Amsterdam University of Applied Sciences

LVNL

THESIS

INVENTORY ON SYSTEM WIDE INFORMATION MANAGEMENT (SWIM) SERVICES TO IMPROVE WORK FLIGHT DISPATCH

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Summary

Sharing information is crucial in aviation as well as ensuring that the shared information and data reaches the stakeholders in an interactive and secured way is important. System Wide Information Management (SWIM) is a concept that facilitates the exchange of ATM-related information among qualified parties via secure and interactive interoperable services. SWIM plays a vital role in information exchange among ANSPs and aviation stakeholders, serving as the key player for creating services and enabling global interoperability. Various models have been established by SWIM for information exchange:

- AIXM exchange model: used for aeronautical information
- FIXM exchange model: used for flight/flow information
- IWWXM/WXXM: used for meteorological information

Within airlines, SWIM hasn't been extensively utilized, and its potential remains largely unexplored. KLM is one airline keen on investigating SWIM's capabilities, particularly within the flight dispatch department. Flight dispatch is involved in creating, filing, and distributing KLM flight plans, overseeing the flight until it is off-block and after the aircraft is off-block, the flight crew can still contact the flight dispatcher for required information at any time. Due to all lot of data within SWIM, KLM is does not know where to start with SWIM services in their operation. The mass of data makes it challenging to select relevant information for flight dispatch purposes. Therefore, KLM aims to explore available services within SWIM that enhance interoperability in flight dispatch, focusing on efficiency and effectiveness. To achieve this objective, a main question is set-up:

"Which services within System Wide Information Management (SWIM) could improve the interoperability in the work of flight dispatch in terms of efficiency and effectiveness? "

To determine the services relevant to KLM flight dispatch, the following approach was followed:
Desk Research: Given the knowledge about SWIM services and flight dispatch operation, understanding both flight dispatch and SWIM is necessary to establish a connection and to select SWIM services.

SWIM Service Registry Identification**:** Identifying SWIM services listed on the registry site, which includes compliant B2B services available for stakeholder use. Identification of potential services for use in flight dispatch is conducted from these listed services.

Interviews: four interviews were conducted with different parties to explore this topic from varied perspectives. Interviews were held with a Flight Dispatcher/Senior Flight Dispatcher discussing services identified, an Expert at EUROCONTROL discussing new services from SESAR research, and a KLM business analyst and LVNL expert discussing their perspective on SWIM within flight dispatch.

In conclusion, six services have been identified that could potentially be utilized in KLM flight dispatch, leading to actual improvements in interoperability. These comprise three aeronautical exchange services: Flight Preparation, Flight Management, and Flight Availability, and three meteorological exchange services: Volcanic Ash Mass Concentration Information Service, Aerodrome Meteorological Information Service, En-Route and Approach Meteorological Information Service, and Network Meteorological Service. For concrete data, further research should be done on these six services. It will be possible to calculate with the following data if the services will be implemented in the future and data becomes available:

- Cost - fuel burn per flight
- Time - flight time and planning time
- Sustainability - CO_2 reduction.

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List of Abbreviations

AIP	Aeronautical Information Publication
AMC	Airspace Management Cells
ANSPS	Air Navigation Service Provider
API	Arrival Planning Information
ARES	Airspace Reservation
ASBU	Aviation Block Upgrades
ASM	Airspace Management
ATC	Air Traffic Control
ATFCM	Air Traffic Flow and Capacity Management
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
AU	Airspace User
AUP	Airspace Use Plan
B2B	Business to Business
B2B P/S	Business to Business Publish/Subscibe
DPI	Departure Planning information
EAUP	European Airspace Use Plan
ETOPS	Extende-range Twin-engine Operational Performance Standards
EUUP	European Updated Airspace Use Plan
FAB	Functional Airspace Block
FAM	Flight Activation Monitoring
FF-ICE	Flight Flow-Information for Collaborative Environment
GANP	Global Air Navigation Plan
GML	Geographical Markup Language
ICA	International Cooperative Alliance
ICAO	International Civil Aviation Operation
ISO	International Organization of Standardization
KDC	Knowledge Development Center
KLM	Royal Dutch Airlines
KNMI	Royal Netherlands Meteorological Institute
LVNL	Luchtverkeers Leiding Nederland
MCDM	Measure Collaboration Decision Making
MET	Meteorological
NLR	Netherlands Aerospace Center
NM	Network Manager
NOTAMs	Notice To Airmen
OCC	Operation Control Centre
OGC	Open Geospatial Consortium
OTMV	occupancy traffic monitoring values
RAD	Route Availability Document
SDM	Service Delivery Management
SWIM	System Wide Information Management
TBO	Trajectory Based Operations
UUP	Airspace use plan

XML	Extensible Markup Language
XSLT	Extensible Stylesheet Language transformations

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Chapter 1 – Introduction

The aviation industry encourages sharing information with stakeholders in an efficient way, to promote safety, capacity and efficiency of air traffic. In the past, information systems of aviation transportation were info/data shared separately with the stakeholders. As a result, information to various stakeholders could not be provided information access timely and accurate to react on certain situations. Connecting all the systems together and having the capacity for all the data, cost a lot of money, time and is complex. For this reason, System Wide Information Management (SWIM) has been established to ensure that information is from quality, secure and easily accessible to all the stakeholders at all time. The information/data exchanged via SWIM is divided into categories: aeronautical, weather and flight data. This information services will possibly help to improve interoperability at flight dispatch.

SWIM concept consists of standards, infrastructure and governance which enables the management of Air Traffic Management (ATM) related information and also possibility to exchange between qualified parties via interoperable services (ICAO, 2015). The system will also give information access and interchange between all stakeholders airlines, airport and Air Traffic Control (ATC) of all the ATM information and services. Global interoperability and standardization have been acknowledged as being crucial for improving the aviation industry (Eurocontrol, 2023). Interoperability is in aviation considered as capability of two or more networks, systems, components or applications working together through exchanges of information between them, without any restrictions and with the ability to use exchanged information for technical or operational purposes (EASA, 2021). Airlines like Royal Dutch airlines (KLM) strive for the best possible interoperability to ensure their operation runs as smooth as possible.

Flight operations is a department within KLM who operates 24/7 to ensure the safety and efficiency of the KLM fleet. To ensure everything runs well, Flight dispatch prepares, files and distributes the flight plan, and also they are responsible for the flight following once the flight is off block. This means that in case of small or big disruptions, the flight crew can contact flight Dispatch for assistance. Thus, they ensure crew has all the required information at all time.

Flight Dispatch uses information from KLM itself as well as from other parties. For this reason, Interoperability is a key characteristic of flight dispatch. Flight dispatch would like to know if there is any information services available within SWIM which can improve their operation. KLM is aware of that SWIM existed, nevertheless it has not been explored enough to use it at flight dispatch. The primary challenge lies in the extensive data within SWIM, making it necessary for airlines such as KLM to navigate through the system to gather essential information for their operations. Currently, KLM does not have a clear understanding of which data is relevant and how it might enhance operational improvement in terms of efficiency and effectiveness. KLM is enthusiastic about delving into SWIM's information services to enhance their flight dispatch processes. Consequently, it's crucial to explore the information and data available in the SWIM system with the goal of enhancing Flight Dispatch's interoperability, whenever feasible.

1.1 – Problem statement

Flight dispatch is looking for new ideas that can improve interoperability in terms of the effectiveness and efficiency of their operation. Flight dispatcher prepares the flight plan for the crew. In doing so, KLM uses two systems LIDO and FAM. In these systems flight dispatcher can prepare two different kind of flights: Europe and ICA. Europe flight dispatchers ensures that flight plans are made for the operation within Europe and ICA ensures that flight plans are made for intercontinental flights. In the process of making a flight plan, the flight dispatcher has to take into account different sources to obtain information about:

- The weather conditions,
- Area restrictions,
- Military exercises and NOTAMs of airports.

SWIM is a online system with services that can provide additional information when creating a flight plan. The information published in SWIM will be real-time data/information about aeronautical data, flight data and weather conditions. With this information, the dispatcher should be able to react in a more accurate and faster way during the flight, but also during the preparation of the flight plan. For this reason SWIM information/data could be one of the that ideas to improve the efficiency and effectiveness of the interoperability flight dispatch. KLM is familiar with the SWIM system, but KLM has not explored its extensively on how information from SWIM can be used for flight dispatch. The main reason is that SWIM contains so much information that KLM has to find their way within SWIM to collect the data needed for their business. KLM does not yet know exactly which information is relevant and which information could or may improve the operation in terms of interoperability. KLM is keen on exploring SWIM information to improve the interoperability in terms of efficiency and effectiveness of flight dispatch. For this reason, available information/data should be investigated on SWIM with the objective of identifying SWIM information that can improve the work of Flight dispatch (KLM) where possible.

1.2 – Main question

The main question of this research is:

"Which services within System Wide Information Management (SWIM) could improve the interoperability in the work of flight dispatch in terms of efficiency and effectiveness?

1.3 – Sub-questions

To include all the relevant data in this research, several sub-questions have been determined. The next sub-questions are described below:

- What kind of services are available within SWIM?
- Where in the operation of flight dispatch will the information improve the interoperability in term of efficiency and effectiveness?
- How will EUROCONTROL Interchange information to flight dispatch?
- What effects will the information has on the operation of flight dispatch?

