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# Airport Operations Centre Amsterdam Airport Schiphol

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# Content

# Abbreviations

| ACRONYM | DESCRIPTION |
|---|---|
| *AAS* | Amsterdam Airport Schiphol |
| *ANSP* | Air Navigation Service Provider |
| *AOP* | Airport Operations Plan |
| *APOC* | Airport Operations Centre |
| *CDM* | Collaborative Decision-Making |
| *DCB* | Demand and Capacity Balancing |
| *IM* | Information Manager |
| *KDC* | Knowledge Development Centre |
| *KLM* | Koninklijke Luchtvaart Maatschappij |
| *KPI* | Key Performance Indicator |
| *LVNL* | Luchtverkeersleiding Nederland |
| *NLR* | Nederlands Lucht- en Ruimtevaartcentrum |
| *NMOC* | Network Manager Operations Centre |
| *NOP* | Network Operations Plan |
| *PCP* | Pilot Common Project |
| *SEAC* | SESAR European Airports Consortium |
| *SESAR* | Single European Sky ATM Research |
| *TAM* | Total Airport Management |
| *WP* | Work Package |

# 1 About this study

In this chapter the background of the KDC APOC study, its planning and deliverables as well as the SESAR APOC concept is elaborated.

## 1.1 Background

In the scope of the SESAR Pilot Common Project (PCP) and ongoing trends at European airports, the concept of Airport Operation Centre (APOC) has been elaborated and specified. Schiphol initiated the start of its APOC 2.0 in August 2020.
The focus of an APOC is on performance-based operations. APOC steers, monitors and manages airport performances and proactively identifies and mitigates possible capacity constraints or disruptions.
The airport operation management is a collaborative process in which airport stakeholders take part in the decision-making process with regard to airport processes that affect multiple stakeholders. The decision-making process comprises scenario-based planning in normal as well as in disrupted operations.

The Knowledge Development Centre (KDC) has initiated an assignment to assist Amsterdam Airport Schiphol (AAS) in creating a methodology for decision-making in the APOC from day minus three (D-3) to day of operations (D-0). This results in an initial decision model for Schiphol's APOC and includes an initial draft of roles and responsibilities for other airport stakeholders, such as KLM, LVNL and ground handling agents.

## 1.2 The SESAR APOC concept

The APOC is a (service-oriented) platform in which multiple airport stakeholders can pro-actively steer, monitor and manage the performance of the present and short-team airport operations. This includes airlines, ground handlers and Air Navigation Service Providers (ANSP). The APOC provides all relevant stakeholders with insights in the operational overview (situational awareness) of the airport and allows them to communicate, coordinate and collaborate their activities. The main deliverable in the APOC is the Airport Operations Plan (AOP). This is a, within the APOC commonly agreed, rolling (operations) plan and is available for all airport stakeholders. The main purpose of the AOP is to have effective airport operations and positively affect situational awareness. The AOP is also one of the fundamental pillars of collaborative decision-making.

At the beginning of each season – both for summer and winter – an initial AOP is determined. Both seasons have seasonal characteristics like: de-icing procedures and snow during winter, and high passenger demands during summer. The initial AOP for each season starts at D-180. This includes among other things opening hours (curfew), initial runway capacity, terminal capacity, baggage handling capacity and the expected maintenance programme. Over the season this initial AOP will be iterated, based on e.g., upcoming bottlenecks, demand-and-capacity balancing and input from the Network. Therefore, the AOP is a rolling plan, which becomes more accurate towards D-0. The APOC scope of an AOP may vary, but a D-7 approach is common.

The role of the APOC is, besides managing and supervising the AOP, to handle day to day operations and continuously balancing airport demand and capacity and anticipate on imbalances due to possible disruptions or events. In this day-to-day period (for Schiphol set to D-1/D0) quick analysis of possible disruptions or events need to be executed. The resulting actions, if necessary, can be seen as mitigative or corrective for airport disruptions depending on the moment of detection. Within the APOC the proposed actions could be widely discussed by different stakeholders. It is recommended to initiate this decision-making if bilateral discussions are not sufficient. The goal is to find support for solutions that avoid/reduce the impact of disruptions on the airport performance without too many negative effects on the operations of one single stakeholder. Maintaining or restoring airport performance is key.

The roles and responsibilities in an APOC organisation should be well-defined. There could be (multiple) roles and responsibilities for the airport operator, the airspace users, the (local) ANSP and ground handling agents. It should be noted that the roles within an APOC are not restricted to those stakeholders (e.g., KNMI could also be involved). In case of a commonly agreed decision between stakeholders cannot be made, it could be possible to consult an APOC supervisor to decide.

Depending on local conditions, the APOC implementation can be either centralised - in which all relevant stakeholders participate physically in a room, or decentralised ('online'). A combination is also possible.

Within the APOC four different services are foreseen. The services are described in the following Table 1.1.

*Table 1.1: generic overview of the APOC services*

| Service | Description |
|---|---|
| **Steer Airport Performance** | In this service the performance standards (goals, targets, rules, threshold etc.) are determined. It provides an – stakeholder agreed – overall strategic direction. The steer service is mainly active on medium-term and long-term planning. Typically this service is executed prior to a new season. The performance standards are refined to the intended situation. |
| **Monitor Airport Performance** | In this service, airport operations surveillance is performed. It determines continuously and in real-time the airport performance (against target KPIs and goals) and therefore increases situational awareness of stakeholders. It is mainly active in the medium-term planning towards, and including, the execution phase (D-1/D0). |
| **Manage Airport Performance** | In the manage service real-time operational data is compared with performance standard defined in the steer service. In case of a disruption, the manage service initiates the assessment of the disruption. This has to result in (commonly accepted) mitigation action. |
| **Post-operations Analysis** | This service, also known as 'post ops', determines whether: (1) disruptions with respect to performance standards took place, (2) the performance plan is still actual, (3) improvements with regard to airport operations are necessary, (4) mitigation were suitable to solve disruptions. |

## 1.3 Assignment and deliverables

The study contains three deliverables. The deliverables are briefly described in the following Table 1.2. This report is the final report KDC APOC.

*Table 1.2: overview of Assignment and deliverables*

| Deliverable | Format | Description |
|---|---|---|
| **Interim report 1** | Report | The interim report provided a brief description of the current implementation of the AAS APOC.<br>The interim report discusses, among other things:<br>• Current and future roles within the APOC<br>• Development of the AOP (D-3 to D-1)<br>• Common disruptions and mitigations<br>• Planning AOP |
| **Interim report 2** | Presentation | After talking with various sector parties, this interim report focused on a first decision model. This model includes:<br>• Flow diagram of decision steps and decision process<br>• Link with current and future APOC roles |
| **Final report KDC APOC** | Report | The final report summarized the activities within all work packages. This report provides insight into, among other things:<br>• Roles in line with the proposed decision model<br>• Initial AAS APOC Decision Model |

## 1.4 Methodology

In this study both desk and field research are performed. The theoretical aspects of the APOC are investigated through literature studies of the SESAR APOC concept. On the other hand, the more practical implementation of APOC at Schiphol was investigated by having multiple interviews and interactive workshops with several sector parties. The following Table 1.3 contains the performed interactive sessions.

*Table 1.3: overview of the methodology for different study elements*

| Deliverable | Action | Stakeholders involved |
|---|---|---|
| **Interim report 1:**<br>Current AOP, (future) roles, AOP planning and common disruptions | Structured interviews with multiple operational experts at AAS. | Johan Blom (AAS)<br>Ewout Hiddink (AAS)<br>Suzan van Zutphen (AAS)<br>Nils Ijske (AAS)<br>Marnix Groenhof (AAS) |
| **Final report** | Structured interviews multiple interviews with Schiphol, LVNL and KLM in order to gather insights in their view on APOC Decision Making. | Rob de Kok (KLM)<br>Desire van Gils (KLM)<br>David Zwaaf (LVNL)<br>Johan Blom (AAS) |
| **Final report** | Workshop about initial Decision Model. During this workshop, participants worked several use cases and discussed how they would approach the problem with APOC Decision Making in mind. | Rob de Kok (KLM)<br>Desire van Gils (KLM)<br>David Zwaaf (LVNL)<br>Johan Blom (AAS)<br>Marnix Groenhof (AAS)<br>Ronald Grosmann (NLR) |

# 2 APOC at Amsterdam Airport Schiphol

## 2.1 Introduction

In 2019 AAS started their APOC program with success. In 2020 Schiphol became one of the first airports in Europe that initiated a live APOC. In the first year of the APOC program the main attention went to development of APOC procedures, its physical location at Schiphol and organisational model. The APOC program foresees a certain growth model, where the APOC will be implemented and extended in iterative steps. Nowadays, the APOC publishes an AOP on a daily basis and is extending the time-scope from D-7 towards D-1. The next step is to include D-0 and D+1 (for post-ops). The APOC program is supported by a development team, responsible for the development of the APOC, and an operational team, which is currently mainly responsible for the creation of the AOP.

In this section both the APOC and AOP concept is briefly described. Subsequently the situation in the 'real' AAS APOC is highlighted. The roles and responsibilities, creation of the AOP, required data sources and best practices for the APOC are elaborated. The section is concluded with the most recent advantages and disadvantages of the current APOC.

## 2.2 APOC and AOP

The main AAS APOC findings are based on interviews with several AAS APOC team (development/operational) members. The questions of the interview were categorized in four categories: Process, Decision-Making, Stakeholders and APOC roles. The full interview plan can be found in Appendix A (written in Dutch).

In subsection 2.2.1 the conceptual SESAR APOC roles and responsibilities, which are compared with the current and foreseen roles and responsibilities in the AAS APOC is described.
Subsection 2.2.2 investigates the AOP, both in concept and 'reality'. It describes the data sources and consultation structures towards the AOP.
In subsection 2.2.3 the current experience with the APOC is described. It provides an overview on where the APOC was able to intervene (with its AOP), highlights the main advantages and disadvantages and concludes with the (current) best practices: capacity briefing and sector briefing.

### 2.2.1 APOC Roles & Responsibilities

During the interviews one of the main investigated topics were APOC roles and responsibilities.
Based on the interviews, the current (and possible future) roles in the AAS APOC are presented. There is a certain difference between both current roles and roles that are foreseen within the AAS APOC, specifically with respect to the APOC Concept [1]. The main differences are elaborated in the end of this subsection.

#### 2.2.1.1 SESAR APOC Roles & Responsibilities

In the SESAR APOC Concept several roles (and responsibilities) are proposed. The main roles and responsibilities are briefly described in Table 2.1.

