

Cost Benefit Analysis for ADS-B Implementation at Pescara Airport

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1. INTRODUCTION

1.1 Background

The objective of the CASCADE (“Co-operative ATS through Surveillance and Communication Applications Deployed in ECAC”) Programme is to reduce ATM delays, increase safety and contribute to increased ATM efficiency.

One of the applications to be implemented as part of the CASCADE Programme is Automatic Dependent Surveillance-Broadcast for non Radar Areas (ADS-B-NRA).

The ADS-B-NRA application is designed to provide surveillance information, in low density en-route and TMA airspaces, solely based on ADS-B

Cost Benefit Analysis (CBA) is among the important deliverables of CASCADE as it plays a major role in the process of stakeholder involvement and commitment to the programme.

A Cost Benefit Analysis (CBA) for the possible implementation of ADS-B at Pescara Airport Italy was conducted at Pescara Airport on 18 and 19 March 2008. The meeting was attended by representatives of the airport operator (S.A.G.A.), Itali Airlines, ENAV HQ Rome, the ATC Manager Pescara, several ATCOs from Pescara and a team from the CASCADE Programme.

1.2 Purpose

The purpose of this document is to give an overview of the cost/benefit considerations for an ADS-B based surveillance covering the Pescara airport and TMA. This document is the CASCADE Business Case Deliverable for the implementation at Pescara Airport of ADS-B.

1.3 Scope

The CBA has been modelled using

- ADS-B implementation cost information from the results of the implementation of the CASCADE CRISTAL network [Ref.1] including, *inter alia*, the purchase, installation and commissioning costs of an ADS-B ground stations plus annual operating costs and training of controllers and technical staff.
- ADS-B benefit information, agreed with the authorities at Pescara Airport. It reflects the economic value of the increase in the quality of the service to the Airspace Users at both the "Pescara TMA and Airport. The Airspace Users' related benefits include reduction in departure trajectory inefficiencies, ground delay, arrival trajectory inefficiencies, vertical flight inefficiencies and holding times. The ENAV direct benefits result from increased controller productivity.

The CBA provides the following outputs:

- **Economic and financial indicators** such as Net Present Value and Cash Flows
- **Sensitivity analysis** identifying the most critical variables to the economic success of the improvement
- **Risk analysis** showing the likelihood of the improvement delivering a certain net present value

ENAV intends to use this CBA as a model to be applied to other airports that currently do not have surveillance.

1.4 Analysis Tool

The European model for strategic ATM investment analysis, EMOSIA, was used to carry out the cost benefit analysis of implementing ADS-B infrastructure in the Pescara TMA in the 2008-2028 timeframe.

2. PESCARA AIRPORT COST BENEFIT SCENARIO

2.1 Case Understanding

Pescara Airport has no radar surveillance sources. Consequently, Pescara Airport is using procedural separation. This results in several operational inefficiencies, including:

- Departure trajectory inefficiencies,
- Ground delay,
- Arrival trajectory inefficiencies,
- Vertical flight inefficiencies,
- Increased holding times,
- A significant number of air-ground co-ordination communications.

Traffic in Pescara

There is a wide mix of traffic using the TMA and the Control Zone. In addition to commercial flights (75% pax and 25% cargo) there are military and civil units operating a mix of helicopters and fixed wing aircraft. These include Coastguard, Police Forestry Commission and Fire fighting Units. In addition, there is a helicopter shuttle to offshore oil rigs and 2 flying schools. A maintenance facility for Airbus and Boeing aircraft is already established and is expected to expand. A particular constraint to operations is the frequent unscheduled Canadair fire fighting activity during summer months. Search and rescue operations can be a further constraint.

Traffic Forecast

STATFOR Annual long-term traffic growth for Italy is expected to vary between 1.8% and 2.2%. However Pescara Airport's growth expectations are above this average corresponding to an increase from currently 25.000 movements to 40.000 by 2011 and 60.000 by 2025.

Passenger traffic is expected to continue growing as more tourists are attracted to the area and a “Master Plan” to extend the terminal and provide more apron space has been approved. The expectation is to increase passenger numbers to 1.5m over the next 15 years.

Weather

Observations at Pescara Airport show an average of 15 days of Low-Visibility-Operations for some hours each day and within a visibility interval less than 4800 meters.

