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# BI dashboard to empower PAC with near real-time decision support

Ricardo Jorge Bento Soares

Project Work

presented as a partial requirement for obtaining the Master's Degree Program in Information Management

**NOVA Information Management School**
**Instituto Superior de Estatística e Gestão de Informação**
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# BI DASHBOARD TO EMPOWER PAC WITH NEAR REAL-TIME DECISION SUPPORT

By

Ricardo Jorge Bento Soares

Project Work presented as a partial requirement for obtaining the Master's degree in Information Management, with a specialization in Information Systems and Technologies Management

**Supervisor:** Mijail Naranjo Zolotov, PhD

July 2023

# STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration. I further declare that I have fully acknowledged the Rules of Conduct and Code of Honor from the NOVA Information Management School.

*[student signature]*

*Lisbon, 13/07/2023*

# ABSTRACT

This master's thesis focuses on the development and implementation of a Business Intelligence (BI) dashboard for an airline company. The objective is to provide a comprehensive data visualization solution that enables real-time monitoring and analysis of key performance indicators (KPIs) in the aviation industry.

The research design combines qualitative and quantitative methods. The qualitative approach involves gathering requirements from stakeholders through the Agile methodology and iterative user feedback. The quantitative approach includes data analysis and the construction of a data model and dashboard using MicroStrategy. The data model follows the star schema model, facilitating efficient data integration and optimized query performance.

The requirement-gathering process involved capturing relevant KPIs and dimensions from existing reports and functional requirements from stakeholders. These requirements were categorized into topics such as general requirements, on-time performance (OTP), crew requirements, cancelled legs, aircraft on the ground (AOGs), maintenance, and spares.

The results section showcases the developed BI dashboard, emphasizing the dashboard design, selected KPIs, and visualizations. The user interface offers intuitive navigation and interactive features to facilitate data exploration and decision-making. User testing and feedback were incorporated to improve the dashboard's usability and effectiveness.

Furthermore, the physical data model based on the star schema model contributes to query performance optimization, meeting the requirement of response times below 5 seconds for live dashboard usage. The use of best practices and methodologies, particularly those advocated by Kimball and Caserta, enhances the data modelling process.

In conclusion, this master's thesis project presents a business intelligence dashboard tailored for the airline industry. By leveraging the power of data visualization and analytics, the dashboard empowers stakeholders to make informed decisions and gain valuable insights into various aspects of airline operations. The research contributes to the field of information management by showcasing the application of agile development, star schema modelling, and user-centric design in developing a robust BI solution for aviation.

# KEYWORDS

Business Intelligence; Decision Support; Real-time Data; Aviation; Data Warehouse; Data Model; Dashboard; Operations Performance; Agile; Scrum

## Sustainable Development Goals (SGD):

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# LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **ACMI** | Aircraft, Crew, Maintenance and Insurance |
| **AOG** | Aircraft on the ground |
| **ATC** | Air traffic control |
| **BI** | Business Intelligence |
| **ETL** | Extract, Transform, Load |
| **KPI** | Key Performance Indicator |
| **MTD** | Month to Date |
| **NB** | Narrow Body |
| **OCC** | Operations Control Center |
| **OTP** | On Time Performance |
| **PAC** | Portuguese Airline Carrier |
| **PNC** | Crew Cabin Chief and Flight Attendant levels |
| **PNT** | Crew Commander level |
| **PTL** | Portugal - PAC Subsidiary Airline |
| **PTT** | Portite - PAC Subsidiary Airline |
| **SQL** | Structured Query Language |
| **UTC** | Universal Time Coordinated |
| **WB** | Wide Body |
| **YTD** | Year to Date |

# 1. INTRODUCTION

PAC is a Portuguese airline carrier, founded in 1945, and headquartered in Lisbon. With over 5.000 employees and a fleet of over 100 aircraft, PAC operates flights to over 90 destinations worldwide as a member of the Star Alliance. Despite its strong presence in European and international markets, PAC faces challenges in providing updated operational insights to its executive and operational teams, also known as the C-level and OCC. The current solution in place involves a manual process that is prone to errors and provides outdated information, making it difficult for the C-level and OCC to make informed decisions promptly.

Nowadays, organizations must have BI solutions that provide information promptly to support decision-making that adds value to the business (Popovič et al., 2012). The combination of timely, accurate information and BI capabilities allows decision-makers to act effectively, with the information presented in a way that the user does not feel overwhelmed (Stadler et al., 2016), and with the help of decision support based on a dashboard (Sarikaya et al., 2019).

PAC currently does not have a tool that allows for the visualization of near real-time information related to daily operations in a centralized and graphical manner (Kimball & Caserta, 2004). The need for a dashboard has emerged, combining quantitative information like punctuality, and aircraft maintenance, and qualitative information like accidents, strikes, and adverse weather conditions from PAC outer stations. The information often does not reach stakeholders promptly, not giving them the power to mitigate the impact of unwanted situations.

The main objective of this project is to provide PAC's management and operations areas with a tool to analyze near real-time data related to daily operations in a condensed and easy-to-read manner, empowering operations management to take preventive measures in response to constraints that may occur during operations, mitigating their impact. The dashboard implementation will follow a prototyping model (Faust et al., 2019) in the first phase of the requirements gathering and later an agile development process using SCRUM methodology for team collaboration, alignment, and transparency (Rising & Janoff, 2000). The dashboard will be developed with MicroStrategy technology, supported by a star schema data model on Microsoft SQL Server.

By the end of the project, it is expected that PAC's operations department will be equipped with a tool to monitor daily operations with valid and up-to-date information, enabling stakeholders to make informed decisions promptly. This will bring not only benefits to the operations department directly involved in the project, but also to all areas of the company globally. This project report will provide a detailed overview of the project, including a literature review of relevant studies and theories to give the reader a conceptualization of the topics that will be addressed during the project, a methodology section outlining the data collection procedures and analysis techniques used, a results section presenting and discussing the project results, and a conclusions section summarizing the original contributions of the project and providing recommendations for future research.

# 2. BACKGROUND

This section is intended to make an introduction to the concepts that will be addressed throughout the project, as well as illustrate how the involved components will interrelate throughout the project. We will start by understanding what BI is and how it can help the aviation business. We will talk about the Agile methodology for gathering the initial requirements and subsequent iterations with user feedback collection and product refinement, and we will also address the data modeling components that will serve as the basis for the datasets to be built in MicroStrategy, which in turn will feed the dashboard that will be consumed by the end users.

## 2.1. Business Intelligence

The use of data and information technology is increasingly important in today's business landscape. Data can provide valuable insights and help organizations make informed decisions. This is where BI comes in, as it provides organizations with the tools and techniques needed to effectively analyze and understand their data. BI helps organizations make sense of their data and turn it into actionable information that can drive better decision-making.

One of the key components of BI is the use of data warehousing. Data warehousing is the process of collecting and storing large amounts of data in a centralized repository, intending to provide fast and efficient access to relevant information (Corr & Stagnitto, 2012). This enables organizations to turn their data into valuable knowledge, which can be used to support decision-making and strategy development (Işik et al., 2013). Agile data warehousing practices can also help organizations to respond to changing business requirements promptly and align their data management processes with their overall business goals (Cao & Ramesh, 2008).

Another important aspect of BI is the use of self-service BI, as it can help organizations to become more agile and respond to changing business requirements promptly (Arnaboldi et al., 2021). (Işik et al., 2013) also, highlight the importance of BI capabilities and decision environments in achieving success with BI systems. They suggest that organizations must have a strong emphasis on data-driven decision-making, to achieve maximum benefits from their BI systems.

In addition to data warehousing, data visualization is another important aspect of BI. It helps organizations to present their data in a way that is easy to understand and can greatly enhance the decision-making process (Faust et al., 2019).

To visually represent the proposed BI system for this project, Figure 1 (BI Dashboard Conceptual Model) has been developed, which depicts the key architectural components, technologies, methodologies, and information flows. This figure was self-developed to provide an overview of the system's structure and serves as a reference for the subsequent implementation stages. It highlights the core elements necessary to achieve the desired business intelligence capabilities, enabling effective data analysis and informed decision-making.

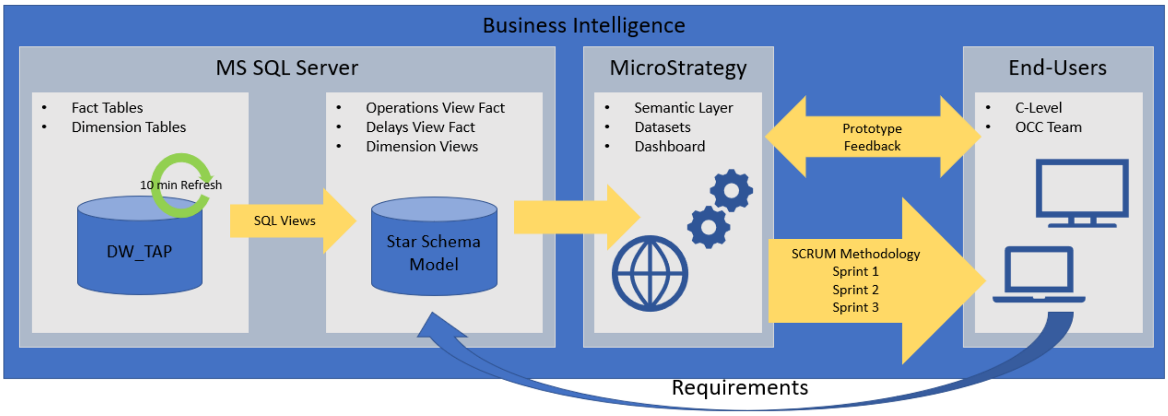



Figure 1 - BI Dashboard Conceptual Model

## 2.2. Dashboards

A dashboard is a visual representation of KPIs and data that provides real-time insights into an organization's operations. Dashboards can range from simple spreadsheets with charts and graphs to interactive interfaces with advanced data visualizations and analytical tools. The purpose of dashboards is to enable business users to quickly understand important information and make informed decisions.

According to Khatuwal & Puri (2022) dashboards are developed using BI tools. BI tools enable the collection, integration, analysis, and presentation of data from multiple sources. Dashboards can be designed to support various types of decision-making scenarios, including monitoring operations, tracking performance, identifying trends and patterns, and exploring data relationships.

Vera-Baquero et al. (2016) found that real-time business activity monitoring and analysis can be improved by using dashboards on big-data domains. Dashboards can be used to display real-time data about business operations and performance, which helps organizations to identify issues and opportunities promptly.

Nadj et al. (2020) conducted a study that found that the use of interactive analytical dashboards can improve situation awareness and task performance. The study found that users who interacted with dashboards were able to perform tasks more efficiently and effectively compared to users who relied on traditional reports.

Sarikaya et al. (2019) note that dashboards can be used to communicate important information to stakeholders and help organizations to achieve their goals. The authors found that dashboards can support decision-making by providing a visual representation of data, highlighting trends and patterns, and enabling stakeholders to explore data relationships.

Stadler et al. (2016) found that data visualization dashboards can improve the efficiency and ease of healthcare analysis. The authors found that dashboards can be used to present complex data clearly and concisely, allowing healthcare professionals to make informed decisions more quickly and accurately.

In conclusion, dashboards are a critical tool in the business intelligence toolkit, providing real-time insights into an organization's performance and operations. Dashboards can be used to support decision-making, improve situation awareness, and task performance, and enable organizations to achieve their goals.

## 2.3. Business Intelligence in Aviation

BI refers to a range of technologies, tools, and techniques used to extract insights from data to support decision-making (Ramesh Sharda, 2013). In the aviation industry, BI plays a crucial role in monitoring and improving operational performance by providing up-to-date data and insights (Arjomandi & Seufert, 2014).

The importance of BI in aviation is two-fold: first, it enables the monitoring of KPIs in real-time, providing a clear understanding of the operational performance of an airline. Secondly, it provides insights into trends and patterns, enabling organizations to make data-driven decisions to improve their operations (Işik et al., 2013).