*Table 2.1: stakeholder roles and responsibilities according to the APOC Concept [1, OFA 05.01.01 Final OSED Part 1a]*

| Role | Role description and Responsibility |
|---|---|
| **Airspace User (Airline), Airline Operations and Control Centre (OCC), Flight Dispatcher, Collaborative Decision Making (CDM) manager** | • Provide operational targets with regard to Airport Performance<br>• Responds to (the evolution of) important KPIs<br>• Update the AOP information (where it is responsible for)<br>• Are informed about the impact of disruptions<br>• Play a role in the decision-making process and what-if assessment<br>• Take decisions to reduce the impact of AOP alerts/warnings<br>• Play a role in post operations analysis to produce post ops reports |
| **Slot Manager** | • Are informed about the impact of disruptions<br>• Play a role in the decision-making process and what-if assessment<br>• Take decisions to reduce the impact of AOP alerts/warnings<br>• Play a role in post operations analysis to produce post ops reports |
| **Airport Operator, Airport Duty Officer, Airport Slot Coordinator, Gate Planner, Apron Manager** | • Provide operational targets with regard to Airport Performance<br>• Responds to (the evolution of) important KPIs<br>• Update ATVs (Airport Transit View)<br>• Integrate Operational Steering Board (OSB) agreed parameters<br>• Update the (relevant) AOP information<br>• Are informed about the impact of disruptions<br>• Play a role in the decision-making process and what-if assessment<br>• Take decisions to reduce the impact of AOP alerts/warnings<br>• Play a role in post operations analysis to produce post ops reports |
| **APOC** | • Facilitate the communication for airspace/airport users in case of capacity issues or disruptions<br>• Coordinate the resolutions in the AOP<br>• Are informed about the impact of disruptions<br>• Play a role in the decision-making process and what-if assessment<br>• Coordinate and facilitate decision-making process whenever necessary<br>• Take decisions to reduce the impact of AOP alerts/warnings<br>• Play a role in post operations analysis to produce post ops reports<br>• Host the role of APOC Supervisor, responsible for communication among airport stakeholders (including the Network) |
| **Ground Handling Agent, De-icing Agent** | • Provide operational targets with regard to Airport Performance<br>• Responds to (the evolution of) important KPIs<br>• Update the AOP information (where it is responsible for)<br>• Are informed about the impact of disruptions<br>• Play a role in the decision-making process and what-if assessment<br>• Take decisions to reduce the impact of AOP alerts/warnings<br>• Play a role in post operations analysis to produce post ops reports |

| | |
|---|---|
| **Local ANSP, ACC/Approach Supervisor, Airport Tower Supervisor, Local Capacity Manager** | • Provide operational targets with regard to Airport Performance<br>• Responds to (the evolution of) important KPIs<br>• Update the AOP information (where it is responsible for)<br>• Are informed about the impact of disruptions<br>• Play a role in the decision-making process and what-if assessment<br>• Take decisions to reduce the impact of AOP alerts/warnings<br>• Play a role in post operations analysis to produce post ops reports |
| **Network Manager** | • Responds to (the evolution of) important KPIs<br>• Update the AOP information (where it is responsible for)<br>• Maintains consistency of the NOP (Network Operations Plan) information<br>• Are informed about the impact of disruptions<br>• Play a role in the decision-making process and what-if assessment (can be delegated to the APOC Supervisor)<br>• Can initiate UDPP (User-driven prioritisation process) through the APOC<br>• Take decisions to reduce the impact of AOP alerts/warnings<br>• Play a role in post operations analysis to produce post ops reports |
| **METEO** | • Responds to (the evolution of) important KPIs<br>• Update weather forecast<br>• Are informed about the impact of disruptions<br>• Play a role in the decision-making process and what-if assessment (only having effects on the AOP)<br>• Take decisions to reduce the impact of AOP alerts/warnings<br>• Play a role in post operations analysis to produce post ops reports |
| **Airport Performance Board (APB)** | Board of strategic representatives from different airport stakeholders. They must have the ability to decide on performance parameters. It is expected to be a board of (delegated) COOs. METEO and ground handling providers are not expected to be in this board. |
| **Operational Steering Board (OSB)** | Board of operational based managers from different airport stakeholders. They come together on a frequent basis (e.g. once per month). The OSB will use the output of the APB and extend this to define more precise metrics. |
| **Airport Steering Administrator (ASA)** | Support of APB and OSB |
| **APOC Supervisor** | • Being the liaison between airport operations, together with the network (manager)<br>• Ensure that all relevant information is with different stakeholders<br>• Initiates UDPP, if necessary<br>• Coordinate whether the AOP is feasible<br>• Ensure that all (agreed) actions are executed by stakeholders<br>• Acts as ‘referee’ in case of disagreement between stakeholders<br>• Update the AOP<br>• Determine and solve inconsistencies between different data sources |
| **Post-Operations Analyst** | • Gather all relevant data for post-ops<br>• Perform post-ops analysis<br>• Trigger the (ad-hoc) report<br>• Distribute Post Ops reports on a regular (daily, weekly, monthly) basis |

#### 2.2.1.2 AAS APOC Roles & Responsibilities

The current APOC team at AAS is divided in two types of expertise: development and operational. The development team is responsible for the incremental growth of the APOC, while the other team is fully responsible for the operational side of the AAS APOC. As mentioned before, to gather insights in the recent developments and current operations within APOC, a selection of four different Schiphol employees from the APOC team were interviewed.

The interviewee are the following people:

- Suzan van Zutphen in the capacity of Lead APOC- programme
- Johan Blom in the capacity of Teamlead D-7/D-1
- Nils IJske in the capacity of Team lead AOP development
- Ewout Hiddink in the capacity of Cluster lead Aircraft

The current APOC team is basically selected based on the following skills/working attitudes:

- Social Agility;
- Understanding the bigger picture of the airport;
- Experience with different airport processes;
- Non-hierarchical approach.

Most people have backgrounds in either airport operations or digital (IT).

The operational team now consist of a day-coordinator, cluster lead and data-analysts. At this moment (March 2021), no further roles are defined. It should be noted that, besides the APOC, the airside also uses control centres ("regiecentra" in Dutch). In the following months the differences between the APOC and control centres should become more transparent.
It is assumed that both organizations influence each other positively, among other things by sharing more information.

The main responsibility of the day coordinator role is the general coordination of the APOC and support all processes. The day coordinator is in the lead during major (operational) APOC meetings. The cluster leads, together with the day coordinator, are responsible to come to a solid D-7 to D-1 planning. They make major decisions towards the day of operations and play a vital role in analysing what-if scenarios and determining the critical path for the operations towards the creation of the AOP. This is further described in subsection 2.2.2.
The cluster leads, together with the day coordinator and supported by the data analysis team, are the main connection towards the main airport stakeholders like the Flow Manager Airport (Airport), Duty Area Managers (Airline) and Duty Managers (ANSP/Ground Handling).

**Future roles in AAS APOC**

An important (conceptual) role that is foreseen in the APOC is the role of Information Manager (IM). This role is not specifically defined in the SESAR APOC Concept, but may be comparable to the informative role of the APOC Supervisor. The IM does not have a (predefined) mandate.
The IM gathers all relevant information that flows into and outside the APOC. It is a neutral stakeholder, with a certain form of (undefined) mandate. The role of the IM is to indicate possible disruptions. A “I see that … is happening, we could ….” is preferred over a “I see that … is happening, we should …” approach.

The IM will become mainly responsible for (if necessary) scenario development, also known as what-if analysis, determining the critical path (of the AOP) and plays a prominent role in the APOC processes. The IM will closely work together with the operational team.

One of the major tasks within the APOC is (to support) decision-making. If more stakeholders start to play a role in the APOC, and the APOC has the mandate to affect airport operations, there could be disagreement between stakeholders. From the theory we could conclude that in case of disagreement there is need for a non-biased and supportive APOC Supervisor, who is able to make decisions and has a certain mandate to initiate actions. A model where a pool of APOC Supervisors from different stakeholders (airport, airlines, ANSPs, ground handlers) provide a delegate to be the APOC Supervisor, is preferred. This avoids potential hierarchical issues. The profile of an APOC Supervisor should therefore be coaching, able to connect people and not biased when it comes to decision-making.

**Stakeholders in the AAS APOC**

In the current AAS APOC, one airport stakeholder is involved. This is the airport operator AAS.
The role of Schiphol is to facilitate airport operations and therefore it takes a prominent role in the development and deployment of the APOC. The initial goal for AAS is to be a sector-wide point-of-contact for operational planning and execution and to act as lubricant between all involved aviation stakeholders.
In the following months it is expected that more stakeholders will start to get more involved. It is uncertain whether they will participate in a 'live' and physical APOC. The current study may accelerate that process, since it focuses on one of the main 'hurdles' of the current APOC: Decision-Making. It should be noted that the development team is looking into the AOP/NOP integration. This automatically requires involvement of the Network, and thus (a delegate of) the Network Manager.

If more stakeholders become active in the APOC, it is foreseen that every stakeholder will participate with at least, and probably at most, one delegate in the APOC Council. This person has back-office support from its own organisation and is mandated to act quickly in case necessary action is required. Initially, internal stakeholder company-specific strategy choices are not made in the (physical) APOC. Those strategical choices should be taken within the organizations themselves. In the future it is expected that stakeholders within the APOC will steer towards certain KPIs. More about KPIs are described in this subsection.

**Concept vs. reality**

The main difference between the current AAS APOC and the APOC Concept is the absence of multiple stakeholders. Another fundamental difference between the concept and reality is the presence of the APOC Supervisor. The current APOC stakeholders do not have a certain mandate to affect the day of operations and therefore an APOC Supervisor does not add anything in this stage. At this moment, stakeholders from airlines, LVNL and ground handlers do not actively participate in the APOC. They currently play a role in delivering data for creating the AOP, which is described in more detail in subsection 2.2.2.2.

To get, among other things, better insights and common situational awareness in the airport operational capacity and demand and upcoming events, an integration between the APOC and Network Manager Operations Centre (NMOC) is recommended. Therefore, an active participation of the Network Manager is required. The NM could help in the Demand-and-Capacity balancing stage and even has a certain influence in the development of operational scenarios and actions to be taken.

**Key Performance Indicators in the APOC**

Currently the APOC does not need to comply with (or steers towards) certain KPIs. First of all, the APOC is not operational at D0 and therefore not able to directly manage the airport operations. A separate department within the airport operator organisation is responsible for the Day-to-Day Operation (i.e., DDO department). Therefore, a certain (operational) mandate is required and a more advanced APOC (including D0) should be realised. The latter is currently part of the APOC growth model that is foreseen by the APOC development team.
Important potential (stakeholder specific) KPIs that have been mentioned are:

- Safety – All stakeholders
- On Time Performance – All stakeholders
- AOP accuracy and predictability (D+1 post-operation analysis required) – LVNL, Airport
- Schedule completion/Schedule adherence – Airline
- Productivity – LVNL
- Delay – All stakeholders
- Cost Efficiency – All Stakeholders

KPIs that are more related to the planning function of the APOC/AOP are:

- Predictability
- Data accuracy
- Planning flexibility
- Scenario planning availability

### 2.2.2 Airport Operations Plan

As mentioned in the previous sections, the main deliverable of the APOC is the Airport Operations Plan (AOP). This section described the AOP concept and a description on the current and future AOP. In addition, it describes an overview on the required data sources to create the AOP.

**AOP SESAR Concept**

Regarding the SESAR Concept, the Airport Operations Plan (AOP) is an 'active' and 'always true' source of information where all airport stakeholders, including the APOC, refer to. An AOP is conflict free and executable. Roughly, it is a database with several check procedures in order to ensure data updates from a couple of different entities are correct and consistent. The AOP is the principle means by which the integration of airports into the overall network is achieved through a shared part of the airport data. Therefore, a link with the NOP (Network Operations Plan) in necessary. This is called the AOP-NOP integration and enhances the predictability of the AOP. For a single aircraft visit, the AOP-NOP integration can be visualised as in Figure 2-1.

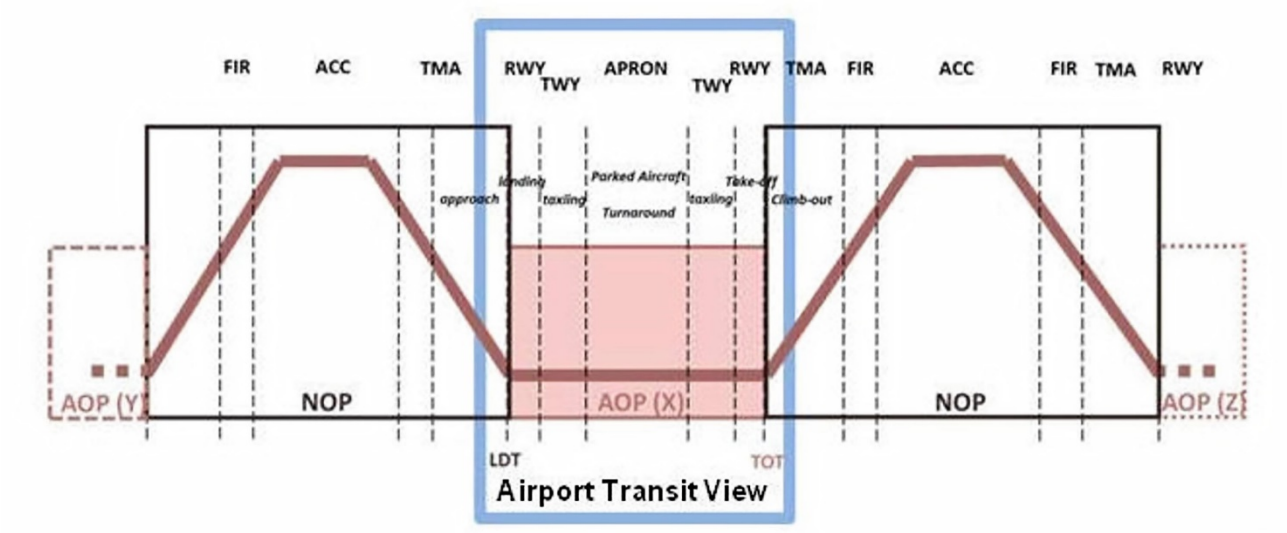


*Figure 2.1: Visualization of AOP-NOP integration [2, OFA 05.01.01 Final OSED Part 1a]*

The AOP is a "rolling plan" which is continuously updated and enhanced with new information, either automatically or through pro-active stakeholder's input. Apart from single flight-based status and planning information, the AOP also contains flow-based planning information such as an airport resource capacity plan and runway configuration plan. The timeframe in which an AOP effectively starts is during the Medium Term Planning (D-180 to D-7) phase and ends with the post operations analysis (D+1 onwards).