2.2 ADS-B Implementation Schedule

Figure 1 summarises the possible ADS-B implementation scheme at Pescara airport. Reviewing the coverage maps suggested that 2 ADS-B ground stations are required to meet the low-level coverage requirements. An earliest ADS-B deployment date of 2008 would be followed by a year of trials with the pre-operational system accruing initial benefits. The operational use of the standard ADS-B infrastructure could therefore begin around 2010.

Currently 95% of the traffic is realised by 3 commercial companies: **60% by Ryanair**, using Boeing 737, **20 % by Air One** using Boeing 737 and Airbus 320, and **15 % by Hamburg Int** (Freight) using Boeing 737, Airbus 319. These aircraft being already equipped with ADS-B, the ground trial period could also be used for airborne testing and certification.

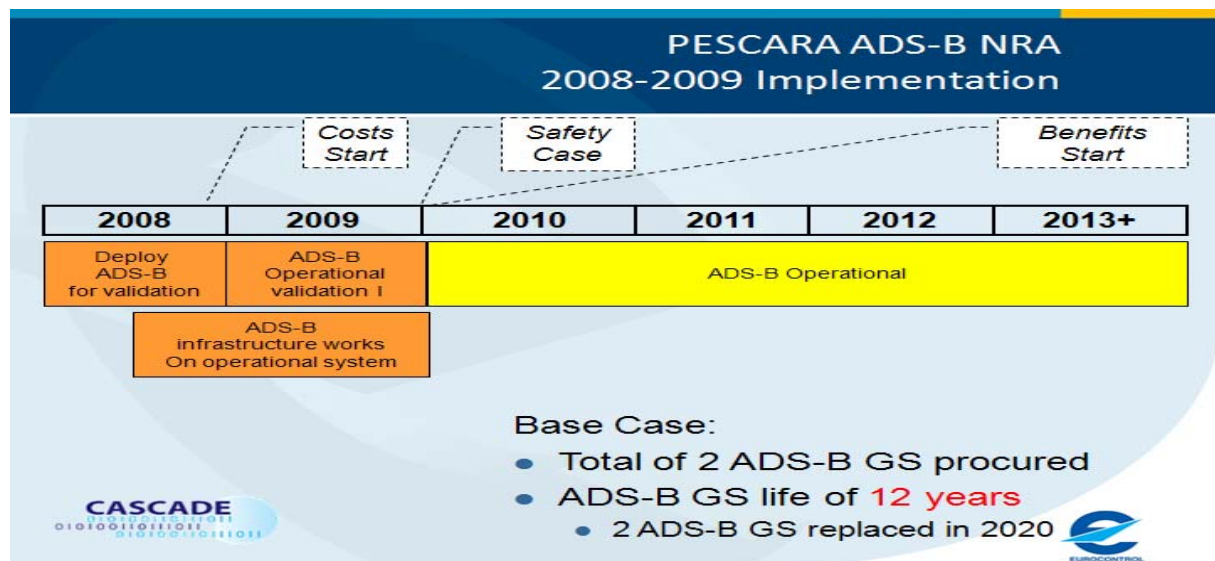


Figure 1: Possible PESCARA ADS-B Implementation Timeline

The Cost Benefit Analysis is based on this timeline for the cost expenditure and for the accruing of the potential benefits.

The bulk of the benefits lie in the economic value of the quality of the service improvement to the Airspace Users of the Pescara TMA and Airport. The benefits result from:

- Avoidance of situations in which future traffic needs to be **diverted and cancelled** due to current surveillance limitations caused by the lack of an autonomous, available and reliable surveillance source,
- Reduction of departure trajectory **inefficiencies**, arrival trajectory inefficiencies, vertical flight inefficiencies, increased holding times and,
- Controller **productivity increase** via significant reduction in the number of air-ground co-ordination communications.

Additional benefits such as qualitative benefits (for example increased controller situational awareness) are difficult to quantify and have not been included in the CBA.

2.3 Pescara Model Assumptions and Costs

The EMOSIA model is defined by a series of equations, input factors, parameters, and variables aimed at assessing the economic viability of implementing ADS-B. Inputs are subject to many sources of uncertainty including errors of measurement, absence of information and poor or partial understanding of the driving forces and mechanisms. This imposes a limit on the reliability of the output of the model; the results are only as reliable as the inputs provided.

