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FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL EXPERIMENTAL CENTRE

ANALYSIS OF PASSENGERS DELAYS: AN EXPLORATORY CASE STUDY

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Project PFE-F- FM

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EXECUTIVE SUMMARY

Project motivation

“Placing users at the heart of transport policy” is a key action proposed by the Commission of the European Community. Policy makers have also expressed a strong interest to further develop rights and obligations of end-users over the next ten years. As a result, several initiatives have been launched to bring European airlines and other interested parties to agree on its regulatory framework. Among other short-term measures, the White Paper’s Action Program proposes to “increase air passengers’ existing rights through new proposals concerning in particular denied boarding due to overbooking, delays and flight cancellations” and to “put forward a regulation concerning requirements relating to air transport contracts”.

Airlines will be mostly affected by these proposed short-term measures. However, service/infrastructure providers to airlines, such as airports, national air traffic control service providers and Eurocontrol, will/can also be impacted.

Until today the above stakeholders had almost no need to set and control performance indicators related to passengers. The reasons are twofold: they do not have direct commercial relationships with the end-user and they provide service to airlines and monitor system-wide performance mostly through aircraft based indicators. Exploring the need for adjusting current statistics to the new regulatory requirements will require new research.

The present study is the result of a collaboration between Eurocontrol and a European Airport. The aim is to identify the main similarities and differences between aircraft or flight-based performance indicators and actual passengers perception.

This report presents an exploratory case study developed at a Southern European airport. Annual traffic exceeds nineteen million passengers and over two hundred thousand aircraft operations. Passengers origin and distribution is mainly domestic and European Union short-haul, whereas non–EU traffic represents only 9% of the total. Ninety-five per cent of passengers fly on scheduled flights. Transfer passengers account for 15% of total traffic. Given the airport current profile, the majority of the passengers are carried in C class aircraft, such as MD80s and A320s.

An open methodology for the project execution was adopted to tackle this new area of investigation. The aim was to obtain factual conclusions whilst gaining an analytical understanding on passengers’ expectations and perception of delays as well as their current forms of measurement. Deliberately, delay sources analysis and passengers’ behaviour investigation were kept to the minimum. Instead, infrastructure/service provision links with passengers were explored in more detail, with a framework formulation that took into account consistently the network and processes analysis, the different agents (aircraft operators, airport, ATC, handling agents) relationship and passenger behaviour up to a point. The scope of the study includes both the departure and the arrival processes.

Results

Results presented in the report are statistically representative. They cover a three week summer period in 2001 of a single node of the European airports network. The project main findings are briefly discussed in the next paragraphs and fully developed in the main report.

I. Punctuality is a key attribute for the Passengers:

- On a ten-point preference scale, importance placed on delays averages seven point seven (7.7 out of 10). Thirty five percent of passengers placed high emphasis on delays with a score of 10.

- **Arrival delays** are quoted to be twenty per cent more important to the passenger than departure delays (fig. 1).

![](image)

*Figure 1 Impact of delay on passenger (% of pax that rank 9 or 10)*

- Passengers’ expectations are independent of the trip chain organisation. Passengers do not care about the sources of delays or how production takes place. Expectations seem to be established rationally. Passengers are concerned by curb-to-curb punctuality and also by each step of the trip chain. For example, passengers flying through a hub airport with connecting flights are more concerned about arrival delays than passengers on a one-leg trip.

- Passengers expectations are updated during the travel journey. Once a passenger learns that he/she is delayed, he/she increases the importance of delays from 7.7 to 8.6 out 10. When a passenger arrives in a delayed flight, he demands a thirty five per cent faster airport processing time than when he/she arrives on time.

II. In the present case study outbound overall ground delays and inbound arrival delays, which can be taken as a good estimate of passengers’ perception, were pervasive:

- Seventy five percent of passengers were affected by outbound overall ground delays, with an average perceived delay of eighteen minutes.

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2 4.685 scales analysed (92% of total period scales)
3 **Outbound overall ground delay** is defined as the difference between Actual Off-Block Time AOBT (measured by the airport or estimated by Eurocontrol) and Scheduled Time of Departure SOBT (from published timetables)
4 **Inbound arrival delay** is defined as the difference between Actual In-Block Time AIBT (measured by the airport or estimated by Eurocontrol) and Scheduled Time of Arrival SIBT (from published timetables)
- **Fifty four percent of passengers were affected** by inbound arrival delays, with an average perceived delay of **nineteen minutes**.

**III. Airlines** are mainly responsible of overall ground delays, although infrastructure/service providers also play a significant role:

- Among infrastructure/service providers, **ATC delays only account for a small portion of delays** perceived by passengers: while only 17% of outbound flights had an ATC delay, 72% of the flights suffered an overall delay; and 70% of long delay situations correspond to non ATC delayed flights.

- The Service Level Agreements with **Handling agents** do not fully capture the real needs for the passengers. For example, a number of SLA are governed by a probabilistic commitment (baggage have to be delivered within a defined time after On Block Time on 95% of the flights; when a given flight exceeds a certain delay threshold and the handling agents resources are not available anymore, it is not rare to see that this flight is considered to be within the 5% of admissible non compliance and there are disincentives to find a way to recover parts of the delay or process faster the flight; this results in a phenomenon which is well known to a number of passengers by which an already delayed flight faces even more delays in the ground processing chains).

- Among other practices, **Airlines** do not appear to schedule systematically realistic times for turnaround processes: too strict lead times generate a high probability of ripple effect. For example, figure 2 illustrates the aircraft turnaround scheduling linkage to delays. It shows that aircraft that have higher scheduled turnaround have higher probability of recovering delay.

![Figure 2 Impact of scheduled turnaround on recovering delay (outbound flights with no ATC delay)](image-url)
IV. Aircraft-based delay indicators are sufficient and not biased to capture passengers delays:

- 72% of outbound flights were delayed, affecting 75% of passenger. The average delay was 13’, calculated both taking into account aircraft and passengers.

- Among the delayed flights, the average delay was 19’ from aircraft point of view and 18’ from passenger point of view.