The AOP incorporates all turn-round information from the airside and the flow information of passengers within a terminal on the landside, to understand the operation at an airport.

### 2.2.2.1 Creating the Schiphol AOP

To create an AOP several steps need to be taken. The operational team of the APOC receives all relevant data – more about data and data sources is written in section 2.2.2.2 - via one central location. This contains planned activities (at the airport) and expected demand and capacity figures. In order to perform scenario planning and deliver the AOP on a daily basis, a certain consultation structure is required. Within APOC consultation structures, 'potential disruptions' could be determined. Those can be seen as an initial warning/alert.

**Consultation towards the AOP**

In the current APOC there are – as described in section 2.1 – three major operational roles: data analysts (DA), cluster leads (CL) and a day coordinator (DC). The data-analysts of the team start their day producing key figures and graphs based on received data. The different cluster leads within the APOC use those figures and graphs to determine the general planning for D-7 towards D-1, which forms the basis for their critical path. See also Figure 2-2.

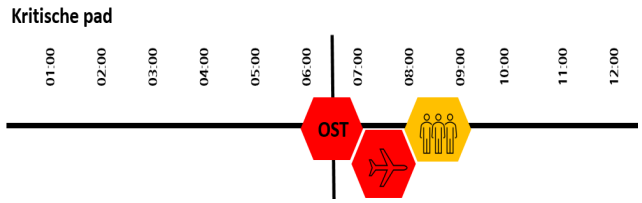


*Figure 2.2: A conceptual visualization of a critical path*

The process to create an AOP is schematically visualised in Figure 2-3, but is further specified in this paragraph. During a day in the APOC, the day coordinator and cluster leads come together multiple times in so-called APOC meetings. Every cluster lead prepares a critical path for the upcoming days. During the meeting they initially discuss how D-1 is currently planned and if there are major changes in the actual execution of the planning at D0. If there are no major events at D-1 (or D0) they chronologically discuss the rest of the upcoming week. It should be mentioned that the cluster leads consider disruptions at D0 as potential disruptions at D-1 (and beyond). The APOC is not yet operationally involved in D0.

If cluster leads mutually agree that a potential disruption might occur, the data analysist could be consulted to further perform what if evaluations and scenario development. It should be noted that the what-if analysis is always performed with respect to available reference scenario. The Airport 'What-If' evaluation and analysis provide insight in options for realising performance goals in nominal and disturbed operations. During the analysis, different mitigations (also known as candidate solutions) form the basis of the decision-making process. The evaluated what-if analysis result in what-if scenarios, including potential mitigation measures.

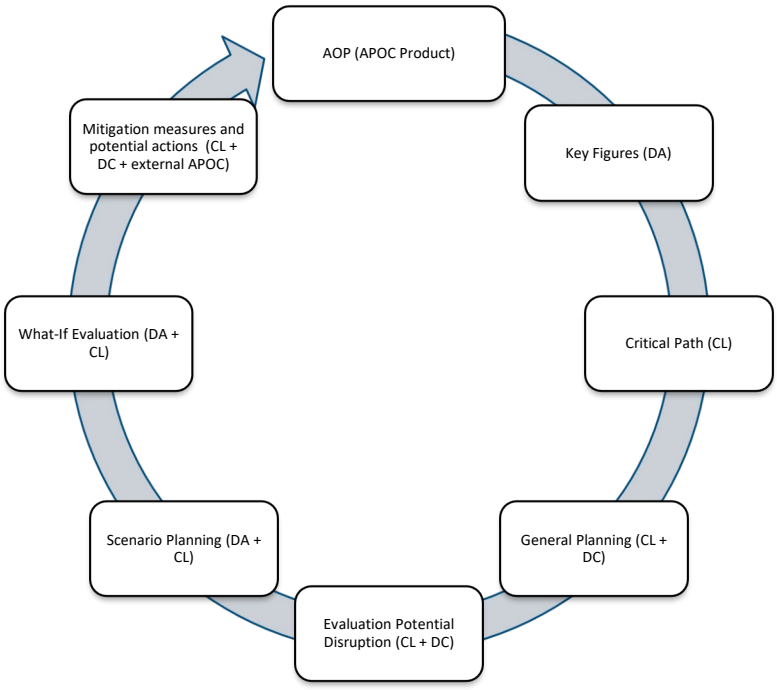


*Figure 2.3 Schematic overview of the current AAS AOP process*

In order to get a better overview of the upcoming situation, the cluster leads might consult both internal (AAS) and external stakeholders (e.g., duty managers, Flow manager operations, duty area manager). In this phase, potential mitigations could already be evaluated and discussed. In a later stadium during the day, the cluster leads can come together to discuss their latest findings. If they all agree with the definition of the disruption and feasibility of the proposed mitigation, this is  used as input for the AOP. If they are not unanimous, the situation could be escalated to the day coordinator. If – after consulting the day coordinator – agreements have not been made, the day coordinator could further escalate the situation towards the Flow Manager Aircraft/Flow Manager Process and beyond (towards the Management Team).

An example of a current Schiphol AOP can be found in Figure 2-4. It contains major points for attention, weather forecast, figures about traffic, passengers and baggage and a rough overview of the critical path.

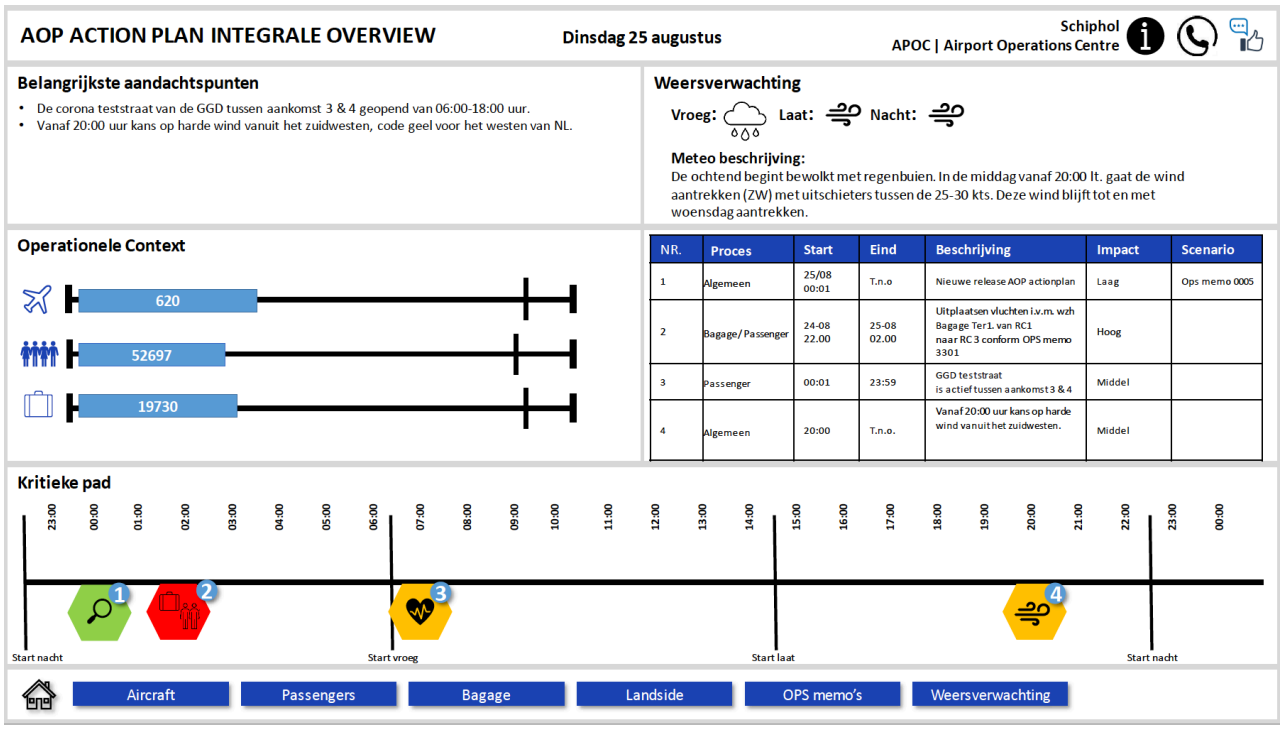


*Figure 2.4: Example of a published AOP*

**The future AOP**

Since the start of the AAS APOC, every two weeks a new and iterated version (release) of the AOP is issued. This allows an agile incremental development of the AOP. It is also called the APOC growth model.

Towards the end of 2020 the AOP is a rolling plan and contains accurate capacity/demand figures, defines and classifies the operational impact of disruptions and mitigations. The goal is to have an airport-wide (integral) overview of the D-7 to D-1 planning. Additionally, one of the logical next steps is to have an AOP/NOP integration.

At this moment no pro-active action is required at day of operation (D0). The D0 activities belong to Airport Operations. However, events at D0 might trigger alerts/warnings or even disruptions at D-1 and beyond. In order to evolve towards a D0-approach, a mandate or more APOC support base at airlines, LVNL and ground handlers is required. This allows better information sharing and, if needed, the possibility to initiate action within the actual

operations. The AOP then becomes a more dynamic plan, which is able to change at D0 itself. However, it should be noted that the APOC program was not initiated to take over all stakeholders' operations. It is there to allow seamless planning and preparation towards D0.

The current AOP is published on a daily basis and is shared through an online (SharePoint-like) environment, around 16:00. At this moment the AOP is created in a PowerPoint environment, but this will soon be transformed to a Power Business Intelligence (Power BI) Tool. This helps the operational team to accelerate the process of filling the AOP with relevant and actual figures. This increases the time available to find suitable mitigations for upcoming potential disruptions. More advanced tooling is required to allow even faster data analysis, translating data from different (external) sources into the required format and automatic triggers and what-if evaluations. An example of a recently published AOP in PowerBI (https://powerbi.microsoft.com/) is shown in Figure 2.4.