1.4 – Objective

SWIM contains an important amount of aeronautical, flight and weather information. Therefore, it will be necessary to examine which information from these three categories can be useful for the flight dispatch operations. For this reason, the main objective of this thesis is to Investigate the available services on SWIM and to provide the SWIM information that could improve interoperability of the work of flight dispatch in terms of efficiency and effectiveness. There will be looked at whether the services are more efficient and effective in terms of time saving during creating a flight plan, and

whether a flight plan can be made optimal by using the services. So, that the flight plan is made in the most efficient way. Below are the sub-objectives that must be done to achieve the main objective:

- Define the services available in SWIM could be used at flight dispatch
- Identify if the useful services will improve the interoperability in terms of efficiency and effectiveness on the work of flight dispatch
- Evaluate at flight dispatch if the services are relevant for their work
- Formulate a recommendation of the information that can be used in the work of flight dispatch

1.5 – Scope and Limitations

The data/information for this study will be collected from SWIM and from Flight Dispatch who are working insight the Flight Operations Department at KLM. Based on the information collected from Flight Dispatch, it will be determined which services from SWIM is useful for Flight Dispatch and will improve the interoperability of the operation. This study will be done in the period from 05-09-2023 to the submission date of 21-01-2024. During this period, an advisory report will be written for the KDC and KLM.

This study will not collect information from other systems and will only examine SWIM and the flight dispatcher operation. The result of the research should lead to useful information within SWIM that could lead to better interoperability within the flight dispatch operation. This will not be done using quantitative research but a qualitative study because no hard numbers are known. This study will only identify the potential information services from SWIM to be used in the work of flight dispatch, it does not verify that all the info is currently being used in practice.

Chapter 2 – Theoretical Framework & Literature review

2.1 – Theoretical framework

This chapter will be a built-up from how operational information is currently shared chapter 2.1.1, SWIM concept and information in chapter 2.1.2, SWIM service registry chapter 2.1.3, what is flight dispatch and how do they use information in their flight plan chapter 2.1.4 and finally the FF-ICE services in chapter 2.1.5.

2.1.1 – Information sharing

In the aviation operations, a great amount of information is shared. The information is shared on different systems and in different ways. Examples of important information that is shared separately/isolated are: aeronautical, meteorologic and flight data. Result of sharing information in a separate way is that not all information is available to all stakeholders in the same standards and at the right time. For this reason, ICAO have discussed some reason for the need of SWIM and the problems of the current information sharing procedure (ICAO, 2015):

- Current systems have not been designed and implemented to be globally interoperable within globally-agreed parameters.
- Many interfaces, which were designed to support point-to-point or application-to-application exchanges, have limited flexibility to accommodate new users, additional systems, new content or changed formats.
- Message-size limitations and a non-scalable approach to information exchange with the present infrastructure.
- The current infrastructure can make it difficult and costly for one stakeholder to access, on a timely basis, information originated by another stakeholder.
- The current variety of systems and exchange models makes it challenging to devise security frameworks across systems and stakeholders so as to support the increasing need for open and timely data exchange whilst at the same time respecting the legitimate security concerns of all stakeholders.
- Currently, most organizations manage their ATM information in partial isolation leading to duplication and inconsistencies.

SWIM aims to address these challenges by leveraging connected web services and established standards among participating parties. Through the utilization of web services, all stakeholders gain the ability to access pertinent data and information whenever required. The adoption of agreed-upon standards within SWIM ensures uniform interpretation of information across all stakeholders. These standards and services in SWIM will be rooted in the Extensible Markup Language (XML), a markup language designed for storing, transmitting, and reconstructing diverse types of data, as elucidated in paragraph 2.1.2.

2.1.2 – System Wide Information Management (SWIM)

System Wide Information Management is an initiative from the ATM industry to harmonize the exchange of Aeronautical, Weather and flight information for all airspace users and stakeholders. SWIM will be a supplement to human-to-human with machine-to-machine communication to improve the data distribution and accessibility regarding the quality of the data exchanged (ICAO, 2023). The parts that SWIM system consists are standards, infrastructure and governance what can been seen in figure 1.

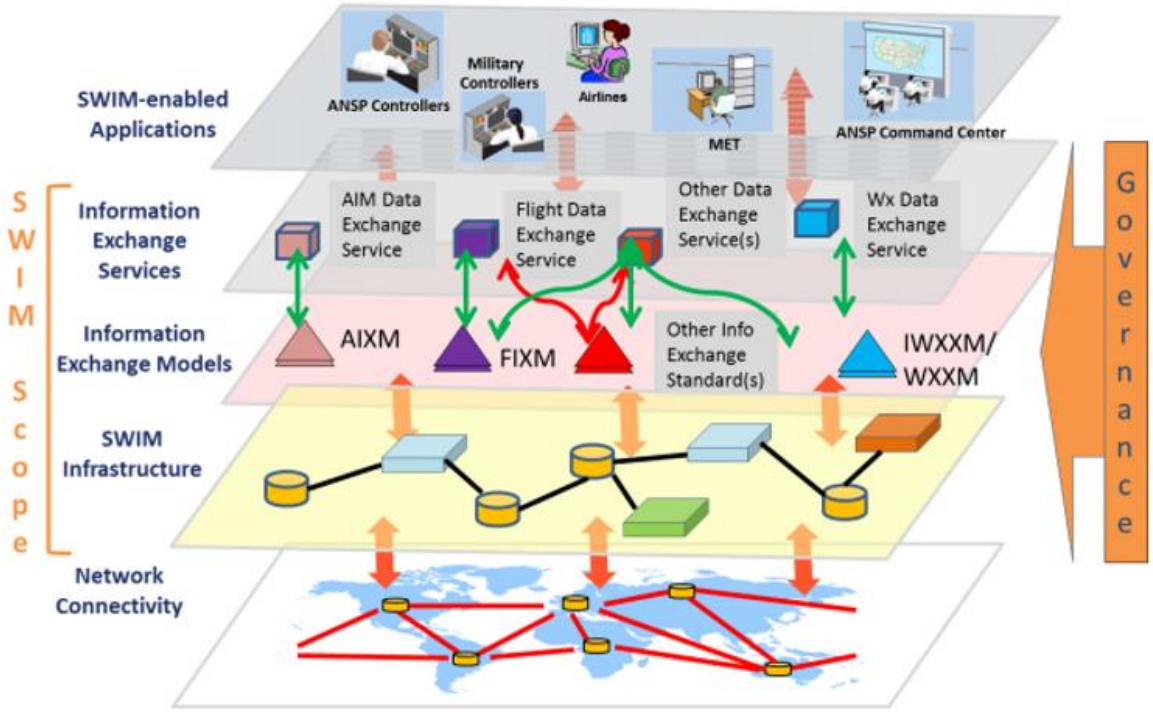

Figure 1 – Overview SWIM (ICAO, 2015)

According to figure 1, the governance structure is set-up as followed:
First the information Exchange Services are the information services in which an organisation exchange information or, make the information available in core of their business. Information services allow organisations to align in the interactions with each other in accordance to their business goals and activities. Examples of this are interfaces between meteorological information or flight data information that should lead to an efficient exchange of information that could possible lead to an optimization in their flight operation (Eurocontrol, 2021).

The information exchange models, allows to gathering different kind of information. Examples of models are (Eurocontrol, 2021):

- AIXM is an exchange model that is used in the aeronautical information domain.
  The key principles of AIXM model are:
  - An extensive temporality model, including support for the temporal information contained in the Notice to Airmen (NOTAM).
  - Alignment with International Organization of Standardization (ISO standards) for geospatial information, including the use of Geographical Markup Language (GML).
  - Support for the latest ICAO and user requirements for aeronautical data, including obstructions, terminal procedures and airport map database.

- FIXM is an Exchange model used in the flight/flow information domain.

This model is a data exchange format for the exchange of flight information throughout its lifecycle. FIXM is part of a large set of technologically independent, harmonized and interoperable information exchange models developed to meet the information needs of the ATM community. Examples of services are: validate flight plan and routes, Exchange flight plans, 4D trajectory, performance data , flight status, flight lists and flight update messages.

- IWWXM/WXXM is an Exchange information model that is used in the meteorological information domain. This model has been developed to enable a platform for the exchange of independent, harmonized and interoperable meteorological information to cover the needs of the aviation industry. The key principles of IWWXM/WXXM are:
    - Support for the latest ICAO and other user requirements for meteorological information.
    - Alignment with ISO standards for geospatial information, including the use of Geographic Markup Language (GML).
    - Alignment with the Open Geospatial Consortium (OGC) for geospatial information, including the observation and measurement Model.

Finally, the SWIM infrastructure, allows the implementation of exchange between systems, providing technical capabilities for the secure and high-performance/reliable exchange of information. The SWIM technical infrastructure capabilities can be divided into three categories (Eurocontrol, 2021):

- Messaging capabilities: allows actual exchange of information by using various access methods.
- Security capabilities: allows the secure exchange of information.
- Technical infrastructure management capabilities: allows monitoring of technical infrastructure for fault and performance, also ensuring reliable and high-performance execution of information exchange.

2.1.3 – SWIM service Registry

The SWIM service registry is a recognized component within the SWIM infrastructure. Developed by EUROCONTROL, this information service serves as a structured repository allowing service providers and consumers to share a standardized view of SWIM services. Its purpose is to enhance service visibility, improve the efficiency of service discovery for consumers, and facilitate the implementation of service acquisition. The SWIM service registry operates as a platform where service providers list their offerings. Consumers can then select desired services from this registry, subsequently accessing the data provided by the selected service provider in XML format. This process simplifies service discovery and acquisition for consumers. The SWIM service registry provides an intuitive online interface featuring search and filtering options. It offers a categorized and structured list of service descriptions aligned with EUROCONTROL SWIM specifications. This user-friendly environment contribute stakeholders in efficiently finding and utilizing relevant services within the online SWIM environment. In Figure 2, there can be seen how the information from the service flows that occur when a consumer wants to use one of the services from the SWIM registry.

The process of implementing a services from SWIM services registry works as follows, The "Web service Provider" collects the information from various "information provider" sources. From these sources, the “Web service provider” creates a service and publishes it on the “SWIM service registry”. If a consumer wants to change something in his operation in terms of services or improve his operation, the consumer would come to the “Web service provider”. The Web service provider offers its services through the “SWIM service registry”. If the "Web service consumer" has selected a service through "SWIM service Registry" he will receive these services in XML datasets.