Assumptions in the EMOSIA model:

- Linear growth of 15% is applied to the current traffic levels from 2008 to 2012 and 1% thereafter until 2026, reaching 60.000 movements as the maximum of ATC capacity after the ADS-B implementation.
- The number of non-commercial flights remains the same from 2008 to 2027.

- 2/3 of movements are not commercial and do not provide commercial revenue.
- The model uses ranges defined by three characteristic values: high, base and low cases with associated probabilities (based on triangular probability distribution). This mathematical treatment allows for evaluating the sensitivity of the model output. The resulting uncertainties contribute to an assessment of the risks associated with the planned investment.
- The move from Procedural Control to ADS-B Surveillance control will enable airspace re-structuring and application of reduced separation standards.
- An ADS-B ground station lifetime is assumed to be in the order of 12 years. The benefits model was run to the end of 2027. The start year for the modelling is 2008. Benefits would start to be accrued 2 years later i.e. in 2010.
- Traffic conditions for the NRA airspace in Pescara assumed for the future are:
 - a) Average duration of a flight: 6 minutes for TMA
 - b) Average number of aircraft per ATSU hour: on average max 20 in TMA
 - c) Maximum instantaneous count of traffic 5 aircraft for TMA at any one time.

Financial Benefits for the **Airspace Users** are a minimum of:

- 2 minutes of ground delay savings for departures,
- 4 minutes of airborne holding time savings for arrivals,
- 15 NM flight trajectory savings for arrivals and departures
- 15 NM flight trajectory savings for arrivals and departures, because of:
 - a) Shorter horizontal separation than in procedural (Introduction of ADS-B could result in traffic spacing reducing from 40NM (Procedural) to 5 NM)
 - b) Vector separation possibility
 - c) Shorter route to initial approach fix: direct instead of commencing the procedure from overhead the airport

- d) Reduced holdings and where holding is required reduced time in the holding pattern.

This is an initial estimation based on expert judgment and will have to be validated. The sensitivity of the net present value (NPV) to changes of each of the values will be shown in a sensitivity analysis.

Costs in the EMOSIA model:

ADS-B costs are standard costs, broken down into:

- Purchase, Installation and commissioning cost of the ADS-B ground surveillance infrastructure.
- Training costs for controllers and technical staff.
- Annual maintenance costs.
- Annual communication charges.

The table below shows the variables used in the EMOSIA model. For the modelled variables, a range of values can be entered so that sensitivity analysis is carried out taking uncertainty into consideration.

Input Parameter	Value				Units
Constants					
Discount Rate	0.05				decimal fraction
Tax Rate	0				decimal fraction
Start Year	2008				year
Final Year	2027				year
Pre-Imp Start Year	2008				year
Model Variables	Value	Low	Base Case	High	Units
ADS-B Server Cost	0	0	0	0	€millions
ADS-B Ground Station SUR Equip Cost	0.125	0.1	0.125	0.155	€millions
ADS-B Installation and Commissioning	0.075	0.05	0.075	0.1	€millions
Pre-Imp Duration	1	1	1	2	years
Annual ADS-B Maintenance Staff Cost	0.006	0.004	0.006	0.008	€millions
Annual ADS-B Maintenance Spare Cost	0.002	0	0.002	0.003	€millions
Annual Leased Lines	0.010	0.008	0.010	0.012	€millions
CWP Cost	0.015	0.005	0.015	0.020	€millions
Controller Training	0.01	0.080	0.100	0.120	€millions
Number ADS-B Ground Station	2	2	2	4	units
Simulation Cost	0.1	0.1	0.1	0.1	€millions
Imp Duration	1	1	1	1	years
HMI Cost	0.075	0.05	0.075	0.1	€millions
ADS-B Working Life Years	12	12	12	12	years

Table 1: Variables in PESCARA Scenario CBA

Pescara Costs Development over time

Costs are sub-categorized under implementation, replacement and operating costs. The implementation and replacement costs are incurred in a specific year, whereas operating costs are recurrent.

The implementation cost was calculated by the model as being € 0.733 M. the replacement cost of two ADS-B stations € 0.25 M and the annual operational cost calculated as € 0.036M. The figure below shows the different cost categories development over time used in the model.