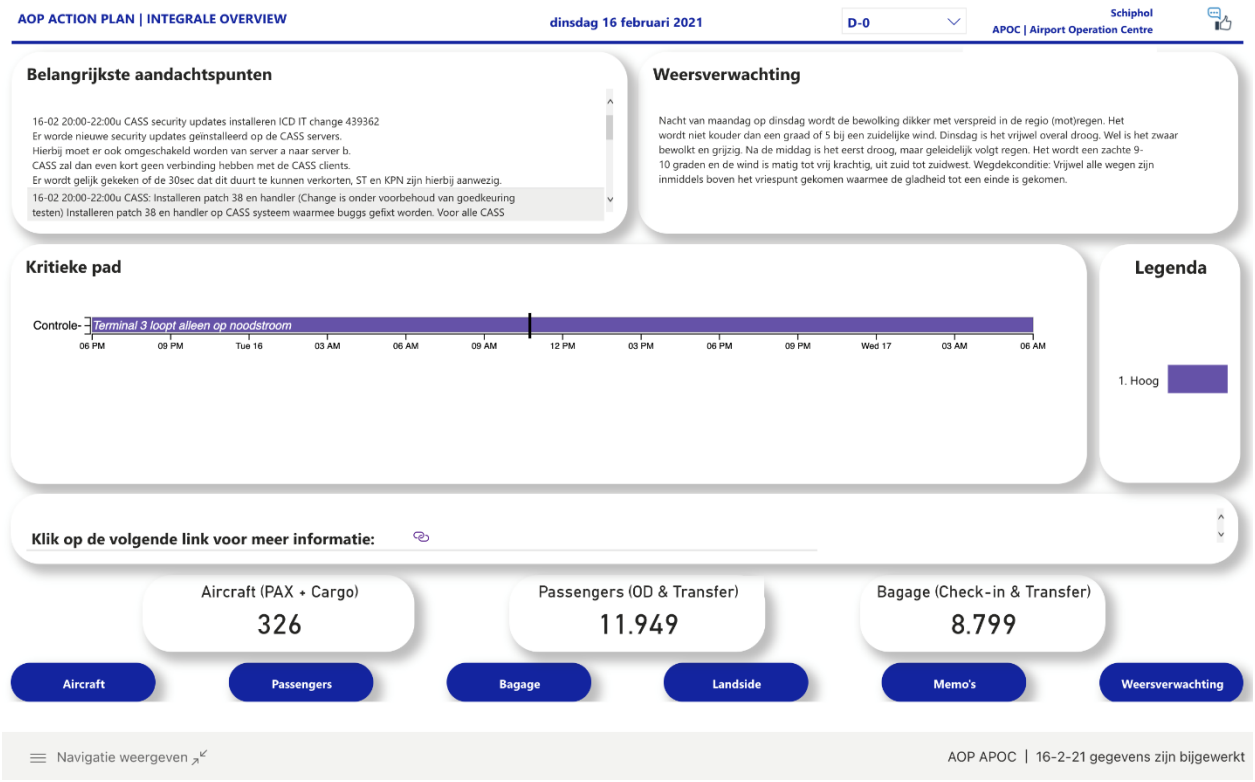


*Figure 2.5: AOP published for 16/02/2021, prepared in PowerBI [Source: AAS APOC]*

It should be noted that LVNL is developing an operations (OPS) plan on a daily basis (office days only), which is meant to plan the operation for tomorrow. In this stage the OPS plan aims to advise the operational department of LVNL. It is not clear to what extent the OPS plan is seamlessly adopted in operations at this stage.

### 2.2.2.2 Information sources

One of the major building blocks of an AOP is that it facilitates airport stakeholders (and other relevant stakeholders) with as real-time as possible (capacity) data. To be able to arrange this and to create an AOP, different information sources are required. The fundamental actions performed in an APOC - what if analysis and scenario planning – are based on both internal and external data flows. As mentioned in the previous paragraph, gathering and combining all

different data sources is relatively time-consuming right now. In addition to this, it is clear that not all relevant stakeholders already share data with the APOC (or somewhere else).
It is expected that if more stakeholders distribute (parts) of their data, the overall APOC data quality increases resulting in a more advanced and accurate AOP. This improved AOP will ultimately result in better predictions which may directly benefit the airport operations.

The most important information sources are described in Table 2.2. Not all of this data is available in the current APOC. Therefore, more cooperation and coordination with other (external) stakeholders is required.

*Table 2.2: High-level overview of relevant data sources for the APOC*

| Data | Source | Relevant for | Description |
|---|---|---|---|
| **Declared Capacity (DC)** | LVNL | Demand and Capacity Balancing (DCB) | This value represents the capacity objective for the airport. It is slightly less than the technical maximum capacity. It is determined per season. |
| **Operational Capacity (OC)** | Capacity briefing (AAS, LVNL, Airline) | DCB and Scenario Planning | The Operational Capacity is determined at D0. Large fluctuations in the OC might trigger the AOP and or result in a recovery plan. |
| **Network Data** | NOP (portal) | DCB and Scenario Planning | Network data contains major events in the airspace, announces strikes, etc. For planning purposes, it becomes most relevant and accurate between D-3 and D-1. |
| **NOTAM** | LVNL | Scenario Planning | The NOTAM (Notice to Airmen) may contain relevant information for airport operations. |
| **MET(EO)** | KNMI | Scenario Planning | Weather information may trigger events in the APOC. The MET information becomes more relevant towards D-3. |
| **Works & Asset Planning (WAP)** | AAS ASM (Schiphol Asset Management) | Scenario Planning | The WAP contains all planned airport activities (e.g. construction) between D-180 and D-7. The WAP is therefore consulted in an early stage. Other information that could be shared by AAS ASM are: events, visits, etc. |
| **Personnel planning** | All stakeholders | DCB and Scenario Planning | In order to run the full airport business, there should be enough personnel available. Different (internal) airport stakeholders could therefore share their personnel planning |
| **Use of taxiways** | AAS ASM | DCB and Scenario Planning | If – in the planning phase – a reduction of taxiways is planned, the APOC team might use this information in order to perform Scenario Planning. |
| **Gate planning** | AAS ASM, Gate Planner | DCB and Scenario Planning | Gate planning is relevant for Scenario Planning. If a reduction of gates is planned, this should play a role in the creation of the AOP. |

In addition to airport stakeholders providing more and relevant data, more non-aviation and context driven information may become beneficial for planning purposes as well. This for example includes, planned disruptions in road traffic, disruptions in public transport or (local) events (e.g. Koningsdag, Formula 1, Football Matches etc.).

### 2.2.3 Schiphol APOC experience

In this subsection a few examples on where the APOC was able to or could play a role, are described. In addition to that, the main advantages and disadvantages (lessons learnt) are described for the current APOC. The subsection is concluded with some best practices.

Although the current AAS APOC has the purpose to be active during the planning phase, it can directly influence actions at D0. As described in the previous paragraph, the AOP – which is the main deliverable of the APOC – may contain warnings/alerts for disruptions and even descriptions of (taken) mitigations. In other words, actions could be triggered for various airport stakeholders based on the AOP. This already happened several times during the active APOC. Some examples are described in this subsection.

However, given the COVID-19 pandemic crisis, traffic demands have drastically decreased with respect to 'normal' operations. Therefore, large demand/capacity issues did not occur during the 'active' APOC since August 2020. It is expected that the APOC could play a major role in the planning phase for those potential disruptions. The following list of events describe several APOC experiences up to now.

**[Example Disruption] Leakage in Terminal**
During night operations one of the roofs of the Terminal building started to leak water. This changed the operational planning. After the roof was repaired, the airport operations team would have liked to start operating from this Terminal again. This was not possible due to insurance issues. The APOC took the temporary 'loss' of the terminal into consideration and played an important role in the recovery (action) plan. In this plan the steps towards 'normal' operation are described. Because the APOC team did not have experience with leakage scenarios, they needed to develop them quickly. The (potential) disruptions and corresponding mitigations could be used if a similar event occurs.

**[Example Disruption] Passengers sleep over**
At D0 the airport operations faced passengers with a sleep over at the airport. Initially, the APOC was not directly involved in this. For this event a recovery plan was created. This means that the disruption may last for multiple days, and therefore this disruption was considered within the D-1 APOC planning. This planning helped the airport operations to accelerate the recovery of the disruption. This shows that despite the APOC is not active at D0, it is able to play a role in (unplanned) D0 disruptions by taking it into account in the next AOP.

**[Example Weather] Strong wind**
Despite most summers are not considered as storm-periods at Schiphol, weather forecasts showed that strong winds might occur at a certain day in August. Without the APOC, every stakeholder tries to mitigate a potential disruption on their own. In a relatively early stage (D-3), the APOC team considered the potential strong wind in their scenario planning. They performed multiple 'what-if' analysis and intervened by having contact with other airport stakeholders (e.g. KLM). Due to the early planning, certain actions were defined. This allowed airport stakeholders to mitigate the potential disruption before D0.

**[Example Weather] Heat**
Although it might be windy during summer, it is more likely to have high temperatures in this period. At a certain location in the airport terminal (e.g., B-pier) the APOC acted quickly by considering the heat as a potential disruption. The situation was analysed in different scenarios. This resulted in some specific actions at the B-pier.

**[Example Incident] COVID-19 test lane**
During the summer period of 2020, AAS took the initiative to start a COVID-19 test lane for arriving passengers. The APOC operational team was able to initiate a 'what-if' analysis and develop scenarios for the operational process changes at the airport.

It is expected that the APOC and its AOP is also able to play a role in situations that did not yet occur. Two examples are described below.

**[Example Weather] Snow**
Because of heavy winter circumstances, such as snowfall, capacity reductions are quite common. In such a situation the sector briefing – more about this briefing is written further in "best practices" of this paragraph – could be triggered at D-3. The sector briefing is – most of the time – triggered by LVNL if an upcoming capacity reduction is foreseen. During the briefing KLM (airline, KLM (ground handler), LVNL (ANSP) and AAS (Airport) determine a sector wide capacity as function of time. It is determined what stakeholder has the most stringent capacity during the disruption. During the sector briefing the planning for a recovery-plan starts. This may be one of the first steps for the APOC to play a role in the sector briefing, by for example support with what if evaluations, relevant and actual data and an integral sector wide approach. The NMOC could also play a role in this situation.

**[Example Disruptions] Early arrivals**
Strong transatlantic tail winds may result in early arrivals for long-haul flights. This will directly affect gate planning and terminal occupancy. Information from the Network could, in an early stage, affect the planning at the airport. Therefore, participation of the Network Manager is required. However, the APOC is not active at D0 in this stage, it may play a vital role in mitigating the effects of early arrivals. It could for example play a role in the coordination with the Network and distribute Target Time (Over) times with airlines, in such a way that (unplanned) arrival peaks can be avoided. Therefore, a strong coordination between the Network – ANSP/Airline is required. The APOC could facilitate that coordination.

#### 2.2.3.1 APOC advantages and disadvantages

Up to now, the main advantages of the APOC that are mentioned are:

- The operational planning is being considered more often and in a better way;
- The APOC is there to facilitate airport operations, also small effects are beneficial;
- The APOC has developed quickly and is improving every day (by making use of an agile approach);
- The AOP is a rolling plan which is updated every day;
- The first connections with other stakeholders (besides the airport operator) have been established.

Based on the experience that have been gathered over the last few months, the following lessons learnt are considered:

- By having more communication with other stakeholders, expectations could be managed more effective;
- Getting all relevant data into one system is relatively time-consuming. To be more flexible, this should improve;
- Creating the AOP is relatively time-consuming;
- Other stakeholders (e.g. KLM) are having a similar type of organisation for planning purpose. In case of KLM this is the OCC.
- The APOC concept is relatively new and therefore there is not yet sufficient support base. The group of APOC 'believers' is still relatively small.

#### 2.2.3.2 Best practices for the APOC

On a conceptual level, there are currently two consultation structures that are somewhat similar to what is foreseen in the APOC. This includes the capacity briefing and sector briefing.
On specific times during the day LVNL, KLM and Schiphol discuss the expected capacity in a D-3 to D-1 time scope. The **capacity briefing** is a consultation structure where the KLM flow/network manager, KLM Hub Control (as ground handler), LVNL Area/Approach Control and Schiphol FMA/FMP play a role. During this meeting the capacity is presented in time-frames of 30 minutes. If major fluctuations are foreseen, at D-3 a **sector briefing** could be triggered. In this session the capacity restrictions will be further discussed and the basics of a recovery plan – where the road towards normal operations is described – will be drafted. In this setting different scenarios and rules are pre-defined. This avoids potential conflicts between stakeholders. Generally, this model is known as the "Collaborative decision-making process". This process is visualized for the APOC Concept and can be found in Figure 2.6. In section 3 this and alternative decision models will be discussed. This multi-stakeholder consultation structure, or something comparable, might take place in the future APOC.