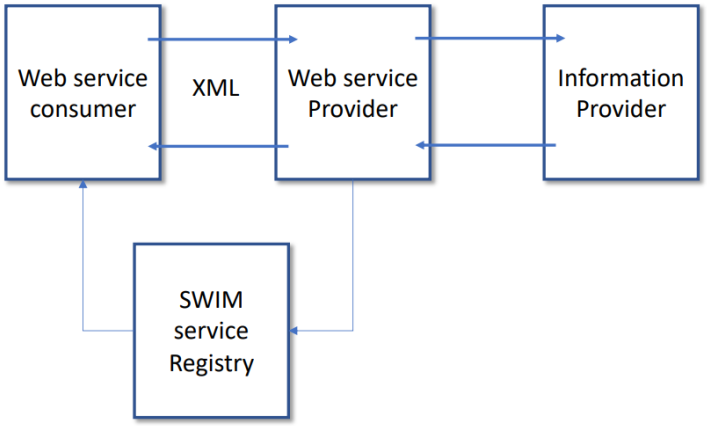

Figure 2 – Principle SWIM services (Fidom)

B2B services

Services from EUROCONTROL that are offered in SWIM service registry are B2B services. These are services that are an interface offered by EUROCONTROL as a system-to-system access to services and data, providing access for users to retrieve the information from the services in their own systems. B2B services facilitates the interoperability sharing of aeronautical and operation information between various stakeholders. According to EURCONTROL, B2B services will play a crucial role in supporting collaboration and communication between the stakeholders who are involved into ATM and aviation operations. All the B2B services are compliant with the SWIM standards and ensuring consistency in information exchange within the aviation industry. B2B services supports operations in several domains such as flight services covers flight data, airspace services covers services about airspace data and flow services covers services related to data about measures, scenarios and traffic volume (EUROCONTROL, 2023). The services are detailed next:

Flight services:

- Flight Plan Preparation
  - These services involve generating and validating flight routes and plans before submitting them to the Network Manager (NM).
  - Provides an assessing of the potential flow measures' impacts on flights and offering assistance in complete rerouting by suggesting alternate routes.
- Flight Plan Management
  - supports initial flight plan submissions, updates, cancellations, and associated operations
  - Allows for functions like rejecting and proposed rerouting
- Flight Data Retrieval
  - Enables querying and retrieving information related to flight plans and detailed flight data, providing lists and specific flight details as required.
- Departure Planning Information (DPI)
  - Designed for Collaborative Decision Making (CDM) Airports and Advanced Tower systems, these services facilitate the transmission of departure planning information to the Network Manager.
- Arrival Planning Information (API)
  - Handle the submission of target times and other relevant arrival information, supporting arrival management processes
- ATFCM (Air Traffic Flow and Capacity Management) Slot-related Messages
  - Manage flight readiness or confirmations concerning regulations and slot allocations.

- Flight Update Information
  - Enable the submission of in-flight information to the Network Manager, such as First System Activation message types.

- Flight and Flow Information for a Collaborative Environment (FF-ICE)
  - Support ICAO FF-ICE/R1 filing, trial, flight data requests, data publication services, and the distribution of flight plans to Air Navigation Service Providers (ANSPs).

Airspace Services:

- Airspace Structure
  Offers access to current and standardized NM operational airspace data utilizing AIXM 5.1.1
  - Provides Aeronautical Information Publication (AIP) sourced data (Points, Routes, Aerodromes, and Airspaces), including updates resulting from NOTAM implementation and European Airspace Use Plan (EAUP)/European Updated Airspace Use Plan (EUUP) implementation.
  - ATFCM (Air Traffic Flow and Capacity Management) Related Airspace Data Services: Includes information on ATFCM-related airspace restrictions, such as Route Availability Document (RAD) and profile tuning restrictions.
- Airspace Availability
  - Provides access to electronic Airspace Management Information containing EAUP/EUUP data in AIXM 5.1.1.
  - Facilitates Flexible Use of Airspace service for managing the AUP/UUP in AIXM 5.1.1

Flow Services:

- Regulation and Reroutings List
  - Provides access to all regulation information utilized in NM flow management systems.
- ATFCM Situation Services
  - Offers information on the Network Situation at a given time, including traffic, delays, delay causes, and regulations.
- Traffic Counts
  - Enables querying and retrieval of traffic counts based on parameters like aerodrome, aircraft operator, point, traffic volume, and airspace.
- ATFCM Tactical Updates
  - Manages ATFCM daily plan elements such as capacity plan, occupancy traffic monitoring values (OTMV) plan, runway configuration plan, sector configuration plan, traffic volume activation plan, and restriction activation plan.
- Measures Management
  - Manages regulation proposals, rerouting, and regulations, including normal and cherry-pick regulations.
- Scenario Management
  - Facilitates access to ATFCM scenarios.
- Simulations Services
  - Offers access to simulation capabilities for conducting network impact assessments of ATFCM measures.
- Measure Collaboration Decision Making (MCDM)
  - Allows coordination at three levels, enabling commenting, approval, or rejection of decisions on measures, flights within a measure, and individual flights via eHelpdesk tickets (e.g., slot improvements, slot extensions, exclusion from regulation, slot swaps, and request for information).

The services above are not only for flight planning but primarily for the stakeholders of air navigation service providers, airlines, airports, ground handling agents, computerized flight plan service providers, and airspace management organisations.

Benefits from SWIM according to ICAO:

In the aviation industry, SWIM is also an integral component of the Global Air Navigation Plan (GANP), a strategic document for regional and national planning for air navigation structure. Also, SWIM covers several aviation block upgrades (ASBU) modules which aims to enable aviation to realize the global harmonization, increased capacity and improved environment efficiency. In addition, SWIM brings many benefits to the operations of various stakeholders such as ATC, airport and airline operators. The benefits from SWIM are (ICAO, 2015):

- Improved decision making by all stakeholders during all strategic and tactical phases of flight (pre-flight, in-flight and post-flight) through:
    - Improved shared situational awareness
    - Improved availability of quality data and information from authoritative sources
- Increased system performance
- More flexible and cost-effective communications by the application of common standards for information exchange
- Flexible coupling which minimizes the impact of changes between information producers and consumers
- Support of ATM Service Delivery Management (SDM), ATM SDM is a Global ATM Operational concept that includes three main functions:
    - ATM performance management
    - Managing t of ATM services
    - Managing of ATM resources (including human resources).

Security:

Stakeholders aiming to implement SWIM in their operation need to be assured that their information/data is properly secured and protected from cyber-attack. SWIM has taken this into account and therefore security will become a critical factor. Therefore, the global SWIM concept includes aspects such as authentication, authorization, encryption, intrusion detection, security policies, etc (ICAO, 2015). KLM is a stakeholder that is interested in SWIM and would like to see the possibilities of an implementation. KLM is particularly interested in the possibility to implement SWIM information within the Operation Control Centre (OCC) at flight dispatch, which is explained in section 2.1.3.

Form of data exchange SWIM:

As described earlier in Chapter 2.1. SWIM's data representation standards consist of XML and XML Schema Definition (XSD). XML provides standardized way of describing data structures and data types, while XSD formalizes how elements are described in an are described in an XML document. Extensible Stylesheet Language transformations (XSLT) is a SWIM standard for XML data transformation. XML Path Language (XPath) and XML Query Language (XQuery) are SWIM standards for querying XML data via Web services. XML is a widely accepted standard for structuring data that provides a foundation for representing data in web services. In web services. XSD, XSLT, XPath, and XQuery are all standards/tools created to facilitate the use of XML (ICAO, 2015).

2.1.4 – KLM flight dispatch

KLM flight dispatch is a department located in the Operation Control Centre. Flight dispatchers uses the LIDO system to make flight plans. LIDO is a Lufthansa system where flight plans can be made and where it can be determined if the flight plan should be adjusted on the basis of flight time, fuel and cost of the flight. The flight dispatcher can be specialized in two different types of flights, an intercontinental flight or an European flight. These two types of flights are different from each other.

For European flights, flight plans are automatically generated by the system LIDO, this system uses data from previous flights on a certain route to choose the optimal route. The flight plans for international flights are still made manually in LIDO by a flight dispatcher, who will therefore have a higher workload than a flight dispatcher on a European flight. So, for creating a flight plan many processes are carried out. Examples of processes performed by Flight dispatchers are (Shefffield, 2023):

- Weather monitoring
  - Wind
  - Departure airport and Destination airport
  - Extreme weather condition
- Flight planning
  - Fuel – Amount of fuel per flight
  - Cost – Cost per flight
  - Time – Time of the flight
  - Restricted area's – Conflict area or military area
- Communication
  - Pilot – Amount of fuel, Change of weather and Congestion area's

Besides this, when deciding which route to put into the flight plan, there are also a number of interests that need to be taken into account. Examples of these are:

- The amount of fuel in terms of cost and sustainability
- Flight time in terms of transferring passengers
- ETOPS, that is the airport which can be reached over the sea within 180 minutes in the event of a failure of one of the two engines.

In figure 3 an flow chart is provided of al the processes that a flight dispatcher will do for a flight plan. There are three different phases: pre-planning all the processes that can be done before the planning, flight planning the actual planning of the flight and eventually, during the flight, the flight will be followed and be informed about the current situation (Huang, 2019).