The implementation of a BI system in the aviation industry typically consists of a data model, which is used to collect and integrate data from various sources, and a dashboard, which is used to visualize the data and provide insights (Khatuwal & Puri, 2022). The dashboard can be designed to be interactive and customizable, enabling users to interact with the data and make informed decisions (Nadj et al., 2020).

In recent years, self-service BI has become increasingly popular, allowing end-users to access and analyze data themselves, without relying on IT support (Arnaboldi et al., 2021). This trend toward self-service BI is driven by the increasing need for agility and responsiveness in decision-making processes (Cao & Ramesh, 2008).

The design of BI dashboards must take into consideration the needs of the end-user and the type of information being presented. A well-designed dashboard should provide a clear, concise, and visual representation of the data, making it easy for the end user to understand (Sarikaya et al., 2019). The use of visualization techniques such as charts and graphs can help to highlight key trends and patterns in the data (Stadler et al., 2016).

In conclusion, BI plays a crucial role in the aviation industry by providing real-time insights into operational performance and enabling data-driven decision-making. The implementation of a BI system typically consists of a data model and a dashboard, which can be designed to be interactive and customizable. With the trend towards self-service BI, end-users can access and analyze data themselves, improving the agility and responsiveness of decision-making processes.

## 2.4. Prototyping and Agile Development

Prototyping and Agile Development are crucial elements of software development processes. Prototyping involves creating a simplified version of the final product to test and evaluate its functionality, usability, and user experience (Faust et al., 2019). Agile development, on the other hand, is an iterative and flexible approach to software development that emphasizes collaboration and continuous improvement (Rising & Janoff, 2000).

The combination of prototyping and agile development can help to improve the development process by facilitating early feedback and making it easier to adapt to changing requirements (Cao & Ramesh, 2008). This, in turn, can lead to improved decision-making and better outcomes (Işik et al., 2013). Furthermore, agile development can improve the efficiency of the development process by breaking it down into smaller, manageable steps and allowing for frequent review and adjustment (Sarikaya et al., 2019).

In practice, prototyping and agile development are often used together in a continuous cycle. The development team creates a prototype, tests it, and receives feedback, which is then used to inform the next iteration of the product. This process continues until the final product meets the desired criteria (Kimball & Caserta, 2004).

Prototyping and agile development can also have positive impacts on the end-users of the product. For example, in the context of BI, prototypes can be used to evaluate the usability and user experience of data visualizations and dashboards, which can have a positive impact on situation awareness and task performance (Nadj et al., 2020).

In conclusion, prototyping and agile development are complementary approaches that can improve the software development process, enhance decision-making, and lead to better outcomes. These approaches can be especially valuable in the context of BI, where they can improve the effectiveness of data visualization and dashboard development (Khatuwal & Puri, 2022). By combining prototyping and agile development, organizations can ensure that their products are designed to meet the needs of both the development team and the end users (Popovič et al., 2012).

## 2.5. STAR SCHEMA DATA MODEL

The Star Schema Data Model is a type of data model used in BI systems. The model is so named because the diagram of the schema resembles a star, with a central fact table surrounded by dimension tables. The fact table contains the data values that are analyzed, such as sales, quantities, and amounts. The dimension tables contain descriptive information about the data in the fact table, such as time, products, and customers (Kimball & Caserta, 2004).

The Star Schema is widely used for BI because it is simple to understand and easy to use for querying data. The model enables users to perform complex analyses with high levels of performance, and to obtain insights into business trends, relationships, and other insights from the data. The Star Schema also facilitates the creation of interactive dashboards, providing a visual representation of data and facilitating decision-making (Stadler et al., 2016).

The design of the Star Schema Data Model is based on the principle of data normalization, which involves breaking down the data into smaller, more manageable pieces and organizing it in a way that reduces redundancy and ensures data consistency (Kimball & Caserta, 2004). By organizing the data in a Star Schema, it becomes possible to create a simple, intuitive, and flexible data model that can be adapted to changing business needs (Nadj et al., 2020).

As depicted in Figure 2 - Star Schema Data Model Diagram, the Star Schema Data Model consists of a central fact table surrounded by related dimension tables, highlighting the relationships between the fact table and dimension tables. This diagram visually represents the structure and organization of the Star Schema, showcasing its simplicity and effectiveness in organizing data for analysis.

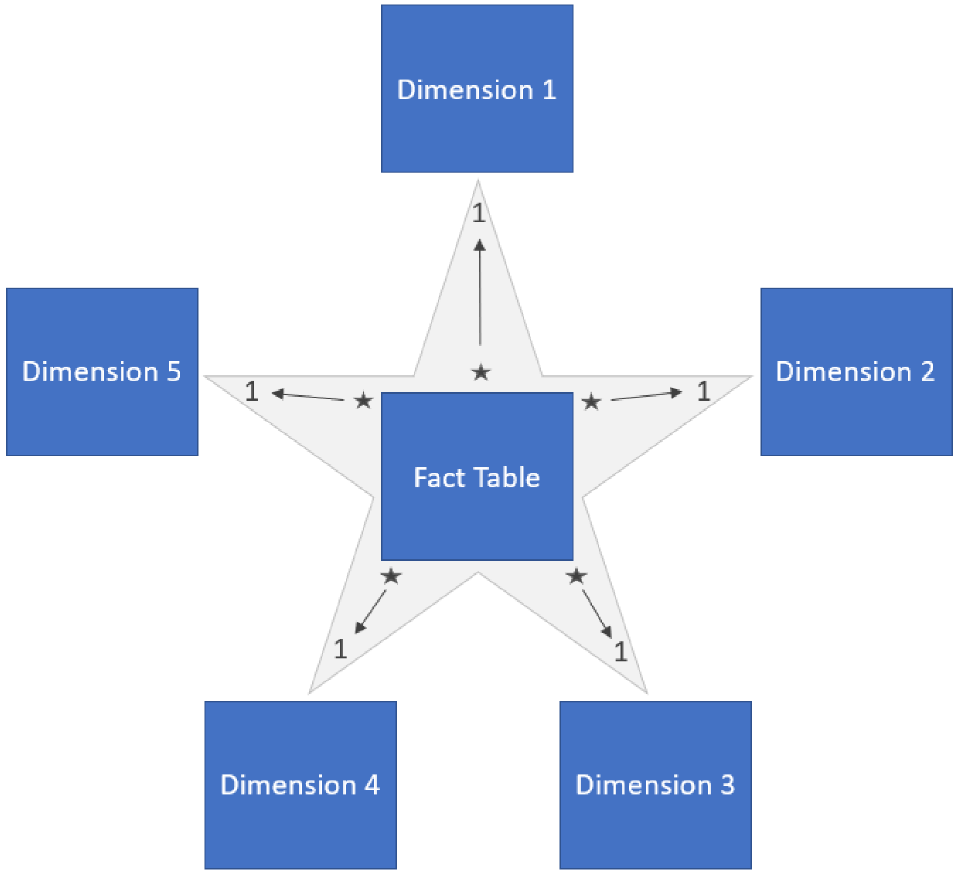



Figure 2 - Star Schema Data Model Diagram

## 3. METHODOLOGY

This section presents the methodology employed in developing the business intelligence dashboard for PAC. The methodology followed a continuous and iterative process, involving research design, requirement gathering, data capture and modeling, prototyping, deliveries & sprints, and validation and acceptance.

The methodology combined qualitative and quantitative approaches, ensuring collaboration with stakeholders, data analysis, and dashboard construction. Figure 3 - Project Methodology Process provides an overview of the interconnected steps in the methodology.

The subsequent sections will delve into each step of the methodology, providing detailed insights into the activities, techniques, and considerations employed in the development of the business intelligence dashboard.

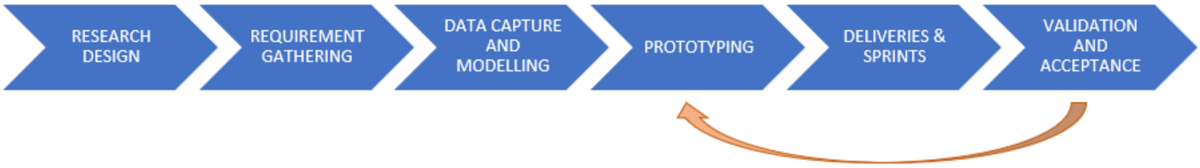



Figure 3 - Project Methodology Process

### 3.1. RESEARCH DESIGN

The research design for this project involves a combination of qualitative and quantitative methods to develop a business intelligence dashboard for an airline company. The qualitative approach was employed to gather requirements from stakeholders through Agile methodology and iterative user feedback. This approach was chosen as it allows for continuous collaboration and feedback from stakeholders, ensuring that their needs and expectations are met. The Agile methodology emphasizes flexibility, adaptability, and iterative development, enabling the project team to respond to changing requirements and feedback from stakeholders.

The quantitative approach was employed to analyze data and build the data model and dashboard using MicroStrategy. MicroStrategy is a powerful business intelligence tool that allows for the analysis and visualization of large data sets. The data model was designed using a star schema, which is a graphical representation of the relationships between the data entities. This approach was chosen as it provides a clear and concise view of the data, making it easier to understand and use for reporting and analysis.

The research design for this project aims to provide a comprehensive approach to developing a business intelligence dashboard for an airline company that meets the needs and expectations of stakeholders. The combination of qualitative and quantitative methods, along with the use of Agile methodology and a star schema model, allows for an iterative and flexible development process that can adapt to changing requirements and feedback. This approach ensures that the resulting dashboard provides valuable insights and helps to improve decision-making processes within the airline company.

## 3.2. Requirement Gathering

In the requirement-gathering process, several techniques were utilized to gather relevant information from stakeholders. One of the methods used was to review existing reports to capture relevant KPIs and dimensions. This approach ensured that the dashboard included the necessary metrics to monitor the airline company's performance accurately. Additionally, direct functional requirements from stakeholders were collected through various communication channels such as interviews, surveys, and focus groups.

The stakeholder feedback was then analyzed and incorporated into the design of the dashboard. The iterative development process allowed for constant communication and feedback with stakeholders, ensuring that the dashboard met their needs and expectations. This approach ensured that the final product was user-friendly, efficient, and fulfilled the requirements of the airline company.

Furthermore, the use of agile methodology ensured that the requirements were reviewed and updated regularly. This approach provided the flexibility to adapt to changing stakeholder needs and allowed for the identification of any issues that may arise during the development process. The agile methodology also ensured that the development process was efficient, and that the final product was delivered within the expected timeline.

In summary, the requirement-gathering process involved the review of existing reports and direct feedback from stakeholders to identify the necessary KPIs, dimensions, and functional requirements. The use of agile methodology and iterative development ensured that stakeholder needs were met, and the final product was user-friendly, efficient, and delivered within the expected timeline.

### 3.2.1. Current Reports Analysis

As a supplement to gathering requirements from stakeholders, the team chose to also analyze reports currently used by business users and C-level executives for decision-making. Although these reports do not contain near real-time data, the dimensions and KPIs employed within them could prove to be valuable assets and add value to the dashboard.

### 3.2.2. Examples of some reports used before the project

The report below (Figure 4 – Daily Performance Full Report) is an excellent source for gathering requirements, as it shares several identified needs that will be addressed by the new dashboard. Many of the KPIs and dimensions in this report will be used in the new dashboard.