- 25% were long-delayed flights (with more than 15’ delay), affecting 26% of passenger. In terms of average delay, 41’ from aircraft point of view and 39’ from passenger point of view.

V. CFMU delays provide a non accurate estimation of overall delays perceived by passenger:

- In 10% of the flights initial off-block time do not match with scheduled off-block time (airlines are the source of non-reliability).

- Actual off-block time is statistically calculated from actual take-off time, including therefore perceived take-off delay and Airport sources of non reliability (take-off measurement and rolling estimation).

- As a result, Eurocontrol is missing 24% of the delays, with estimation of long delayed situations looking 30% less serious than those perceived by passenger (fig. 3).

- However, Eurocontrol’s current balanced score card is comprehensive, so it would not be difficult to improve passengers’ perception measurement by incorporating more accurate existing information sources (from airlines and/or airports) to the current database.

<table>
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<th>% of delayed pax</th>
<th>Min. (flights delayed more than 15’)</th>
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<td>Airport estimation</td>
<td>Eurocontrol estimation</td>
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<td>55%</td>
<td>Airport estimation</td>
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Figure 3 Airport Authority vs. Eurocontrol estimation of overall ground delays perceived by passenger
Summary and Conclusions

Case study conclusions can be summarized in the following seven points:

- Delay conditions were **pervasive** in the case study period
- **Airlines** were the main agents responsible for delays
- **Punctuality is a key** attribute for the passengers
- Industry agents do **not** assess passenger delays **homogeneously**
- Currently Eurocontrol indicators **focus on ATC** performance management but they could be **extended** to monitor passengers' perceptions
- “Curb-to-curb” punctuality can be improved by using **standardized indicator scorecard**

Eurocontrol's reliability and objectivity on the processing and monitoring of delays indicators are recognized by all industry actors: making use of the enhanced information flows gained through the implementation of CDM network in pilot projects (Barcelona and Brussels), the Agency could assess the opportunity of further exploring how to implement an indicator scorecard which contributes to capture passengers-based performance indicators.
1. Project Background

1.1 Industry environment

“Placing users at the heart of the transport policy” is one of the key actions proposed by the White Paper of the Commission of the European Community. Among other measures, “The Commission’s aim over the next ten years is to develop and define the rights of users”. In the short term, the Commission intends to:

- Increase air passengers existing rights through new proposals concerning in particular, denied boarding due to overbooking, delays and flight cancellations

- “Put forward a regulation concerning requirements relating to air transport contracts”

Developing such policies requires an important effort by all parties involved. Implementation is likely to have an impact not only on the transport operators and its clients but also in infrastructure and service providers.

Any work trying to establish the nature of these efforts, such as this report, must first set up a clear scenario of the implicated parties. In the next paragraphs, a brief synthesis of the main actors and agents are presented:

- Airlines are the main agents of the air transport operation. They are the main link to the end-user both in terms of commercial relations and operation activities. They are responsible for structuring air services (routes and schedules), setting up transport contracts with the passengers, organising operations, specifically related to the aircraft and crews, and also arranging/subcontracting all the support activities in airports such as passenger and aircraft handling. Although national flag carriers are exposed to increased competition, they prevail in most internal markets in Europe.

- Airports and both National and European Air Navigation Authorities are the main suppliers of operational services to the airlines. They have limited contact with the passenger but their activity has an important impact on the quality of service delivered to him/her. Passenger and aircraft tariffs collected by airlines are their main source of revenue.

- The Airports’ main function is to assist airlines in their ground operations. Traditionally airports authorities have developed all airport infrastructures: runways, terminals and land facilities. However, airport management is very different throughout Europe. Airport and air navigation services may be delivered by separate or joint organisations. Airport owners can be local, regional or national operators and could be both state owned or privately held. There are also differences on how the ground services are provided. They could be provided through handling agents, subcontractors or internal departments of the airports. Even the relationship between airports and airlines are structured differently throughout Europe.

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- National **Air Navigation Authorities** are in charge of delivering air traffic control services. Current organisation and regulation also varies throughout Europe. **Eurocontrol** is responsible for the co-ordination and management of air traffic flows.

According to the Commission’s proposals, airlines will be mostly affected by the short-term measures, eg publishing a classification of airlines according to their performance (or lack of performance) in terms of punctuality, number of passengers denied boarding, baggage loss levels,…to give users objective criteria for comparing the various airlines and this transparency will without any doubt be the best way of putting pressure on airlines to improve their services. Service/infrastructure providers to airlines will also be influenced twofold: information provision into regulators and improvement of their own performance.

Service delivered onto the passenger suffers of an intrinsic problem of **supply fragmentation** that becomes very real when one decides to promote passenger rights or industry performance improvements. The different actors of the industry have strong incentives to behave with the typical stereotypes: “pass on the puck”, “it is not my fault”, “you should be fixing your bit”, “it is the system fault”, and so on. As no agent has complete control, everybody tries to optimise its own portion of the air travel chain. This situation is particularly pervasive in scarcity of resources (aircraft are optimised by airlines, runways and terminals by airports, and airspace by air navigation authorities). It is also worsened by the fact that releasing resources constrains is not easy.

One could argue that airlines are already taking care of their customers. Among all the players mentioned earlier, airlines are probably the best positioned to have a clear view of the overall needs, and the service currently delivered to the passenger. However, government bodies and not airlines are promoting passenger rights and system-wide increase in performance. This is a natural situation in regulated markets where public service requirements need to ensure the general economic interest besides considering commercial interests.

Service/infrastructure providers to airlines have had almost no need, until today, to set and control **performance indicators related to passengers**. The reasons are twofold: they do not have direct commercial relationships with the end-user; and they provide service to airlines and monitor system-wide performance mostly through aircraft based indicators.

In this context, setting up measures to ensure and enforce passengers’ rights will require agreement by all involved parties. Partial knowledge and the information held by each agent has to be unified into an overall view of the air travel chain, from the beginning to end with the passenger’s perspective in mind. Performance indicators used by each agent have to be reconciled to the gain a true understanding of expectations, targets and actual service delivered to passengers. Establishing a common problem understanding is the first step towards putting the passenger at the centre of the industry’s action plan.

