disrupt the normal flow of the departure process, leading to uncertainties in the timing of take-off.

Implications:
Inconsistency in scheduled or expected take-off times due to various factors.

Challenges in adhering to published schedules.
Passenger waiting times is longer and overall operational inefficiency.

Potential Solutions:
Foster collaboration between KLM, ATC, and airport authorities.
Implement predictive tools for dynamic departure process adjustments.
Continuous improvement efforts for adaptive procedures.

Target Off-Block Time (TOBT) Information is not always up to date:
TOBT is the expected time when an aircraft is predicted to push back from its gate.
The updating of Target Off-Block Time (TOBT) information is frequently neglected, and Collaborative Decision Making (CDM) processes do not contribute to addressing this issue.

The information regarding this off-block time is not regularly revised by KLM or kept up to date. Collaborative Decision Making (CDM) typically involves cooperative efforts among various stakeholders in the aviation system to optimize operations.

Implications:
Neglect in updating TOBT information, creating mismatches between predicted and actual departure times.
Potential operational misalignments.
Limited coordination and absence of Collaborative Decision Making (CDM).

Implications:
Lack of communication and timely sharing of information between LVNL and KLM.
Hindered decision-making for KLM based on outdated or incomplete data.
Disruption in collaborative decision-making process.

Potential Solutions:
Define clear communication protocols for regular sharing of DST information.
Develop automated notification systems for critical updates.
Conduct collaborative workshops and training sessions.

In navigating these challenges, KLM can not only optimize its own operational efficiency but also contribute to the overall resilience of airport operations. By implementing the suggested solutions, KLM can foster a more collaborative and informed operational environment, ultimately enhancing the passenger experience and ensuring smoother airport processes. The success of these solutions relies on a commitment to continuous improvement and a collective effort from all stakeholders involved.

6.1.2 Bottleneck Faced By Schiphol APOC Airport

This chapter is a summary deduced from several meetings with several people holding different positions in Schiphol APOC, as performance manager, data professional, and business transformation consultant, highlighting several key challenges and bottlenecks in airport operations.

Last-minute Gate Changes:
Last-minute gate changes are made without direct coordination between APOC Schiphol and ground handlers, relying solely on continuous monitoring of the Central Information System Schiphol (CISS).

Implications:

- Swift communication is essential for informing stakeholders about changes. Lack of coordination may lead to delays and inefficiencies in disseminating critical information.

Potential Solutions:

- Introduce direct communication channels alongside system monitoring.
- Integrate CISS with relevant systems for enhanced data sharing.
- Train personnel on protocols for handling last-minute changes.

Delays in the Apron Process:
Delays in the Apron process can impact departure schedules and suggest challenges in collaborative decision-making.

Implications:

- Inefficiencies and disruptions may occur due to lack of synchronization in the Apron process and gate assignments.

Potential Solutions:

- Analyze root causes behind delays and implement proactive measures.
- Improve collaborative decision-making and coordination.
- Optimize scheduling and coordination efforts for peak times.

Constrained Availability of Gates and Buffer Positions:
Limited gates and buffer positions create bottlenecks, affecting the efficient flow of arriving and departing flights.

Implications:

- Increased turnaround times, congestion, and reduced efficiency in handling air traffic.

Potential Solutions:

- Invest in construction of additional gates.
- Implement a dynamic gate allocation system.
- Develop flexible systems for managing buffer positions.
- Strengthen collaboration and communication through CDM initiatives.

Not Enough Information Exchange Between Stakeholders:
The stakeholders involved in airport operations, such as airlines, air traffic control, ground services, and others, are not adequately sharing critical information with each other. This can include data related to flight schedules, ground movements, weather conditions, and other factors influencing airport operations.

The APOC relies on comprehensive and timely information to make informed decisions and manage the overall flow of airport operations.

Implications:

- The lack of sufficient information exchange poses a challenge for the APOC in executing its duties effectively.
- Incomplete or delayed information hampers decision-making can lead to suboptimal resource allocation.

Potential Solutions:
- Develop integrated information platforms for real-time data sharing.
- Implement collaborative decision-making frameworks.
- Establish standardized communication protocols.
- Integrate communication technologies for seamless exchange.
- Implement automated alert systems.
- Organize regular collaborative planning sessions.
- Establish continuous improvement feedback loops.

In addressing these bottlenecks, APOC Schiphol Airport could enhance its overall efficiency, minimize delays, and optimize resource allocation. The success of these solutions relies on a concerted effort from all stakeholders involved, emphasizing the importance of collaborative decision-making and real-time information sharing. By implementing these solutions, APOC Schiphol can contribute to a more resilient and streamlined airport operation and ensuring the airport's long-term sustainability.

6.1.3 Bottleneck Faced By LVNL

This chapter is a summary deduced from several meetings with several people holding different positions in LVNL, as capacity management expert, business analyst milieu and data analyst, highlighted several key challenges and bottlenecks in thier operantional plan.

Inaccurate and not timely aircraft Parking information:
That indicates the smooth and efficient movement of aircraft on the ground, particularly during taxiing, relies on the timely availability of information regarding when a flight is allocated a specific time for the aircraft to be on the block. This helps in avoiding congestion and streamlining the overall taxi process.
Air traffic control relies on the allocation of aircraft Parking for each flight. Apron process is the anticipated time when an aircraft is expected to arrive at its designated parking position or gate.

Implications:
- Without accurate and timely aircraft Parking information, the taxi process can become congested, leading to delays and inefficiencies in ground movements.
- Airports may face challenges in allocating resources optimally, as they may not have real-time information on when flights are expected to arrive at their designated positions.

Potential Solutions:
- Automated systems for real-time aircraft Parking updates.
- Integrate Collaborative Decision Making (CDM) tools to enhance communication and coordination between airlines and air traffic control, facilitating efficient aircraft Parking information exchange.
- Establish standardized communication protocols to enable timely Apron information updates.
- Utilize real-time monitoring systems to track actual arrival times and automatically update the Apron information.
- Conduct training programs and seek regulatory support to enforce compliance with timely Apron updates.

Addressing this obstacle involves establishing effective communication channels and systems between airlines and air traffic control to ensure the timely and accurate exchange of Apron information. This allows for better coordination and planning, contributing to a more efficient and streamlined taxi process.

Late Runway Changes Impacting Gate Occupancy:
Changes in active runways at airports can significantly impact gate occupancy. The rapid transitions strain air traffic control's capacity to effectively manage and communicate these changes, creating bottlenecks in coordination.

Implications:
- Swift runway changes lead to shifts in gate assignments, in this context, when the gate is changed, this will lead to disrupting the typical flow of arriving and departing flights within the terminal.
- Frequent changes can create communication bottlenecks, hindering efficient coordination between stakeholders.
- Sudden shifts challenge optimized ground control procedures based on typical runway usage, potentially causing inefficiencies in guiding flights to appropriate gates.
- Late changes to runway assignments can indeed have significant impacts on airport operations, particularly in the context of handling activities. If runway changes are communicated too early, handling activities, such as baggage loading and aircraft servicing, may not commence as staff wait for the aircraft's arrival at the designated location. Conversely, if these changes are relayed too late, there can be inefficiencies, as handling staff and equipment might be left waiting, leading to delays in the overall turnaround time of the aircraft. Efficient and timely communication of runway assignments is therefore crucial to optimize handling activities and minimize delays.

Potential Solutions:
- Improve communication protocols between ATC and ground operations to ensure timely and accurate information exchange regarding runway switches.
- Provide training to air traffic controllers and other relevant staff in handling flexible operational scenarios caused by sudden runway changes.
- Implement technologies facilitating real-time information sharing between ATC and ground operations.

Effectively managing the impact of runway changes on gate occupancy requires a comprehensive approach. Enhancing communication, optimizing ground control/ ground handling procedures, and leveraging technology are key strategies to minimize disruptions, ensuring smoother transitions effective use of scares handling resources and preserving operational efficiency.

6.2 Discussing the Bottlenecks Faced by Stakeholders

After analyzing the stakeholders' bottlenecks individually, problems were discussed that could be the basis for these individual bottlenecks, as solving or avoiding these bottlenecks can eliminate the other basic problems that were idintifed previously.

Insufficient Standardization of Terminology

Within the intricate web of airport stakeholders, limited interaction often gives rise to distinct linguistic references. This linguistic diversity extends to the terminologies used by various groups, creating a situation where standardized definitions and a shared understanding of processes are lacking.

The concept of "arrival time" may denote the moment of touchdown for an air traffic controller or an airline, whereas ground handling agencies might interpret it as the time when an aircraft reaches the gate. KLM's issues with early arriving aircraft, unstable (TOT), and outdated (TOBT) information may be exacerbated by inconsistent terminology across different stakeholders.