**Daily Performance Full Report** UTC Time

Yesterday: 07/02/2019

Executed at: 08/02/2019 07:54

| | |
|---|---|
| **Major Events** | TP1557 LIS/VXE diverge para RAI devido a razões meteorológicas.<br>Divulgado voo Posição TP9342 de RAI/LIS.<br>CSTVA - AOG EM LIS (FILTRO COMBUSTIVEL #2 - SEM MATERIAL EM LIS).<br>Implica: TP1970/1925 LIS/OPO/LIS ope AT7 (WHITE) iso a320.<br>Para protecção de todo o payload, TP1528 TMS/ACC/LIS efectua Escala Técnica em RAK, para reabastecimento. |

| | | | Yesterday | PAC | | PAC Express | | Last 7 Days | MTD | YTD |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | WB | NB | PTL | PTT | | | |
| Network OTP | Delayed Legs | | 139 | 13 | 102 | 23 | 1 | 1.079 | 1.079 | 7.096 |
| | Delay Min / Delayed Legs | | 11,0 | 12,3 | 11,4 | 9,0 | 5,0 | 20,1 | 20,1 | 21,9 |
| | Departure | D:00 | 57% | 54% | 53% | 61% | 94% | 52% | 52% | 44% |
| | | D:15 | 92% | 86% | 91% | 95% | 100% | 83% | 83% | 79% |
| | Arrival | A:00 | 62% | 44% | 61% | 64% | 89% | 59% | 59% | 53% |
| | | A:15 | 91% | 75% | 90% | 95% | 100% | 82% | 82% | 78% |
| | Fleet Launch | D:00 | 68% | 100% | 66% | 58% | 100% | 58% | 58% | 50% |
| | | D:15 | 100% | 100% | 100% | 100% | 100% | 93% | 93% | 87% |
| Activity | Aircraft Block Hours | | 884 | 209 | 534 | 116 | 26 | 6.610 | 6.610 | 37.726 |
| | Scheduled Legs | | 326 | 28 | 221 | 59 | 18 | 2.280 | 2.280 | 12.902 |
| | Operated Legs | | 325 | 28 | 220 | 59 | 18 | 2.265 | 2.265 | 12.834 |
| | Cancelled Legs | | 1 | 0 | 1 | 0 | 0 | 15 | 15 | 68 |
| | Completion Rate | | 99,7% | 100,0% | 99,5% | 100,0% | 100,0% | 99,3% | 99,3% | 99,5% |
| | Diverted Legs | | 1 | 0 | 1 | 0 | 0 | 5 | 5 | 17 |
| | Flight Return | | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 6 |
| | Ramp Return | | 0 | 0 | 0 | 0 | 0 | 4 | 4 | 20 |
| | Nr Paid Pax Legs | | 32k | 5k | 22k | 4k | 941 | 228k | 228k | 1.323k |
| | Load Factor Legs | | 64,0% | 67,2% | 62,0% | 57,1% | 73,3% | 68,3% | 68,3% | 71,9% |
| Hub OTP | Delayed Legs | | 64 | 8 | 44 | 11 | 1 | 489 | 489 | 3.204 |
| | Delay Min / Delayed Legs | | 10,2 | 6,0 | 11,3 | 9,1 | 5,0 | 17,1 | 17,1 | 18,7 |
| | Departure | D:00 | 55% | 43% | 53% | 54% | 89% | 50% | 50% | 43% |
| | | D:15 | 93% | 93% | 91% | 96% | 100% | 85% | 85% | 81% |
| | Arrival | A:00 | 53% | 50% | 51% | 57% | 78% | 57% | 57% | 54% |
| | | A:15 | 87% | 75% | 86% | 91% | 100% | 79% | 79% | 77% |
| Ponte Aérea OTP | Delayed Legs | | 10 | 0 | 7 | 2 | 1 | 57 | 57 | 407 |
| | Delay Min / Delayed Legs | | 7,1 | -- | 7,6 | 6,5 | 5,0 | 17,1 | 17,1 | 23,0 |
| | Departure | D:00 | 64% | -- | 56% | 80% | 50% | 69% | 69% | 61% |
| | | D:15 | 96% | -- | 94% | 100% | 100% | 91% | 91% | 87% |
| | Arrival | A:00 | 82% | -- | 75% | 90% | 100% | 83% | 83% | 76% |
| | | A:15 | 100% | -- | 100% | 100% | 100% | 91% | 91% | 88% |

Figure 4 - Daily Performance Full Report

The following reports (Figure 5 to Figure 9) do not add much in terms of the information itself, but their usefulness lies mainly in the fact that they help us convey to the user experience team how business users and C-level executives are accustomed to viewing data. The types of charts and visualizations are what we seek in the following examples.