Up to now information on this subject is scarce and scattered. Limited work has been undertaken and not many references exist today. The present Project tries to contribute to the overall definition and understanding of the current status, what does it mean and what are the implications of incorporating the passenger’s view into performance indicators that monitor the air transport industry in Europe. This report specifically deals with the issues that concern “delay”.
1.2 Purpose of the study

The present Case Study is a collaboration between Eurocontrol and an European Airport. The aim of this study is to:

- Improve the knowledge about passengers’ delay expectations and passengers’ delay perception, and
- Identify the main similarities and differences between aircraft or flight-based performance indicators and actual passengers’ perception.

1.3 Local conditions

The Case Study has been developed at a single node of the European airports network, with an annual passenger traffic of over nineteen million. Figure 4 illustrates passenger distribution. Air traffic and infrastructure/service conditions can be summarized as follows:

- Passenger distribution by origin and destination are predominately domestic and European Union short-haul, with Non-EU traffic representing only 9% of the total. More than half of passenger traffic is domestic. The studied Airport does currently enjoy the benefits of a hub, as transfer passengers represent 15% of the total.

- Given the Airport’s current profile as a predominately domestic and short-haul airport it is not surprising that the majority of passengers are carried in C class aircraft such as the MD 80 series. Indeed, 83% of all aircraft movements are class C, with 12% being domestic feeder flights in smaller class B aircraft such as SAAB 340. The small proportion of class D and class E aircraft (5%) reflects the lack of long-haul flights.

- More than 95% of the passengers fly on scheduled flights. This high proportion is due to the routing of inbound charter flights to neighbouring airports which are located close to package holiday resorts. In addition, the majority of outbound package holidays are carried on scheduled current domestic carriers.

- The considered Airport is dominated by the national flag carrier, which carries more than half of the passengers. None of the foreign national carriers have currently more than a 3% share of passengers.

- The main handling agent is part of the main flag carrier group, and attends both flights from its group (self-handling) and flights from other companies. The second handling agent in importance is a third party agent, while the third and last agent is an autohandling agent.

- The existing runway configuration and certain areas of the existing Terminal are currently approaching saturation at peak hours due to strong demand growth. Airport processes present an important degree of complexity.
Analysis of Passengers Delays: An Exploratory Case Study

Figure 4 Traffic distribution at the studied airport

6 (*) Source: Annual statistics, studied Airport
(**) Source: Field work, 5,072 scales from 30/07/2001 to 17/08/2001
2. Methodology

2.1 Case study development

The project has been structured into five activity blocks, as shown in figure 5:

![Figure 5 Case study development](image)

2.2 Basic framework

A detailed methodology has been developed to allow a complete picture of ATC and Airport processes, focusing on passengers delays. Delay models have not been considered. The basic framework formulation has taken into account consistently:

- The **processes** and the different agents relationship (airlines, airport, ATC and handling agents).
- The **passengers’ behaviour**: the linkages between **passengers’ delay expectations** and **passengers’ delay perceptions**.
- The **indicators** used to measure passengers’ delays.

**Processes**

The main aim of the study of processes is to understand what agents do throughout the travel chain, what is their partial behaviour in each subprocess, and what is their overall performance.

The scope of the study includes both the **departure** and the **arrival** processes. These processes were thoroughly analysed incorporating the passenger, aircraft, airport and ATC’s points of view. The **turnaround process** has been partially studied.
Passengers' behaviour

Passengers' behaviour concerning delays can be understood by studying and comparing their delay expectations and their delay perceptions:

- **Passengers' delay expectations** can be defined as the level of service which passengers would like to receive.

- **Passengers' delay perceptions** can be defined as the level of service that passengers perceive that they have received.

Passengers form their delay perceptions throughout their journey:

- **Overall extended delay**, is understood as the difference between passenger actual and expected time of leaving the destination airport, after all the ground and air processes are executed. Different metrics such as curb-to-curb or door-to-door indicators can be used to assess this concept.

- **Overall delay** can be defined as the comparison between published scheduled times of departure and arrival with actual times of departure and arrival.

- **Partial delay** can occur at any link of the trip chain, even if they will not affect the overall performance. Partial delays may have a significant impact on the passenger experience. Those delays are difficult to measure, and its management can be done by local agents.

- Airport infrastructure processes and airlines procedures at both the Terminal and the aircraft can result in substantial different sub processes lead-times. **Variability of lead times** add noise to how passengers appraise delays.

Delay indicators

Under such changeable conditions, the passengers’ perceptions of delays could be subjectively formed, and as a consequence, passengers’ delay perception has to be measured with some form of convention in order to obtain objective appraisals.

Among the different delay estimations, two indicators are good to focus on main passengers' delay perception, because they are available to both passengers and industry agents: **outbound overall ground delay** and the **inbound arrival delay**.

The **outbound overall ground delay** is defined as the difference between Actual Off-Block Time (AOBT) and Scheduled Time of Departure (SOBT). AOBT corresponds to chock-off time. Airlines and handling agents have the best estimation of this parameter; in this case study, Airport can estimate it by visualizing the aircraft push-back; Eurocontrol can calculate it as a difference between actual take-off time (from FSA message) and statistically generated rolling time; and, finally, passengers can estimate it when they realize that the aircraft is moving.

SOBT is a scheduled time published in public and commercial timetables. Passengers have it printed in their ticket, and it is also available from the Airport monitoring system. At present time, it is not available from CFMU information systems. Eurocontrol can estimate it from the Initial Off-Block Time (IOBT) included in the flight plan issued by the airlines.
The **inbound arrival delay** is defined as the difference between Actual In-Block Time (AIBT) and Scheduled Time of Arrival (SIBT). At present time, *Eurocontrol* does not manage this indicator. AIBT corresponds to chock-on time. *Airlines* and *handling agents* have again the best estimation of this indicator. In this case study, the *Airport* calculates it by adding to the actual landing time (from FSA message) the taxiing time; *passenger* can estimate it as the moment when the aircraft stops its engines.