The problems of last-minute gate changes and delays in the apron process could be partly attributed to a lack of standardized terminology. If APOC and ground handlers or airlines use different terms for the same concepts or processes, it can lead to confusion and inefficiencies.
the same thing for LVNL, the dependency on timely apron process allocation and the impacts of runway changes could be mitigated by standardizing terminology. This would ensure that all parties have a clear and consistent understanding of the processes and expectations. This variance in defining commonplace terms results in a lack of collective awareness and operational clarity, leading to potential confusion and heightened inefficiencies.

Lack of Information Exchange and Communication

The prevalence of inefficiencies and misunderstandings among stakeholders is significantly influenced by a lack of transparent communication and information exchange processes. In numerous instances, independent departments and organizations operate in isolation, neglecting the sharing of crucial information, data, and concerns. This isolated approach often results in reactive decision-making and actions based on incomplete or faulty information rather than proactive measures.

A notable issue is the absence of established processes or agreements that regularly bring together all stakeholders. This lack denies stakeholders the opportunity to openly discuss challenges and successes within the airport community. Furthermore, the absence of a structured process complicates the timely sharing of relevant information with concerned stakeholders.

Challenges like unstable TOTs and TOBT information updates are directly linked to inadequate communication and information sharing. If KLM doesn't receive or disseminate timely and accurate information, it can't adjust its operations effectively. At Schiphol APOC issues like last-minute gate changes and constrained gate availability are significantly impacted by poor information exchange. Without real-time communication, APOC can't coordinate effectively with airlines or ground services. The smooth functioning of taxi processes and managing runway changes heavily depends on effective information exchange. Timely communication of aircraft parking allocations and changes in runway usage is crucial for LVNL to manage its operations efficiently.

Addressing the challenges faced by Schiphol airport requires tackling the unawareness among stakeholders regarding the needs, constraints, and objectives of others. This lack of awareness leads to decisions and actions that impact other stakeholders and the overall system operation in an escalating manner. The necessary data and information to enhance efficiency are available and must be shared in real-time within the network to facilitate more informed decision-making across the stakeholder community. Real-time sharing enables business partners to act with greater predictability, even in unusual situations, ensuring a smoother overall process.

Disconnected approaches and operating in solitud

Sometimes, different groups at the airport try to do their best on their own to make things more efficient, but they don't realize how it affects everyone else and the overall operation. When each group follows its own set of rules and ways of doing things, it often makes the whole operation less efficient.
KLM’s bottlenecks suggest a need for more collaborative approaches. For example, handling early arrivals and unstable TOTs would benefit from a more integrated approach with ATC and ground services. The same thing at Schiphol APOC the challenges of gate availability and information exchange

highlight the consequences of working in isolation. A more connected approach with airlines and ground handlers could streamline processes. The dependency on Apron allocation and the effects of runway changes on gate occupancy demonstrate the need for coordinated efforts across the aviation ecosystem, rather than isolated decision-making.

The problems caused by delays affect all stakeholders. Without everyone knowing what's happening and being able to plan for it, delays can get worse and cause more problems. This can create a culture where stakeholders start blaming each other. To avoid this, it's important for everyone to work together and communicate well.

Tackling Airport Issues Through Collective Efforts

All the identified bottlenecks at KLM, Schiphol APOC, and LVNL point towards the need for collective efforts to address airport issues.

By setting up collaborative processes involving everyone in both the landside and airside areas of the airport, the system can work more efficiently. Collaboration not only boosts awareness for everyone involved but really shines when shared information and data lead to smarter strategic and tactical decision-making. Taking a collaborative approach means shifting away from only caring about individual needs and actively working together to achieve the common goal of improving safety and efficiency across the entire stakeholder network.

Furthermore, when we're looking at future investments, it's crucial to think about what the whole stakeholder community needs. Going solo without considering the bigger picture might end up with not-so-great returns on investment for both individual organizations and the stakeholder community as a whole.

6.3 Assessment of Information Exchange Efficiency

To obtain nearly real-time insights into both APOC's planning and execution, it is crucial to actively measure and evaluate various processes through the establishment of Key Performance Indicators (KPIs). This involves making a clear distinction between evaluating operational performance, focusing on how well operations align with the AOP on D-0, and assessing information exchange during the preparatory phase on D-1.

Based on this research and information summarized from interviews with stakeholders. I suggested these indicators for several reasons:

Average Time of Data Updates: This KPI addresses the bottleneck of delayed information flow. Timely data updates are crucial for operational efficiency, and any delays can lead to cascading issues in airport operations.

Frequency of Shared Critical Information: This KPI tackles the bottleneck of insufficient communication. Regular sharing of critical information is essential for collaboration and coordinated response to operational challenges.
Percentage Increase in Information Exchange Over Time: This KPI helps in overcoming the bottleneck of stagnant or declining collaboration levels. By measuring the growth in information exchange, it ensures continuous improvement in communication practices.

Percentage of Preparatory Plan Exchanged: This KPI aims at the bottleneck of inadequate preparedness for operations. A high exchange of preparatory plans ensures that all stakeholders are well-informed and ready for effective execution of day-to-day operations.

Each KPI is designed to target and alleviate specific bottlenecks, thereby enhancing overall operational efficiency and collaboration at the Schiphol airport.

KPI 1: Average Time of Data Updates

The "Average Time of Data Updates" KPI is a vital metric for evaluating the efficiency of information exchange in airport operations, with a specific focus on APOC's planning and execution processes at Schiphol Airport. This Key Performance Indicator aims to measure the average time taken to update critical operational information, such as flight schedules, ground movements, and weather conditions, which are essential for the smooth functioning of airport operations.

Stakeholders, including teams within the Schiphol APOC handling flight operations, ground services, and meteorological data, actively collect and calculate this data on a daily basis. This process involves assessing the timeliness of data updates and analyzing them to identify trends, spikes, or patterns that may indicate areas needing improvement or potential bottlenecks in the information exchange process.

Airport management utilizes this KPI to gauge operational efficiency and make strategic decisions, while other stakeholders like KLM, ground handling agencies, and LVNL use it for better coordination and planning. The primary goal is to ensure that information exchanged remains relevant, up-to-date, and readily available for collaborative decision-making, thereby contributing to a more agile and responsive operational environment.

A lower average time in updating critical operational data indicates more timely and responsive data updates, which are crucial for maintaining high operational efficiency, supporting effective decision-making, and managing risks, particularly in adverse conditions or emergencies. By consistently tracking this KPI, stakeholders can enhance the overall efficiency of airport operations, leading to streamlined processes and better coordination among all parties involved.

Overall, the "Average Time of Data Updates" KPI is not just a measure of current performance but a tool for continuous improvement, guiding operational processes towards greater efficiency and responsiveness.

KPI 2: Frequency of Shared Critical Information

The "Frequency of Shared Critical Information" KPI is crucial for measuring and enhancing collaboration and transparency in airport operations at Schiphol APOC. This indicator tracks and quantifies how often stakeholders share essential information related to changes in flight schedules, weather conditions, and operational challenges. The primary goal is to assess the level of collaboration among various entities involved in airport operations, including teams coordinating flights, ground services, and safety operations, as well as external stakeholders like KLM, ground handling agencies, and LVNL.

In practice, stakeholders monitor and record instances of critical information sharing over set periods (daily, weekly, etc.) and analyze this data to identify trends. An increasing trend in the frequency of shared critical information indicates a positive shift towards enhanced collaboration and operational transparency, which is vital for safety and efficiency. Conversely, a decreasing trend suggests a need for a closer examination of communication channels and protocols to identify areas for improvement.

Currently, the desired level of information sharing is not being met, as information is shared sparingly and not all changes are communicated effectively. Regular tracking of this KPI enables airport Schiphol APOC to gauge the effectiveness of information-sharing processes and pinpoint opportunities to enhance collaboration for improved operational outcomes.

Setting adaptable targets based on changing operational needs and challenges is essential. Regular tracking and analysis of this KPI can significantly improve the operational dynamics of the airport. It serves as a barometer for current collaboration levels and acts as a catalyst for fostering a more integrated and transparent operational environment. This is crucial for the efficient and safe running of airport activities, especially in dynamic operational environments where timely sharing of critical information is key for proactive risk management.

KPI 3: Percentage Increase in Information Exchange Over Time

The "Percentage Increase in Information Exchange Over Time" KPI is an essential tool designed to measure the growth and effectiveness of communication and collaboration among stakeholders in airport operations. The primary objective of this KPI is to assess and quantify improvements in collaboration and communication practices among entities involved in airport operations, including teams within Schiphol APOC, airline operators, ground handling agencies, air traffic control, and other relevant parties.

To implement this KPI, stakeholders collect and compare data on the volume of information exchanged over a set timeframe with a baseline or a previous period. This comparison is used to calculate the percentage increase in information exchange. The KPI is evaluated regularly (e.g., monthly, quarterly) to monitor the trend and trajectory of information exchange. This regular assessment helps in understanding the extent of improvement in collaboration and communication practices over time.

A positive percentage increase in this KPI reflects growing collaboration and indicates that communication strategies are becoming more effective. This is crucial for tracking improvements in collaboration among various operational entities, leading to more efficient operations and better decision-making. The KPI also aids in adapting communication strategies to meet the dynamic needs of Schiphol airport operations.