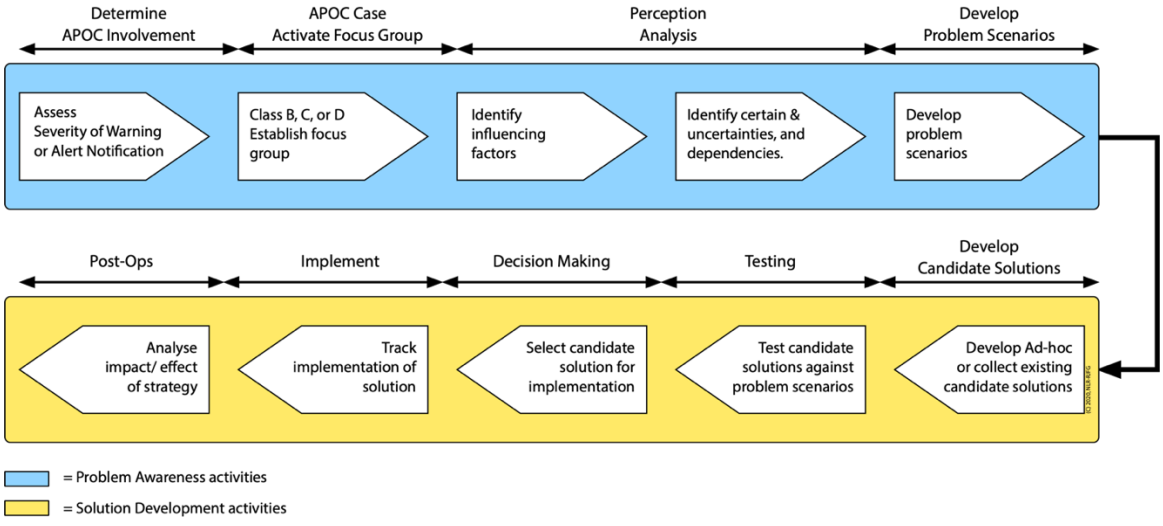


*Figure 2.6: General visualization of the Collaborative Decision-Making Processes following the TAM/APOC concept [Ronald Grosmann, NLR]*

# 3 Decision Model

In this section theoretical background of Decision-Making, SESAR models and practical Decision-Making Models for the Schiphol APOC is elaborated. In 3.1. the general theory behind Decision-Making is presented. It includes different decision-making models and the main key lessons learnt from strategic and scenario-based Decision-Making.
Section 3.2 presents the major thoughts on Collaborative Decision-Making from the perspective of several SESAR projects. The final section of this chapter describes the main findings of this study when it comes to a practical Decision-Making Model for the AAS APOC. It contains insights for stakeholder consultation structures, Decision-Making processes, required tooling and stakeholder roles. It should be noted that KLM (as airline) did not actively participate in the discussions towards an initial Decision Model. A logical next step is to include this part of the chain in future developments.

## 3.1 Decision-Making

A decision-making process may be triggered because of a discrepancy between a certain goal and realisation. This discrepancy is also known as a 'problem' or in terms of airport operations, a potential disruption.
First of all, it is important to define certain goals that belong to the operational strategy. Those goals can be used in order to trigger the Decision-Making.

Four popular generic decision-making models that could be distinguished are [3, 5]:

- Intuitive Decision-Making
  - Decision Makers (or managers) have extensive experience. In this model managers rely on the past experience and/or a personal assessment of the situation. This model is often used in situation with high uncertainties, or when a problem could not be caught in other models and previous experience is not available.
- Garbage Can Model
  - Decision Makers brainstorm about the problem, potential solutions, stakeholders and other items related to the decision. All this information is used to randomly generate potential decisions. The process to generate decisions in this model is quite chaotic. Therefore, it is often not used for important long-term decisions.
- Linear Model
  - In the linear model decision makers list positive and negative factors of all decision options (or alternatives). This can be compared to making a list of pros and cons. The main difference is that the linear model requires numerical imports (with certain weights in a certain range, e.g. -5 to +5).
- Rational Decision Model
  - In the rational decision model, it is assumed that making decisions has an orderly flow: the basis is information gathering and analysis. This method requires some time, because it consists of different steps. This can also be seen in Figure 3.1. The Rational Decision Model is often used in as a basis for strategic planning, therefore this model is explained in further detail [3].

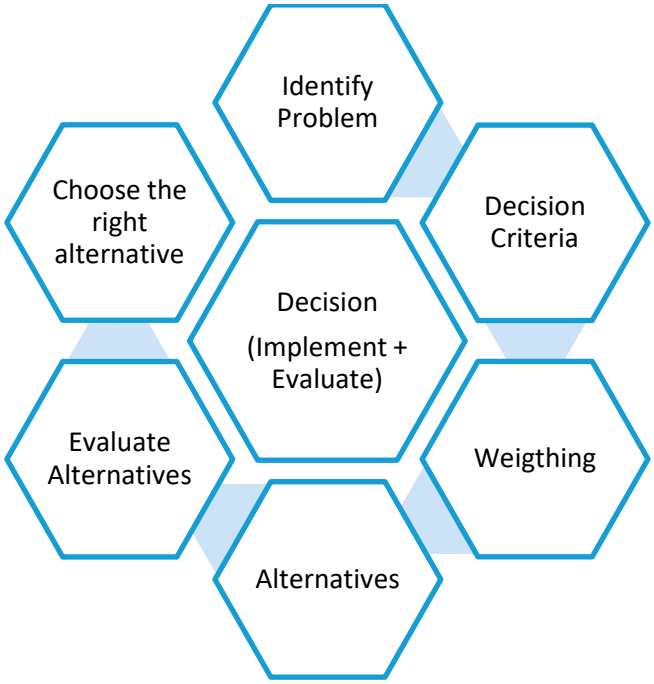


*Figure 3.1: Schematic overview of the Rational Decision Model*

**Identify Problem**
One of the major steps in finding solutions for a problem, is understanding the problem. Having a wrong problem in mind, negatively affects the Decision-Making.

**Decision Criteria**
Decision Makers need to determine what (steering) parameters are relevant for the problem/decision. In a multi-stakeholder environment, this step allows all stakeholders to bring all important aspects (interests, values and preferences) for Decision-Making to the table.

**Weighting**
Criteria do not always have the same importance, therefore it is vital to determine weighting factors for criteria, to evaluate according to the right (and pre-defined) priorities.

**Alternatives**
Once the preconditions (problem, criteria and weighting) are set, all potential options/solutions could be listed. It is important that not only 'common' solutions are on the list.

**Evaluate Alternatives**
Given the list of alternatives and preconditions, the alternatives could be evaluated (or ranked). The output is a list of alternatives included with e.g. 'scores'.

**Choose the right Alternative**
After the alternatives are ranked (or evaluated) a solution should be picked. The final solution may be one of the alternatives proposed, an adapted version, a combination of different alternatives or a completely new solution.

A more advanced version of the previous decision model are models that comply with scenario based strategic planning. One of those models is developed by Roland Berger. This methodology – which is based on six evolutionary steps – has shown potential to increase quality of decisions and performance of company processes (Chermack, 2011). The model is described below, because it has a strong link with the methodologies proposed for Collaborative Decision Making in the SESAR concept.

The corresponding model [4] is visualised in Figure 3.2.

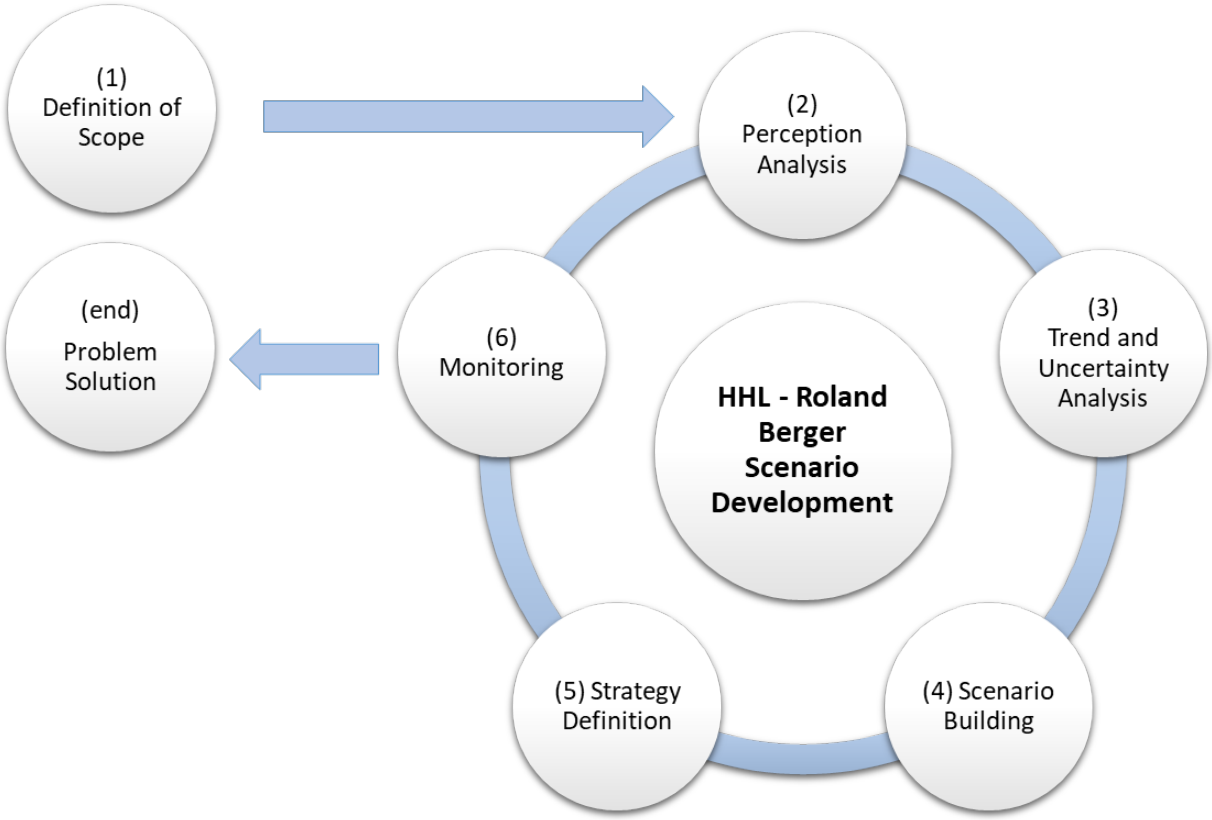


*Figure 3.2: Schematic overview of HHL Scenario Development Model [4]*

It allows organisational bodies to plan for different potential future developments. Therefore, it integrates different perspectives into scenario planning (multi stakeholder). This results in a more flexible organisation, which allow the organisation to respond faster and more effective.

In the first step it is important to identify the (core) of the upcoming problem. This problem may come with several assumptions over different stakeholders. In step two those assumptions are identified. Based on those assumptions the problem related uncertainties are determined. This step is vital in getting a good overview of knowledge gaps. Those knowledge gaps/uncertainties could be elaborated in scenarios, including e.g. what-if analysis. Based on the scenarios different 'problem escape' strategies could be developed. Finally, all strategies could be ranked, based on e.g. pre-defined requirements, such that decision makes could select the most effective strategy.

To allow an objective ranking, different evaluation methodologies could be used. A very common approach is Multi Criteria Decision Analysis (MCDA). In MCDA the goal is to provide decision makers with a tool to avoid decisions based on intuition and come up with an objective ordering of options.

The MCDA methodology could be explained based on the following example.

**An event takes place at a certain point in time, affecting RWY capacity. Measures should be taken to avoid (secondary) effects.**

Within the APOC several stakeholders are able to decide on upcoming measures. The measures (or solutions) are A, B and C. All those solutions affect pre-defined criteria, such as In-Terminal Congestion (ITC), On Time Performance (OTP) and Cancellation Rate (CR). All criteria have a certain 'weight'. It should be noted that the weighting factors may play a crucial role in the final conclusion of the analysis.

In this example the variables are weighted as follows: ITC = 0.22, OTP = 0.42, CR = 0.32. Different rating levels are distinguished, corresponding to a certain rating 'score'. The final score of a solution could be determined by calculating the sum of weighting factors multiplied with the rating 'scores.

During the discussion between stakeholders solution A brings a "Fair" ITC, a "High" OTP and "Poor" CR. Therefore, the score for solution A is 0.22 x 25 + 0.42 x 100 + 0.36 x 0 = 47.5.

This MCDA evaluation is summarized in the following tables.