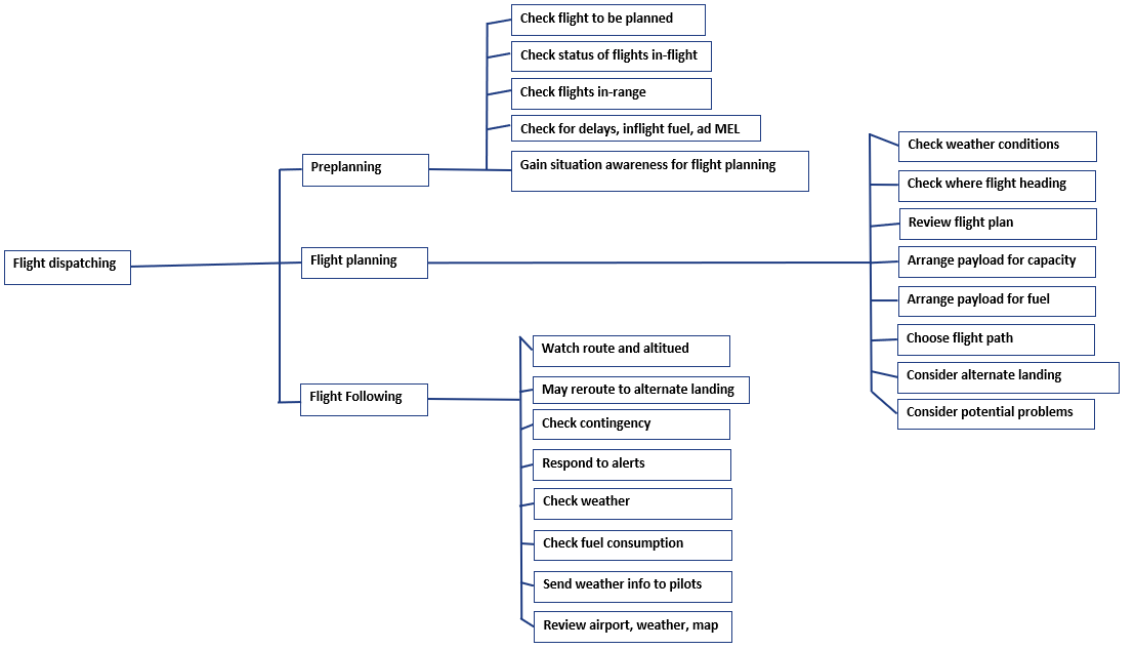

Figure 3 – Flowchart flight dispatching

The LIDO system mentioned earlier in this chapter is a tool used to provide computerized flight plan services to KLM's flight dispatchers. This system contains several modules that can be used by flight dispatchers, LIDO is including the following modules:

- Flight planning (LIDO/FPLS),
- Flight trajectory optimisation (LIDO/Flight)
- Flight position following (LIDO/WINDS)

The flight plan data of KLM is managed and entered in the LIDO system who will then provide the KLM flight plan to Network Manager Operation Centre (via LVNL).

Over the last few years, LIDO has developed LIDO flight 4D. LIDO flight 4D is an advanced technology that calculates the most efficient routes from a variety of possibilities, taking into account real-time flight data, including weather conditions, NOTAMS, aeronautical information, ATM restrictions, performance data and ATC charges. In the older LIDO system, some factors are also used, but what is new in LIDO flight 4D is that an automatic flight plan can be created based on business rules, with flight dispatch only having to fine tune the business rules.

The aviation industry has been aware for a long time that the existing ICAO 2012 flight plan format has its limitations and restrictions, and that a new flight plan format will be needed to implement future ATM concepts such as TBO (Trajectory Based Operations). The sharing of a flight trajectory in a collaborative environment is a fundamental requirement and an important means of optimizing flights at each phase of flight. In the long term, this is expected to have significant benefits for all airlines, such as bringing the planned flight trajectory closer to reality, creating more efficiency in the airspace, resulting in more sustainable flight operations and fewer ATC rules and delays. The basis for this, according to ICAO, is known as Flight & Flow Information for a Collaborative Environment (FF-ICE) further explained in chapter 2.1.5; a comprehensive flight plan format that can be exchanged in the context of SWIM based on the FIXM as a new standard (Lufthansa systems, 2022).

2.1.5 – Flight Flow-Information for a Collaborative Environment

FF-ICE, is a new concept for the flight plans that will become effective at the end of 2025 according to ICAO (ICAO, 2012). KLM Flight Dispatch will have to work with this and will probably come across the new FF-ICE concept in the LIDO planning system of Lufthansa. The FF-ICE concept will ensure that all members of the ATM community are supported in managing strategic, pre-tactical and tactical performance. FF-ICE emphasizes the need for information sharing and will provide operational benefits. The sharing of flight/flow information will contribute to the present and future ATM situations. In addition, information sharing will improve the decision making of ATM stakeholders during the flight to 4D trajectory operations (ICAO, 2023).

The FF-ICE services use the NM B2B services defined in Chapter 2.1.3, which is an interface provided by the EURCONTROL Network Manager (NM) for system-to-system access to all its services and data, and in addition, it gives permission for users to retrieve information from NM and use it in their own system. NM B2B services follow the principles of SWIM and are therefore essential for real time information exchange. NM B2B services were explained and described in the European SWIM Registry mentioned in Chapter 2.1.3. FF-ICE uses the following NM B2B services from the SWIM registry (LEPORI, 2023):

- **NM B2B Filling Service**

  This service includes the ability to submit a new flight plan, update an existing flight plan, and cancel a flight plan using the FIXM data/messaging model, supplemented by NM extensions to cover European specifics. It also provides feedback to the airline operator as to whether the flight plan has been successfully processed and if it is acceptable.

- **NM B2B Flight Data Request Service**

This service includes the ability to obtain a flight plan, obtain additional details about a flight plan, and obtain the filing status of a previously submitted flight plan.

- **NM B2B Trial Service**

This service provides the ability to evaluate a flight plan before it is submitted or can be used to evaluate potential changes to a flight plan. This service is intended for airspace users and stakeholders involved in flight plan activities for example creating a flight plan or flight following.

- **NM B2B Publication Service**

This service distributes accepted flight plans using the FIXM data/message model and is intended for any organization involved in flight planning activities for example creating a flight plan or flight following.

- **NM B2B Notification Service**

This service is intended to distribute NM processed flight arrival and departure messages received through the Notification Service with the basic information to all parties who have previously received the corresponding eFPL/FPL (flight plan). The service is intended for Air Navigation Service Providers.

All these services use the FIXM data/messaging model were explained earlier in the chapter 2.1.2 and can be seen in figure 1, which is a data/messaging model for flight information.

2.2 – Literature review

Prior to this research, not many studies have been done on the topic of SWIM. For this reason, it is important to select important researches that can contribute to this research. In addition to this, it is important to have an understand standing of how flight dispatch do their work.

In June 2016, the Knowledge Development Center (KDC) initiated a significant project in partnership with the Netherlands Aerospace Center (NLR, 2015), aiming to delve into the practical application of SWIM. This pioneering study involved comprehensive research methodologies, including extensive literature reviews and targeted interviews with prominent Dutch stakeholders, among them being KLM. This thorough investigation resulted in an illuminating overview of SWIM and its extensive impact on various systems. The outcomes identified notable opportunities to pertaining SWIM for several Dutch stakeholders like LVNL, KLM, and KNMI, such as: Connecting SWIM to LIDO and FIRDA to improve planning and standardize communication and the consumption of weather information.

While the study didn't specifically focus on SWIM and its relationship with Flight Dispatch within KLM, it set the stage for further explorations in subsequent research. At the current stage of SWIM's development, it provided a foundation for future assessments and comparisons to gauge whether such opportunities continued to be viable for Dutch stakeholders, particularly KLM.

Meanwhile, other international research contributed significantly to understanding SWIM's multifaceted aspects. The research conducted by the Civil Aviation University of China notably emphasized not only the seamless information exchange capability but also delved deeply into the critical security facets of SWIM. This investigation scored the importance of safe and sensitive data within the SWIM system, recognizing the potential business impact if such confidential information were compromised (Zhang, 2022).

Simultaneously, the International Civil Aviation Organization (ICAO) published a comprehensive manual describing the SWIM concept and its operational nuances at various levels. This document provided insights into stakeholder participation, governance, and possibilities for further advancements in SWIM. However, it did not extensively explore the interface between SWIM and

airline operator stakeholders, presenting an opportunity for future research to explore SWIM's implications specifically in airline flight dispatch operations (ICAO, 2015).

Furthermore, the Whitepaper by CANSO Strategic (2021) outlined SWIM's evolution over the past decade, highlighting diverse interpretations and slower-than-anticipated progress compared to ICAO's initial expectations. This paper showcased SWIM's implementation disparities across various global regions:

- United States (FAA)
- Europe (EUROCONTROL)
- Middle East (UAE SWIM Gateway)
- Asia Pacific (SWIM Task Force)
- Latin America(CADENA)
- Caribbean region (CADENA)

With this offering insights into potential regional variations in SWIM's utilization for flight planning and providing recommendations.

Eventually, An investigation by Huang shares insights into the work of a flight dispatcher and the tasks they perform to create a flight plan. This student has delved into how flight dispatchers manage flights (Huang, 2019). This research will assist in better understanding the flight dispatch processes and establishing a connection between services of SWIM and the work of flight dispatch.

Collectively, these studies and research encompassed a comprehensive exploration of flight dispatch and SWIM's inceptions, security implications and global guidelines. They laid the groundwork for the investigations, offering crucial insights into studies, particularly in optimizing SWIM's application within flight dispatch operations.

Chapter 3 – Research Methodology

In this study, qualitative data will be used. To collect this data, several methods will be used. First desk research and a SWIM services identification will be done. Second, interviews will be conducted with different people from different companies; LVNL, EUROCONTROL and KLM flight dispatch department.