Both SOBT and SIBT is a scheduled time published in public and commercial timetables. *Passengers* do not have it printed in their ticket, but this information is easily available from any agent involved in the trip chain (airlines, airport, travel agencies,...). In fact, SOBT and SIBT are used by most of the airlines as a contractual reference when managing passengers’ complains.

In this case study, the **extended overall delay** has been defined by the overall delay plus statistically generated walking times in the terminal and baggage reclaim times (for those passengers with bags). Times to access ground transportation modes (train, frequency, taxi queues,...) have not been taken into consideration.

**Key parameters** have been established for each of the studied processes: *departure subprocesses*, *arrival subprocesses* and *turnaround*. The selection of those parameters has been done in a way that they bring together the customers’ perception of the delay and its impact on the internal control of operations into a single data point. A description of the parameters established can be consulted in annex 1.

### 2.3 Database compilation and reliability

The information currently available from *Eurocontrol* and from the studied *Airport data bases* has been reviewed. Field work has also been undertaken in order to complete informational gaps for developing the data base. *Field work* was basically focused on incorporating the passengers’ perceptions and the passengers’ expectations into the data set.

A **three-week Summer period**, from 30th of July to 17th of August, was used to study the air traffic movement at the Airport. During this period, 5.072 scales took place at the Airport, amounting to 850.000 passengers. The key parameters of those scales have been obtained from both Eurocontrol and Airport databases. The debugging process completed and contrasted a data set of 4.685 scales, which represent 92% of the operated scales during the considered period.

The reliability of the debugging process has been guaranteed by the accurate analysis of the principal aircraft parameters of the database. Each flight is identified by just one number that is the date of the flight, the aircraft company code and the flight number (choosing inbound or outbound flight number depending on each case). This key-parameter was unique for each flight and is the connection parameter of all the databases. In addition, origin city airport was also verified. Finally, it was guaranteed that non duplicity of flights by using departure time to identify possible flights with shared code occurred.

The field work was carried out to measure the objective times that were not available from the previous databases. The data collection during the studied three weeks period was organized in the following way: at the beginning of each day, a sample of flights was...
selected from to the airport flight schedule. In order to have a reliable\(^7\) sample (global sample error target less than 10%), the selection was done using the following criteria:

- Regular flights with more than 100 seats (excluding the air shuttle service, service with particular procedures and with only a few passenger with luggage). The resultant sample represents 64% of the scales, and the 84% of the passenger.
- A minimum of 12 scales per day.
- The field sample mix of handler agents (three different agents operating at the studied airport), kind of traffic (domestic, UE and non-UE), ramp position (finger, remote) and airlines was kept similar to the overall traffic mix.
- The daily traffic profile, eg. hub windows.

The data were collected by four co-ordinated teams placed at strategic positions:

- Two teams were in charge of processes related to aircraft. They were placed at remote positions (one at the Airport Operational Center, where there were cameras filming the arrival and the turnaround process; and another at the boarding gate, were observers tracked the departure process)
- One team was in charge of arrival, turnaround and departure processes related to aircraft placed at finger positions
- One team was in charge of baggage arrival processes and was placed at the air side of the baggage belt

This enabled us to fully study 183 scales, with a 7% global sample error. Even when the scales were broken up by ramp position (aircraft standing at finger and remote positions), the reliability of the data was acceptable (9% finger sample error and 11% remote sample error). In addition, full data on the baggage claim process was collected from 42 additional flights.

Although the initial scope of the study did not consider the measurement of passenger expectations, additional field work was conducted from 28\(^{th}\) of August to 5\(^{th}\) of September to incorporate this information. The goal was to estimate the match of current industry practices with passenger expectations by comparing the actual agent performances throughout arrival processes with passenger arrival expectations. This is defined as their expected time of leaving the Airport. So the question “when you left home, at what time did you expect to take the taxi/train/bus in your destination Airport?” was answered by 199 arrival passengers at the baggage claim lounge, corresponding to 44 different flights (half of them delayed), with an estimated 7% sample error.

\[^7\] Error approximated by:

\[ n = \frac{k^2 \cdot p(1-p) \cdot N}{((N-1) \cdot e^2 + k^2 \cdot p(1-p))} \]

\(n\) = size of the sample  
\(N\) = population (flights or passengers)  
\(p\) = minimum percentage of successes; adopted 0.5  
\(e\) = sample error  
\(k\) = confidence level; adopted 1.96 (95%)
The relevance of these results, concerning both the passenger awareness of the arrival scheduled time and the clear correlation between his/her expectations with the delay of the flight, led to expanding the interviews to an additional two-day field work (1st and 2nd of October), to focus only on the departure passengers, in order to avoid any kind of subjective component related to the passenger’s previous experiences throughout his/her trip chain.

A total of 583 passengers, corresponding to 95 different flights, were interviewed at the departure lounge (reliability of the sample: 4% error). The following questions were asked:

- “At what time was the plane scheduled to open exit doors at your destination airport?”, this question gave us an understanding of the degree of the passenger’s awareness of the arrival schedules.
- “At what time did you expect to take the taxi/train/bus in your destination Airport?”, to estimate the passenger’s expectations on the airport arrival processes performances. The difference between these two times is the time they expect to spend at the Airport.
- “Score from 1 to 10 (10= very serious) how serious you consider a departure delay at the origin airport” and “Score from 1 to 10 (10= very serious) how serious you consider an arrival delay at the destination airport” to estimate the impact of both delays on the passenger perception.

The sample of passengers was balanced according with the size of the destination airport: approx. 50% hub airports and 50% regional airports. The outbound flights were fully identified (date of the flight, airline code and flight number, destination, scheduled time of departure), and the actual time of departure and the flight duration were imported from Airport and Eurocontrol databases. The devised database took into consideration the following data groups:

- Passenger:
  - With luggage
  - Without luggage

- Flight parameters:
  - Destination airport: hub, regional
  - Destination airport: domestic, non-domestic
  - Flight length

- Time fence:
  - Morning
  - Evening

- Delay information:
  - Aware passenger
  - Non aware passenger
2.4 Analysis

Once the devised data base was completed, analysis were carried out to study the passengers’ perceived overall departure and arrival delays, and their expectations and perceptions throughout the ground processes chain. Overall delays have been analysed as well as ground partial delays, taking as a reference the Airport Service Level Agreements (SLA) reached with the handling agents.