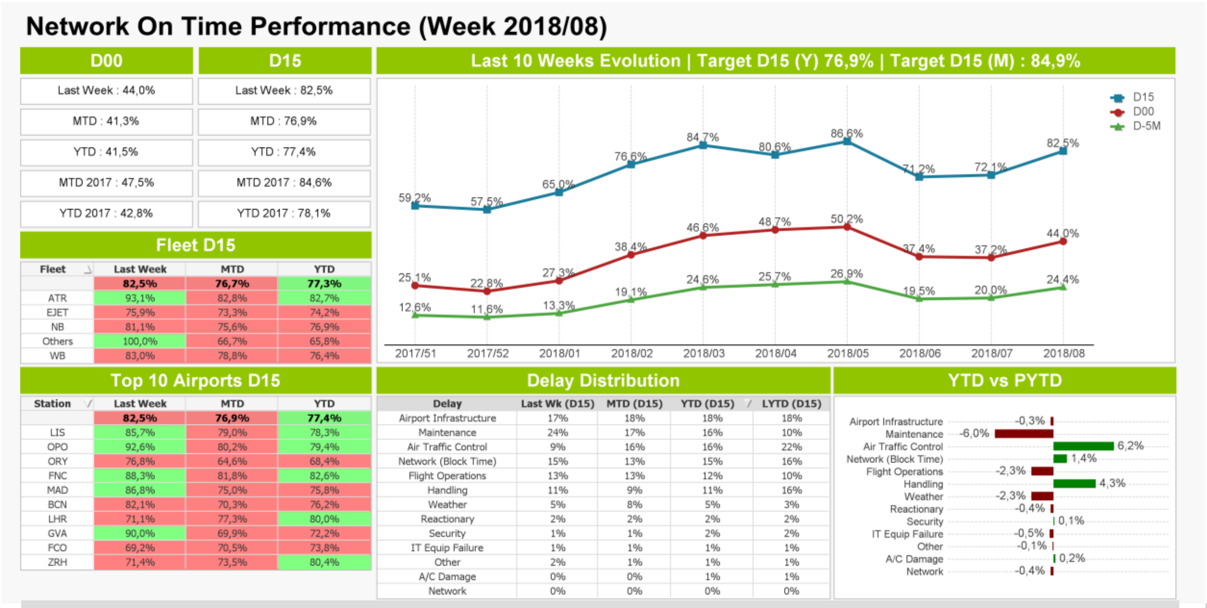



Figure 5 - Network OTP weekly report

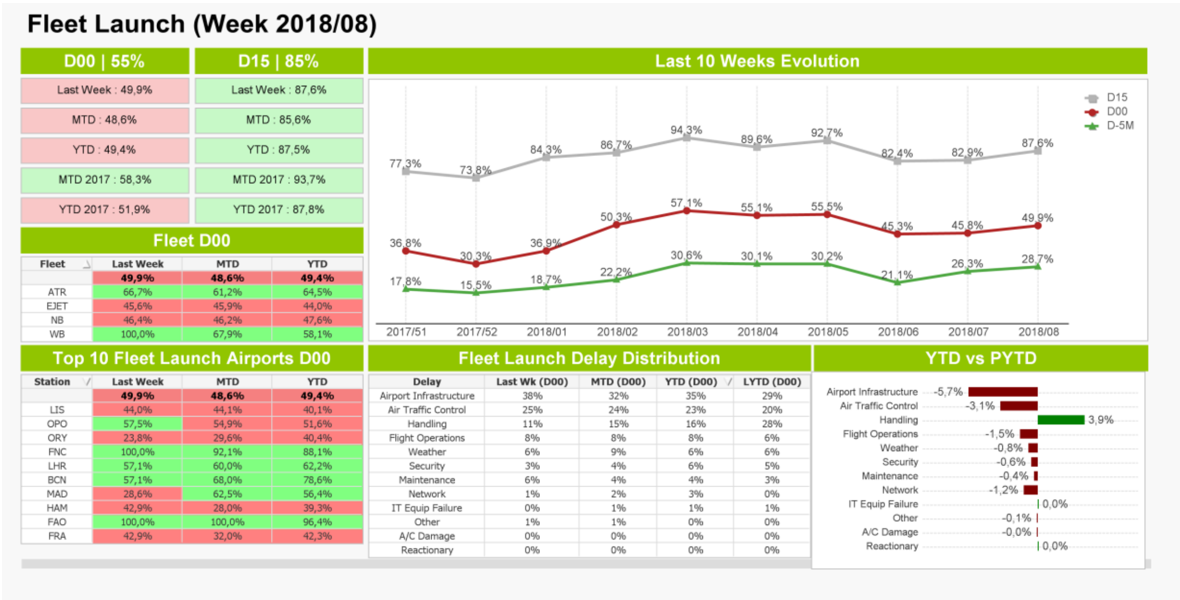



Figure 6 - Fleet launch weekly report

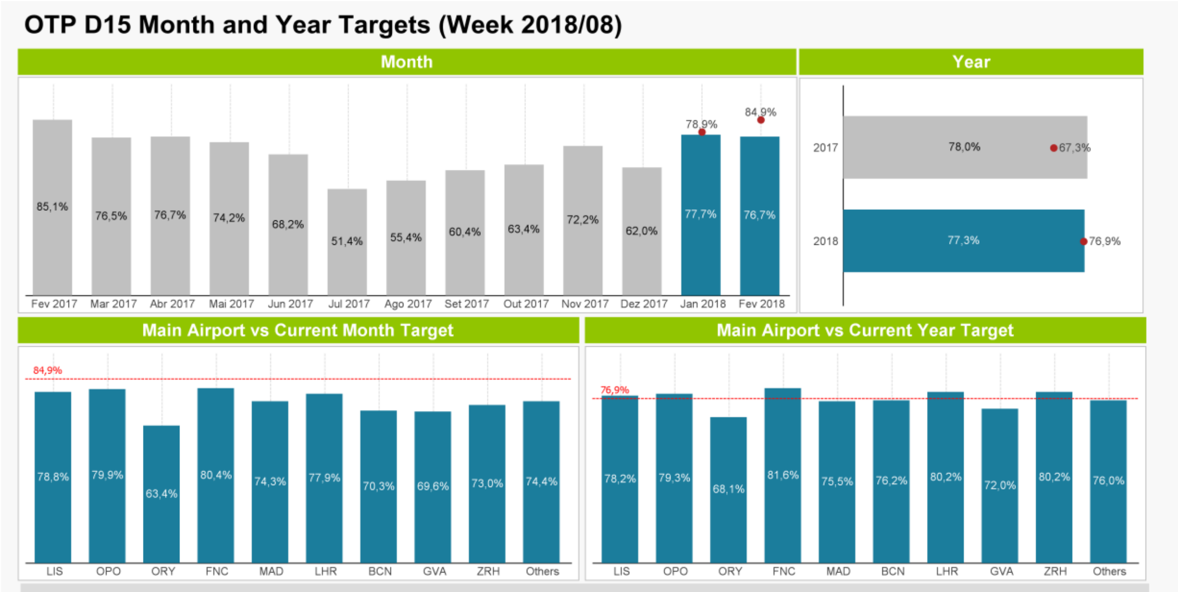



Figure 7 - OTP D15 month and year targets

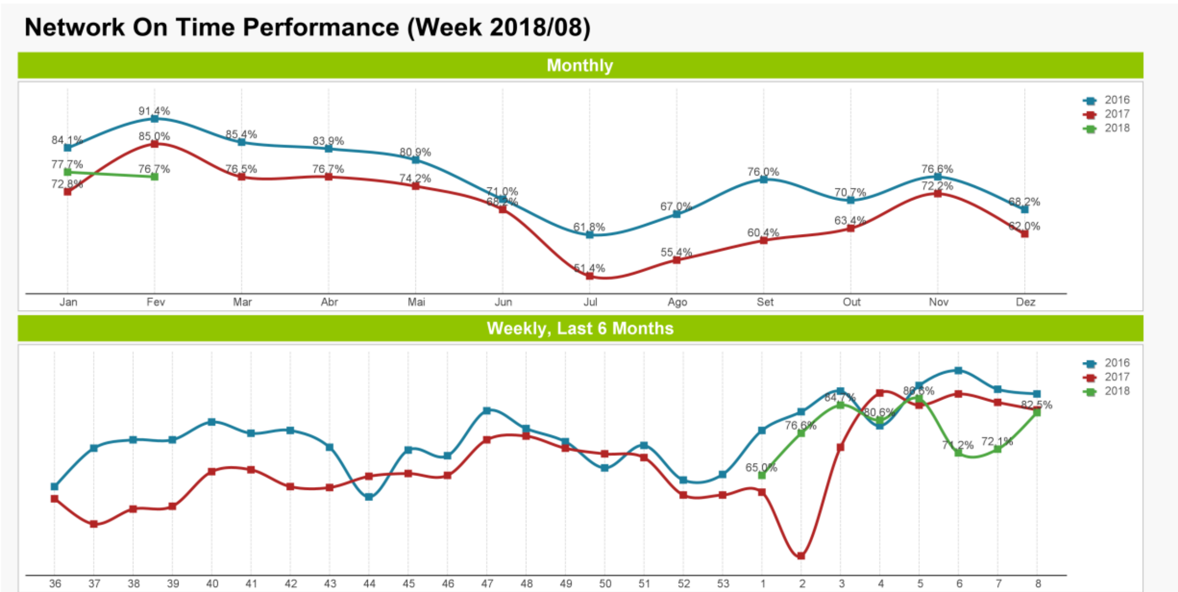



Figure 8 - Network OTP evolution

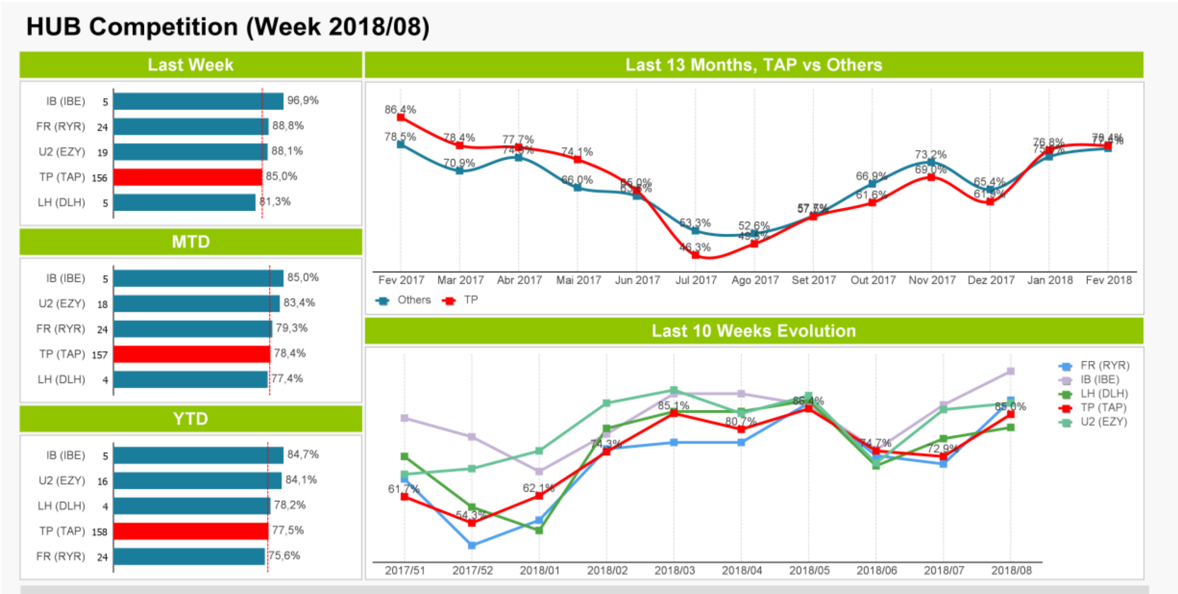



Figure 9 - HUB competition report

### 3.2.3. Functional Requirement List

During the requirement-gathering process, stakeholders provided specific features and functionalities that were compiled into a functional requirement list. These requirements were critical in ensuring that the dashboard met the needs of the airline company and provided valuable insights into its operations. The functional requirement list was split into different information topics, including General requirements, OTP requirements, Crew requirements, Canceled legs & ATCs (slots) requirements, AOGs, Maintenance aircraft, and Spares. The list served as a guide for the design and implementation of the dashboard, making it an essential component of the development process. With these requirements, the dashboard was designed to provide meaningful insights into the airline company's operations, allowing for informed decision-making and improved performance.

#### 3.2.3.1. General Requirements

General Requirements encompass the key aspects of dashboard refresh rate and presentation, ensuring up-to-date and visually appealing data display for effective decision-making.

| No. | Requirement |
|---|---|
| FR01 | The dashboard must be available on TV screen |
| FR02 | Refresh information every 5 minutes |

Table 1 - General Requirements

#### 3.2.3.2. On Time Performance Requirements

This topic addresses the key aspects of On Time Performance (OTP) and how it impacts various aspects of an airline's operations, including fleet types, airlines, and delay reasons.

| No. | Requirement |
|---|---|
| FR03 | Information about Daily On Time Performance D15, MTD OTP D15 and YTD OTP D15. The OTP information must be available for Network, Hub LIS and LIS-OPO-LIS Ponte Aérea. |

| | |
|---|---|
| FR04 | The daily OTP D15 information must be visual, with a color threshold: Green - above target, yellow - slight below target, red - below target |
| FR05 | There should be a section with Daily On Time Performance D15, split by Fleet type Narrow Body or Wide body types |
| FR06 | Display information about daily Number of Scheduled, Operated and Canceled Legs Split by PAC Network, PAC Fleet Type (Narrow/Wide Body) and Airline Companies PGA and ACMI |
| FR07 | Display the top 3 daily delay reasons, accumulated delay minutes and accumulated legs split by PAC Network, PAC Fleet Type (Narrow/Wide Body) and Airline Companies PGA and ACMI |
| FR08 | Leg classification as Regular, Planned, Diversion, or Cancelled |
| FR09 | Airline Company: PAC |
| FR10 | Traffic type: T1, T2, T8, T5, TA, TD, TN, U2, UD |
| FR11 | Exclude Delay Group React = Unknown |
| FR12 | Schedule ground time is empty or greater than or equal to 120 min |
| FR13 | For the delay section, only flight codes starting with TP and minutes of delay different from 0 or with an empty field and Flight Leg status different from X |
| FR14 | Information about daily fleet launch On Time Performance (OTP D0) |
| FR15 | Information about daily fleet launch On Time Performance (OTP D0) compared with previous day On Time Performance (OTP D0) |

Table 2 - OTP Requirements

### 3.2.3.3. Crew Requirements

Crew Requirements focus on the management of crew members, considering activity groups, standbys, open positions, and pairings to optimize workforce allocation and efficiency.

| No. | Requirement |
|---|---|
| FR16 | Activity groups: Airport Standby, Home Standby, RSVC |
| FR17 | Exclude crew type Pool ABIN (PNT) and CBIN (PNC) students |
| FR18 | Crew information for Current day Date |
| FR19 | Display the number of open positions and open pairings for PNT and PNC, split by Narrow Body and Wide Body |
| FR20 | Exclude completed AOGs during the day |
| FR21 | Display the number of crew standbys, split by professional category |

Table 3 - Crew Requirements

### 3.2.3.4. General Information, Cancelled Legs & ATC (Slots) Requirements

This area deals with the vital details of flight cancellations, reasons, and air traffic control, as well as the manual input of related comments to inform decision-making processes.

| No. | Requirement |
|---|---|
| FR33 | Indication of cancelled flights and reasons |
| FR34 | Indication of air traffic control (ATC) |
| FR35 | Information manually inserted, related to cancelled flight comments |
| FR36 | Information input though Transaction Services in Microstrategy |

Table 4 - General Information, Cancelled Legs & ATC (Slots) requirements

#### 3.2.3.5. Maintenance & Engineering

Maintenance & Engineering requirements ensure the effective tracking and management of aircraft maintenance, AOGs, and spares, with the goal of minimizing downtime and maximizing fleet availability.

| No. | Requirement |
| --- | --- |
| FR22 | There must be visible the current number of AOGs |
| FR23 | Display the detail of top 4 AOG, ordered by scheduled start date. The detail must have the airport code, Aircraft Tail Number, Aircraft ICAO Tail Number, scheduled check start date, scheduled check end date, actual check start date |
| FR24 | There must be visible the current number of aircrafts under maintenance |
| FR25 | Display the detail of top 4 aircraft maintenance, ordered by scheduled start date. The detail must have the Aircraft Tail Number, Aircraft ICAO Tail Number, Aircraft Model, check type, scheduled check start date, scheduled check end date, actual check start date |
| FR26 | There must be visible the current number of spare aircrafts |
| FR27 | Display the detail of top 4 aircraft spares, ordered by scheduled start date. The detail must have the Aircraft ICAO Tail Number, Aircraft Model, scheduled start date, scheduled end date, actual start date |
| FR28 | Include available spares and those expected until the end of the day |
| FR29 | Exclude check type not starting with A, C, or VT |
| FR30 | Exclude spares, AOG, and those not starting with AG |
| FR31 | Exclude maintenance with less than 180min predicted resolution |
| FR32 | Exclude completed maintenance with actual end date filled |

Table 5 - Maintenance & Engineering Requirements

### 3.2.4. Functional Requirement Treatment

This section will resume the listed requirements into actionable KPIs and dimensions, which will be presented on the dashboard. This chapter will provide a comprehensive understanding of the metrics used to measure performance and the dimensions that help categorize and filter the data, enabling efficient analysis and decision-making.

#### 3.2.4.1. KPIs

| Name | Description |
| --- | --- |
| Delay in Minutes | Total duration of delays in minutes |
| Number of Delays | Total number of delayed flights |
| Number of Legs | Total number of flight legs |
| On-Time Performance | Percentage of flights departing on time or early |
| On-Time Performance Target | Target value for On-Time Performance |
| Number of Open Pairings | Total open pairings for crew members |
| Number of Open Positions | Total open positions for crew members |
| Number of Spare Aircrafts | Total number of available spare aircrafts |
| Number of AOGs | Total number of Aircraft on Ground incidents |
| Number of Maintenance Aircrafts | Total number of aircrafts under maintenance |

Table 6 - List of KPIs

#### 3.2.4.2. Dimensions

| Name | Description |
|---|---|
| Actual Fleet | Type of aircraft fleet (Narrow/Wide Body) |
| Actual Owner Tail | Identifier for the actual aircraft owner |
| Aircraft Check Type | Type of aircraft maintenance check |
| AOG Group | Aircraft on Ground classification group |
| Crew | Crew members involved in the flight |
| Crew Activity Group | Type of crew activity (Airport Standby, etc.) |
| Delay Range | Range of delay times for flights |
| Flight Date LOC | Local date of the flight |
| Flight Traffic Type | Type of flight traffic (T1, T2, T8, etc.) |
| Leg Classification | Classification of flight leg (Regular, etc.) |
| Operating Airline Company | The company operating the flight |
| Operating Flight | Identifier for the operating flight |
| OTP Target | On-Time Performance target value |
| Scheduled Arrival Airport | Airport where the flight arrives |
| Scheduled Departure Airport | Airport from which the flight departs |
| Scheduled Departure Time UTC | Coordinated Universal Time of departure |

Table 7 - List of Dimensions

## 3.3. Data Capture and Modelling

### 3.3.1. Data Collection

Data was collected from various sources within the aviation company, including flight logs, maintenance records, and crew data. The data collected was primarily numerical, including flight times and duration. The scope of this project doesn't include all the sources that are relevant for the dashboard because the data is already loaded in the Data Warehouse (DW). For this project, the source will be the DW itself, where we will retrieve the required information and map it to a Data Mart in the format of Views.