3.1 – Desk research (connection between literature review)

Comparing sources from internet to identify any existing studies on SWIM or flight planning is important for this research. As there is little to no existing information about the use of SWIM services in flight dispatch work, direct research findings may not be readily available online. Therefore, this method will rely on studies and literature found on the internet to establish a connection between the two topics. This can only be achieved when both subjects are well understood, and for this reason, this chapter will focus on desk research. To select services within SWIM that could potentially be used in the work of flight dispatch and actually improve interoperability in terms of efficiency and effectiveness, understanding SWIM and work of flight dispatch is important. Before interviews can take place or SWIM services can be determined for flight dispatch, it is important to do desk research on understanding flight dispatch. For this purpose a study has been published by Huang (Huang, 2019) mentioned earlier in chapter 2.2 that explains the work of flight dispatching and gives a step-by-step explanation of how flight dispatching starts and when the work is finished. In addition, Sheffield (Sheffield, 2024) gives a clear explanation of the work of a flight dispatcher. By understanding the work step by step, there can be determined where in the work of flight dispatch SWIM services can be used.

Next, desk research will be done on SWIM. This will be done from a manual of ICAO (ICAO, 2015). ICAO shares information about how they think about SWIM and the possible benefits. These benefits will be looked at and it will be seen when implementing SWIM these benefits will also apply to the work of a flight dispatcher. In addition, EURONCONTROL has published a site that explains SWIM and also shares a lot of qualitative data about SWIM (EUROCONTROL, 2021). By collecting more and more qualitative data through desk research, a more concrete decision can be made about which services will be relevant for flight dispatch. The services relevant to flight dispatch are selected in the SWIM service registry. In this SWIM service registry an identification will be done to determine which services are suitable for flight dispatch. This will be further explained in Chapter 3.2.

3.2 – SWIM Registry services identification

SWIM contains a lot of information and data that is available online. Not all the data and information from SWIM available on the internet is relevant for the work as a flight dispatcher. For this reason, it is important to filter which services offered by SWIM can be used in the work of a flight dispatcher. SWIM registry is an online environment of SWIM containing an overview and explanation of SWIM services explained earlier in chapter 2.1.3. SWIM registry provides a filter box where different filters can be selected. The following filters are available:

- Service Provider Name
- Service Type
    - Candidate
    - Compliant
- Lifecycle Stage
    - Operational
    - Prospective
    - Expired
- Service Version

- Sort by
    - Title
    - Changed date
    - Provider
    - Published date

The three filters used for this research are Service Type, Lifecycle Stage, and Service Provider Name. First filter that is used in this method is Service Type, this is a service that is used to select if the service is already useable for flight dispatch. This filter shows whether a service is candidate, the SWIM service is currently being tested and also evaluated for compliance, or the service is Compliant, the services meets the specifications for a SWIM service and thus can already be used. Second filter used within this method is lifecycle stage, which filters whether the services of SWIM are already operational, whether the services will be used in the future or whether the service has expired. Third filter used in this method is Service provider Name, this filter is used when specifically searching for a service from a particular provider that provides a SWIM service. After the services were filtered using the filter box, the description of the service was used to select the audience for which the service was intended. This made it easy to filter which services were important for flight planning and which services were irrelevant for flight planning.

As mentioned earlier in this chapter, not all SWIM services provided by the SWIM registry are relevant for flight planning. By filtering the SWIM services to flight planning, some SWIM services can be selected. From these SWIM services, relevance can be extracted with reliance to the work of a dispatcher. The relevance of these services depends on the following factors:

- Purpose - The purpose of the services and what can be achieved with the services.
- Description - Explanation of the service and how the service will be used.
- Service Provider - Who provides the service?
- Access - How does the party in question gain access to the service?

After this, an interview will take place with a flight dispatcher or senior flight dispatcher to evaluate if they agree that these services can be used in the flight dispatch department and whether these services will actually provide an improvement in their work. This will be further described in chapter 3.3.

3.3 – Interviews

Interviews are important for this research. The reason for this is, based on authors knowledge there is little or no literature on the Internet available about the relationship between flight dispatch and SWIM. In order to get the link between Flight Dispatch and SWIM, this method will conducted interviews with different parties; flight dispatch department of KLM, EUROCONTROL and LVNL.

The first interview that will take place with an expert from LVNL. LVNL is more advanced with SWIM than any other parties in the Netherlands and aims to lead the developments concerning SWIM within the Dutch aviation industry according to a unstructured conversation at KLM. LVNL has an expert who has a lot of knowledge about SWIM and is working within Dutch aviation sector to spread the knowledge about SWIM and its possibilities. For this reason, a semi-structured interview will be conducted. This will involve asking questions that cannot be answered through literature. Additionally, the LVNL expert will have the opportunity to share their ideas about SWIM in the Netherlands.

In order to determine whether the services that have been identified are interesting for fight dispatch and whether there can be improvement in the work of flight dispatch on the basis of these services, it is important that an interview with a flight dispatcher takes place. Flight dispatchers have the best view on whether a service can be useful in their work, therefore an interview must be conducted to validate whether the flight dispatcher and the senior flight dispatcher agree on the service as defined in Section 4.1. The interview that will take place with the flight dispatcher and senior flight dispatcher will be and structured interview where the services will be presented in a presentation form along with an explanation of the services. The flight dispatcher can then express his ideas about the specific services and indicate whether the service can possibly be used in the work of a flight dispatcher. From this interview a selection of services will then be made that can be used in flight dispatch in the future and also provide improvement in interoperability in the work of a flight dispatcher in terms of efficiency and effectiveness.

EUROCONTROL is a party that is closely involved in the developments around SWIM, for this reason it is important not only to read about SWIM articles from EURCONTROL but also to interview an expert. This interview will conducted questions about airlines' commitment to SWIM and if there are SWIM services developed for the work of a flight dispatcher. SWIM is still developing and there may be many changes in the future and therefore their will also be discussed about SWIM and its future perspectives. The interview will be asked semi-structured. The reason for this is that answers on certain question are needed for this research, but also that new ideas may arise during the interview.

The last interview that will be done in this research is an interview with the Business Product Analyst of KLM. For this research it is important to know what the operations department of KLM has in mind about SWIM and the developments of SWIM within flight dispatch. The business product analyst of KLM will be able to give input for this. The Business Product Analyst at KLM deals with the products that KLM has in use and product that KLM will be use in the future. SWIM is one of the products that the KLM will be dealing with in the future. In this interview, questions will be asked about how KLM thinks about SWIM in the future and how KLM will use SWIM in the work of Flight Dispatch. The interview will be conducted in a semi-structured form.

Chapter 4 – Results & Discussion

This chapter contains the identification on SWIM services registry, results interview KLM, results interview EUROCONTROL and the results interview Product analyst KLM.

4.1 – Results identification SWIM services registry

The services listed here are all from the SWIM service registry and are all compliant B2B services from EUROCONTROL (EUROCONTROL, 2023). This means that the services are already in use by EUROCONTROL and that they could be used by KLM flight dispatch. The results are described on a description of the service, the purpose of the service, how to access the service, the target audience and an explanation of why this service is suitable for flight planning. The following results were selected based on the identification method from Chapter 3.2:

Airspace Availability service

This service provides the Airspace User (AU) or airport operator with the ability to optimize the daily operations in their system through NM updates in the European Airspace Use Plan and European Updated Airspace Use Plan (EUUP). This allows the flight dispatcher to see airspace availability more accurate and possible in an earlier stage. This can then lead to more accurate routes and thus optimized fuel calculations for the flight.

Table 1 – Overview Airspace availability service

Service	Airspace Availability
Description	Supports the Airspace Management (ASM) processes, whereby the Airspace Management Cells (AMC) update and share their Airspace Use Plan (AUP) within the central NM system, allowing NM Operations to publish a consolidated European AUP (EAUP), enabling the airspace users to make the best possible use of airspace availability.
Purpose	Update AU about airspace availability
Access	The EAUP can be retrieved on demand via the request/reply operations of this service and via the NM B2B Publish/Subscribe (P/S). The P/S is the ideal means of getting the EAUP and its dynamic updates (EUUP) in a timely manner.
Target audience	This service is targeted for the AMC in what regards the management of the AUP, and for all operational stakeholders in what regards the read access to the EAUP/EUUP.

Airspace Structure service

The AUP/UUP by the local ASM support systems requires the same airspace data to be used by both NM and ASM support systems. As a result, both parties contain the same data/information which improves interoperability. Airspace Structure Service, which allows it to obtain all the airspace data required (in AIXM 5.1) by the local ASM support systems for the management of the AUP (Aeronautical Information Regulation and Control(AIRAC) data and the live updates**.**

Table 2 – Overview Airspace structure services

Service	Airspace Structure
Description	The service follows the AIXM 5.1 model to provide following data: • Complete airspace dataset, built on daily(nightly) basis, delivering the users a day-fresh airspace baseline • Each time NM updates its airspace data, an incremental airspace dataset is put online. An incremental dataset is

	much smaller than a full one because it contains only the airspace entities affected by the NM update.
Purpose	The service simultaneously enables a simple, but potentially heavy method of refreshing the user's airspace database (usually performed at the end of the night) and a simple, powerful way of updating that data with updates occurring during the day. With the simple and proper design on the client side, it becomes advantageous to avoid any de-synchronization of NM airspace structure data at any time.
Access	Access to airspace data can be done via request/reply operations of this service and via the NM B2B P/S. The subscription mechanism allows to select AIXM feature types for which they want to receive data. P/S is ideal means of getting the dynamic airspace live update in timely manner.
Target audience	This service is targeted for operational stakeholders having the need to access the airspace context data used in NM flight and flow systems

Flight Data Request service

This service allows FF-ICE-enabled stakeholders to retrieve data about a flight such as the whole eFPL, search and rescue data or the filing status. The operational stakeholders shall use NM B2B Services supporting the information Exchange of FF-ICE. This service will not be available until FF-ICE is implemented within LIDO. The service will provide better interoperability between the airline operator and NM through more visibility of flight data/information.