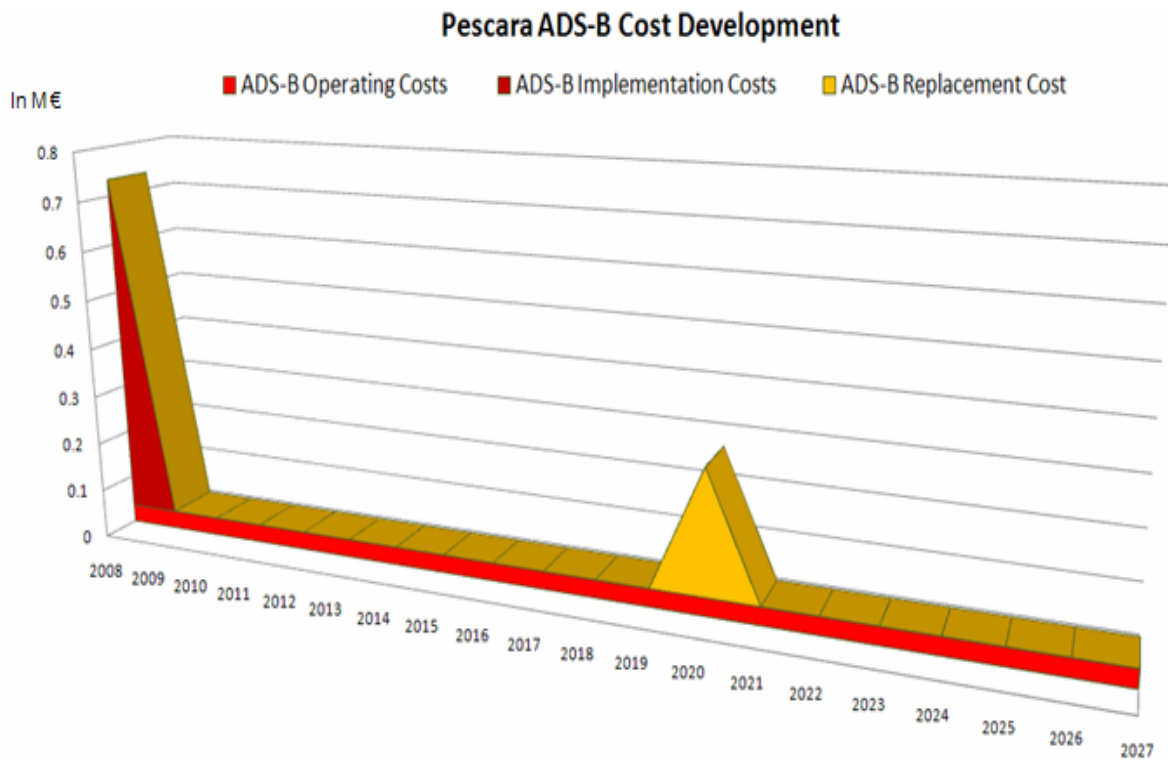


Figure 2: Possible Pescara ADS-B Cost Development

2.4 Pescara CBA Results

The net present value of the project is € 15.91 M.

Figure 3 shows the benefits and the different cost categories development as nominal, **not-discounted** cash-flows over time used in the model.