By regularly monitoring and analyzing the "Percentage Increase in Information Exchange Over Time" KPI, Schiphol airport management and other stakeholders can quantify the effectiveness of their initiatives to promote collaboration. This continuous tracking ensures that information exchange practices evolve in line with the changing needs of airport operations. Therefore, this KPI not only measures current performance but also serves as a guide for ongoing improvements in operational processes and stakeholder engagement, ensuring that efforts to enhance collaboration and communication yield positive results.

KPI 4: Percentage of reparatory Plan Exchanged

The "Percentage of Preparatory Plan Exchanged" KPI is a critical measure for evaluating the effectiveness of information exchange during the preparatory phase (D-1) of airport operations. This KPI focuses on quantifying the extent to which crucial information from the preparatory plan is shared among stakeholders. It involves calculating the percentage of information exchanged about Aircraft,

Passengers, Landside, Baggage, and Weather between key stakeholders like LVNL, KLM, and Schiphol APOC, compared to the total content of the airport operation plan.
Stakeholders assess this KPI daily during the preparatory phase to determine the readiness and collaboration levels for the upcoming day of operations (D-0). This assessment helps in understanding how effectively the preparatory information is communicated and distributed among stakeholders. A higher percentage indicates a more collaborative approach, which is essential for the smooth execution of airport operations and mitigating risks and potential operational surprises.

Regular monitoring and analysis of this KPI ensure that all stakeholders are well-informed and prepared, thereby reducing the likelihood of disruptions on the day of execution. It serves as a guide for enhancing the exchange of information, leading to more streamlined and efficient operations. The KPI also provides insights into how well stakeholders are prepared for day operations by measuring the degree of exchange in preparatory plan information.

Targets for this KPI should be agreed upon by all key stakeholders, ensuring alignment with operational needs. A committee, including representatives from Schiphol APOC, LVNL, KLM, and possibly other stakeholders, should regularly review this KPI to ensure it aligns with broader operational objectives. Adjustments may be made based on collective feedback and operational changes. In conclusion, the "Percentage of Preparatory Plan Exchanged" KPI is a vital tool for enhancing collaborative efforts and operational readiness at Schiphol Airport. By ensuring a high level of information exchange in the preparatory phase, stakeholders can significantly improve the effectiveness of their day-of-operations planning and execution.

The KPIs offer Schiphol APOC several benefits:

- Improved Decision-Making: Timely data updates enable quicker, more informed decisions.

- Enhanced Collaboration: Regular sharing of critical information fosters better coordination among stakeholders.

- Increased Operational Efficiency: Tracking the growth in information exchange helps streamline operations.

- Better Preparedness: Assessing the extent of preparatory plan exchange ensures readiness for daily operations.

These KPIs collectively lead to more efficient, responsive, and coordinated airport operations.

7. Data Idintifying And Comparison Between Stakeholders

Due to the limited research time, it is not possible to consider the extent to which all the information provided by stakeholders matches. Paragraph (7.1) identify the data source of APOC Schiphol. Paragraph (7.2) show the CDM system structure of the stakeholders and explain the importance of the conformity the structure of this system as a first step towards stronger cooperation in the future. Paragraph (7.3) provide an example of comparison in the EIBT and AIBT information between LVNL, KLM and APOC Schiphol. Paragraph (7.4) present a discussion about the data shared between the stakeholders.

7.1 Data Sources Idintifying

The purpose of this research is to identify the sources of information that Schiphol APOC relies on.
In Chapter 4 was analyzed AOP and the operational planning process at Schiphol APOC, in the following paragraph, after a comprehensive analysis that lasted seven chapters, Schiphol APOC's sources of information were identified as follows:

7.1.1 Central information Schiphol system (CISS)

CISS is a critical aspect of ensuring efficient and coordinated airport operations. APOC use CISS as a platform to disseminate information to various airport stakeholders, ensuring everyone is informed about current operations, changes, or emergency protocols.

CISS acts as a central repository of all operational data, where APOC utilizes this data for decision-making and operational control. APOC relies on CISS for real-time information on various aspects of airport operations, such as flight schedules, gate assignments, baggage handling, and ground services. This real-time data is crucial for APOC to monitor, manage, and respond to operational needs effectively. In case of emergencies or disruptions, CISS can provide immediate data on the status of various operations, which APOC can use to coordinate response strategies and communicate effectively with all stakeholders. Also, CISS provides the data foundation for the collaborative approach.

The types of data included in CISS typically encompass the following:

Flight Scheduling Information:
This includes data on flight arrivals, departures, and any changes to the flight schedules.

Aircraft Turnaround Data:
Information regarding the turnaround process of each aircraft, including times for unloading and loading of passengers, baggage, and cargo, as well as refueling and maintenance activities.

Gate Assignment Details:
Information about which gates are assigned to which flights, including any changes to gate assignments due to operational needs or emergencies.

Baggage Handling Information:
Details concerning baggage loading and unloading, transfer baggage processes, and any related delays or issues.

Ground Handling Services Data:
Information related to ground services such as catering, cleaning, and transportation services for passengers and crew.

Weather Conditions:
Real-time data on local weather conditions, which is vital for flight operations and scheduling.

Air Traffic Control (ATC) Information:
Data from ATC, including aircraft movements on the runways and taxiways, airspace restrictions, and other relevant air traffic information.

Airlines' Operational Data:
Information provided by airlines about their flights, including crew details, passenger loads, and special requirements.

Resource Allocation and Utilization:
Data regarding the allocation and use of various resources like check-in counters, baggage belts, and other airport facilities.

Security and Safety Information:
Details pertaining to security measures, incidents, and safety-related information critical for airport operations.

Passenger Flow Data:
Information on passenger flow through the airport, including transit times, waiting times, and congestion points.

Real-time Status Updates:
Continuous updates on the status of various operations and facilities within the airport, essential for managing day-to-day activities and responding to emergencies.

Maintenance and Technical Data:
Information on maintenance schedules, technical issues, and resolutions, particularly relating to aircraft and airport infrastructure.

Regulatory Compliance Information:
Data ensuring that operations are in compliance with aviation regulations and standards.

By compiling and processing these diverse types of data, CISS plays a vital role in enhancing the efficiency, safety, and responsiveness of airport operations at Amsterdam Airport Schiphol. The system enables various stakeholders to access up-to-date information, facilitating better coordination and decision-making.

7.1.2 The Terminal Aerodrome Forecast (TAF)

TAF is a crucial meteorological tool, provides essential weather-related data that APOC relies on for making informed decisions, coordinating operations, managing risks, and ensuring the overall smooth functioning of airport activities in all types of weather conditions.

APOC at Schiphol Airport utilizes the data provided by TAF for operational planning and decision-making. TAF offers detailed weather forecasts, which are critical for anticipating and managing the impact of weather on airport operations.

TAF data informs APOC about potential weather-related disruptions to flight schedules. This includes information on visibility, wind speed and direction, and other weather phenomena that could affect flight arrivals, departures, and turnarounds.
APOC uses TAF data to communicate relevant weather-related information to various stakeholders, including airlines, ground handlers, air traffic control, and passengers. This ensures that all parties are aware of potential weather impacts and can adjust their operations and expectations accordingly.

7.1.3 Weather Data (SKV)

The Schiphol Coordination Platform (SKV) at Amsterdam Airport Schiphol plays a crucial role in providing weather data for airport planning and daily operations.

SKV is primarily designed to gather, analyze, and disseminate detailed weather data, includes information on wind speed and direction, visibility, precipitation (like rain, snow, and sleet), temperature, humidity, cloud cover, and other relevant meteorological conditions that can affect both flight operations and ground handling activities.

As a coordination platform, SKV likely facilitates the sharing of weather-related information among various stakeholders at Schiphol Airport, including airlines, air traffic control, ground services, Schiphol APOC and airport management.

<u>Data sources of the SKV</u>

- Royal Netherlands Meteorological Institute (KNMI), provide weather data and forecasts to SKV.
- Pilots often report weather conditions they encounter during flight, which can be a valuable source of real-time, in-situ weather data.
- ATC may provide updates on weather conditions reported by pilots or observed at different altitudes and locations relevant to the airport's airspace.
- Specialized aviation weather services that provide detailed forecasts and weather information tailored to aviation needs, including Terminal Aerodrome Forecasts (TAFs) and METAR reports, are probable sources.

These diverse data sources enable SKV to compile a detailed and accurate picture of current and upcoming weather conditions, crucial for effective and safe airport operations. The integration and analysis of data from these varied sources are key to the platform's ability to support decision-making and operational planning at Schiphol Airport.

7.1.4 METAR Report

METAR stands for Meteorological Aerodrome Report. It is a standardized format for reporting weather conditions at airports and airfields around the world.
A typical METAR report includes information on several weather elements: Temperature and Dew Point, Wind Speed and Direction, Visibility, Cloud Cover, Barometric Pressure and Precipitation. (Dataplatform, n.d.)