### 3.3.2. Sources of Information

Although not in the scope of the project, it is important to understand the sources of information that feed into the Data Warehouse. The ETL process for these sources has already been implemented, but knowing where the information comes from can provide useful context. The sources are:

#### 3.3.2.1. Compass

- Crew Activities
- Delays
- Fleet Launch
- Maintenance
- Pairings
- Flight / Passenger Data

#### 3.3.2.2. ODS Flight

- Flight / Passenger Data (Source: Compass and ODS Flight) - Treatment of dates in which if they come empty, year 9999 or year less than 1900, then it should assume the date of December 31, 9999

By understanding the data collection and sources of information, we can ensure that the dashboard accurately represents the performance of the airline operations and provides insights for effective decision-making.

### 3.3.3. Logical Data Model

The chosen data model for this project is a star schema, which is a widely adopted data model in data warehousing due to its simplicity and effectiveness in querying large datasets (Kimball & Caserta, 2004). A star schema organizes data in a way that optimizes query performance, making it particularly suitable for the creation of dashboards and reports.

In this project, we utilized a star schema data model consisting of 7 fact tables. The decision to use multiple fact tables stemmed from the different granularities of data across various aspects of the organization, as well as the need to address specific dashboard requirements. Two of the fact tables contain operated flight and flight delays information, which share common dimensions. However, merging them into a single fact table would have been difficult due to their different granularities.

The remaining five fact tables also follow a star schema model, representing maintenance slots, OTP targets, qualitative manual information inserted through the back office, open pairings, and standbys. These fact tables capture distinct aspects of the organization's operations, ensuring that the data model can address a wide range of dashboard requirements.

The methodology to build the logical data model involves the following steps:

- Identify key business processes and requirements that need to be represented in the data model, focusing on the specific KPIs and dimensions identified in the requirements analysis stage.
- Define the entities and attributes relevant to each fact table, ensuring that these entities can capture the necessary information for the identified KPIs and dimensions.
- Determine the granularity of each fact table, taking into consideration the different levels of detail required for the KPIs and dimensions.
- Establish relationships between the entities, identifying one-to-one, one-to-many, and many-to-many relationships as appropriate.
- Validate the logical data model against the business requirements, adjusting the model as necessary to ensure its ability to support the desired dashboard functionality.

The methodology outlined above aligns with the best practices and recommendations found in the literature, particularly in the works of (Kimball & Caserta, 2004), who advocate for the use of star schema models in data warehousing projects. The star schema's ability to optimize query performance and support analytical decision making (Popovič et al., 2012) further justifies its use in the context of this project.

### 3.3.3.1. Operations Control Center Flights Data Model

The data model depicted in Figure 10 - Flights Logical Data Model will support the acquisition of information related to PAC's daily operations and will be instrumental in generating various visualizations that provide insights on KPIs such as punctuality, number of operated flights, and dimensions like fleet and time.

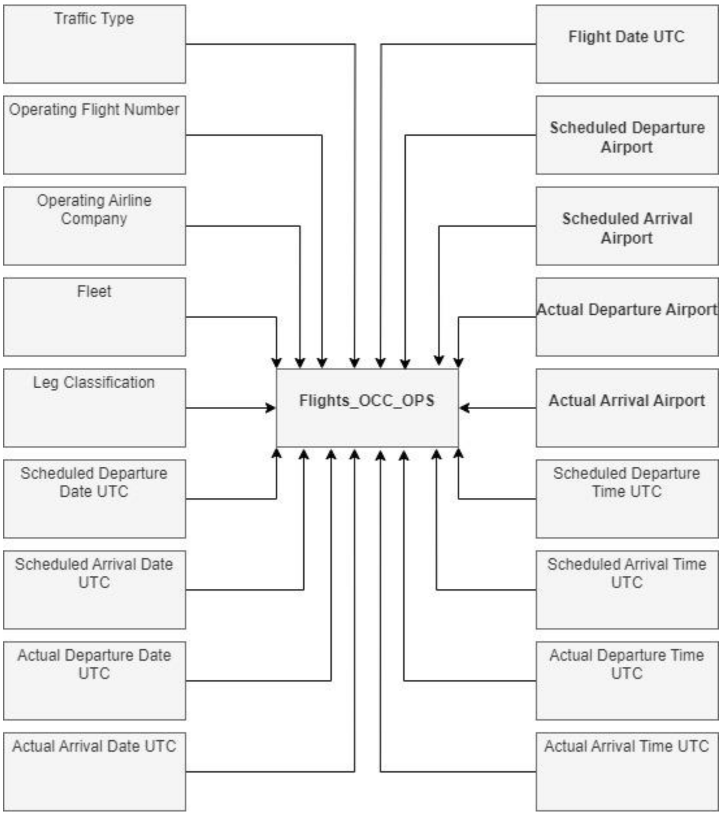



Figure 10 - Flights Logical Data Model

### 3.3.3.2. Operations Control Center Delays Data Model

The data model depicted in the Figure 11 - Delays Logical Data Model bears strong resemblance to the operations model, sharing most of the dimensions. However, as it pertains to flight delays, the granularity of the facts differs from the operations model. While the operations model focuses on flights as the primary grain, the delays model zooms in on delays as the central unit. This distinction is crucial as a single flight may encounter various types of delays, each treated as a separate entity within the model.

By adopting this refined granularity, the delays data model enables a more comprehensive analysis of flight delays. It captures and associates various delay types, such as weather-related, technical, or operational delays, with specific flights. This enhanced level of detail allows for a more nuanced examination of the causes and impact of delays.

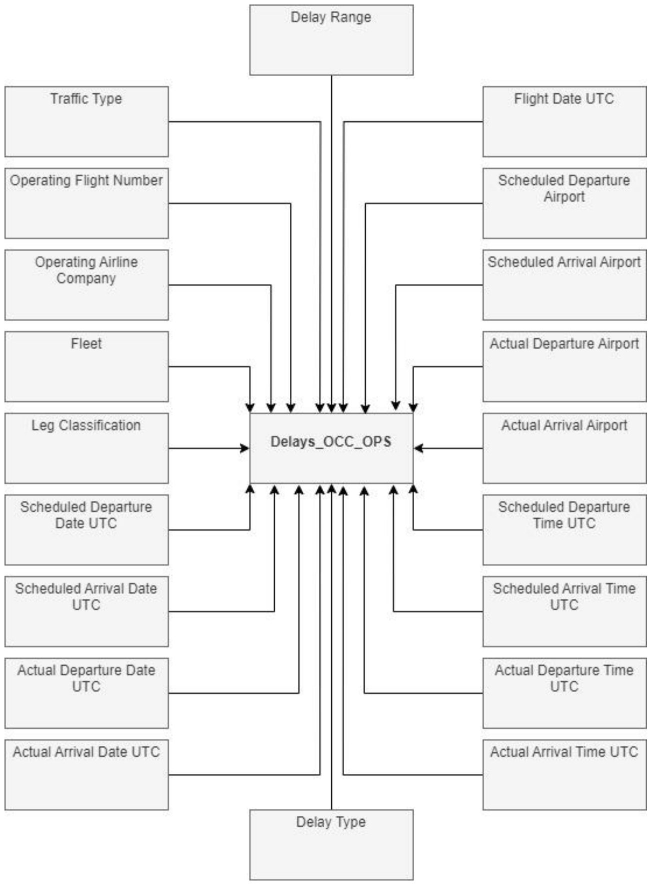



Figure 11 - Delays Logical Data Model

#### 3.3.3.3. Operations Control Center Backoffice View

This view provides ad-hoc observations and commentaries manually inserted by the operations control center in a dedicated Backoffice system. These observations and commentaries serve as valuable insights for monitoring and analyzing the airline's operations. In the dashboard, these inputs from the Backoffice will be displayed to provide real-time updates and contextual information for various operational metrics and key performance indicators. The Operations Control Center Backoffice view contributes to the overall situational awareness and decision-making capabilities of the dashboard, enabling stakeholders to have a comprehensive understanding of the operational context.

#### 3.3.3.4. Aircraft Maintenance View

The Aircraft Maintenance view contains information about aircraft currently undergoing maintenance activities. It includes details on both planned inspections and unplanned Aircraft on Ground (AOG) situations caused by aircraft failures. This view serves as a vital component of the dashboard, providing visibility into the maintenance status and availability of the fleet. It enables stakeholders to monitor the impact of maintenance activities on operational schedules, identify potential disruptions, and allocate resources effectively. The Aircraft Maintenance view supports proactive maintenance planning and helps ensure the smooth operation of the airline's fleet.

#### 3.3.3.5. Crew Pairing View

The Crew Pairing view focuses on providing information related to crew pairings, which represent a sequence of flight legs operated by the same crew and within the same fleet. This view highlights the crew base, flight legs, and relevant scheduling details. The Crew Pairing view enhances the dashboard's ability to monitor crew performance, maintain crew scheduling accuracy, and support effective crew resource allocation.

#### 3.3.3.6. Crew Standbys View

The Crew Standbys view offers information about the periods during which a specific crew member is on standby or acts as a backup in case of the absence of another crew member. This view provides insights into crew availability, standby assignments, and potential backup scenarios. By incorporating the Crew Standbys view into the dashboard, stakeholders can monitor crew standby periods, optimize crew deployment, and ensure operational continuity in case of unforeseen circumstances. This view enhances the dashboard's functionality by offering real-time visibility into crew availability and standby arrangements.

#### 3.3.3.7. Monthly OTP Target View

This is another view based on a Backoffice table that is periodically filled by business users. It contains information about punctuality targets for a specific period. In the dashboard, its primary purpose is to populate colored thresholds, enabling users to understand whether the punctuality for a specific period is above or below the target set by the company.

### 3.3.4. Physical Data Model

For this project, we aimed to employ best practices of star schema data modeling to optimize query performance on the database. Since some views required additional logic in their code, as the tables serving as the source for these views were not specifically designed for this project but were already available, we focused on incorporating star schema modeling principles (Inmon & Hackathorn, 1994).

Star schema modeling offers several advantages in the context of data warehousing. It simplifies data integration and enhances query performance by organizing data into a centralized fact table surrounded by dimension tables. This structure enables efficient aggregation and slicing of data, providing a solid foundation for reporting and analysis.

Drawing on the methodologies introduced by Ralph Kimball and Joseph Caserta in "The Data Warehouse ETL Toolkit" (Kimball & Caserta, 2004), we incorporated their principles and guidelines into our data modeling approach. These methodologies emphasize dimensional modeling techniques, including the use of star schemas, which aligns with our project goals.

By employing a star schema model, we anticipate improved query execution for the live dashboard, aiming for response times below 5 seconds. The star schema's simplified structure and optimized indexing contribute to faster query processing, enabling real-time data exploration and analysis.

Additionally, the star schema facilitates ease of maintenance and extensibility. As new data sources and dimensions become available, they can be easily integrated into the existing model without significant disruptions or modifications to the dashboard.

In summary, our utilization of the star schema model, guided by Kimball and Caserta's methodologies, positions us to leverage the advantages of efficient query performance and streamlined data integration. This approach ensures that our dashboard delivers timely insights and meets the performance requirements for interactive and responsive data exploration.

### 3.3.4.1. OCC Flights Physical Model

The diagram presented below (Figure 12 - OCC Flights Entity Relationship Diagram) illustrates the entity-relationship model of the OCC flight model that underlies the dashboard. As depicted, the model adopts a star schema approach, where the Flight fact table serves as the central entity, and the supporting dimensions are connected to it.