Graph of Net Cash Flow

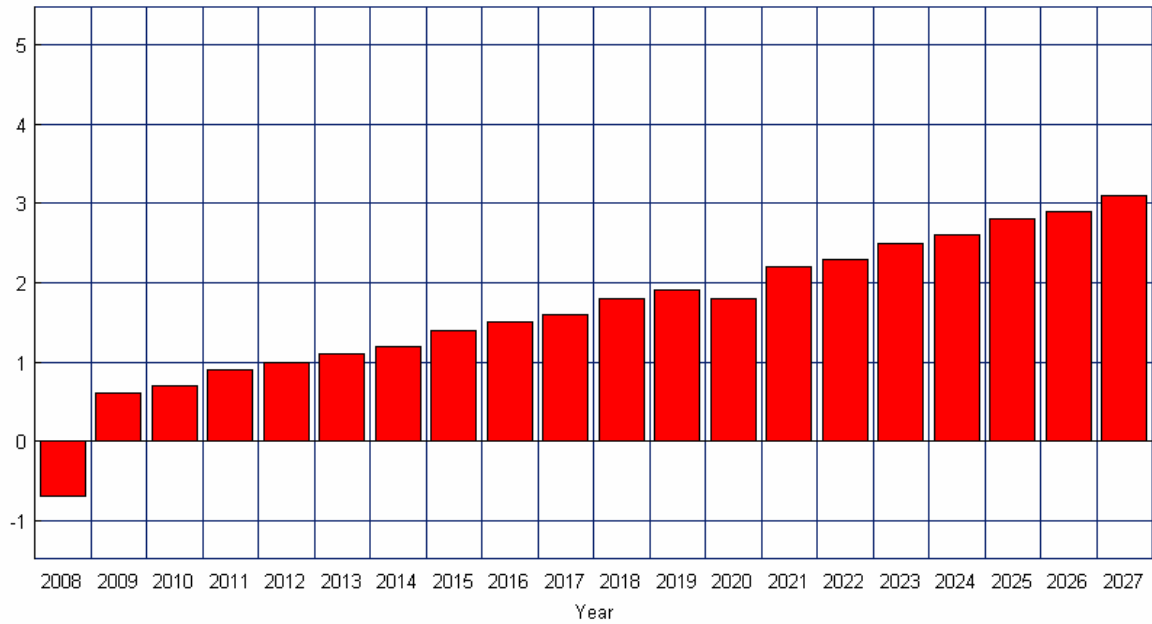


Figure 3: PESCARA ADS-B Cash Flow

The discounted net present value over the implementation programme is shown in **Error! Reference source not found.3**. The graph shows that between 2008 and 2010 the break-even point is reached. From 2010 onwards the future traffic is enabled. Hence the operational benefits listed below are accruing:

- Airborne Holding Savings
- Vertical Flight Efficiency Savings
- Arrival Trajectory Efficiency Savings
- Departure Trajectory Efficiency Savings 2009-2028
- Air-Ground Communication Savings

As a result the cumulative NPV grows as shown in Figure 4. The growth of the NPV reduces slightly in 2020 as the ADS-B sensors installed in 2008 reach their end of life and hence require replacement.