METARs are typically issued within Schiphol once an hour. Pilots use METAR reports for pre-flight briefings to understand the current weather conditions at Schiphol. Air Traffic Control (LVNL) uses METAR to assess weather conditions for safe takeoff and landing operations.

The operational teams at Schiphol APOC utilize METAR reports to make critical decisions about resource allocation. In situations of adverse weather, such as fog, heavy rain, or snow, the APOC needs up-to-date weather information to adjust resource deployment, manage flight schedules, and ensure operational safety and efficiency.

7.1.5 Eurocontrol D-1 Network Plan

Eurocontrol's D-1 Network Plan is a strategic tool used for air traffic management across Europe. It provides a comprehensive overview of expected air traffic flows and potential constraints in the European airspace for the next day (D-1). (Eurocontrol, n.d.)
The plan includes forecasts of traffic demand, sector capacities, weather implications, and any other factors that might impact air traffic management across the European network.
The goal is to optimize air traffic flows and minimize delays by anticipating and managing potential constraints or bottlenecks in the airspace.

APOC at Schiphol utilizes the Eurocontrol D-1 Network Plan to align its operational planning with the broader European air traffic management strategies. This helps in anticipating traffic volumes and managing airport resources effectively. By understanding the expected air traffic flows from the D-1 Network Plan, APOC can better coordinate with air traffic control for efficient handling of flights, both arriving and departing.

The data from the D-1 Network Plan enables APOC to proactively address potential delays or disruptions, aligning local operational strategies with the larger network situation.
Insights from the D-1 Network Plan assist APOC in making strategic decisions regarding flight scheduling, resource allocation, and ground operations.

In summary, Eurocontrol's D-1 Network Plan is fundamental for APOC in ensuring that airport operations at Schiphol are well-coordinated with the broader air traffic management strategies across Europe, leading to improved efficiency, reduced delays, and enhanced overall operational effectiveness.

7.1.6 Other Data Sources

Due to time constraints, It was looked at some of the data and analyzed the source of information. The most important time elements that are analyzed are: the Estimated Landing Time (ELDT), the Estimated In-Block Time (EIBT), the Target Off-Block Time (TOBT), the Target Start-Up Approval Time (TSAT), Estimated Off-Block Time (EOBT), Actual Landing Time (ALDT),
Actual Start-up Request Time (ASRT), Actual Take-Off Time (ATOT), Scheduled Off-Block Time (SOBT) and the Target Take Off Time (TTOT). The source of this information is identified in the table below, outlines the flow of data between various systems and stakeholders in the Schiphol APOC CDM system:

Information	Sources
EOBT	Received from the flight plan, facilitated in CISS, but the source can be LVNL, ground handlers, or airline systems.
TOBT	Initially set equal to SOBT, later updated by the Main Ground Handling Agent (MGHA) or automatically calculated based on EIBT + MTT by the Schiphol APOC CDM system.
EIBT	Updates can result in an update of the auto-TOBT by the Airport CDM system, provided to ATC TWR.
ELDT	Eurocontrol Flight Update Messages (FUM) used by ATC TWR to determine ELDT for inbound flights.
ALDT	ATC TWR flight plan data updates automatically update ALDT for the applicable arrival flight in the Schiphol APOC CDM system.
ASRT	Set by ATC when the flight is ready and within its TSAT window, provided to the Schiphol APOC CDM system.
TSAT	Calculated by the Collaborative Pre-Departure Sequence Planning (CPDSP) module, provided by ATC TWR to the Schiphol APOC CDM system.
TTOT	Determined by CPDSP, value depending on DPI type and regulation, and provided by ATC TWR to the Schiphol APOC CDM system.
ATOT	Automatic updates for the applicable departure flight in the Schiphol APOC CDM system provided by ATC TWR.
SOBT	Scheduled Off-Block Time received from the Airport Slot Coordinator.

Table 6: APOC CDM Data Sources

The table reflects some of the data sources within the Schiphol APOC CDM system.

7.2 Data Comparison Between Stakeholders

The data structure used within the CDM tool is examined, with a specific focus on the data descriptions provided by LVNL, KLM, and Schiphol APOC. Through this analysis, crucial insights are revealed into the commonalities and differences in data usage and representation among these stakeholders. This understanding is seen as essential for optimizing joint efforts, ensuring seamless communication, and fostering a more integrated and efficient air transportation system. In the sections that follow, the specifics of these data structures are delved into, uncovering the intricacies and implications of their usage in the realm of CDM.

The structure of the CDM tool

Figure (10,11&12) below, show what each column in the CDM Information table contains, and the difference in the provided information between LVNL, KLM and Schiphol APOC. It could infer several structural aspects:

Common Timestamps:
All three stakeholders use common timestamps, such as EOBT (Estimated Off-Block Time) and ALDT, to track key milestones in the flight process. This consistency in timestamp usage helps align events across different stages of a flight.

Aircraft Identification:
LVNL and KLM use columns like AC_TYPE and WTC for identifying aircraft. Standardized aircraft identification facilitates uniformity in data representation and ensures that all stakeholders can recognize and interpret the type and characteristics of the aircraft.

Runway and Gate Information:
LVNL and KLM provide information about planned runway and gate details. This includes columns like LRWY (runway) and ARR_GATE (arrival gate). Standardizing these columns allows for a consistent representation of planned infrastructure usage.

Operational States:
LVNL includes operational states indicating the current state of a flight in the CDM process. This could include information about whether the flight is in a specific planning or execution phase. Common operational states contribute to a shared understanding among stakeholders.

Flight Planning and Execution Data:
KLM focuses on flight planning and execution data, emphasizing timestamps for key milestones, runway, and gate details. This data structure aligns with the airline's role in flight planning and execution, providing a comprehensive view of the flight process.

Ground Operations and Facility Information:
Schiphol's CDM data includes ground operations and facility information. Timestamps like SIBT (Scheduled In-Block Time), SOBT (Scheduled Off-Block Time), and EOBT (Estimated Off-Block Time) reflect different phases of the flight on the ground. Columns like Stand and Gate indicate allocated positions.

The observed structure suggests a commonality in the types of information shared by these stakeholders, emphasizing timestamps, aircraft identification, infrastructure details, and operational states. While specific columns may differ based on the role of each stakeholder, and this hinders successful joint work because having a standardized set of columns and classifications in CDM data across stakeholders is crucial for several reasons:

Standardized data formats and classifications enable seamless integration of information across different stakeholders. A standardized format ensures clear communication among stakeholders, reducing the likelihood of miscommunication or misinterpretation. Having a common set of columns and classifications streamlines the exchange of information, leading to more efficient and timely decision-making. When all stakeholders use the same set of columns and classifications, it becomes easier to analyze, compare, and make decisions based on the shared information.

While each stakeholder may focus on specific aspects of the flight process, having a common foundation in CDM data promotes a collaborative and well-coordinated air transportation system. This is especially critical in the dynamic and safety-sensitive aviation industry where timely and accurate information exchange is essential for safe and efficient operations.

CLOCK	MS	SFLID	CSN	DEP	FR	AC_TYPE	WTC	ENG_TYPE	NR_ENGINE	ARR_GATE	LRWY	POINT	ELDT	ALDT	EIBT	AIBT	EOBT	FUM_FLIGHT_	CDM_FLIGHT_STATE
30/10/2023 0:00	954	1271	TRA9N	LPPR	IFR	B738	M	J	2	D52	27	RIVER	30/10/2023 0:17		30/10/2023 0:22		29/10/2023 21:55	AA	FIR
30/10/2023 0:00	4	1272	TRA6204	LPPT	IFR	B738	M	J	2	D49	27	RIVER	30/10/2023 0:15		30/10/2023 0:19		29/10/2023 21:40	AA	TMA

Figure 10: CDM Structure at LVNL

	Clocktime change	FLTNR	CALLSIGN	SIBT	ELDT	ELDT SOURCE	ALDT	ALDT SOURCE	EIBT	AIBT	AIBT SOURCE	RUNWAY	CDMFLTSTATE	ACREG	ACTYP	RAMP	GATE	CONFLTNR	MGH
1																			
2	14/11/2023 00:19	KL1082	KLM90S	13/11/2023	14/11/2023 00:17	ATC_RWY	14/11/2023 00:17	ATC	14/11/2023 00:22	14/11/2023 00:19	ATC	27	IBK	PHEXN	E75L	D31	D31	2023-11-14|	KLM NV
3	14/11/2023 00:18	KL1082	KLM90S	13/11/2023	14/11/2023 00:17	ATC_RWY	14/11/2023 00:17	ATC	14/11/2023 00:22			27	TAX	PHEXN	E75L	D31	D31	2023-11-14|	KLM NV

Figure 11: CDM Structure at KLM

Alert	Flight	Callsign	Fltst	SIBT	LDT	IBT	RWY	Stand	AcReg	Type	Handler
	KL0686	KLM686	IBK	02-15:10	14:48A	14:57A	18R	E09	PHBHE	789	KLM
	KL0744	KLM744	IBK	02-14:05	14:46A	14:58A	18R	E22	PHBVR	77W	KLM

Alert	Flight	Callsign	Fltst	Stand	SOBT	EOBT	TOBT	TSAT	ASRT	AOBT	CTOT	TOT	RWY
	KL0701		SCH	E09	02-21:00		21:00						
	KL0875	KLM875	SCH	E22	02-17:05	17:05	17:05	17:17				17:30T	24

Figure 12: CDM Structure at Schiphol APOC

7.3 The Extent of Information Matching Between Stakeholders

Due to the limited time, it is not possible to analyze all the information that each company receives. In this analysis, It have been delved into the dynamics of information flow among key aviation stakeholders concerning the Actual In-Block Time (AIBT) and the Estimated In-Block Time (EIBT) of a specific flight. The focus is on one day (13 November 2023), for one flight (kl1000), comparing how LVNL, KLM, and APOC receive and handle information updates related to (EIBT) and (AIBT).