The analysis covers the interaction among the following parameters:

- Flight parameters:
  - Ramp position: finger, remote
  - Origin/destination airport: domestic, UE, non-UE
  - Length of the scale
  - ATC regulation
  - Delay

- Handlers:
  - Self-handling
  - Handling to third parties

- Aircraft:
  - Seats
  - Baggage: bulk, ULD

- Passenger:
  - With luggage
  - Without luggage

- Time fence
3. Main findings and Results

The main findings of this project can be summarized as follows:

- **Punctuality** is a key attribute for the Passengers

- In the present case study **outbound overall ground delays** and **inbound arrival delays**, which can be taken as a good estimate of passengers’ perception, were pervasive

- **Airlines** are mainly responsible of overall ground delays, although infrastructure/service providers also play a significant rôle

- **Aircraft delay indicators** are sufficient and not biased in capturing actual delay

- **Eurocontrol’s current sources of information** provide a non accurate estimation of overall delays perceived by the passenger

While the first main finding is related to **Passengers’ delay expectations**, second and third statements refer to **Passenger’s delay perception**. Finally, the two last findings correspond to **Passengers’ perception measurement**. These three main sections are used for developing the study’s results.

3.1 Passengers’ delay expectations

The results obtained from the departure passengers’ responses at the departure lounge show the importance of **punctuality**. Both departure and arrival delays are important attributes of the trip chain: on a ten-point preference scale, importance placed on delays averages 7.55 (departure) and 7.81 (arrival), with 43% (departure) and 51% (arrival) of the responses scoring seriousness of delays 9 or more. Passengers, once they arrive to the departure airport, are more worried about **arrival delays** (20% of difference) than departure delays (fig. 6):

![Figure 6 Importance of delay on departure passenger (ten-point preference scale)](image_url)

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8 **Outbound overall ground delay** is defined as the difference between Actual Off-Block Time AOBT (measured by the airport or estimated by Eurocontrol) and Scheduled Time of Departure SOBT (from published timetables)

9 **Inbound arrival delay** is defined as the difference between Actual In-Block Time AIBT (measured by the airport or estimated by Eurocontrol) and Scheduled Time of Arrival SIBT (from published timetables)

10 Reliability of the sample: 4% error
This aggregate value can be split up into various groups of analysis: by destination airport (hub or regional), by flight (domestic, non domestic), by time fence (morning, evening), by baggage claim (with luggage, without luggage), and by awareness of departure delay at the time of the interview (aware passenger, non aware passenger). In all the above groups of analysis studied, passengers are more sensitive to arrival delay compared to departure delay.

The importance given to punctuality is also illustrated by the following fact: passengers that were unaware of any delay on their flight ranked 7.3 the importance of departure delay, while passengers that already knew that their flight was delayed ranked 8.5, this is an increase of 16%.

The results also show that passengers’ expectations are independent of the travel chain organisation. Passengers do not care about the sources of delays or how production takes place. Expectations seem to be established rationally and formed in relation to passenger needs (fig. 7):

- Passengers flying through a hub airport are more concerned about arrival delays than passengers on a one-leg trip.
- Passengers flying with luggage are more concerned for arrival delays than passengers without luggage.
- Passengers with non domestic destinations are more concerned for arrival delays than passengers on a domestic flight.

The analysis of the field work concerning arrival passengers also show how passengers update their expectations depending on their journey experience. The interviewed passengers were already on the last link of their trip chain, waiting for baggage claim. Almost half of them had suffered a delay on their flight. Delayed passengers are 35% more demanding on faster airport processing time than passengers that arrive on time (fig. 8).

17 Reliability of the sample: 7% error
Passengers’ expectations on **Airport arrival processes performance** were studied in more detail. In order to avoid any kind of subjective component related to their previous experiences throughout their trip chain, the study focused on departure passengers. It was found that the time they expected to spend at the destination airport (calculated as a difference between their expected time of leaving the terminal and their expected time of arrival at the airport), has the following values:

- 95% of departure passengers expected to spend at the destination airport not more than 30’ from the flight arrival, with an average expected time of 17’.

- Splitting up the total sample into passengers with destination to large/hub airports and to small/regional airports, it was possible to measure the knowledge of airport processing, as the average expected time is 19’ for the first group and 14’ for the second one: passengers with destination to regional airports are more demanding.

- Splitting up the sample of passengers with destination to hub airports into passengers with luggage and passengers without luggage, the average expected time is 21’ for the first group and 9’ for the second one.

The case study shows that **level of satisfaction of passengers’ expectations** on curb-to-curb performance is heavily influenced by arrival performance at the airport:

- 40% of first passengers disembarked without bags at finger positions and 50% at remote positions perceive overall delay.

- Last passengers to be disembarked receive better service at remote parking than contact stands (61% vs. 73% unsatisfied passengers without bags).

- When baggage reclaim is taken into account, 64% of passengers travelling with bags perceive extended overall delays. If last bags put into belts are measured only 14% of passengers are fulfilled to their expectations.

These statements and figures have to be carefully managed. Passengers do not seem to have full information of the trip chain events. While most of them know the scheduled departure time, this case study unveiled the **current level of unawareness of the arrival time** (fig. 9). As a result, curb-to-curb passenger expectations need to be filtered with reasonable assumptions.
Two reasons could explain this unawareness: on the one hand, passengers do not always have in their hands the scheduled arrival times, although it is published and they have access from different public sources (travel agencies, airport, airlines,…), and, on the other hand, even if they have this information they generally cannot relate it with the events at destination (landing, taxiing, docking and disembarking…).