Table 3 – Overview Flight data request service

Service	**Flight Data Request Service**
Description	The service includes facilities to obtain the flight plan , obtain the additional flight plan data, and obtain the filing status of a previously submitted flight plan, or the filing status (in case of manual intervention).
Purpose	NM B2B service supports the capability to obtain information about a particular FF-ICE flight plan
Access	NM B2B Services supporting
Target audience	Airspace used and other organizations involved in flight planning activities, provided in accordance with ICAO FF-ICE/R1 specifications

Flight Preparation service

This service offers many possibilities for a flight dispatcher. With the help of this service, routes of the flights can be made more accurate and the work of a dispatcher can be made more efficient. The Flight Dispatcher has more possibilities to make his own choices and is able to get quick feedback on the proposed flight plan. This feedback can be used to ensure that the flight plan has made all the necessary adjustments before submitting it to the NM.

Table 4 – Overview flight preparation service

Service	**Flight Preparation**
Description	Preparing a flight plan can be simplified by using route generation and flight plan validation functions before submitting the plan to NM. Route generation produces valid route candidates, given some constraints. Flight plan validation checks the flight plan, not only

	syntactically, but also with respect to the network situation (e.g., constraints, FUA, etc.). The service includes operations that allow the flight planner to be informed of the potential impact of current flow measures on the flight (such as delay or suspension) before submitting the flight plan to the network manager. This facility enables the airspace user to find the best route that minimizes the impact of flow-through measures on his flight. Last but not least, the service supports flight detour, namely the ability for the flight planner to have the NM system make a persistent "proposal flight" based on an existing flight and a maximum delay. Later, when a new flight plan for that flight is received (resubmitted or updated) and successfully processed, the flight is given a delay corresponding to the maximum delay of the "proposal flight," unless the network situation no longer allows it.
Purpose	NM B2B service assists the airspace users in the flight plan preparation before submission to NM. It allows to validate flight plans against constraints, obtain the flow impact, generate routes and obtain rerouting
Access	NM B2B service
Target audience	Airspace users and other organizations involved in flight planning activities

Tactical update service

This service provides the ability to offer certain data/information that may already be known at an early stage to publish to flight dispatcher or flow controller. This service will ensure better interoperability, because many parties will have the same information and there will be no differences about certain restrictions.

Table 5 – Overview Tactical update service

Service	Tactical Updates
Description	Through this service, the local Air Traffic Flow Management (ATFM) Units provide to NM the planned sector configuration activation, runway configuration, traffic volume activation, restriction activation, capacity values and occupancy traffic monitoring values (OTMV). Each update sent to NM updates the plan for the whole day, and may apply to current day (tactical updates) or to five days in the future (pre-tactical updates).
Purpose	The service is targeted for the local ATFM Units in what concerns the provision of the information to NM, and additionally, for the airspace users in what concerns read access to the runway configurations.
Access	NM B2B Flow Services group.
Target audience	Airspace users

4.2 – Results interviews KLM

The results from the interview can be seen in appendix I and it will be discussed in this chapter. Based on the interview with a Flight Dispatcher and a Senior Flight Dispatcher, the following results were obtained:

So, In the interview that was given in a presentation form. The following services were selected as being of most interesting for improvement in the work of a flight dispatcher in terms of efficiency and effectiveness:

- Flight preparation
- Airspace Structure
- Airspace Availability

The two services airspace structure and airspace availability are services from the Air Space Management (ASM), which in turn is a management that falls under the Aeronautical information exchange domain previously explained in chapter 2.1.2 of the AIXM model. Flight preparation, as seen in figure 4, does not come under the aeronautical information exchange but the flight information exchange domain. Flight preparation is a service offered in the SWIM services registry intended for creating and validating flight plans.

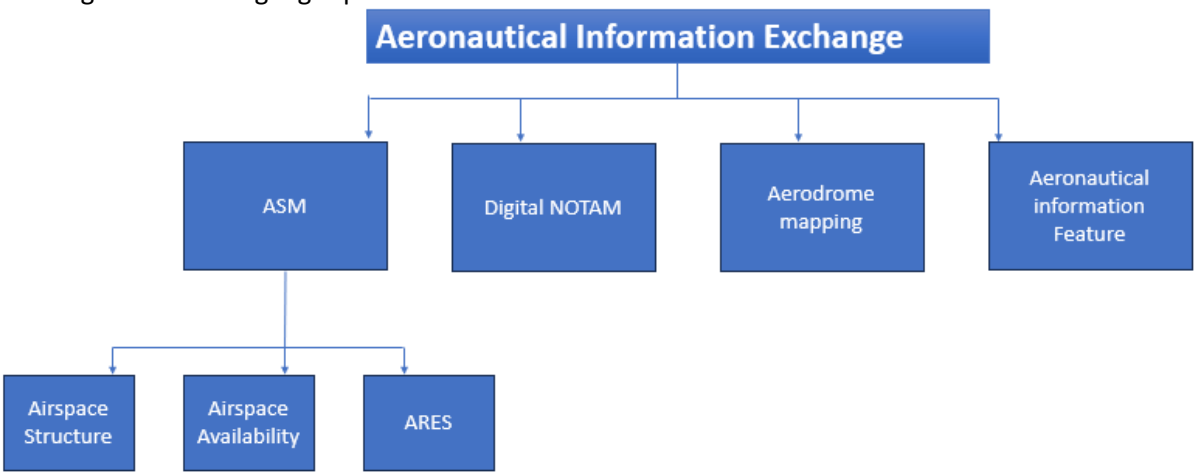

Figure 4 – Aeronautical Information Exchange

Within the Aeronautical information exchange, not only ASM is included under this exchange model, as seen in figure 4, but also other services. Digital NOTAM is one of the services that is offered in this model and might be useful in the work of a flight dispatcher. The reason for this is, flight dispatch regularly needs to review NOTAMs for route planning, with this exchange model information NOTAMs can be retrieved when needed. The other two services aerodrome mapping and aeronautical information feature services are not directly relevant for flight dispatch because they will not use these services during the flight planning process, nor do they contribute to an improvement in their work.

As shown above, there is also the Airspace Reservation (ARES) service under ASM. This is a service that is not on SWIM services registry and so for this reason it could not be validated at flight dispatch but this services could potentially be interesting to flight dispatch. The Airspace Reservation (ARES) information service facilitates the exchange of data related to ARES between local Airspace Management (ASM) support systems and at Functional Airspace Block (FAB) level. Its primary aim is to support cross-border operations. At ASM, the focus is on the tactical activation and deactivation of airspace structures. Several services support ASM, including (SESAR, 2022):

- Notifying the activation of an Airspace Reservation/Restriction (ARES)
- Notifying the deactivation of an Airspace Reservation/Restriction (ARES)
- Pre-notifying the activation of an Airspace Reservation/Restriction (ARES)

- Notifying the release of an Airspace Reservation/Restriction (ARES)
- Querying Airspace Reservation/Restriction (ARES) information

KLM is therefore able to receive notifications about certain airspace restrictions. The dispatcher can be informed by a notification whether an airspace is open or closed. KLM normally receives restrictions on military area from EUROCONTROL and almost never deviates from the 9 a.m. to 5 p.m. times. The new SWIM services will allow the dispatcher to be informed earlier and will allow the dispatcher to make the route faster and also to make the optimal route, which will possibly save fuel and reduce CO2 emissions.

The senior flight dispatcher and flight dispatcher mentioned the following about the services:

Airspace structure: "We find this service interesting for flight dispatch because it allows us to preview the airspace structure beforehand. With this information, we can potentially save time during flight planning by creating flight routes based on the airspace structure."

Airspace Availability: "The service is definitely interesting for flight dispatch as it saves time and provides more certainty about airspace availability. This allows decisions to be made earlier with more certainty."

Flight preparation: " This service will certainly be interesting because we can use it during flight planning beforehand, potentially resulting in time savings."

Based on the answers from the interview, a following conclusion can be drawn from the perspective of a flight dispatcher. All the three services can contribute to the operation and also bring improvements. Both the flight dispatcher and senior flight dispatcher indicated that the services could save time during the making process of a flight plan and might be for that reason, more efficient. Further, the flight dispatcher will be better informed about how the route could proceed due to having more information available about the airspace through which the certain flight route will pass. The flight dispatcher and senior flight dispatcher both indicated the potential for en-route services. Currently, SWIM is developing services that could be used for operations but not specifically for en-route purposes. SWIM is working on en-route services; however, due to laws and regulations, these services may not be immediately adopted worldwide.

4.3 – Results interview EURCONTROL

From the interview with EUROCONTROL appendix II, more clarity emerged regarding the use of SWIM among airlines. Currently, airlines are minimally or not actively engaged in the implementation of SWIM. However, the EUROCONTROL expert provided a document from SESAR that provided more insight into the services offered by SWIM . Within this interview, the EUROCONTROL expert gave an explanation of meteorological information exchange that could potentially be used in flight dispatch operations.