Estimated In Block Time (EIBT) at LVNL

The first EIBT updated that LVNL system recived from the tower sysytem Electronic Flight Strips (EFS), commence at 04:50:00 AM and continue with receiving update information until the actual arrival time at 10:15:00 AM. The observed delay of about 5 hours from the initially estimated time raises concerns. The high frequency of 23 updates during this period suggests a dynamic and possibly challenging operational environment for this specific flight.

The EIBT as show in figure (13) went forward and backward. When looking at the informatio in the table that LVNL has, it shows that at 06:44 AM the Estimated In Block Time is 10:08 AM, then it later changes at 07:42 Am to become 10:02 AM, and then later at 08:11 AM the expected time becomes 09:21.

		UTC+1	data source			
		LVNL				
13/11/2023	KLM1000	clock time change	EIBT	AIBT	ELDT	ALDT
		13/11/2023 3:50			13/11/2023 7:15	
		13/11/2023 3:50	13/11/2023 7:25		13/11/2023 7:15	
		13/11/2023 4:28	13/11/2023 7:25		13/11/2023 7:15	
		13/11/2023 4:28	13/11/2023 9:15		13/11/2023 9:05	
		13/11/2023 4:30	13/11/2023 9:15		13/11/2023 9:05	
		13/11/2023 4:36	13/11/2023 9:37		13/11/2023 9:27	
		13/11/2023 4:53	13/11/2023 9:32		13/11/2023 9:22	
		13/11/2023 6:16	13/11/2023 9:32		13/11/2023 9:22	
		13/11/2023 6:25	13/11/2023 10:03		13/11/2023 9:53	
		13/11/2023 6:44	13/11/2023 10:08		13/11/2023 9:58	
		13/11/2023 7:42	13/11/2023 10:02		13/11/2023 9:52	
		13/11/2023 8:03	13/11/2023 9:21		13/11/2023 9:11	
		13/11/2023 8:11	13/11/2023 9:21		13/11/2023 9:11	
		13/11/2023 8:11	13/11/2023 9:18		13/11/2023 9:08	
		13/11/2023 8:29	13/11/2023 9:15		13/11/2023 9:05	
		13/11/2023 8:29	13/11/2023 9:13		13/11/2023 9:05	
		13/11/2023 8:29	13/11/2023 9:13		13/11/2023 9:05	
		13/11/2023 8:29	13/11/2023 9:16		13/11/2023 9:08	
		13/11/2023 8:35	13/11/2023 9:14		13/11/2023 9:06	
		13/11/2023 8:35	13/11/2023 9:16		13/11/2023 9:08	
		13/11/2023 8:41	13/11/2023 9:15		13/11/2023 9:07	
		13/11/2023 8:42	13/11/2023 9:16		13/11/2023 9:08	
		13/11/2023 8:47	13/11/2023 9:16		13/11/2023 9:08	
		13/11/2023 8:55	13/11/2023 9:16		13/11/2023 9:08	
		13/11/2023 9:01	13/11/2023 9:14		13/11/2023 9:06	
		13/11/2023 9:03	13/11/2023 9:14		13/11/2023 9:06	
		13/11/2023 9:04	13/11/2023 9:14		13/11/2023 9:06	
		13/11/2023 9:07	13/11/2023 9:15		13/11/2023 9:07	
		13/11/2023 9:08	13/11/2023 9:15		13/11/2023 9:07	
		13/11/2023 9:08	13/11/2023 9:15		13/11/2023 9:07	
		13/11/2023 9:15	13/11/2023 9:15	9:15:00 AM	13/11/2023 9:07	13/11/2023 9:07

local time						
KLM						
clock time change	EIBT	AIBT	ELDT	ELDT Sources	ALDT	ALDT Sources
13/11/2023 10:15	13/11/2023 10:15	13/11/2023 10:15	13/11/2023 10:07	ATC_RWY	13/11/2023 10:07	ATC
13/11/2023 10:08	13/11/2023 10:15		13/11/2023 10:07			
13/11/2023 10:07	13/11/2023 10:15		13/11/2023 10:07			
13/11/2023 10:04	13/11/2023 10:14		13/11/2023 10:06			
13/11/2023 10:03	13/11/2023 10:14		13/11/2023 10:06			
13/11/2023 10:01	13/11/2023 10:14		13/11/2023 10:06			
13/11/2023 09:55	13/11/2023 10:16		13/11/2023 10:08			
13/11/2023 09:47	13/11/2023 10:16		13/11/2023 10:08			
13/11/2023 09:42	13/11/2023 10:16		13/11/2023 10:08			
13/11/2023 09:41	13/11/2023 10:15		13/11/2023 10:07			
13/11/2023 09:35	13/11/2023 10:16		13/11/2023 10:08			
13/11/2023 09:35	13/11/2023 10:14		13/11/2023 10:06			
13/11/2023 09:29	13/11/2023 10:15		13/11/2023 10:07			
13/11/2023 09:28	13/11/2023 10:20		13/11/2023 10:12			
13/11/2023 09:09	13/11/2023 10:10		13/11/2023 10:02			
13/11/2023 07:16	13/11/2023 09:32		13/11/2023 09:24			
13/11/2023 07:15	13/11/2023 09:32		13/11/2023 09:24			
13/11/2023 07:12	13/11/2023 10:15		13/11/2023 10:07			
13/11/2023 05:53	13/11/2023 10:30		13/11/2023 10:22			
13/11/2023 05:36	13/11/2023 10:35		13/11/2023 10:27			
13/11/2023 05:28	13/11/2023 10:13		13/11/2023 10:05			
13/11/2023 04:50	13/11/2023 09:00		13/11/2023 08:52			

Figure 13: CDM Data (EIBT, AIBT, ELDT and ALDT) comparing between LVNL and KLM

The forward and backward adjustments in the EIBT suggest that there may be operational complexities or uncertainties affecting the flight. These complexities could be related to air traffic management, weather conditions, airport operations, or other factors.

If there are rapid and non-sequential adjustments to the EIBT, it could lead to communication challenges among different stakeholders. Airlines, ground handling services, air traffic control, and other involved parties may need to adapt quickly to changes, and effective communication is crucial to manage the situation.

Actual In Block Time (AIBT) at LVNL

AIBT for an arrival flight is the total time the aircraft is within the airport's block (parking) area from the moment it arrives until the engines are shut down and the aircraft is ready for disembarkation. The In Block Time is composed of ALDT+ taxi Time.

Air traffic control (LVNL) uses radar systems to track the position of aircraft in real-time. The radar data provides information about the aircraft's altitude, speed, and location. The moment the aircraft's landing gear touches the runway is considered the actual landing time. LVNL shares ALDT with various stakeholders, including airlines, ground services, and Schiphol Airport

The taxi times on the day of execution is initially a default value. As soon as the arrival runway and arrival gate become known, a specific taxi time is linked to that combination. These times come from the LVNL tower sysytem (EFS).

EIBT and AIBT information at KLM

Turning the attention to EIBT data at KLM, a similar update timeline is observed, with the first update at 04:50:00 AM, aligning with LVNL's initial update. Despite KLM receiving a slightly lower frequency of updates (21 times), the analysis concludes that both companies receive timely and ongoing information about the flight. However, a noteworthy issue arises—the significant disparity between EIBT and AIBT.

KLM itself also has a real-time system called FIRDA. KLM-specific items that it used within the company can be entered here. FIRDA is also linked to CISS Schiphol system , they can send data back and forth.

So CISS can send taxi times to FIRDA and FIRDA can send, for example, TOBT times to CISS. (other ground handlers set their TOBT directly in the CISS, only KLM does it to FIRDA who forwards it to CISS). Appendix (1) shows the information in the FIRDA system about flight KL1000.

The taxi time in this example for the flight KL1000 was as recording by KLM 8 mintes, ALDT was at 10:07, so 10:07 + 8 mintes it gives the AIBT which is at 10:15. as shwo in the table the all data are correct in alle three parties. The diffrence lies in the number of updates information and the time at which each receives these updates.