The low level of satisfaction of passengers’ expectations can also be explained because passengers are quite demanding on airport processes as seen in figure 10, where target operational values at the studied Airport12 are compared with the passengers expected time to spend at the destination airport:

---

12 Reasonable operational values at the studied Airport:

- Passenger without baggage:
  - 10’ to 15’ (finger positions)
  - 15’ to 20’ (remote positions)

- Passenger with bagage:
  - 25’ to 35’
3.2 Passengers' delay perception

Overall delays

Outbound overall ground delay (defined as AOBT-SOBT) and inbound arrival delay (defined as AIBT-SIBT) are two indicators that can be taken as a good choice to measure passengers’ delay perception, because they are manageable by both passengers and industry agents. In the present case study, outbound overall ground delays\(^\text{13}\) and inbound arrival delays\(^\text{14}\) were pervasive (fig. 11):

Figure 11 Departure and arrival punctuality performance from passengers’ point of view

Among infrastructure/service providers, ATC delays\(^\text{15}\) only accounted for a small portion of delays perceived by passengers: From the analysis of Eurocontrol and Airport database the following assessments could be made:

- Only 17% of outbound flights had an ATC delay, with a 3’ average ATC delay among the overall sample of outbound flights. Using the same sample, the average outbound overall ground delay was 13’.

- 70% of long delay situations correspond to non ATC delayed flights. Among the ATC delayed flights, the average ATC delay was 21’, while the average outbound overall ground delay was 38’.

How these objective measurements were translated into the passenger perception is another matter. As delay communication processes/information onto the users is not standardised, passengers are not necessary aware of the source of delays.

Travel chain

Passengers perceive many partial delays, affecting or not affecting the overall perception, which can occur at any link of the chain. Those delays, mostly non measured and even non measurable, can have a significant impact on the passengers experience.

\(^\text{13}\) Calculated from Airport database
\(^\text{14}\) Calculated from Airport database
\(^\text{15}\) ATC delay is defined as the difference between Calculated Off-Block Time COBT (issued by CFMU) and Estimated Off-Block Time EOBT (issued by the airlines).
The main origin of partial ground delays is focused on the variability of airport infrastructure and processes, and airlines procedures at the terminal and at the aircraft. These delays imply substantial differences of lead times, either throughout the arrival processes or departure processes: Did passenger know if disembarking would be through a remote position? (disembarkment processes lead times are quite different from finger position); Did passenger with luggage know what kind of aircraft would he/she fly in? (the size of the aircraft, the kind of flight –charter flight, hub operation,…–, the storage system –ULD or bulk–, and the handling agent – auto-handling or third parties agents– those factors have direct impact on the passenger’s waiting time at baggage claim station). Such perceived variability is pointed out using several examples in figures 12 and 13, below the figures illustrate the difference between the fastest and the slowest performance in various departure and arrival subprocesses, measured from the field work.

The variability in lead times shown in figure 12 and 13 does not allow departure passenger to schedule precisely his arrival at origin airport and its trip from arrival airport to final destination. This factor influences heavily on the perception of curb-to-curb service. It also would have a strong impact in trying to develop curb-to-curb performance metrics.

### Average processing lead times (1)
- Boarding call
- Loading first bus
- First passenger on board
- Last passenger on board

### Variability of processing lead times (2)
- Boarding call
- Loading first bus
- First passenger on board
- Last passenger on board

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<tr>
<td>Boarding call</td>
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<td>-5</td>
<td>+10</td>
<td>+25</td>
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<td>Loading first bus</td>
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(1) ALG estimation based on airport process knowledge
(2) Field work statistical results

**Figure 12** Departure passenger processes time at remote stands
Partial delays associated to lead time variability may not impact overall delay. However the passenger experience is compromised as passenger do not receive a consistent service. When looking from the passenger’s point of view, it is difficult to understand why there is such variability in waiting time once seated inside the aircraft before push back (50’ difference for first passenger on board and 40’ difference for last passenger on board, as shown in figure 13). Is there any problem in my flight? Why can’t I wait at the Terminal, instead of waiting in the aircraft?

Departure passengers do not know if those partial delays will affect the overall delay, arrival passenger are more sensitive to partial delays throughout the disembarkment and baggage claim processes. At this last step of the trip, passenger with luggage, it can be immediately translate partial delays into overall extended delay perception from their point of view.

This large variability observed in lead times and the importance of partial delays does not mean that the involved parties do not perform according to their business targets. What occurs is that their fragmented targets / information throughout the trip chain translates into poor overall service level to the passenger.

**Airlines are mainly responsible for ground delays.** Airlines are the main reference in scheduling the aircraft trip chain and times of processes. They even define the procedures which will be used by handling agents to perform the different processes. In the present case study, we found that handlers behaved according to contracts established with airlines rather than Service Level Agreements established with Airport.

Among other factors, this study has substantiated two main areas of improvement:

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**Figure 13 Arrival passenger processes times at remote stands**

<table>
<thead>
<tr>
<th>AIBT</th>
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<tr>
<td><strong>Average processing lead times (1)</strong></td>
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<tr>
<td>Chock-on</td>
</tr>
<tr>
<td>Stairs positioning</td>
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<tr>
<td>Bus ready to embark passengers</td>
</tr>
<tr>
<td>Bus loaded to leave to terminal</td>
</tr>
<tr>
<td>Bus arrival to baggage reclaim</td>
</tr>
<tr>
<td>First and last bag on belt</td>
</tr>
<tr>
<td>Dolleys unload</td>
</tr>
<tr>
<td>Total passenger without bag</td>
</tr>
<tr>
<td>Total last passenger with bags</td>
</tr>
</tbody>
</table>

| **Variability of processing lead times** |
| Chock-on | -4 |
| Stairs positioning | -1 |
| Bus ready to embark passengers | -4 |
| Bus loaded to leave to terminal | +6 |
| Bus arrival to baggage reclaim | -13 |
| First baggage on belt | -16 |
| Last baggage on belt | -9 |
| Total passenger without bags | -9 |
| Total last passenger with bags | +24 |

(1) Field data processing
- Build in slack capacity to allow lead time corrections inside the commercial schedules which relaxes the fleet management targets
- Information and control of ground processes, eg. information systems with shared real time information, to ensure that processes performed by different agents are properly integrated

_Aircraft turnaround scheduling linkage to delays_

Current scheduled aircraft turnaround time at the studied airport are very tight: 50% of the scales have a scheduled turnaround lower than 50', and only in a 9% of the cases the scheduled turnaround is higher than 100'. Although airlines have special procedures to make up reactionary delay by reducing aircraft attention, lead times which are too strict generate a high probability of ripple effect, as illustrated in figure 14:

*Figure 14 Impact of scheduled turnaround on recovering delay (outbound flights with no ATC delay)*

Scheduled turnaround profile of delayed inbound flights has been split up into flights that succeeded in recovering the whole delay, and flights that did not recover the arrival delay during their turnaround process. In order to avoid ATC implications, only outbound flights not affected by ATC delay have been considered. Results show that:

- Only 18% of the inbound delayed arriving flights recovered their whole delay for the subsequent rotation. The difference between scheduled turnaround and actual performance was 17%.