*Table 3.1: Example MCDA evaluation*

| Criterion | Weight | Levels | Score |
|---|---|---|---|
| ITC | 0.22 | Poor, Fair, Good, Excellent | 0, 25, 50, 100 |
| OTP | 0.42 | Low, Medium, High | 10, 30, 100 |
| CR | 0.36 | Poor, Fair, Good, Excellent | 0, 20, 50, 100 |

| | Criterion | Solution | | |
|---|---|---|---|---|
| Weight | | A | B | C |
| 0.22 | ITC | 25 | 25 | 0 |
| 0.42 | OTP | 100 | 30 | 100 |
| 0.36 | CR | 0 | 50 | 20 |
| Score | | 47.5 | 36.1 | 49.2 |

| Criterion | Solution | | |
|---|---|---|---|
| | A | B | C |
| ITC | Fair | Fair | Poor |
| OTP | High | Medium | High |
| CR | Poor | Good | Fair |

Following the calculation, the evaluated MCDA ranking is C, A, B. This is input for the Decision-Making process. The higher the evaluated score, the more positive the effects of the solution on criteria is.

This model summarizes the theory behind Decision Making. The SESAR CDM models based their ideas on the models discussed in this subsection. In the next subsection SESAR CDM is discussed.

## 3.2 SESAR Collaborative Decision Making

The models described in the previous paragraph have a strong link with the current forms of Collaborative Decision-Making (CDM). CDM is one of the vital goals of multi stakeholder involvement. The APOC can be seen as the facilitator for the Decision-Making process. The APOC uses all actual and historical data (and experience) to effectively manage

deviations in performance and disruptions. According to the SESAR model, the APOC contains decision support systems, including what if tooling and collaborative procedures to ensure multi stakeholder management.

It should be noted that there is a difference with Airport Collaborative Decision-Making (A-CDM). This APOC concept aims at improving Air Traffic Flow and Capacity Management (ATFCM) at airports and tries reducing delays, improving event predictability and effective resource planning. The Decision-Making in the Airport CDM concept is facilitated by sharing relevant data and by sharing common procedures, mechanisms and tools. The CDM in the APOC concept is a next step of A-CDM.

In the SESAR CDM concept several processes are described. Those processes could be categorized in three groups:

- Asses Overall Impact Process;
- Support Decision-Making Process;
- Make Decision Process.

Regarding the concept, the APOC monitor service initiates a trigger (in case of deviations from the goals that were set in the APOC steer function) that starts the Decision-Making Process. In order to understand what the actual problem is, the Support Decision-Making Processes could be used in order to execute a “what-if we do nothing” analysis. This is input for the determination of “Severity” and “Impact”. If the upcoming deviation is exceeding certain pre-defined severity-levels, the Make Decision Process could be initiated. The Support Decision-Making Process could be triggered if a certain scenario or candidate solution should be evaluated. This process chain follows the theoretical framework of the rational decision model and scenario-based strategic planning, which were described in Section 3.1. The three process categories are visualised in Figure 3.3.

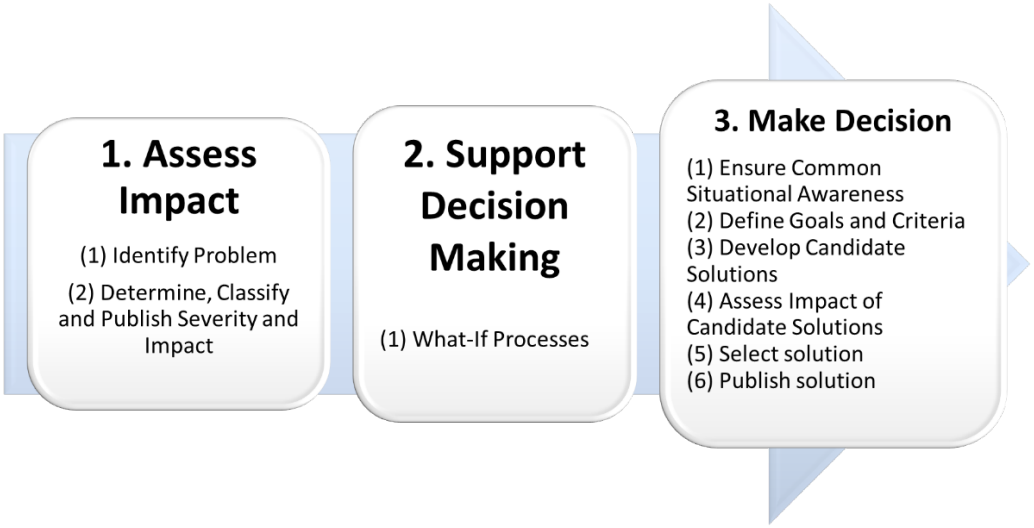


*Figure 3.3: Decision-Making Process in APOC [1]*

This figure summarizes the theory behind SESAR CDM, which is (mainly) based on rational decision making. In the next chapter these models will be used in order to find a tailored initial Decision Model for the Schiphol APOC.

## 3.3 Decision Model Schiphol APOC

In this section all theory and practical applications of the APOC come together, resulting in an initial Decision-Making Model for the Schiphol APOC. In this section the different stakeholder consultation forms, (potential) data sharing, decision making steps and a glimpse into future tooling is discussed.

As elaborated in section 2.2.3. there are already two examples of consultation procedures that touches the functionality of APOC Collaborative Decision Making: capacity briefings and sector briefings. In both consultation forms executives/seniors from all involved stakeholders manage to compromise on (mitigation) measures and actions. During a few discussions with different stakeholders both of the consultation forms are suggested to take place in the APOC. The main advantage of the APOC is that more relevant data will be shared, which improves common situational awareness, development of solutions and quality of scenario planning and subsequently decision making.

In the current consultation forms both the rational and intuitive decision models are applied. Initially decision makers try to use the rational model, but if time is sparse it could also trigger the intuitive model. In this model decisions are made based on (previous) experience. The proposed intuitive solutions are more subjective and it is more difficult to reach consensus.

Based on the several discussions it can be concluded that the dynamics of airport operations – also affected by actions within the Network – makes it difficult to fully adopt measures proposed in planning (e.g., AOP). As an example, a difference in forecasted wind direction may already influence the use of runways, which affects the rest of the airport operations. Therefore, different stakeholders indicated that the APOC should start playing a role at D-0, in order to make changes to the proposed plans (which is in line with the SESAR APOC Concept and fundamentals). It is also noted that this is only possible if different stakeholders start to (partly) participate in the APOC. A logical first step towards a more intense collaboration is the distribution of relevant data.

### 3.3.1 APOC data sharing

In order to create a relevant and actual AOP and in order to increase interest in participating in the APOC, the APOC should become a central body at the airport when it comes to receiving and (re-)distributing data.
According to workshop participants and different interviewees, one of the fundamentals for creating a common understanding of the situation at the airport is getting insight into different (expected) capacity numbers.

It starts with the hourly capacity, based on the operational runway capacity declared by LVNL which is determined per IATA season (starting from D-180). Most operations/capacities at the airport are aiming to comply with this hourly capacity, in order to run an efficient operation. Deviations in planning, caused by disruptions, might interfere with one (or more) stakeholder processes and therefore affecting different capacities. This potential change in capacity could be shared through an APOC, such that all stakeholders are aware of some (potential) disruption somewhere in the operations chain.

If necessary the APOC team could request additional data, such as described in Table 2.2. Besides, it would be beneficial if the LVNL OPS planning and AOP published by the APOC are related to each other, this might positively affect common situational awareness.

The following data elements were discussed during the workshop in which Schiphol, LVNL and KLM Hub Control actively participate. This list could be considered in further discussions between the involved stakeholders and could be seen as a basis to start sharing more information through the current APOC.

*Table 3.2 Suggested data-elements (for the AOP) that could be shared through the APOC*

| Element | Shared by |
|---|---|
| **Number of passengers and potential sleepovers** | Schiphol/Airlines |
| **(Ground) handling capacity** | KLM HCC, Ground Handling agencies |
| **Tow-capacity** | KLM HCC |
| **(Proposed) changes or adaptions to the** Local Rule (2) | Airport Coordination Netherlands/LVNL |
| **Adaption in Timetable and changes in DEP/ARR planning** | LVNL |
| **Control measures taken by LVNL OPS** | LVNL |
| **(Expected) use of runways** | LVNL/Schiphol |
| **(Expected) occupation of different airport filters** | Schiphol |
| **(Expected) occupation of Royal Military Police** | KMAR |
| **VOP Capacity** | Schiphol/KLM HCC |
| **De-icing capacity** | Schiphol/KLM HCC |
| **Conclusions based on internal scenario development** | All |
| **Important planning documentations (AOP, OPS plan, etc.)** | All |

### 3.3.2 Decision-Making: a flow diagram

During the workshops two use cases have been elaborated and discussed, one focusing on long-term power cuts at the airport, the other one aiming at (expected) heavy snowfall. Both use cases have been extensively discussed with involved stakeholders. See also Table 1.2. in the Methodology section.
From the discussions an initial Decision-Making model for the APOC is extracted. This model is initial because it needs additional refinements and alignment in further discussions with involved stakeholders. The model is as much as tailored for the Schiphol situation. It is assumed that this model starts at D-1, however also D-3 could have been taken. The Decision Model (Decision Tree) mainly focuses on (potential) disruptions affecting capacity (vs. demand). As per present Schiphol APOC approach (i.e., focus on valid AOP prior to D0), the Decision Model is meant for short-term planning and needs to be refined and adapted for D-0. For the moment, no direct link with KPIs have been made, because it is unclear to what extent certain KPIs will be taken into scope for the Schiphol APOC.

The model starts with an alert/warning for a potential disruption, gathered from (internal) what-if analysis/scenario development which is published in the most recent AOP. All stakeholders contributed to the establishment of this AOP, especially within the current Capacity Briefings and by sharing data. Generally, all involved stakeholders should gather (e.g. by performing internal scenario planning or reading the AOP) their expected (most stringent) capacity imbalances. (The APOC and AOP concept specifies that the AOP is always valid and updated, meaning that all capacity and demand considerations of all airport stakeholders is reflected in the acting AOP. As a consequence, the aforementioned action should only implicate a retrieval of relevant information of the AOP. In the APOC concept this also implies that as part of the scenario specification the required information need is specified.)

Based on the capacity imbalance, the most stringent capacity shortage is determined. If this imbalance exceeds a pre-defined (and sector-wide approved) threshold, a sector consultation with relevant stakeholders through the APOC is initiated. In theory this is called a Focus Group. If the threshold is not exceeded, the AOP is further specified within the AOP team (= multi-stakeholder), published and given to stakeholders' operations.

Within the Focus Group all necessary data is shared through the APOC, such that the APOC team is able to perform scenario development and execute scenario planning. The organisation with the most stringent imbalance could additionally provide a "Chairman" for the Focus Group, in order to guide the Focus Group through the Decision-Making process. A (future) APOC supervisor remains responsible, while some duties are delegated to the chairman of the focus group. Of course, the mandate depends on the type and severity of the raised event. To 'weight' the outcomes of the Development of Scenarios, certain recovery criteria and rules should be determined. The scenario development that follows, result in an impact assessment for different proposed solutions. For this Impact Assessment the Candidate Solutions from Scenario Development and Recovery Criteria/Rules are taken into consideration. The outcomes are published in the Assessment Report. The output of this document triggers a decision point, where (delegated) sector participants (or Focus Group) select the most suitable candidate solution(s) for operation. This could be done according to the SESAR "Make Decision" steps, shown in figure 3.3. During the first iterations a rational model could be used. If multiple attempts to reach agreement fail, the intuitive model or additional tooling might help. If there is mutual agreement, the APOC publishes an (internal) action plan, which is input for the (to be) published AOP. The AOP is then given to stakeholders' operations. If there is no mutual agreement, the APOC team could repeat the process of scenario planning, in order to make changes to the scenarios with respect to previous loop(s). If multiple attempts fail (3 attempts proposed), the APOC team continues with the AOP without the Sector Consultation. In this case the situation could be escalated such that a Sector Briefing could be triggered. Besides the AOP that will be published, the Sector Briefing could additionally inform Operations with their advice.