This time gap can lead to a cascade of problems:

- Planning based on EIBT may cause disruptions if the actual time significantly deviates.
- Allocating resources based on the estimated schedule may lead to inefficiencies.
- Significant delays can inconvenience passengers and disrupt service management.
- Delays can result in added operational costs for airlines (KLM) and Schiphol airport.
- Substantial delays can contribute to air traffic congestion, affecting subsequent flights.
- Coordinating activities becomes complex when deviations occur.
- Delays negatively impact the reputation of KLM and Schiphol airport.
- KLM may face compliance issues and potential fines due to significant delays.

7.4 Discussion Shared Information

Considering the shared AIBT between LVNL and KLM, it becomes evident that both entities receive consistent information. However, a deeper dive int' APOC's system reveals a limitation—it lacks updated EIBT information and relies solely on the latest update received from CISS system at Schiphol. This constraint hinders a comprehensive analysis and comparison with other stakeholders.

The Actual In-Block Time (AIBT) received by KLM and APOC aligns precisely with the information provided by LVNL. This correlation is attributed to the fact that KLM derives its information directly from LVNL. Consequently, the primary focus of this analysis shifts to scrutinizing the accuracy and reliability of the information held by LVNL.

It is concludede here that the ground control information, encompassing details like taxi time and other ground-related aspects, is primarily provided by air traffic ground controllers. Their task is overseeing aircraft movements on the ground, including taxiing to and from runways, gates, and different areas within the airport.

Key functions of ground controllers include issuing precise taxi instructions to pilots, outlining the designated route for the aircraft's ground movement. They actively monitor the movements of aircraft on the ground, ensuring adherence to prescribed routes and promptly reporting any irregularities or potential conflicts.

In essence, LVNL emerges as a pivotal authority responsible for ground control services at Schiphol Airport. Stakeholders, including pilots and ground services, rely on LVNL's information and instructions to facilitate the seamless operation of aircraft movements on the ground.

An examination of the accuracy and reliability of the information within LVNL's dataset can be conducted through the following steps:

- The AIBT received by KLM and APOC can be cross-checked with the corresponding information in LVNL's dataset to ensure accurate matching of timestamps.

- The AIBT provided by LVNL can be compared with the ground truth or actual arrival time of the flight, involving a review of airport records, official reports, or other authoritative sources independently verifying the actual arrival time.

- An analysis of the historical performance of LVNL's data accuracy can be carried out by reviewing past instances of AIBT and comparing them with the actual arrival times, with a focus on identifying patterns or trends indicating consistency or potential discrepancies.

- Communication logs between LVNL and KLM can be examined to ensure that information flow is consistent, with a focus on identifying any communication breakdowns or misinterpretations leading to inaccuracies.

- Collaboration with other stakeholders, such as KLM and APOC, can be initiated to gather insights into their experiences with the data provided by LVNL, seeking feedback on the reliability of LVNL's information from those who directly utilize it.

- If discrepancies are identified, a root cause analysis can be conducted to understand why inaccuracies may have occurred, involving a review of the processes, systems, and communication channels involved in transmitting and recording AIBT.

- Evaluation of the existing quality assurance measures in place within LVNL for data validation and verification can be carried out, with a focus on identifying any gaps in these measures and proposing improvements if necessary.

- External auditors or experts in aviation data analysis can be involved to provide an unbiased assessment of LVNL's data accuracy and reliability.

- Continuous monitoring mechanisms can be implemented to track the accuracy of LVNL's data over time, with the establishment of protocols for regular reviews and updates to ensure ongoing data quality.

Through the systematic implementation of these steps, a comprehensive understanding of the accuracy and reliability of the information within LVNL's dataset can be obtained, and areas for improvement can be identified if needed. This examination should be approached with attention to detail and a commitment to enhancing data quality over the long term.

8. Finding Recommendation

Based on interviews with experts from stakeholders LVNL, KLM, and Schiphol APOC, as well as research findings, the following recommendations are suggested:

1. Shared Communication Platforms:

The shared communication platforms are recommended based on identified issues in chapter (6), such as operational misalignments, a lack of collaborative decision-making, and deficiencies in timely information sharing. These challenges hinder effective decision-making and operational efficiency at Schiphol APOC. Shared Communication Platforms are proposed to address these issues by enabling better data sharing and collaboration among key stakeholders like LVNL, KLM, and Schiphol APOC.

The collaborative process is fundamental for successful airport operations. Whether the airport is operating at full capacity or experiencing fluctuations, bringing together all stakeholders at the outset facilitates a comprehensive assessment. Through collective efforts, insights into system vulnerabilities can be gained. It is crucial for stakeholders to collectively educate themselves, establish shared objectives, and align their focus not as individual entities but as integral parts of the entire system. Each stakeholder should understand and communicate how their involvement enhances overall system performance, emphasizing the significance of their contribution. This shared understanding promotes active engagement.

In parallel with fostering collaboration, the establishment of shared communication platforms is essential. This involves creating channels or platforms where stakeholders can exchange real-time information. A centralized digital platform accessible to all parties involved can facilitate efficient communication.

2. Joint Planning Sessions:

One of the key finding problems found in chapter (6) was that stakeholders work in disconnected approaches and operating in solitude, these sessions are crucial in the planning process to overcome this issue of disjointed operations. Achieving unanimity on objectives and expectations is crucial. This involves defining and gaining consensus on strategic objectives and establishing key performance indicators (KPIs). These sessions, scheduled in advance, align operational plans. Stakeholders discuss preparation timelines, identify dependencies, and coordinate efforts to streamline the planning process.

Time	Agenda Item	Discussion Points
09:00 - 09:15	Welcome and Overview	Introduction of participants, overview of the agenda, and confirmation of the session objectives.
09:15 - 09:45	Individual Preparation	Representatives from APOC, LVNL, and KLM share their individual preparation timelines, highlighting key milestones and processes.
09:45 - 10:30	Identifying Dependencies	Discuss and identify interdependencies between the operational plans of APOC, LVNL, and KLM. Explore areas where collaborative efforts can enhance efficiency.
10:30 - 11:15	Coordination of Efforts	Brainstorm strategies for coordinating efforts, especially in areas such as runway usage, capacity planning, and response to unforeseen events.

11:15 - 11:45	Streamlining the Planning Process	Evaluate current planning processes and explore opportunities for streamlining to reduce redundancy and improve overall effectiveness.
11:45 - 12:00	Break	Brief break for participants to refresh.
12:00 - 12:45	Collaborative Decision-Making	Discuss mechanisms for collaborative decision-making, including communication protocols and information exchange mechanisms.
12:45 - 13:30	Action Items and Responsibilities	Define specific action items arising from the discussion and allocate responsibilities to each stakeholder for implementation.
13:30 - 14:00	Future Planning	Explore opportunities for future joint planning sessions, including frequency, format, and additional stakeholders who may benefit from participation.

Table 7: Proposed Planning Sessions between stakeholders

The plan in table (7) can be implemented considering that the frequency of joint planning sessions among APOC Schiphol, air traffic control (LVNL), and KLM Airline would depend on the stakeholders' requirements and various factors, including the complexity of operations, the need for coordination, and any related changes.

3. Clear Responsibilities and Timelines:

Clear responsibilities and timelines is recommended based on identified operational challenges at Schiphol APOC, such issues present in chapter (6) like misaligned processes among stakeholders, delays in information sharing, or inefficiencies in decision-making. By establishing clear responsibilities and timelines. By clearly outline tasks, deadlines, and dependenciesthe, APOC aims to improve coordination, enhance the timeliness and accuracy of information exchange, and streamline operations. This approach is crucial for ensuring efficient and safe airport management, particularly in complex and dynamic environments like Schiphol Airport.

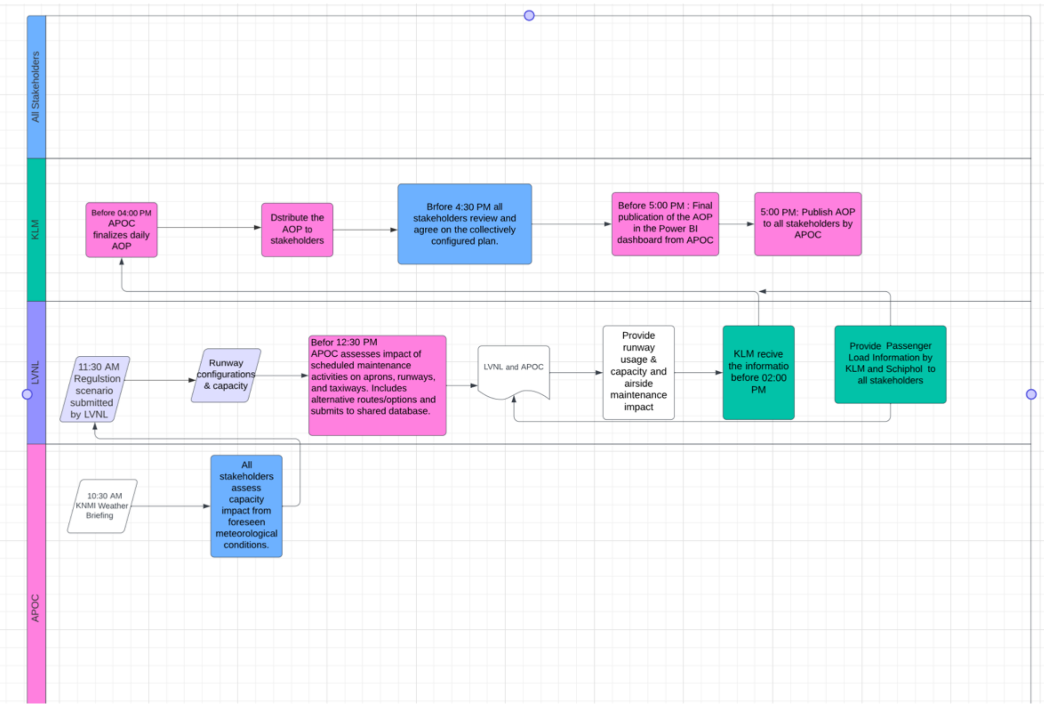


Figure 14: Proposed process of collective preparation between stakeholders.