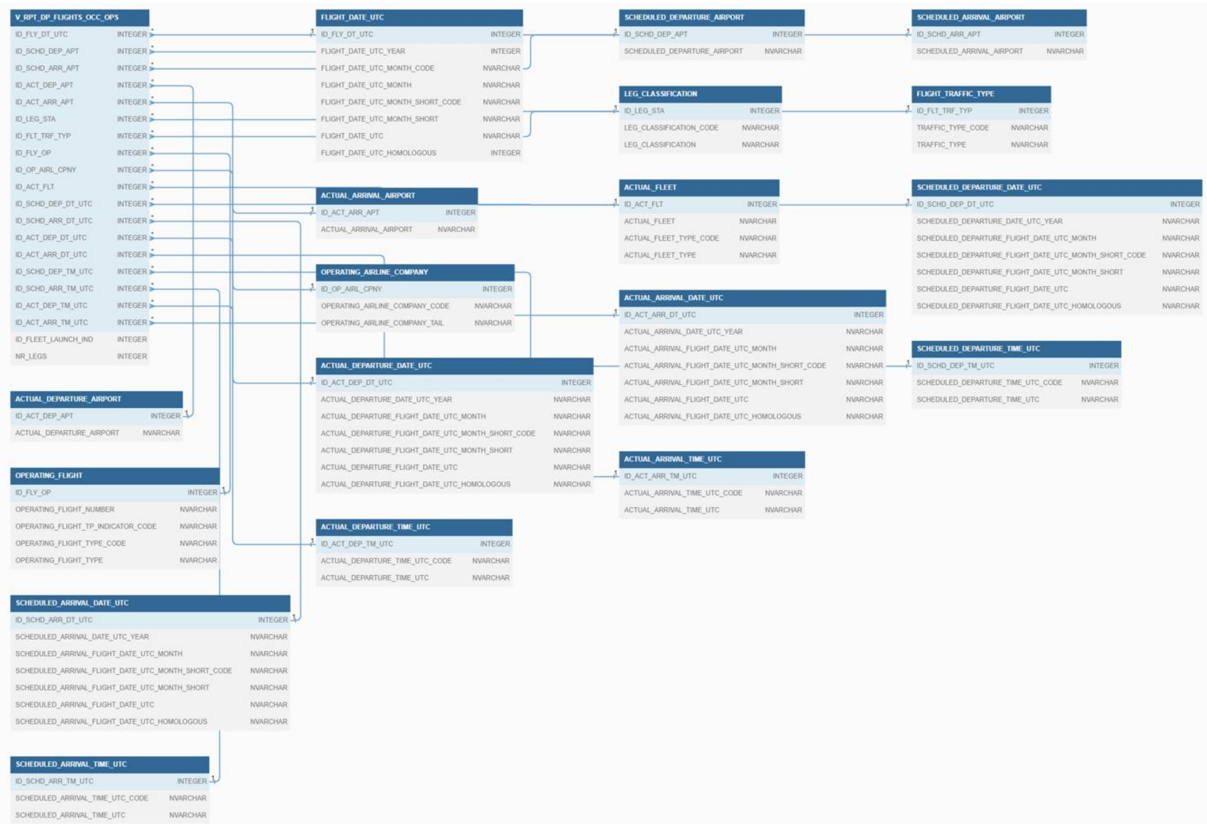



Figure 12 - OCC Flights Entity Relationship Diagram

### 3.3.4.2. OCC Flight Delays Physical Model

Displayed in the diagram below (Figure 13 - OCC Flight Delays Entity Relationship Diagram) is the entity-relationship diagram depicting the OCC flight delays model that underpins the dashboard. The model adheres to a star schema design, with the Flight Delays fact table at its center, around which the supporting dimensions are organized. It is important to note that all other dimensions, such as

Scheduled Departure Airport, Scheduled Arrival Airport, Actual Departure Airport, Actual Arrival Airport, and others, are common between both fact tables.

The Flight Delays fact table stands apart from the Flights fact table due to their distinct granularities. While the Flights fact table captures flight-level data, the Flight Delays fact table provides insights into individual delay occurrences, enabling the representation of multiple delays per flight. This separation allows for more detailed analysis and understanding of the factors contributing to flight delays.

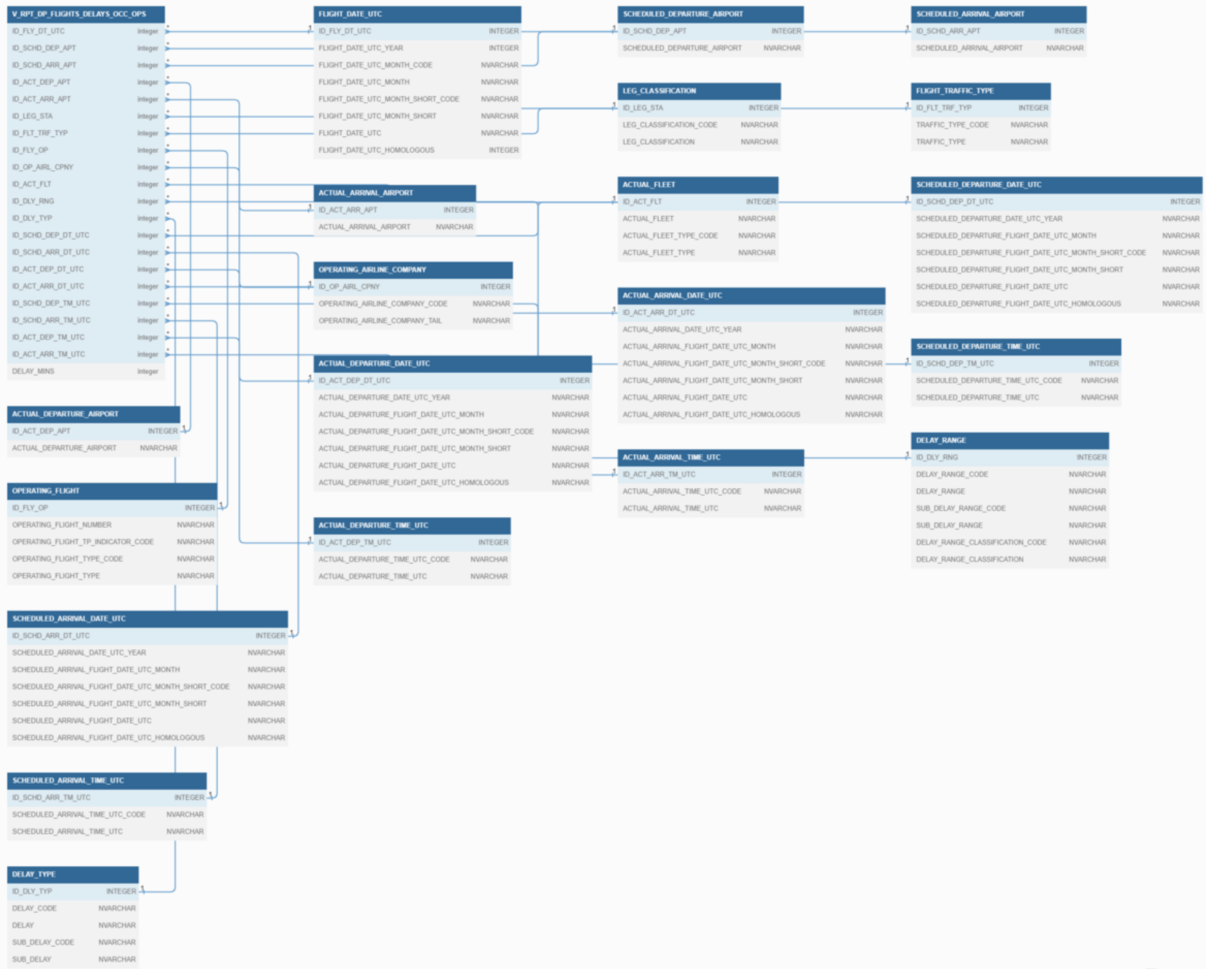



Figure 13 - OCC Flight Delays Entity Relationship Diagram

### 3.3.4.3. Standalone Views

The figure below (Figure 14 - Standalone Views Diagram) represents a diagram that, in this case, does not show relationships. These are views specifically designed to address a specific area of the dashboard, primarily aimed at saving development time. These views are independent and have no connection to the rest of the model.

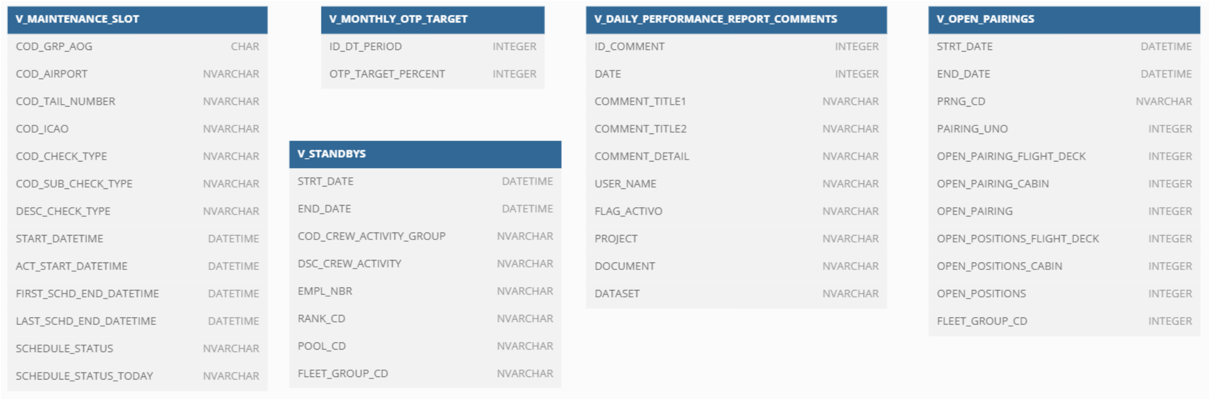



Figure 14 - OCC Standalone Views Diagram

### 3.4. DELIVERIES & SPRINTS

The project was organized into two sprints, each spanning a month, with clear deliverables outlined for each sprint. The initial sprint focused on establishing the foundation for the project, including the development of the data model and the setup of the required hardware and software infrastructure. During this phase, the project team worked diligently to design an efficient and scalable data model that could effectively support the desired KPIs and reporting requirements. Additionally, the necessary hardware and software components were implemented to ensure optimal performance and data accessibility.

Once the groundwork was in place, the project transitioned into the second sprint, which culminated in the delivery of the dashboard. Leveraging the insights gained from the prototype, the development team was able to streamline the dashboard development process significantly. The existing design and functionalities of the prototype were refined and translated into the final version of the dashboard, resulting in considerable time savings. Throughout the second sprint, regular validations and feedback sessions were conducted with the stakeholders, allowing for continuous refinement and improvement of the dashboard based on their inputs.

### 3.5. VALIDATION AND ACCEPTANCE

After the delivery of the dashboard, a comprehensive validation process was undertaken to ensure its accuracy, reliability, and adherence to the established requirements. A robust testing plan was devised, encompassing various critical aspects of the dashboard's functionality. The validation process involved rigorous checks to verify the correctness of KPI values, assess the data refresh frequency, evaluate the effectiveness of defined thresholds, and measure the performance of the dashboard on the TV display. The MicroStrategy datasets supporting the dashboard were also thoroughly tested to ensure optimal execution performance.

The validation activities were a collaborative effort involving the development team and key stakeholders, including business analysts and subject matter experts. Feedback from these individuals played a crucial role in identifying any potential issues or areas for improvement. The project team diligently addressed the identified concerns and made the necessary adjustments to enhance the dashboard's functionality and usability.

While the validation and acceptance process were successful, it is important to note that it is an ongoing endeavor. Continuous validation, feedback gathering, and refinement will contribute to the ongoing enhancement of the dashboard. The project team remains committed to incorporating user feedback and addressing any future challenges that may arise, ensuring that the dashboard remains a valuable tool for the organization's decision-making processes.

## 4. PROTOTYPING

As previously mentioned, the prototyping phase having started earlier than the project provided a boost, as stakeholders having already seen something helped in generating ideas (Faust et al., 2019). After collecting requirements from stakeholders, it was relatively simple to incorporate these requirements into the existing prototype, and then involve the UX team to improve the layout and the way information is visualized (Sarikaya et al., 2019).

The UX team greatly contributed to clarifying the best ways to visualize information, as well as the optimal color scheme and number formatting, based on the initial prototypes developed (Arnaboldi et al., 2021). The prototype was refined using Invision technology (Khatuwal & Puri, 2022).