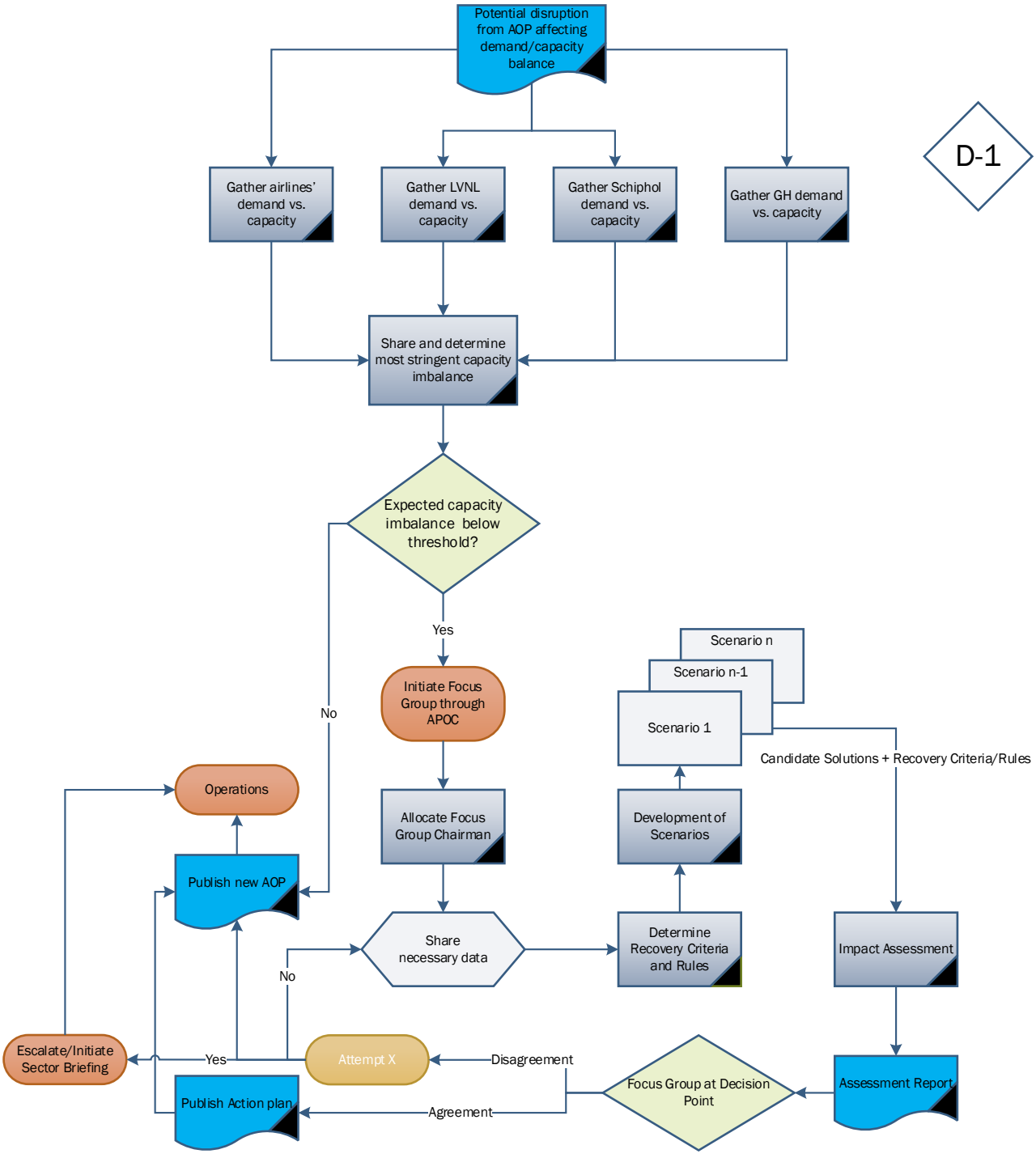


*Figure 3.4: initial Decision Model for Schiphol APOC for short-term planning*

### 3.3.3 Impact of Decision-Making

Currently, the Decision-Making process within the APOC result in a valid and executable AOP, which is used during operations. It should be noted that operations is not obliged to stick to the agreements made in the AOP. Therefore, the actual impact on Day of Operation may be limited and therefore hardly measurable. Towards the development of D0 functionality and more mandate for the APOC, the APOC process and stakeholders' operations need more harmonization. A commonly agreed first step is to share more data.

To be able to 'measure' the impact of the Decision-Making process also D+1 (post-ops) processes should be set-up. If the post-ops service is available, actions taken based on the published AOP and based on APOC Decision-Making could be evaluated. If the impact of certain measures were less effective, this could be used for optimizing scenario's and subsequently even improving APOC Decision-Making itself.

### 3.3.4 Tooling

To achieve independent scenario planning results, tooling can provide an advantage over the manual execution of data analysis or the isolated execution of scenario development. As described in the example of MCDA in section 3.1 provide users with an independent solution ranking based on pre-defined conditions/weightings. Tooling might help improving situational awareness through, for example, advanced dashboards. In addition, tooling could have multiple applications in the Decision-Making process, because advanced data analysis and what-if analysis could result in ranking alternatives/solutions and therefore support Decision Makers.

During interviews it is concluded that however prototypes have been tested, the software to perform what-if analysis/scenario development is not yet available. A recent development is that Schiphol is willing to invest in the APOC tooling. This tooling could best be compared with software that performs a continuous analysis of demand and capacity (balancing) for multiple airport processes, and potentially also for other APOC stakeholders.

Interviewees concluded that tooling is necessary to support the Decision-Making process. However, an expert-judgement (senior management) should always be taken into consideration to somehow over-rule the conclusions from tooling, especially in new situations or situations where the time to decide is limited. On top of that tools are less flexible compared to humans. It is suggested that the separation between (1) following tooling advisory and (2) follow expert judgement/senior management, is taken into consideration in the post-ops analysis.

### 3.3.5 APOC roles

One of the fundamental questions of the Schiphol APOC is who will participate and what will be the foreseen roles. During several discussions the following participants were suggested:

**Employee planning KLM Hub Control**
Capacity is mainly related to resources. This could be machinery, but an even more vital aspect is the availability of personnel. Because the Employee planning department of KLM Hub Control is mainly driven by capacity vs. demand, this is potentially the backbone of the Ground Handling organisation of the airport. Therefore, they could play a vital role in the APOC.

**Flow Managers from Schiphol**

Because of their strong roots in the operations and experience in sector briefings, the different flow managers from the airport could play a very important role in hosting APOC consultation and Decision Making. In the current process they already have a prominent role in the development of the (daily) AOP.

**Flow Manager Process from LVNL (online)**

The Amsterdam FMP is mainly the interface between the Network (Manager) and ATC, by constantly managing demand and capacity figures. Because of their role in determining the effectiveness of ATFCM (Air traffic flow management) measures, they could have a critical role in the APOC Decision Making and preparation of the AOP.

In one of the interviews it was suggested that the organization with the most stringent capacity imbalance will provide a Chairman for the APOC Consultation/Focus Group. In this case the Chairman is responsible for gathering all relevant information in guiding the Focus Group through the Decision-Making process. This is an alternating role and appointing the Group Chairman is based on the event. In this situation no APOC Supervisor is appointed, which may avoid hierarchal issues. The mandate for making a final decision lies in the Sector Briefing and/or stakeholders' operations.

# 4 Summary

In this report an initial Decision Model for the Schiphol Airport Operations Centre is drafted. This model enables Decision Making in the future APOC.
In the first section the background of the KDC APOC study is described and elaborates the methodologies to draft the Decision Model. The study background also includes a broad description of the SESAR APOC Concept, including all different services that could be offered by an APOC: steering, monitoring, managing and post-analysis. There has been chosen for interactive consultations with different airport stakeholders, because the APOC requires involvement of a (major) part of the sector.
In the second section the current Amsterdam Airport Schiphol APOC was introduced. In this section different APOC roles were described, both in their current forms as well as in their (expected) future forms. The Airport Operations Plan is currently published every day. The second subsection of section 2 focuses on the establishment of the AOP as a rolling plan, and elaborates on the operational processes within the APOC. The second section is concluded with some best practices of the current APOC, which shows that the APOC has the potential to play a major role in airport operations planning and mitigation of upcoming disruptions. It also shows that the APOC could be beneficial if it plays a larger role on the day of operations (D0).
The final section focuses on Decision Making. In the first subsection the theory behind Decision Making is described. This includes several models like the intuitive, rational, garbage can and linear decision model, but also highlights a Decision Model developed by Roland Berger. In the second subsection the translation between these models and the SESAR APOC/CDM Concept is made. From this it could be concluded that the Roland Berger model, including a solid methodology to perform stakeholder alignment, scenario development and decision Making, has a major overlap with the SESAR CDM concept.
Based on interviews and an interactive workshop a Decision Model for the Schiphol situation is set-up. This Decision model is developed for planning purposes around D-1, in order to develop the AOP. During a few interviews it became clear that tooling is important in order to allow data sharing as well as scenario development and post-ops analysis.

**How to move forward with the initial Decision Model?**

The results of this study show that one of the logical next steps is to continue the alignment between stakeholders when it comes to their role/participation in the APOC (process). In order to further improve the decision model, multiple working sessions (workshops) with a broad sector participation could be set up. During those workshops different use-cases/scenarios could be discussed, to find the right decision steps for all stakeholders. It is expected that this will further enhance collaboration between stakeholders and will result in a widely accepted decision model and decision-making process for the future APOC.

# 5 References

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[2] SESAR, OFA 05.01.01 Final OSED, November 2016

[3] The Interplay between Intuition and Rationality in Strategic Decision Making: A Paradox Perspective (2017). Calabretta, G., Gemser, G., Wijnberg, N. M. (2017). Organization Studies, 38(3-4), 365-401.

[4] Scenario-based Strategic Planning (2013). In B. Schwenker & T. Wulf (Eds.), Roland Berger School of Strategy and Economics. Springer Fachmedien Wiesbaden

[5] Decision-making and problem solving skills: the rational versus the garbage can model of decision-making. Einsiedel Jr., A. A. (1983). Project Management Quarterly, 14(4), 52–57.

# Appendix A Interview plan (Dutch)

**Interview structure KDC APOC - Situation now (WP1)**

This interview guide has been created to provide conversation structure for the interviews that take place with APOC and sector stakeholders.

| | |
|---|---|
| I. | Naam en rol (interviewee): |
| II. | Aanleiding, onderwerp en doel van het interview doorspreken →<br>• Aanleiding → KDC-studie → APOC heeft baat bij initieel beslismodel<br>• Onderwerp → Situatie APOC op dit moment<br>• Doel → Inzicht krijgen in huidige situatie APOC (o.a. rollen, totstandkoming en uitvoering AOP, disrupties vs. maatregelen, APOC-planning en informatiebronnen |
| III. | Generiek → rol van APOC binnen airport operatie.<br>• Welke rol wil de airport vervullen in de APOC?<br>• Welke contacten zijn er op dit moment met andere stakeholders over APOC<br>• Welke informatie is gedeeld over de voorgenomen APOC<br>• De APOC is nu actief, welke rol heeft de APOC gespeeld in recente voorvallen/verstoring?<br>• Hoe worden stakeholders betrokken in het vinden van oplossingen?<br>• Hoe werkt het besluitvormingsproces in het algemeen?<br>• Hoe werkt het besluitvormingsproces in de specifieke situatie dat als er geen consensus is over de oplossingsrichting?<br>• Hoe is dit voor andere (niet airport) stakeholders?<br>• Zijn er verschillen tussen (bijv.) airlines?<br>• Wat zijn de (onderlinge) belangen op dit moment?<br>• Op welk niveau (en welke regelmaat) vindt nu afstemming plaats?<br>• Hoe is de acceptatie van de APOC bij stakeholders<br>• Hoe is het gesteld met de bereidheid om deel te nemen in de fysieke APOC?<br>• Wat zijn de condities en voorwaarden die zij daaraan stellen?<br>• Welke verstoring worden door interventie van de APOC behandeld?<br>• Welke gradaties kent de APOC voor de interventies<br>• Wat is de gemiddelde doorlooptijd van een interventie (waarneming, oplossing, besluitvorming, toepassing)?<br>• Welke KPI (type, normen, schalen) zijn vooraf aan de APOC gesteld als het gaat om bijv. capaciteit, OTP, hersteltijd, etc onder verschillende omstandigheden.<br>• Wat gaat er momenteel goed? Waar hebben jullie op verkeken (wat was daarvan de oorzaak)? En, wat gaat er fout/wat kan beter? |

| | |
|---|---|
| IV. | APOC rollen → Wat zijn de huidige APOC rollen? Welke rollen zijn voorzien? High level beschrijving.<br><br>Zijn functieprofielen bekend? Per wanneer moeten deze 'rollen' idealiter worden ingevuld? Effecten COVID en reorganisatie(s)? Wat zijn de huidige en toekomstige taken en verantwoordelijkheden van het operationeel- en ontwikkelteam? |
| V. | Inzicht huidig AOP → rol van APOC bij totstandkoming AOP. Interne afstemming APOC voor bijdrage AOP, rol andere] organen/sectorpartijen. Wat is de output? Hoe gaat die output er 'op termijn' uit zien? |
| VI. | Disrupties en mitigaties → wat is de scope van disrupties die in de APOC worden meegenomen? Hoe wordt een disruptie intern/extern gecommuniceerd? Welke processen worden gestart bij het (h)erkennen van een (aanstaande) disruptie? Hoe worden mitigaties bepaald? Is er een (beknopt) beslisproces voor handen? |
| VII. | APOC-planning → is er een APOC 'draaiboek'? Welke planning doorloopt men? Hoe verandert deze planning in aanloop naar dag van operatie? Zijn er (externe) factoren die deze planning mogelijk kunnen verstoren? |
| VIII. | Informatiebronnen → welke informatiebronnen kunnen worden gebruikt voor de totstandkoming van AOP? Welke voor overige regievoering? hoe werken de huidige detectiesystemen bij de toetsing van het AOP (consistentie, uitvoerbaarheid)? |
| IX. | Wvttk |