Proposed process and timeline of Information for collective preparation:

At 10:30 AM, Schiphol APOC convenes a gathering of all stakeholders. The purpose is to collectively assess the capacity impact due to the day's meteorological conditions, a crucial step in preempting any disruptions that the whims of weather might impose.
LVNL submit their 'Regulation scenario' at 11:30 AM. This scenario is a strategic plan that outlines the day's runway configurations and capacities, considering the safe and efficient flow of air traffic.

Before 12:30 PM Schiphol APOC review the potential impacts of planned maintenance activities. These activities, vital for the safety and integrity of the airport infrastructure, include works on aprons, runways, and taxiways.
Alternative routes and options are considered, and a consensus is reached on the best course of action, which is then recorded in a shared database for all to access. APOC finalizes its AOP by 4:00 PM, which is essential in aligning the airline's operations with the day's overall airport strategy.

By 4:30 PM, it's time for a critical review as all stakeholders over the proposed plans. Together, they review and agree on the collectively configured plan, ensuring that all pieces of the operational puzzle fit perfectly together.
The crescendo of the day's planning comes just before 5:00 PM when APOC publishes the final version of the AOP.
It is an optimized, data-driven blueprint of the day's operations, displayed on the Power BI dashboard.
Lastly, as a closing act, APOC disseminates the AOP to all stakeholders by 5:00 PM as a final publish.

4. Cross-Training Initiatives:

Implement cross-training initiatives where representatives from APOC Schiphol, air traffic control, and KLM Airline gain insights into each other's operational requirements.
This cross-training enhances understanding, encourages, and promotes a collaborative mindset, leading to more effective planning.

5. Continuous Improvement Feedback Loop:

Establish a continuous improvement feedback loop where stakeholders regularly evaluate the effectiveness of the collaborative planning process. This approach is proposed to address issues related to the timeliness, accuracy, and efficiency of information exchange. Encourage open communication for feedback and suggestions, allowing stakeholders to adapt and refine their approaches based on shared experiences.

6. Common Data Sources:

The common data sources at Schiphol APOC stems is recommended from identified challenges in information sharing and data consistency among stakeholders. These challenges include discrepancies in the availability, accuracy, and timeliness of critical operational data. By implementing common data sources, Schiphol APOC aims to address these issues, ensuring that all stakeholders have access to consistent and reliable information, which is crucial for effective operational planning and decision-making. This approach facilitates better coordination, reduces operational inefficiencies, and enhances overall Schiphol airport performance.

The following table outlines key data points and their sources:

Data Point	Common Data Source
Weather Information	Meteorological Agency (KNMI)
Runway Configuration	Air traffic control (LVNL)
Airside Maintenance Activities	Airport Operations Center (APOC)
Flight Schedules	Airlines (e.g., KLM)
Passenger Load Information	Airlines and Airport Authorities
Regulation Scenarios	Air traffic control (LVNL)
Capacity Projections	Air traffic control (LVNL)

Table 8: Common Data Sources between stakeholders

By implementing these collaborative strategies, APOC Schiphol, LVNL and KLM Airline can create a more integrated and fine-tuned operational planning process, fostering cooperation and improving overall Schiphol airport performance.

9.Discussion

This chapter presents a comprehensive discussion of the findings from the research, focusing on the analysis of critical aspects and implications of effective information exchange and collaboration among the key stakeholders (Schiphol APOC, KLM, and LVNL). The transformative role of technology in communication, which significantly improves the speed, accuracy, and reliability of information vital for operational planning, is underscored in the study.

The identification of gaps in the availability and quality of airside information at Schiphol APOC stands out as a crucial discovery of the study. These gaps directly impact the operational efficiency and decision-making processes at Schiphol Airport. A more integrated approach in information sharing and data exchange protocols among stakeholders is suggested due to the lack of complete airside information availability at Schiphol APOC.

Insights into the nature of data sources used by stakeholders, especially focusing on airside operations like runways, taxiways, and aprons, are provided by the research. The importance of data accuracy, reliability, timeliness, and consistency has been revealed through a thorough examination of these data sources. The quality of data used by Schiphol APOC is emphasized as fundamental for effective operational planning and the smooth functioning of airport operations.

Contributions to the existing theoretical framework are made by the research, enriching it with practical insights into data quality and sharing in airport operations. Valuable guidance for stakeholders like Schiphol APOC, KLM, and LVNL is provided, bridging the gap between theory and practice. Actionable strategies for enhancing efficiency, safety, and collaborative decision-making in airport operations are offered by the research.

LVNL is highlighted as serving as a foundational source of information on which stakeholders rely. The provision of crucial data regarding air traffic management, real-time operational conditions, and resource availability by LVNL is indispensable for the overall operational framework of Schiphol Airport.

The research is portrayed as a narrative of progress, a confluence of theory and practice, and a harbinger of a more collaborative, efficient, and informed future in airport operations management.

10. Conclusion

The research highlighted the critical role of effective information exchange and collaboration among Schiphol APOC, KLM and Air Traffic Control the Netherlands (LVNL). The study reveals that delays and operational inefficiencies are often a result of gaps or delays in information sharing.
The integration of technology in communication has been a key enabler, improving the speed, accuracy, and reliability of information crucial for operational planning. The research identified and compared various airside data sources, such as runways, taxiways, and aprons data, from LVNL, Schiphol APOC and KLM.

The research suggests that joint operational planning sessions, establishment of common communication platforms, and harmonizing data management approaches can significantly improve efficiency and reduce operational discrepancies.
The outcomes of this research offer practical insights that could inform strategic decisions, enhance collaboration among stakeholders, and contribute to overall operational improvement at Schiphol Airport. A significant issue identified is the identification of gaps in the availability and quality of airside information at Schiphol APOC. The study emphasized the importance of the quality of data and raised concerns about the mechanisms of data sharing among stakeholders.

The main research question is: "What available data do stakeholders possess that APOC requires and what constitutes the most valuable data for operational planning and decision-making processes at Amsterdam Airport Schiphol?". Based on the outcomes, the research have addressed this question effectively by:

1. Identifying available data: The study identified the types of data available to stakeholders and their relevance to Schiphol APOC's operational planning needs.
2. Evaluating data quality: The research evaluated the quality of the data in terms of accuracy, reliability, and timeliness, which are crucial for operational planning.
3. Determining the sources of data: The study assessed which data sources were most valuable for Schiphol APOC's decision-making processes, helping to refine and prioritize information flow for more effective operational planning.

The research contributes new understanding by performing a gap analysis between the data currently received by Schiphol APOC and the data required for optimal operations, shedding light on specific areas where improvements are needed.

After looking at the data sources, this research shows that the LVNL has a basic source of information that stakeholders rely on. LVNL's provision of crucial data regarding air traffic management, real-time operational conditions, and resource availability makes it a foundational source of information. Therefor steps for examination of the accuracy and reliability of the information within LVNL dataset have been proposed.
This research enriches the existing theoretical framework with practical insights into data quality and sharing in airport operations, offering valuable guidance for the stakeholders Schiphol APOC, KLM, and LVNL. It bridges the gap between theory and practice, providing actionable strategies for enhancing efficiency, safety, and collaborative decision-making in airport operations.

The findings go beyond academic discourse, offering practical insights that can redefine how airport operations centers, like Schiphol APOC, interact with and utilize data. The implications of the study are far-reaching, extending a blueprint for enhanced collaboration and decision-making in complex operational environments. This research is a clarion call to all stakeholders in the aviation sector to acknowledge and embrace the power of shared knowledge and integrated operations.

11. Future Research and Recommendation

The recommendations derived from this thesis highlight several focused areas for future research and development, each aimed at enhancing operational efficiency, safety, and strategic planning at Amsterdam Airport Schiphol.