The digitalization of MET services will enable the implementation of SWIM services to provide dynamic meteorological information in digital format. These services will be useable by ATM systems and actors during all phases of flight. Operational stakeholders will be able to consume operational MET information in IWXXM format when applicable. The following services that can been seen in figure 5 will be implemented by operational stakeholders to support the exchange of meteorological information (SESAR, 2022):

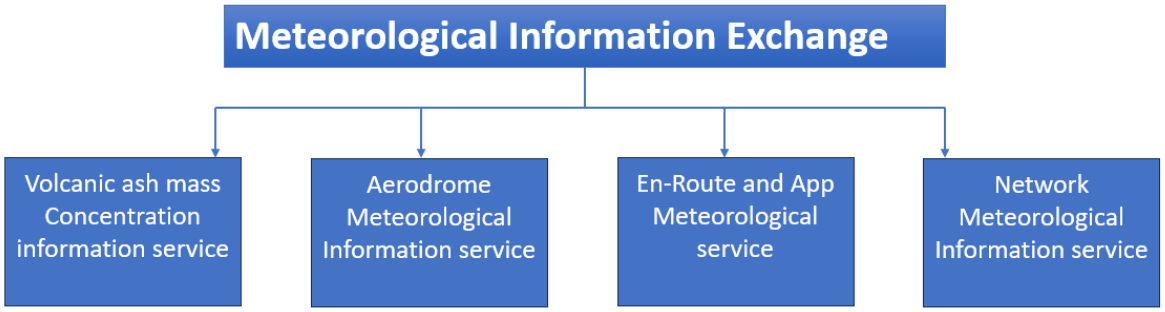

Figure 5 – Meteorological information exchange

The Volcanic Ash Mass Concentration Information Service: coordinated by the European Volcanic Ash Advisory Centres (VAACs), delivers advisory details on volcanic ash clouds in compliance with EU regulations. Additionally, these VAACs generate supplementary volcanic ash concentration data, serving flight planning and operational purposes during volcanic ash incidents. The goal is to align all volcanic ash advisory and concentration data services with EUROCONTROL's SWIM specifications, ensuring compliance.

Aerodrome Meteorological Information Services: These providers collaborate closely with aerodrome stakeholders to customize meteorological support based on specific local aerodrome needs, weather conditions, and operational constraints. The aim is to integrate existing weather information into operational processes to enhance decision-making and mitigate adverse weather impacts.

En-Route and Approach Meteorological Information Services: managed by certified meteorological service providers, involve collaboration with operational stakeholders to tailor weather information for En-Route and Approach domains. This aims to integrate weather data with operational processes to improve decision-making, particularly concerning adverse weather effects.

Network Meteorological Information Services: involve meteorological service providers working with the Network Manager and other stakeholders to address weather-related impacts on En-Route flight phases and critical aerodrome operations. These services aim to integrate weather information into operational processes for better decision-making, emphasizing safety and efficiency in flight operations.

In essence, these services focus on integrating meteorological data into operational procedures to improve decision-making during adverse weather conditions. They aim to aid various stakeholders, including aerodromes, En-Route domains, and the network , in better managing weather-related challenges for safer and more efficient flight operations. While Airspace Users are not obligated to implement these services, accessing and using tailored meteorological information can significantly enhance the safety and efficiency of flight operations.

4.4 – Results interview KLM product analyst and LVNL expert

This Chapter shows the results gathered from the interviews in appendix III and IV with the LVNL expert and KLM Product analyst.

Result interview LVNL

This section will discuss the result from the interview appendix III with LVNL expert. This interview questions were asked about how SWIM services work and whether SWIM services are available to flight dispatchers. From this un-structured interview came the following result. SWIM Services are available free of charge to anyone who can prove that they are an operator in the aviation industry,

This means that KLM does not charge extra for using SWIM services. However, EUROCOTROL does regulate all information coming in and going out, this in connection with data streaming and possible overloading.

In this study it would have been beneficial if the SWIM services could be made visual for the flight dispatcher and senior flight dispatcher. In the interview the question was asked, the LVNL expert indicated that unfortunately there is no possibility for this at the moment. It could be possible in the future if KLM is has a system that can make it visual for the flight dispatcher.

Result interview KLM

This section will discuss the result from the interview appendix IV with KLM's product analyst. KLM indicated in this interview that they do not have much information about SWIM and that they are mainly watching how SWIM develops. SWIM is currently known within the stakeholders of Dutch aviation but not much is being done with it. Airlines, KNMI and Schiphol are still monitoring the situation and are not taking immediate action with SWIM. KLM is one of the airlines that is looking into SWIM the most and tries to stay informed about possible developments around SWIM. LVNL is currently a party more concerned with SWIM and is trying to share information about SWIM with KLM,KNMI and Schiphol.

KLM would like to see SWIM services within the work of flight dispatch. However, benefits will have to come along with this and it will have to be examined how the SWIM services can be used by means of, for example, systems that can visualize the SWIM services for the flight dispatchers. Through this research KLM hopes to become more informed about the developments around SWIM and whether there are possible SWIM services that can improve the work.

Chapter 5 – Conclusion

The problem of this study, where KLM does not exactly know which services can be used from SWIM that could improve the interoperability in the work of flight dispatch in terms efficiency and effectiveness had to become clearer. For this reason, the following main objectives was set-up, SWIM needed be to investigate on the available services , and provide the SWIM services that could improve interoperability of the work of flight dispatch in terms of efficiency and effectiveness. The results of this study revealed several services that could potentially be adopted by KLM's flight dispatch department. These services were identified in the SWIM service registry and subsequently validated by a flight dispatcher and senior flight dispatcher:

- Airspace structure
- Airspace Availability
- Flight preparation

Alongside the services listed in the SWIM service registry, there are additional potential services that have not been validated but might be of interest to flight dispatch. These meteorological services, described in a SESAR study, include:

- The Volcanic Ash Mass Concentration Information Services
- Aerodrome Meteorological Information Services
- En-Route and Approach Meteorological Information Services
- Network Meteorological Information Services

For this research, insights were gathered through interviews and information from SESAR documents, indicating that these services bring benefits to KLM's flight dispatch department, thereby contributing to the interoperability of flight dispatch in terms of efficiency and effectiveness. Implementing these services will provide several potential benefits for flight dispatch:

- Predictability
    - Earlier knowledge of restrictions allows for better optimization of routes.
    - Better route prediction using meteorological data, thus predicting impacts more accurately.
- Safety
    - Accurate information.
    - En-route and approach information aids in predicting weather impacts, allowing for the selection of the safest route.
- Work efficiency
    - Time-saving benefits.
    - More information and clarity regarding airspace structure and availability.

This study concludes that the investigation of certain services might improve flight dispatch operations and provide associated benefits. The services mentioned earlier in this paragraph might improve the interoperability in the work of a flight dispatcher. Flight dispatchers will have easier access to the information they need for creating a flight plan, the information will be more accurate and more route information will be available to ensure that, the most efficient flight plan will be made. In addition to ensuring the most efficient route, the effectiveness in the work of a dispatcher will also increase. The reason for this is, the dispatcher can access data for the services in a faster way and can complete a flight plan more quickly. In addition, the interview in chapter 4.4 and the desk research on the Internet showed that SWIM is in full development and that many changes will be made in the future, which may lead to new services. In the future, KLM's dispatchers may be able to benefit from this, and companies can develop systems that visualize these services for the dispatchers. The methods in this study do not show that there will actually be an improvement in services, but they do show that there are services available that have the potential for improvement in the work of flight dispatch. If SWIM wants to become bigger in the Dutch aviation industry, more initiative and other methods need to be done on SWIM and its developments.

Chapter 6 – Recommendation

This research has aimed to investigate the available services on SWIM and with this to provide information that could improve interoperability of the work of flight dispatch in terms of efficiency and effectiveness. There is still much research need to be done in the world before SWIM could be used at airlines. The purpose of this chapter is to provide recommendations for further research and to discuss findings and ideas from that research.

6.1 – Implementation SWIM at flight dispatch

As mentioned earlier in the conclusion, SWIM is still in full development and will not be finished in the next five years. SWIM is seen as the future regarding information exchange within aviation operations as explained earlier in chapter 2.1.2. For this reason there is a lot of potential in SWIM and it will remain interesting for KLM to pay attention to SWIM in the future. SWIM is not a system in itself as explained earlier in chapter 2.1.2 but a concept that contains services and data. The data of SWIM need to be visualized through a system. The For this reason, SWIM would face operational challenges by implementing SWIM in their operation. First the possibilities of implementing services from SWIM will therefore have to be investigated. Different possibilities to implement SWIM must be considered:

- Systems at KLM that may be able to incorporate and visualize SWIM services in the form of text or dashboards.
- External parties who can develop systems that can enable the visualization of data from SWIM services.
- Existing systems at other airlines that may be able to incorporate and visualize SWIM services.
- Flight planning system LIDO from KLM who may be implementing SWIM services within their system.

If a possibility for implementing SWIM services is found, experiments with certain SWIM services mentioned in the results could be possible. This can be done by selecting a number of three to six flight dispatchers. These flight dispatchers will be able to use the SWIM services for a period of one to two weeks in their work. Subsequently, the flight dispatchers will provide feedback on the use of the SWIM services by the work of creating a flight plan. If this feedback turns out to be positive, the next step can be taken to implement SWIM services within the work of a flight dispatcher. However, if the results are negative, the decision may be made that SWIM is not feasible in the work of flight dispatch.

6.2 – Continued research

If SWIM can be implemented within the flight dispatch department. Further research can be done on the benefits that SWIM brings. Earlier mentioned in the results and conclusion SWIM brings benefits to the work of flight dispatcher; predictability, safety and work efficiency. These benefits are based on textual information and no hard data was used. If SWIM will be implemented within the flight dispatch operation, it will be possible to investigate how these benefits contribute to the operation of flight dispatch. This can be done using the following data that can be calculated:

- Time
  - Time saving during planning
  - Time saving flight
- CO_2 reductions
  - Less fuel burn
  - Optimal route
- Cost
  - Less use of fuel

A Potential objective that can be set for this continued research can be:

Demonstrated with hard data that the benefits from SWIM actually can contribute to the operation of flight dispatch and that subsequently, through the implementation of SWIM, investigate if other benefits will arise.

A potential main research question for continued research could then be formulated as follows:

What are the are effects and impact of the SWIM services in the operation of flight dispatch in terms of time saving, sustainability, safety and cost?

The main question could be supported by the following sub-questions:

- What impact would SWIM services have on the predictability of a flight route?
    - How much time before making a flight plan will the information be predicted?
    - How accurate is the information from the SWIM services in comparisons with other services?