- Within the rotations that succeeded in recovering the whole arrival delay, only 34% of them had a scheduled turnaround lower than 50', and 29% of them had a scheduled turnaround higher than 75'.

- Comparing those figures with the rotations that did not recover all the arrival delay, 48% of them had a scheduled turnaround lower than 50', and only 19% of them had a scheduled turnaround higher than 75'.

- Focusing on the group of scales that did not recover all the arrival delay, the analysis also shows that the delay was even increased during rotation in the group of scales with a scheduled turnaround lower than 50': a 10' average increase for scheduled turnaround of 30' (37% increase), and a 10' average increase for scheduled turnaround from 31’ to 50’ (11% average increase).
Therefore, results show that only by scheduling realistic rotation times it is possible to reduce reactionary delay with adequate management of the turnaround process. If airlines define lead times too strict, even with special procedures, it will not be possible to recover the inbound flight arrival delay.

**Ground processes performance**

The study has found that there is room for improving ground process (passengers, bags and aircraft), especially in delay conditions. Handling agents would provide a better service if they followed passenger needs but not contract rules; and if they scheduled their current work force with flexibility for allowing delay situations.

*Why do handlers not follow passenger needs but contract rules?* There is a twofold explanation, one is related to current established Airport SLA, and the other to the airlines’ commitments with other agents, such as passengers, Airport and ATC.

In this case study, current Airport SLA reached with handling agents are mainly based on the assumption that handler’s performance is accepted if the 90-95% of the situations complies with the agreed level. This can also be read in the following terms: handler’s performance is accepted even if the bottom 5-10% is very poor. And, according to airlines’ commitments with other agents, delays under 15 minutes are commonly accepted.

Figure 15 shows the impact of those statements on handling agents’ performance, focusing on the turnaround process of scales with an outbound overall ground delay that is not affected by an ATC delay. The graph shows that performance of turnaround, corresponding to long delayed arrivals, is worse than the one corresponding to short delayed inbound aircraft. Whereas in the former delays increase 10’, the later reduce delays 6’. This is due to the above reasons.

![Figure 15 Impact of contract rules on handlers’aircraft rotation performance](image)
In order to improve their operational performance during delay situations, handling agents should operate using special scheduling plan developed for critical situations. The current task force is scheduled following the aircraft ground attention demand profile. Figure 16 outlines the current scheduling procedure for the main operator at the studied Airport.

The work force values are illustrative. According to the daily profile of ground attended flights, handling agents define a base-line work force that must be adjusted for a few hours in different parts of the day. The peak adjustment for the work force is contracted the day before, so that no information about delays is known when contracting. The current procedure leads to a valley at the right of the hub window, from approx. 9h 45’ to approx. 10h 15’, during this valley all flights are attended only by the baseline work force. The analysis carried out show that these resources are not sufficient to manage a long delay situation from both the left side (delayed flights) and the right side (anticipated flights) of the valley. Looking to handling agent’s performance while executing the baggage claim process, measured as the difference between the last baggage on belt and the actual in-block time, it is shown that:

- 46% of the bottom 10% performance corresponds to flights with actual in-block time within the time fence 9h 45’ – 10h 15’. Among them, 83% of the inbound flights with delay/advance of more than 15’.

- 71% of the bottom 5% performance corresponds to flights with actual in-block time within the same time fence. All of them were inbound flights with long delay situations, both delayed or anticipated.

This situation could be minimized by scheduling the work force with more flexibility, what could be achieved by increasing the peak hours man power or with a more generous baseline work force.

Figure 16 Current handling work force scheduling procedure (main operator)
3.3 Measurement and indicators assessment

Delays perceived by passenger may be divided into two main groups, as shown in the previous section:

- Partial delays, either with or without impact on overall perceived delay (eg. waiting for push-back after last passenger in plane) or with impact on overall extended delay (eg. waiting for baggage delivery at baggage claim lounge)

- Overall delays can be measured by using indicators manageable both by passenger and industry agents, as published scheduled times of departure and arrival

The measurement of the first group of delays implies basically the use of partial indicators and the implementation of a monitoring system at the Airport. This monitoring system must be aligned with the Service Level Agreements reached among airlines and handling agents.

Current Delay Monitoring Systems (DMS) are prepared to measure overall delays, that as shown in the last section can be defined as outbound overall ground delay for departure flights and inbound arrival delay for arrival flights. But DMS overall indicators are currently based on aircraft or flight performance rather than passenger, and do not take into account other parameters such as the number of passengers per flight and so on.

Within this case study, the error of calculating passenger’s delay perception has been calibrated only by using current DMS parameters vs. passenger-based parameters. The analysis compared the values obtained per aircraft with the values weight using the number of passenger per flight, occupational indicators (figure 17, outbound flights):

Figure 17 Measurement of passengers vs. aircraft indicators (outbound overall ground delay)

The results shown in figure 17 refer to passengers’ departure perception delays. Focusing on inbound arrival flights, it shows that:
- 51% of inbound flights were delayed, affecting 54% of passenger.
- Among the delayed flights, the average delay was 20’ from aircraft point of view and 19’ from passengers’ point of view.

It is important to note that the present study shows that **Aircraft delay indicators are sufficient and not biased** to capture passenger actual delay, so that there is no need to use occupational indicators.