- One key area involves investigating the creation and application of more secure and efficient data-sharing protocols among airport stakeholders. This includes assessing the feasibility and benefits of using blockchain technology for data integrity and transparency in airport operations, possibly through pilot projects testing blockchain-based systems for specific data types like flight schedules or maintenance records. Additionally, exploring and implementing state-of-the-art encryption methods for secure data transfer, particularly for sensitive information such as passenger data or security protocols, is essential.

  Blockchain technology in Air Traffic Management (ATM) offers a decentralized approach for reliable access to real-time air traffic data, enhancing transparency, coordination, and security among stakeholders. Its immutable and secure nature ensures data integrity and prevents tampering, while smart contracts automate critical decisions for efficient air traffic distribution and management.

  This system fosters collaborative and standardized global practices in ATM, significantly improving efficiency and safety in air travel. Studying the effects of these new protocols on decision-making speed and efficiency at APOC, using metrics like response times to operational changes or the accuracy of decision-making, is also recommended. (Airport-technology, n.d.)

- Harnessing the power of AI and machine learning for real-time data processing and analysis is another vital area. This encompasses developing machine learning algorithms for predictive analytics to anticipate airport operational needs like passenger flow or resource allocation. It could involve analyzing historical data to forecast future trends.

  Machine learning can be used to anticipate air traffic congestion and suggest alterations to flight schedules to minimize delays. AI can help in dynamic allocation of gates and ground services based on real-time flight data, weather conditions, and airport traffic, leading to smoother operations. AI can also process vast amounts of data to identify the most efficient flight paths, reducing fuel consumption and delays. (Interactive.aviationtoday, n.d.)

- Broadening the research to include more stakeholders in the airport ecosystem is also essential. This involves analyzing how the inclusion of data from ground handling services, security agencies, and other airlines impacts overall airport efficiency and safety.

  Exploring the dynamics of stakeholder collaboration during emergency situations or irregular operations through case studies or simulations can help understand the efficacy of information sharing under stress.

- Finally, making a comparison between the data sharing and operational planning strategies of Amsterdam Airport Schiphol with other leading airports globally could provide valuable insights. Understanding what other airports are doing right can help identify best practices in data sharing and operational planning, which Schiphol can adapt or adopt to improve its own operations.

By comparing strategies, Schiphol can learn about innovative approaches and technologies that have been successful elsewhere and consider their applicability in its own context. This comparative analysis should identify best practices and innovative approaches in data sharing and operational planning, determining how these practices can be adapted or implemented at Schiphol, considering the unique operational context of each airport.

By pursuing these specific areas of investigation, Schiphol and similar airports can enhance their operational efficiency, safety, and strategic planning, potentially setting new standards in airport operations globally. These investigations not only offer actionable insights for Amsterdam Airport Schiphol and its stakeholders but also contribute significantly to the broader field of aviation management and operations.

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13. Appendix

Appendix 1: The FIRDA system Information about flight KL1000.

FlightEventCode	FlightEventMessageTimeUtc	FlightEventMessageTimeLocal	FlightEventTimeUtc	FlightEventTimeLocal	FlightEventInfo	Sequence	SequenceReversed
ETA	2023-11-13 06:12:28.790	2023-11-13 07:12:28.790	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	NULL	1	12
EBAE	2023-11-13 06:12:28.790	2023-11-13 07:12:28.790	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	NULL	1	3
EBAE	2023-11-13 06:15:28.160	2023-11-13 07:15:28.160	2023-11-13 08:32:00.000	2023-11-13 09:32:00.000	NULL	2	2
ETA	2023-11-13 06:15:28.160	2023-11-13 07:15:28.160	2023-11-13 08:32:00.000	2023-11-13 09:32:00.000	NULL	2	11
EBDE	2023-11-13 06:15:28.190	2023-11-13 06:15:28.190	2023-11-13 07:30:00.000	2023-11-13 07:30:00.000	NULL	1	1
CDC	2023-11-13 06:17:00.000	2023-11-13 06:17:00.000	2023-11-13 06:17:00.000	2023-11-13 06:17:00.000	NULL	1	1
PDC	2023-11-13 07:20:00.000	2023-11-13 07:20:00.000	2023-11-13 07:20:00.000	2023-11-13 07:20:00.000	NULL	1	1
ADC	2023-11-13 07:20:00.000	2023-11-13 07:20:00.000	2023-11-13 07:20:00.000	2023-11-13 07:20:00.000	NULL	1	1
EBAE	2023-11-13 08:09:14.360	2023-11-13 09:09:14.360	2023-11-13 09:10:00.000	2023-11-13 10:10:00.000	NULL	3	1
ETA	2023-11-13 08:09:14.360	2023-11-13 09:09:14.360	2023-11-13 09:10:00.000	2023-11-13 10:10:00.000	NULL	3	10
EBD	2023-11-13 08:11:00.000	2023-11-13 08:11:00.000	2023-11-13 08:11:00.000	2023-11-13 08:11:00.000	NULL	1	1
EBDA	2023-11-13 08:11:46.500	2023-11-13 08:11:46.500	2023-11-13 08:11:00.000	2023-11-13 08:11:00.000	NULL	1	1
EBAT	2023-11-13 08:28:58.740	2023-11-13 09:28:58.740	2023-11-13 09:20:00.000	2023-11-13 10:20:00.000	NULL	1	7
ETA	2023-11-13 08:28:58.740	2023-11-13 09:28:58.740	2023-11-13 09:20:00.000	2023-11-13 10:20:00.000	NULL	4	9
ABT	2023-11-13 08:28:59.050	2023-11-13 08:28:59.050	2023-11-13 08:28:00.000	2023-11-13 08:28:00.000	NULL	1	1
EBAT	2023-11-13 08:29:02.340	2023-11-13 09:29:02.340	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	NULL	2	6
ETA	2023-11-13 08:29:02.340	2023-11-13 09:29:02.340	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	NULL	5	8
ETA	2023-11-13 08:29:07.020	2023-11-13 09:29:07.020	2023-11-13 09:20:00.000	2023-11-13 10:20:00.000	NULL	6	7
EBAT	2023-11-13 08:29:07.020	2023-11-13 09:29:07.020	2023-11-13 09:20:00.000	2023-11-13 10:20:00.000	NULL	3	5
ETA	2023-11-13 08:35:41.750	2023-11-13 09:35:41.750	2023-11-13 09:14:00.000	2023-11-13 10:14:00.000	NULL	7	6
EBAT	2023-11-13 08:35:41.750	2023-11-13 09:35:41.750	2023-11-13 09:14:00.000	2023-11-13 10:14:00.000	NULL	4	4
EBAT	2023-11-13 08:35:42.090	2023-11-13 09:35:42.090	2023-11-13 09:16:00.000	2023-11-13 10:16:00.000	NULL	5	3
ETA	2023-11-13 08:35:42.090	2023-11-13 09:35:42.090	2023-11-13 09:16:00.000	2023-11-13 10:16:00.000	NULL	8	5
EBAT	2023-11-13 08:36:26.020	2023-11-13 09:36:26.020	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	NULL	6	2
ETA	2023-11-13 08:36:26.020	2023-11-13 09:36:26.020	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	NULL	9	4
ETA	2023-11-13 08:42:42.280	2023-11-13 09:42:42.280	2023-11-13 09:16:00.000	2023-11-13 10:16:00.000	NULL	10	3
EBAT	2023-11-13 08:42:42.280	2023-11-13 09:42:42.280	2023-11-13 09:16:00.000	2023-11-13 10:16:00.000	NULL	7	1
ETA	2023-11-13 09:01:49.280	2023-11-13 10:01:49.280	2023-11-13 09:14:00.000	2023-11-13 10:14:00.000	NULL	11	2
EBAF	2023-11-13 09:01:49.280	2023-11-13 10:01:49.280	2023-11-13 09:14:00.000	2023-11-13 10:14:00.000	NULL	1	2
EBAF	2023-11-13 09:07:46.300	2023-11-13 10:07:46.300	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	NULL	2	1
ETA	2023-11-13 09:07:46.300	2023-11-13 10:07:46.300	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	NULL	12	1
EBAR	2023-11-13 09:08:57.530	2023-11-13 10:08:57.530	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	NULL	1	1
TDT	2023-11-13 09:09:00.560	2023-11-13 10:09:00.560	2023-11-13 09:07:00.000	2023-11-13 10:07:00.000	NULL	1	1
EBA	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	2023-11-13 09:15:00.000	2023-11-13 10:15:00.000	NULL	1	1
ADO	2023-11-13 09:17:00.000	2023-11-13 10:17:00.000	2023-11-13 09:17:00.000	2023-11-13 10:17:00.000	NULL	1	1
CDO	2023-11-13 09:17:00.000	2023-11-13 10:17:00.000	2023-11-13 09:17:00.000	2023-11-13 10:17:00.000	NULL	1	1
PDO	2023-11-13 09:18:00.000	2023-11-13 10:18:00.000	2023-11-13 09:18:00.000	2023-11-13 10:18:00.000	NULL	1	1