- Why is the operation safer with SWIM services?
    - Where in the operation of flight dispatch will the safety effects occur?

- Where in the operation will SWIM services save time?
    - How much time will SWIM services save during the make of a flight plan?
    - How much time will SWIM services save in the route of a flight?
    - Where in the route of a flight will time be saved?
    - Will there be a difference in time saving between European and international flights?

- How will SWIM services save fuel during a flight?
    - How much fuel can be saved by the use of SWIM services during one flight?
    - What information from SWIM is needed to create an optimal flight plan?

- How much cost can be saved?
    - How much cost can be saved per flight intercontinental?
    - How much cost can be saved per European flight?
    - Where in the operation will the cost be saved?

- What is the impact of SWIM on the sustainability plan of KLM?
    - How much CO_2 will reduce as effect of the use of SWIM services?

This research should lead to more clarity about the effects and impact of SWIM within flight dispatch. If there is more clarity about the impact of SWIM services within KLM's Flight Dispatch department, could this lead to more airlines taking attention to the use of SWIM within the Flight Dispatch department. In the future, this may lead to airlines sharing more data with each other, which in turn will improve interoperability between airlines and make flight planning more sustainable in the future.

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Appendix

Appendix I – Interview flight dispatcher and senior flight dispatcher

Bij dit interview is er een presentatie gegeven waarbij de flight dispatcher en senior flight dispatcher de beschrijving van de B2B services op de PowerPoint konden lezen.

Geïnterviewde: Flight dispatcher and senior flight dispatcher (FD)
Interviewer: Thomas Konijnenberg (T)
Datum: 13 December 2023 om 11:30
Locatie: Schiphol-Oost

T: Bedankt dat u tijd heeft genomen voor dit interview.

FD: Geen probleem, We zijn zeer geïnteresseerd naar je vragen.

T: Kunt u mij uitleggen hoe het plannen van een vlucht gaar bij internationale vluchten plannen en Europese vluchten?

FD: Europees gaat tegenwoordig bijna alles automatisch via EUROCONTROL. EUROCONTROL heeft vliegplannen die via flight dispatcher bekeken kunnen worden en daarbij word het gekeken of het past bij de route en eventuele disrupties die er op dat moment zijn. Internationaal word het vluchtplan nog zelf gemaakt en zal er in het LIDO systeem een akkoord komen of het plan mogelijk is en vervolgens zal het vluchtplan gefiled worden aan EUROCONTROL.

T: Hoe denkt u over de B2B service, Flight data request service?

FD: De service is een interessante maar is mogelijk niet relevant omdat het LIDO systeem al binnen paar minuten een vliegplan heeft geëvalueerd over de route. Dus binnen een paar minuten weten wij al of de route correct is.

T: Hoe denkt u over de services Flight preparation?

FD: Deze service zal zeker interessant, dit omdat we dit van de voren bij de vlucht planning zouden kunnen gebruiken en voor mogelijke tijdbesparing zal zorgen.

T: Hoe denkt u over de services Airspace structure?

FD: Deze service vinden wij ook interessant voor flight dispatch omdat wij van te voren kunnen bekijken wat de airspace structure is en aan de hand van dat tijdens de vluchtplanning ook tijd kunnen besparen met het maken van een vluchtroute.

T: Hoe denkt u over de services Airspace Availability?

FD: De service is zeker interessant voor flight dispatch doordat er tijd bespaard kan worden en er meer zekerheid is over wat de airspace availability is en daarmee zouden besluiten ook eerder genomen kunnen worden met zekerheid.

T: Waarmee zouden de services die u aangaf interessant zijn met betrekking tot interoperabiliteit en efficiëntie op de werkvloer?

FD: De services die van te voren bekeken kunnen worden dus in de voorbereidende fase zullen kunnen bijdragen leveren aan de operatie, hierbij kan er gedacht worden aan tijdbesparing doordat de flight dispatcher de mogelijkheid krijgt om bepaalde informatie te bekijken. Daarnaast zal een flight dispatcher eerder het besluit kunnen nemen over een vliegplan dus het nemen van een besluit zal mogelijk makkelijker gemaakt kunnen worden doordat er extra informatie beschikbaar is gesteld voor een flight dispatcher.

T: Bedankt voor u tijd.

FD: Jij ook bedankt voor de presentatie.

Appendix II – interview EUROCONTROL/IATA

Geïnterviewde: Expert EUROCONTROL/IATA (E)
Interviewer: Thomas Konijnenberg (T)
Datum: 14 December 2023 om 14:00
Locatie: TEAMS

T: Bedankt dat u tijd heeft genomen voor dit interview.

FD: Ben benieuwd wat u te weten bent gekomen en wat wij kunnen bijdrage aan het onderzoek.

T: Wat zijn mogelijke B2B services die gebruikt kunnen worden bij flight dispatch?

E: Op SWIM service registry staan veel services die in gebruik zijn bij EUROCONTROL. Ik kan u niet direct vertellen welke B2B services gebruikt kunnen worden. Wel kan ik u vertellen dat het interessant is om naar meteorologische data te kijken en eventuele FF-ICE services. Hierbij is een document waarin interessante meteorologische services staan, die mogelijk gebruikt zouden kunnen worden bij flight dispatch als er een systeem beschikbaar is die de services visiueel zou kunnen maken.

T: Wat zijn u ideeën over SWIM en flight dispatch?

E: Flight dispatcher zullen niet direct gebruik maken van SWIM services. Dit zal aan de hand van een programma of systeem visueel gemaakt moeten worden. Zo kan je denken dat een flight planning systeem een programma bedenkt die eventueel interessant SWIM services visueel kan maken. Dit zou KLM zelf kunnen maken maar dit zou ook aangevraagd kunnen worden bij EUROCONTROLof LIDO.

T: Kent u airlines die momenteel zelf bezig zijn met SWIM services?

E: SWIM service worden bij veel airlines niet door hun zelf in gebruik genomen. De meeste airlines die ik ken zijn niet bezig met SWIM. KLM is één van de airlines die meest gevorderd is met de kennis met betrekking tot SWIM.

T: Hoe worden SWIM services bij airlines in gebruik genomen ?

E: SWM services worden meestal niet door airlines zelf in gebruik genomen. De meeste airlines laten dit door externe bedrijven doen. Bij KLM is het mogelijk dat LIDO er al veel mee bezig is en SWIM services zoals FF-ICE gaan implementeren in het flight planning programma.

T: Bedankt voor u tijd

E: U ook bedankt

Appendix III – Interview LVNL

Geïnterviewde: Expert LVNL (L)
Interviewer: Thomas Konijnenberg (T)
Datum: 29 November 2023 om 14:00
Locatie: LVNL gebouw

T: Zijn SWIM services betaalde services of zijn de services voor iedereen gratis beschikbaar?

L: EUROCONTROL bied de services gratis aan als er aantoonbaar is dat je een operator bent en daarmee ook kan aangeven dat je er geen misbruik van gaat maken. In principe zijn er geen kosten aan verbonden voor KLM.

T: Zijn er nog restricties of andere regulaties waaraan EUROCONTROL zich houd?

L: EUROCONTROL reguleert wel welke informatie er binnen komt en of de informatie relevant is en niet voor onnodige data opslag zorgt. EURCONTROL stelt restricties aan hoe vaak je informatie kan opvragen dit in verband met overbelasting met data stromen.

T: Kan er een visueel beeld gecreëerd worden om de SWIM services te laten zien aan de flight dispatchers?

L: Er kan geen beeld gecreëerd worden van de services dit doordat er een systeem nodig is om de service te ontgrendelen en daarmee de service te kunnen gebruiken.

T: Bedankt voor u tijd.

Appendix IV – Interview KLM Data analyst

Geïnterviewde: Interview KLM Data analyse (A)
Interviewer: Thomas Konijnenberg (T)
Datum: 12 December 2023 om 13:00
Locatie: OCC gebouw

T: Hoe ziet u SWIM binnen de Nederlandse luchtvaart?

A: Wij zien dat veel partijen binnen de Nederlandse luchtvaart zich niet bezighouden met SWIM. KNMI, Schiphol en de airlines zijn nog niet echt betrokken bij hoe SWIM er nu voor staat en wat de mogelijke tot ontwikkelen zijn. LVNL daarin tegen loop wel een stap voor op al deze partijen en neemt de voortouw hierin. Om deze reden laten wij ons veel informeren door LVNL over SWIM

T: Hoe ziet u SWIM ontwikkelen binnen KLM?

SWIM kan zich gaan ontwikkelen binnen KLM omdat het de toekomst gaat zijn voor het uitwisselen van informatie. Hoe SWIM zich gaat ontwikkelen kan ik je niet vertellen omdat wij binnen KLM daar nog niet genoeg in verdiept zijn.

T: Hoe ziet u SWIM binnen flight dispatch?

A: Wij zien niet dat de services direct geïmplementeerd zullen kunnen worden binnen onze systemen van KLM. Hiervoor zal een externe partij zoals EUROCONTROL een dashboard of systeem moeten creëren die het mogelijk maakt om SWIM services te visualiseren voor de flight dispatcher. Daarnaast zullen de services gebruikt kunnen worden gebruikt voor een day-to-day operations waarbij de data en informatie relevant en accuraat moet zijn.

T: Hoe ziet u dit onderzoek bijdragen aan KLM?

A: Dit onderzoek zal een eerste stap zijn voor het verdiepen in SWIM in betrekking tot het werk van een flight dispatcher. Wij als KLM kijken mee met de ontwikkelen rondom SWIM en zijn die niet het bedrijf die directe stappen neemt met SWIM. SWIM zien wij erg ontwikkelen in de afgelopen jaren en dat zal vooral nog zo doorgaan en daarom is het moeilijk te voorspellen hoe we het in gebruik gaan nemen en wat we in gebruik kunnen nemen.

T: Bedankt voor u tijd.