### 4.1. First Ideas

The prototyping of this dashboard began sometime before the project. By analyzing some existing reports, shared in a previous chapter, we started producing prototypes to show the business the technological potential that could be delivered for value creation. The following prototypes were very helpful and served as a quick win in the project launch, as they contained a mix of the capabilities we could deliver in terms of visualization and some indicators that could be relevant for the daily decision-making of the C-level executives.

### 4.2. First Prototype (2018)

This first prototype, represented in the Figure 15 - IOCC Dashboard first prototype, was developed through informal discussions between the business and the BI team. The BI team attempted to create a visual representation with some suggestions for real-time analysis. Although the prototype was far from the final product, it was well-received and met with enthusiasm from the business, paving the way for the project to proceed.

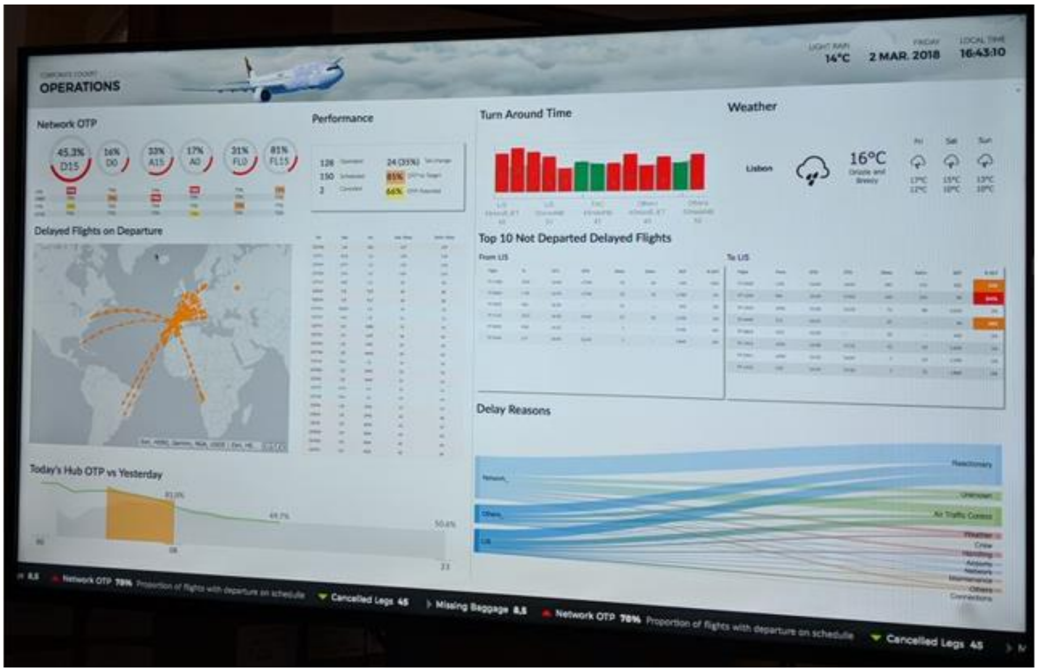



Figure 15 - IOCC Dashboard first prototype

## 4.3. INTERMEDIATE PROTOTYPE WITH SOME STAKEHOLDER FEEDBACK

After receiving feedback and analyzing existing reports within the company, the BI team created a new prototype, represented in the Figure 16 - IOCC Dashboard intermediate prototype. This prototype focused solely on operational information, excluding delays and maintenance data. It allowed for fine-tuning the distribution of KPIs within the dashboard.


Figure 16 - IOCC Dashboard intermediate prototype

## 4.4. FINAL PROTOTYPE ALREADY WITH ALL THE REQUIREMENTS AND UX TEAM DESIGN

This final prototype, represented in the Figure 17 - IOCC Dashboard final prototype, emerged after several interactions between the BI department and the business, incorporating additional feedback and effectively gathering requirements for the final dashboard. The UX team at PAC would be responsible for developing this prototype.


Figure 17 - IOCC Dashboard final prototype

## 5. RESULTS

### 5.1. OVERVIEW OF DASHBOARD FUNCTIONALITY AND FEATURES

The final output produced was a highly useful dashboard for daily operational analysis, as it encompasses various KPIs that enable quick interpretation of ongoing operations at any given moment. Within a single dashboard, it was possible to condense operational information, including the number of flights operated and their corresponding punctuality, across the entire PAC network, as well as specific insights for the Lisbon Hub or the Lisbon-Porto air bridge, and even by fleet type. The dashboard also includes pertinent information on delays, offering insights into the most frequently occurring delays. Additionally, summarized crew management information provides insights into crew pairings and crew members on standby. Aircraft maintenance information is also presented in a tabular format, allowing for knowledge extraction on metrics such as the number of aircraft under scheduled maintenance, those experiencing failures, or those available as backups.


Figure 18 - IOCC Dashboard area division

1. **Operations**
   This section provides information about flight operations. It allows for the analysis of the number of planned, operated, and canceled flights, as well as the percentage of punctual flights for the entire PAC network. This data is available for the current day, as well as the current month (MTD) and year (YTD), with cumulative values. The same indicators can be analyzed for Narrow Body (NB) and Wide Body (WB) aircraft types, as well as for the Portugal and Portite subsidiaries. Additionally, there is a graphical representation of the percentage of punctuality for the PAC network, along with punctuality for Fleet Launch flights, which are flights without precedence where the first leg departs from Lisbon. The same indicators are available for the Lisbon Hub and the Lisbon-Porto air bridge.
2. **Delays**
   The delays section provides an overview of the top 3 types of delays occurring, displaying the total number of minutes associated with each delay type, as well as the number of legs affected by a specific delay type.

3. **Crew**

   In this section, information is presented on open pairings, open positions, and standbys categorized by professional level. "PNT" refers to the commander level, and "PNC" refers to the cabin chief and flight attendant levels.

4. **Observations and Comments**

   This section contains information inputted manually through a Backoffice. It provides relevant qualitative information related to operations and is divided into three themes: canceled legs, air traffic control (ATC) management information, and a general information table that may include constraints observed at a specific airport due to strikes or adverse weather conditions that could impact flight performance.

5. **Maintenance**

   The maintenance section displays tabular information representing aircraft on the ground, either due to failures (AOG category) or for scheduled maintenance (Maintenance aircrafts category). This information includes details such as the scheduled completion date for maintenance or information on available aircrafts for backup purposes (Spares category).

### 5.1.1. Threshold: (Red Limit PAC = 50%)

Figure 19 - OTP Threshold Configuration represents the limits used in the dashboard threshold, comparing punctuality with the corresponding target. By observing a color, the user can immediately determine whether punctuality is within the established target.

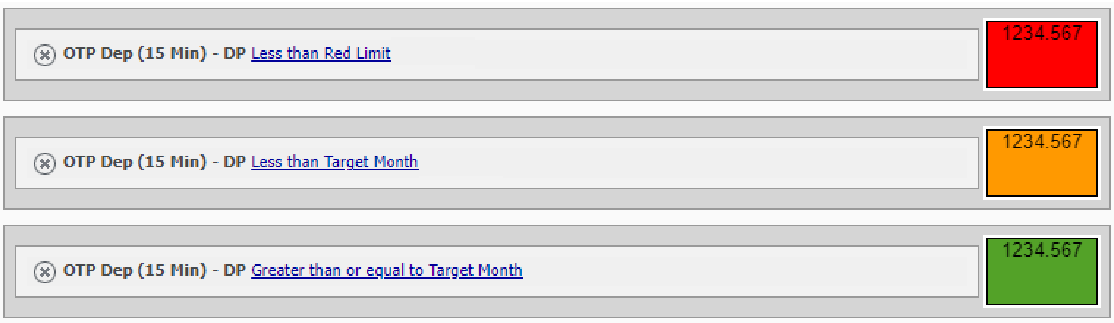



Figure 19 - OTP threshold configuration

## 5.2. Analysis of Key Performance Indicators (KPIs)

Present an analysis of the KPIs displayed in the dashboard. Discuss the insights and trends revealed by these KPIs, emphasizing their relevance to the airline industry and the specific goals of the company. Include visualizations or tables that illustrate the KPIs and their performance over time.

### 5.2.1. Operations KPIs

The following image, Figure 20 - Network OTP KPIs, provides an overview of KPIs related to operations. These KPIs play a crucial role in monitoring and evaluating the punctuality and efficiency of aircraft departures. In the image, various metrics and their descriptions are provided to offer a comprehensive understanding of the operational performance.


Figure 20 - Network OTP KPIs

| Section | Metrics |
|---|---|
| Network OTP | - OPT D15: Percentage of aircrafts departing with <15 minutes delay |
| | - Target OPT: Monthly punctuality target percentage (currently 75%) |
| Accumulated Punctuality | - OPT D15 MTD: Percentage of aircrafts departing with <15 minutes delay from beginning of current month until the current date |
| | - OPT D15 YTD: Percentage of aircrafts departing with <15 minutes delay from beginning of current year until the current date |
| Legs Count | - Total Legs: Number of legs scheduled for current day |
| | - Operated Legs: Number of legs already departed from origin |
| | - Canceled Legs: Number of legs scheduled but subsequently canceled |
| Punctuality Intraday evolution | - OPT D15: Percentage of aircrafts departing with <15 minutes delay |
| Hub / Air Bridge | - OPT D15: Percentage of aircrafts departing with <15 minutes delay |
| | - Target OPT: Monthly punctuality target percentage (currently 75%) |
| | - Total Legs: Number of legs scheduled for current day |
| | - Operated Legs: Number of legs already departed from origin |
| | - Canceled Legs: Number of legs scheduled but subsequently canceled |

Table 8 - Network OTP Sections & KPIs

### 5.2.2. Crew KPIs

Figure 21 - Crew KPIs illustrates KPIs related to the crew's performance and allocation. These metrics play a vital role in monitoring the crew's availability and ensuring efficient crew management. The image provides an overview of various crew related KPIs, including the number of open positions, open pairings, and standbys.

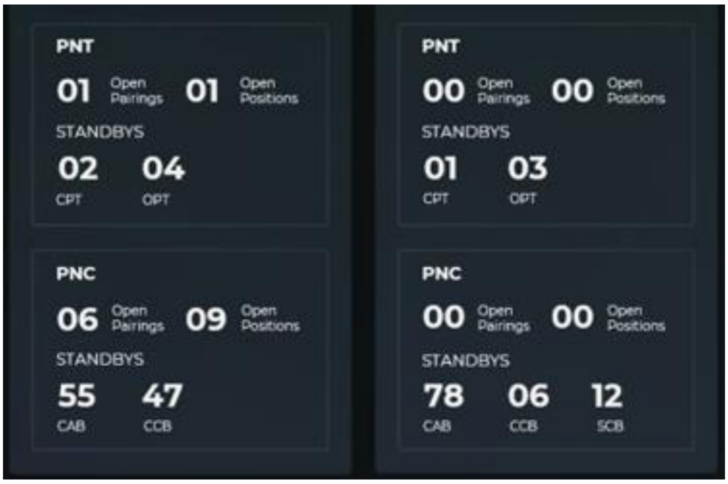


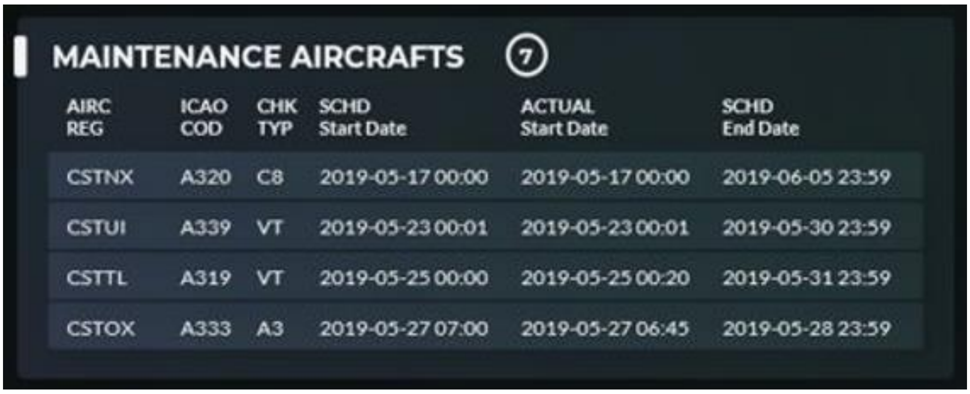

Figure 21 - Crew KPIs

| Section | Metrics |
|---|---|
| Crew | - Number of Open Positions |
| | - Number of Open Pairings |
| | - Number of Standbys |

Table 9 - Crew Sections & KPIs

### 5.2.3. Maintenance KPIs

Figure 22 - Maintenance KPIs showcases KPIs related to aircraft maintenance. These metrics provide insights into the status of aircraft availability and maintenance activities. The image presents a grid that displays important maintenance KPIs, including the number of aircrafts in AOG (Aircraft on Ground), in maintenance, and in spare.