# Appendix B APOC Workshop

## Agenda

| Agendaitem | Duur | Tijd |
|---|---|---|
| Welkom en introductie | 5 min | 15:00 – 15:05 |
| Resultaten tot nu toe | 10 min | 15:05 – 15:15 |
| Use Case 1 | 40 min +/- 10 min | 15:15 – 15:55 |
| Use Case 2 | 40 min +/- 10 min | 15:55 – 16:35 |
| Use Case 3 | 20 min (als er tijd is) | 16:35 – 16:55 |
| Afsluiting | 5 min | 16:55 – 17:00 |

 | 3

## Welkom en introductie

- NLR – ATM & Airports
- Drones & Airport Operations – Total Airport Management

| KLM | LVNL | Schiphol | NLR |
|---|---|---|---|
| Rob de Kok | David Zwaaf | Johan Blom | Wesley Poland |
| Desire van Gils | | Marnix Groenhof | Ronald Grosmann |
| | | Suzan van Zutphen | |

 | 4

## APOC functies (SESAR concept)

- Sturen/Monitoren van events op operatie → severity levels
- Hoe hoger het 'severity level', des te groter de invloed van APOC regie
- Vanuit APOC → bepalen van impact, ondersteunen decision makers, nemen van beslissing
- Achteraf: post-analyse

 | 5

## Resultaten Werkpakket 1 & 2

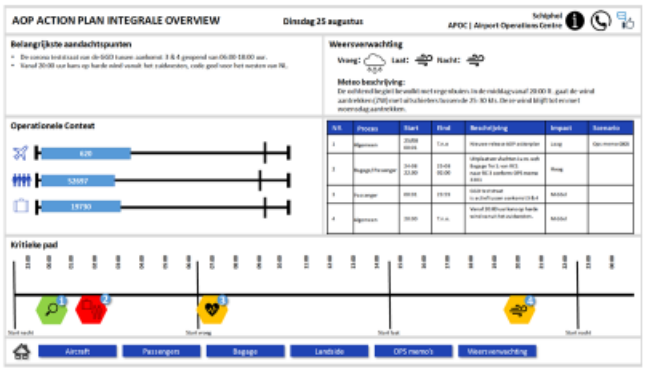
### Totstandkoming AOP

*Rollen voor:*

- Data Analysts
- Cluster Leads
- Day Coordinator

## Voorbeeld AOP 1.0 (PPT versie)

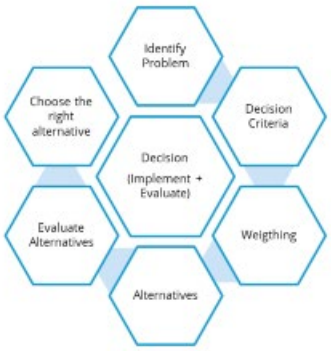


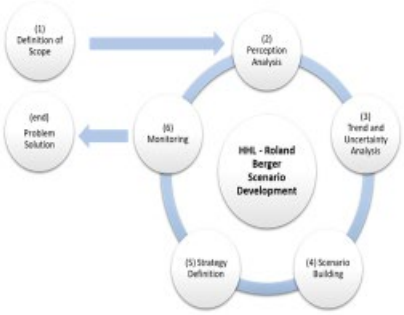

 

## AOP 2.0 (PowerBI)

## Decision Models

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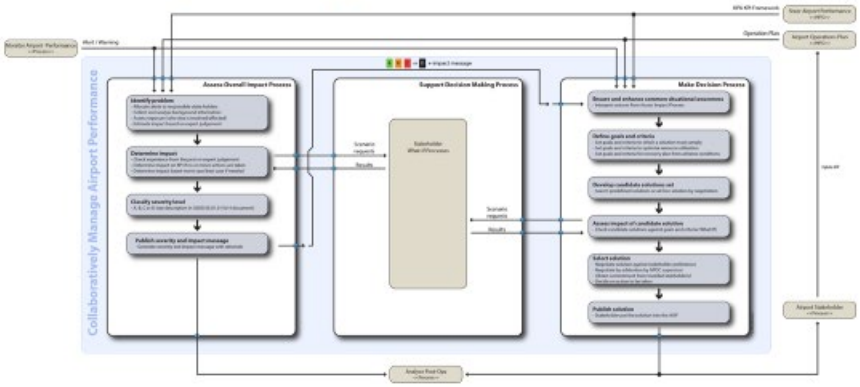
## Beslis- en processtappen beslismodel

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## Collaboratively Manage Airport Performance


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## Hoe tot een initieel beslismodel te komen?

*Aan de hand van use-cases:*

- Welke interne stappen/acties voorzie je bij deze situatie?
- Wanneer deel je zaken extern? Wanneer van interne besluitvorming naar ketensamenwerking
- Welke externe data/gegeven zou je kunnen gebruiken? Wat kun je delen?
- Welke beslisstappen passen in het (toekomstige) APOC model?

KLM: Stap 1 → Stap 2 → Stap 3 → Stap 4 → Stap 5

LVNL: Stap 1 → Stap 2 → Stap 3 → Stap 4 → Stap 5

Schiphol: Stap 1 → Stap 2 → Stap 3 → Stap 4 → Stap 5

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## Scenarios

A. Hevige sneeuwval voorspeld over twee dagen

B. COVID-19 restricties voor vluchten buiten EU

C. Langdure stroomuitval D-pier

 13

## Use Case 1 - Sneeuw

Er is over twee dagen hevige sneeuwval voorspeld op Schiphol. In de situatie waarbij KLM, LVNL en Schiphol actief participeren in de APOC, kan er collectief gehandeld worden.

Sneeuwval kent de volgende (belangrijke) effecten:

- Reductie gate, stand en baancapaciteit
- Reductie in staffing door slechte bereikbaarheid luchthaven
- De-icing unit raakt overbelast
- Pax is niet in staat de luchthaven (bijtijds) te bereiken
- Pax stayovers
- Verstoringen in het Netwerk
- .....

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## Use Case 1 - Sneeuw

Welke interne stappen/acties voorzie je?

| KLM | LVNL | Schiphol |
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## Use Case 1 - Sneeuw

Welke externe stappen/acties voorzie je? Wanneer breng je zaken van intern naar ketenafstemming zoals bij een APOC?

| KLM | LVNL | Schiphol |
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## Use Case 1 - Sneeuw

Welke relevante data zou je kunnen delen met deze sneeuw in aantocht? Welke informatie heb je van de ander nodig?

| KLM | LVNL | Schiphol |
|---|---|---|
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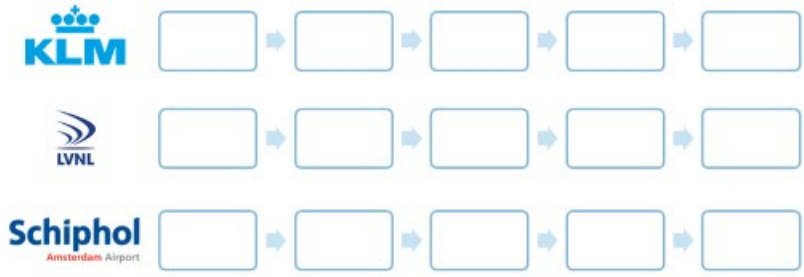
## Use Case 1 - Sneeuw



## Use Case 2 – COVID 19 restricties

In een COVID persconferentie wordt aangegeven dat verkeer van en naar landen buiten Europa niet langer is toegestaan vanaf 09:00 de volgende ochtend. De tijd om dit in te regelen is beperkt (24 uur). Ook andere EU landen handhaven deze regels. Meerdere Schiphol stakeholders krijgen actief met deze restricties te maken en interne besluiten hebben effect op andere stakeholders. Wat is de rol van het APOC?

Dergelijke restricties kennen de volgende (belangrijke) effecten:

- Gestrande (transfer) pax blijven op de luchthaven (stayover)
- Diverse vluchten moeten worden geannuleerd
- Gate en standplaatsen kennen een hogere bezetting
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## Use Case 2 – COVID 19 restricties

Welke interne stappen/acties voorzie je?

| KLM | LVNL | Schiphol |
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## Use Case 2 – COVID 19 restricties

Welke externe stappen/acties voorzie je? Wanneer breng je zaken van intern naar ketenafstemming zoals bij een APOC?

| KLM | LVNL | Schiphol |
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## Use Case 2 – COVID 19 restricties

Welke relevante data zou je kunnen delen met deze restricties in aantocht? Welke informatie heb je van de ander nodig?

| KLM | LVNL | Schiphol |
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## Use Case 2 – COVID 19 restricties

KLM

LVNL

Schiphol Amsterdam Airport

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## Use Case 3 – Stroomuitval D-pier

Er vindt een grote stoomstoring plaats, waardoor een groot deel van de D-pier niet langer beschikt over stroom. Een typisch onverwacht event op D0. Om het voorbeeld te laten kloppen met de huidige APOC situatie gaan we ervan uit dat deze stroomstoring een aantal dagen duurt. Wat is de rol van het APOC?

Dergelijke restricties kennen de volgende (belangrijke) effecten:

- Schermen aan de gates doen het niet, pax kan niet boarden. Alleen handmatig
- Kisten dienen aan andere gates te worden gezet, dit heeft effect op de gatebezetting
- Drukte aan airside neemt toe, vluchten moeten worden geannuleerd om 1.5 meter afstand te kunnen blijven waarborgen
- Binnenkomende vluchten kunnen niet aan gates terecht
- .....

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## Use Case 3 – Stroomuitval D-pier

Welke interne stappen/acties voorzie je?

| KLM | LVNL | Schiphol |
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## Use Case 3 – Stroomuitval D-pier

Welke externe stappen/acties voorzie je? Wanneer breng je zaken van intern naar ketenafstemming zoals bij een APOC?

| KLM | LVNL | Schiphol |
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## Use Case 3 – Stroomuitval D-pier

Welke relevante data zou je kunnen delen met deze restricties in aantocht? Welke informatie heb je van de ander nodig?

| KLM | LVNL | Schiphol |
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## Use Case 3 – Stroomuitval D-pier

KLM

LVNL

Schiphol Amsterdam Airport

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## Hoe verder?

- Uitwerken beslismodel aan de hand van use cases en interviews
- Terugkoppeling deelnemers – eventueel nog 1-op-1 gesprekken
- Iteratieslag
- Opleveren initieel beslismodel + eindrapport





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