Passenger’s current perception measurement **differs by involved agent**, reflecting the current chain fragmentation:

- **Airlines** have the best information in real time, but they only share it partially to other infrastructure/service providers, such as airports, handling agents or ATC.
- In this case study, the **Airport** has good quality information: DMS with direct access to scheduled times; actual off-block time visually assessed and manually incorporated to system; and actual in-block time estimated from landing FSA message by adding an average 5’ taxiing time.
- The quality of the estimates currently available from **Eurocontrol** databases is not as good as the information available from Airports databases.

What is the level of the reliability of IOBT and (ATOT-rolling time) as estimates of SOBT and AOBT? What is the level of accuracy of the outbound overall ground delay calculated from those estimates? A study was carried out to answer these questions, by analysing the overall sample of the outbound flights managed at the studied airport within a three week period.

The case study results show that IOBT match with the SOBT in 90% of the flights. The following differences have been observed, affecting both repetitive and non-repetitive flight plans:

- 8% of the flights presented an IOBT greater than SOBT, with an average difference of 54 minutes. In this group of flights, average passenger’s delay perception was 66’, while delay measured from Eurocontrol’s database was only 15’.
- 2% of the flights presented an IOBT lower than SOBT, with an average difference of 11 minutes. In this group of flights, the average passenger’s delay perception was 5’, while delay measured from Eurocontrol’s database was 11’.

Concerning to AOBT, estimated as the difference between ATOT with rolling time, results indicate that **this estimate includes take-off delays**. An analysis of the accuracy of the rolling time estimation, statistically generated by CFMU, within the flights with a generated rolling time of 12’ (which represents the 96% of the flights) illustrates that:

- The average rolling time was of 13’, that is 1 minute difference from the theoretical value considered. That means an average underestimated outbound delay of 1 minute.
- 23% of the outbound flights experienced a take-off taxiing longer than 15', with an average taxiing time of 21', that is 9 minutes difference from the theoretical value considered.

- 2% of the outbound flights experienced a take-off taxiing longer than 25', with an average taxiing time of 44' (long take-off delay perception).

The detailed analysis of IOBT and AOBT already indicates that Eurocontrol current sources of information **underestimates overall ground delays** perceived by the passenger. In order to quantify this underestimation, it was compared to the overall ground delay calculated from Airport's AOBT and SOBT estimates with the delay calculated from Eurocontrol's estimates. Results are illustrated in figure 18:

![Bar chart showing % of delayed pax and Min. (flights delayed more than 15')](image)

**Figure 18 Eurocontrol estimation of outbound overall ground delay (by aircraft)**

- While 72% of flights were delayed, with an average delay of 13' (19' if only considering the delayed flights), from Eurocontrol's databases only 55% of flights were delayed, with an average delay of 10' (18' if only considering the delayed flights).

- On delayed situations, quoted as 25% of the overall outbound flights, were affected by an average delay of 41'. From Eurocontrol's point of view, flights affected by long delay situations were 23% of the overall sample, with an average delay of 29'.

Therefore, Eurocontrol current sources of information **provide a non-accurate estimation of overall ground delays** perceived by passenger: Eurocontrol is currently missing 24% of delays, with estimation of long delayed situations looking 30% less serious than those perceived by passenger.
4. Conclusions

Passenger expectation summary

- Passengers place **high importance on punctuality**. Arrival punctuality is more important, but more difficult to appraise by passengers, than departure punctuality.

- Passengers form their extended expectations **rationally but without full information or with incomplete logic**:
  - Expectations relate to passenger needs
  - Expectations are also correlated to end-to-end trip characteristics
  - Passengers update their expectations during the travel journey
  - Expectations are independent of trip chain organization

- The level of satisfaction of passengers’ curb-to-curb expectations is low, partially because of their **current level of awareness of the scheduled time of arrival**

- Passengers’ expectations on **Airport arrival processes performance are higher than assumed by industry managers**.

Passenger perception summary

- In the present study, **outbound overall ground delays** and **inbound arrival delays**, which can be taken as a good estimate of passengers’ perception, were **pervasive**.

- Among infrastructure/service providers, **ATC delays only accounts for a small portion of delays perceived by passengers**: only 17% of outbound flights had an ATC delay, and 70% of long delay situations correspond to non-ATC delayed flights. However, as the delay communicated passengers is not standardised, passengers may perceive incorrectly the sources of delay.

- **Airport processes variability heavily influences the level of curb-to-curb service for the user**. Variability also impacts the passenger experience and influence the perception of true punctuality.

- **Airlines** are mainly responsible for the ground delays:
  - Lead times are too strict when **scheduling turnaround process**: 50% of the scales have a scheduled turnaround lower than 50’, and only 18% of the inbound delayed arriving flights recovered their delay for the subsequent rotation
  - **Handling agents** behave according to procedures and contracts established with airlines rather than SLA established with the **Airport** (even though this could also be improved).
  - **Handling agents** do not follow passenger needs but follow contract rules with airlines

- Information, integration and control of ground processes could improve handling agents performance which would enhance turnaround flexibility.
Delay measurement summary

- **Aircraft delay indicators are sufficient and not biased** to capture passenger actual delay:
  - 72% of outbound flights were delayed, affecting 75% of passenger, with the same average delay calculated both taking into account aircraft and passenger.
  - 25% were long-delayed flights (with more than 15’ delay), affecting 26% of passenger. In terms of average delay, 41’ from aircraft point of view and 39’ from passenger point of view.
  - Concerning to arrivals, 51% of inbound flights were delayed, affecting 54% of passenger. Among the delayed flights, the average delay was 20’ from aircraft point of view and 19’ from passenger point of view.

- Eurocontrol current sources of information **provide a non accurate estimation of overall ground** delays perceived by passenger:
  - Eurocontrol is currently missing **24%** of delays.
  - Long delayed situations look **30%** less serious than those perceived by passenger.

- However, Eurocontrol’s current balanced score card is comprehensive, so it would not be difficult to improve the passengers’ perception measurement by incorporating more accurate and existing information sources (from airlines and/or airports) to the current database.

Conclusions

Being Eurocontrol's reliability and objectivity of delays indicators recognized by all industry actors and having the agency successfully lead convergence processes, Eurocontrol could assess the opportunity of further exploring how to implement an indicator scorecard which contributes to enhance passenger rights.