MAINTENANCE AIRCRAFTS (7)

| AIRC REG | ICAO COD | CHK TYP | SCHD Start Date | ACTUAL Start Date | SCHD End Date |
|---|---|---|---|---|---|
| CSTNX | A320 | C8 | 2019-05-17 00:00 | 2019-05-17 00:00 | 2019-06-05 23:59 |
| CSTUI | A339 | VT | 2019-05-23 00:01 | 2019-05-23 00:01 | 2019-05-30 23:59 |
| CSTTL | A319 | VT | 2019-05-25 00:00 | 2019-05-25 00:20 | 2019-05-31 23:59 |
| CSTOX | A333 | A3 | 2019-05-27 07:00 | 2019-05-27 06:45 | 2019-05-28 23:59 |

Figure 22 - Maintenance Aircrafts grid

| Section | Metrics |
|---|---|
| Maintenance Aircrafts | - Number of Aircrafts in AOG |
| | - Number of Aircrafts in Maintenance |
| | - Number of Aircrafts in Spare |

Table 10 - Maintenance Aircrafts Sections & KPIs

## 5.3. User Experience and Feedback

The user experience of the dashboard was a key consideration during its development. Several adjustments were made to enhance the aesthetics and usability of the dashboard, based on user feedback and requirements. The following improvements were implemented:

**Aesthetic Enhancements:** As per user request, slight modifications were made to the labels, changing them from white to a color closer to gray. This adjustment aimed to improve readability and visual appeal.

**Data Update Status Flag:** To ensure users are aware of data currency, a flag was included to indicate when the data is not up to date. This feature helps users identify instances where there may be issues with the ETL (Extract, Transform, Load) processes, ensuring data accuracy and reliability.

**Revised Airline List:** The airline list was updated to reflect operational changes and include relevant entities. The "White" airline was removed, and "ACMIs" (Aircraft and Crew Maintenance and Insurance) were added. ACMIs refer to aircraft and crew chartered by PAC, expanding the representation of operational entities within the dashboard.

**Weather Information:** To provide comprehensive insights, weather information was incorporated into the dashboard. This addition enables users to consider meteorological conditions that may impact flight operations, offering a holistic view of factors influencing performance.

These user experience enhancements aimed to optimize usability, enhance data transparency, and provide a more comprehensive operational overview. By incorporating user feedback and addressing their specific needs, the dashboard offers an improved and tailored user experience.

# 6. DISCUSSION

## 6.1. Business Impact and Decision-Making

The implementation of the dashboard has significantly impacted the airline company's business operations and decision-making processes. By providing real-time and comprehensive insights into KPIs, the dashboard has empowered stakeholders to make informed decisions and take proactive actions (Guo & Sheffield, 2008).

One of the key beneficiaries of the dashboard is the Operations Control Center, which can now act in coordination with other departments, ensuring seamless collaboration across the company's ecosystem. This coordination allows for timely responses to unfavorable indicators, preventing operational disruptions and enhancing overall performance (Eckerson, 2010).

The dashboard's ability to present KPIs related to flight operations, punctuality, fleet performance, crew management, and maintenance provides a comprehensive overview of the company's daily operations. Decision-makers can identify trends, patterns, and potential areas of improvement promptly, facilitating strategic and operational decision-making (Jiang & Ren, 2019).

By leveraging the insights derived from the dashboard, the airline company can identify bottlenecks, mitigate risks, and optimize performance. The real-time nature of the dashboard ensures that decision-makers have access to the most current information, enabling them to make agile and data-driven decisions (Sharda et al., 2020).

Moreover, the dashboard fosters collaboration and cross-functional alignment, as stakeholders from various areas can access a shared platform to monitor performance and work towards common goals. This alignment enhances communication, enables better resource allocation, and facilitates a holistic approach to operational management (Fertier et al., 2020).

## 6.2. Comparison With Existing Reporting Methods

In this section, we compare the newly implemented TV dashboard with the existing reporting methods previously used by the C-level executives and the Operations Control Center. This comparison highlights the advantages of the TV dashboard in terms of data accessibility, visualization capabilities, and the ability to provide comprehensive and real-time insights (Larson & Chang, 2016).

Prior to the implementation of the TV dashboard, the reliance on static reports and email distributions hindered access to up-to-date and comprehensive data. The TV dashboard revolutionizes information presentation by consolidating key operational metrics into a single, up-to-date screen. It offers a holistic view of the organization's performance, allowing users to access real-time data and derive meaningful insights without the need to navigate through multiple reports (Sharda et al., 2020).

The TV dashboard's strength lies in its ability to present diverse operational information in a visually impactful and easily digestible format. By combining data on flight operations, punctuality, fleet performance, crew management, and maintenance, the dashboard offers a comprehensive overview. Decision-makers can quickly identify patterns, trends, and potential areas for improvement on a single screen (Larson & Chang, 2016).

The real-time updates of the TV dashboard enhance decision-makers' ability to respond promptly to emerging issues, make informed decisions, and drive operational efficiency. Its user-friendly interface allows for intuitive exploration and analysis, empowering users to gain valuable insights and take immediate action (Sharda et al., 2020).

Compared to other reporting methods that require navigating through multiple reports or waiting for periodic updates, the TV dashboard provides an always-updated, centralized source of information. This accessibility to real-time data facilitates a proactive approach to decision-making, empowering executives, and the Operations Control Center to address operational challenges promptly and make data-driven strategic decisions (Ridzuan & Wan Zainon, 2019).

### 6.3. Agile Methodologies and Scrum Practices

The successful implementation of the dashboard can be attributed, in part, to the adoption of agile methodologies and scrum practices. Agile methodologies emphasize iterative development, collaboration, and flexibility in response to changing requirements (Larson & Chang, 2016). By following agile principles, the development team was able to deliver a functional dashboard incrementally, allowing for early feedback and continuous improvement.

The use of scrum practices, such as sprint planning, daily stand-up meetings, and regular retrospectives, ensured efficient project management and effective communication among team members. These practices promoted transparency, adaptability, and collaboration, leading to the timely development and deployment of the dashboard.

In conclusion, the implementation of the dashboard, has had a profound impact on the airline company's business operations and decision-making processes. The real-time data accessibility, visualization capabilities, and comprehensive insights provided by the dashboard have empowered stakeholders to make informed decisions, optimize performance, and drive operational excellence.

The adoption of agile methodologies and scrum practices has further enhanced the responsiveness and adaptability of the dashboard. By leveraging the power of business intelligence and analytics, the dashboard has facilitated data-driven decision-making, improved cross-functional collaboration, and fostered a culture of continuous improvement within the organization.

## 7. LIMITATIONS AND CHALLENGES

During the development and implementation of the dashboard, certain limitations and challenges were encountered. These factors influenced the effectiveness and usability of the dashboard, and it is important to acknowledge them to provide a comprehensive analysis. Additionally, user feedback played a significant role in shaping the dashboard's features and functionalities.

One limitation of the project was the reliance on existing data models that were not specifically designed for this dashboard. While this saved time in developing dedicated ETL processes for data extraction, transformation, and loading, it posed challenges in terms of data modeling and performance. The data models lacked the flexibility and optimization that could have been achieved with a dedicated design. However, the team worked diligently to overcome these challenges and ensure that the dashboard still provided valuable insights despite the limitations.

Data quality issues were another challenge encountered during the development of the dashboard. Although the data was sourced from the company's data warehouse, some inconsistencies and discrepancies were identified, requiring additional data cleansing and validation efforts. These efforts were crucial to ensure the accuracy and reliability of the information presented in the dashboard.

Technical constraints also influenced the development process. Integrating data from multiple sources, especially those not initially designed for the dashboard, required careful consideration of compatibility and data integration methods. The team implemented necessary transformations and mappings to align the data from different sources, ensuring a cohesive and unified view in the dashboard.

Throughout the development and testing phases, user feedback played a pivotal role in shaping the user experience and enhancing the dashboard's functionality. The team actively solicited feedback from end-users, including C-level executives and the Operations Control Center, to understand their specific needs and preferences. This feedback led to refinements in the visual aesthetics, such as adjusting label colors and incorporating flags to indicate data freshness. The inclusion of additional information, such as weather data, was also a result of user suggestions and requirements.

By acknowledging these limitations, addressing data quality issues, and incorporating user feedback, the dashboard can continue to evolve and adapt to the changing needs of the organization. The iterative nature of the development process ensures that the dashboard remains a valuable tool for decision-making and supports the organization in achieving its strategic objectives.

## 8. CONCLUSIONS AND FUTURE WORKS

The completion of this project marks an important milestone in the development of a comprehensive and real-time dashboard for the airline company. By following a combination of qualitative and quantitative methods, we were able to gather requirements, analyze data, and construct a robust data model and dashboard. The methodology employed ensured the accuracy and validity of the results, as they were validated through comparisons with external sources and verified by relevant stakeholders.

Through the implementation of the dashboard, significant improvements have been achieved in terms of data accessibility, visualization capabilities, and decision-making processes. The dashboard provides a consolidated view of key performance indicators (KPIs) related to flight operations, delays, crew management, and aircraft maintenance. This centralized and up-to-date information empowers C-level executives and the Operations Control Center to make informed decisions, take proactive measures, and ensure the smooth functioning of the organization's operations.

The integration of various data sources into a unified and user-friendly interface has enhanced the efficiency and effectiveness of data analysis. The ability to slice and dice the data by different dimensions, such as fleet, time periods, and specific airport routes, allows for a deeper understanding of the company's performance and operational trends. The inclusion of real-time updates and intuitive visualizations further facilitates data interpretation and enables timely interventions to address potential issues.

While the results obtained from the data analysis and dashboard implementation have provided valuable insights, it is important to acknowledge certain limitations and challenges. The accuracy and reliability of the results are contingent upon the quality of the collected data and the inherent constraints of the analysis techniques employed. Ongoing efforts to address data quality issues and refine the modeling and analysis processes will further enhance the accuracy and effectiveness of the dashboard.

Looking forward, there are several areas of future work that can be explored to continuously improve and expand the functionality of the dashboard:

**Continuous Enhancement:** Regular updates and refinements to the dashboard based on user feedback and evolving business requirements. This ensures that the dashboard remains relevant and aligned with the organization's changing needs.

**Advanced Analytics:** Incorporating advanced analytics techniques, such as predictive analytics and machine learning, to provide predictive insights and identify patterns and trends that can guide strategic decision-making.

**Data Enrichment:** Exploring opportunities to incorporate additional data sources, such as social media data, customer feedback, and operational data from external partners, to further enrich the analysis and provide a holistic view of the airline's operations.

**Mobile Accessibility:** Developing a mobile version of the dashboard to provide on-the-go access to key performance metrics and facilitate decision-making even when users are not in their office environments.

By addressing the identified limitations and embracing future enhancements, the dashboard will continue to serve as a valuable tool for the organization's growth and success. The iterative nature of the development process ensures that the dashboard remains adaptable to evolving business needs and leverages emerging technologies to drive continuous improvement in decision-making and operational efficiency.

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