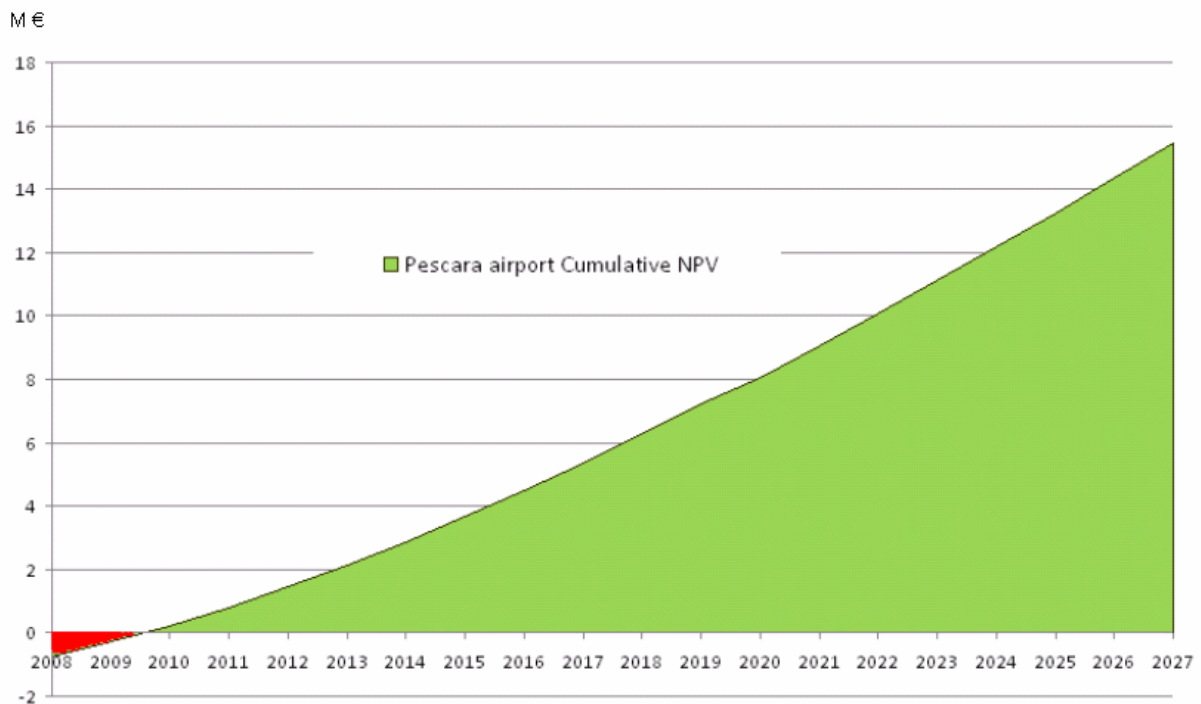


Figure 4: PESCARA CBA Cumulative NPV

Figure 5 below shows the tornado diagram for the CBA scenario. Any variables entered into the model with a range of input values are shown on this diagram and it indicates the impact on the NPV should these variables values change within the given range. The 2 factors which have the most impact on the net present value are the ATC Charges for passenger flight landings and maximum incremental passenger flights. The impact on the NPV of changing these variables is shown below.

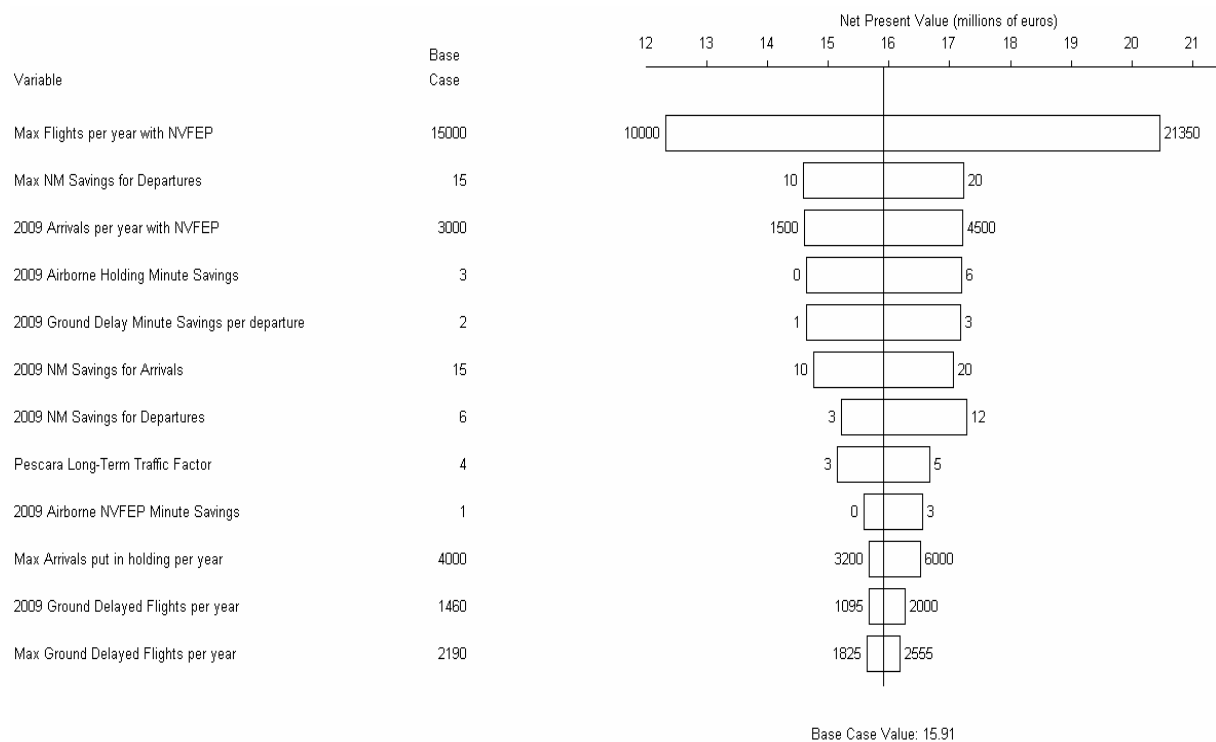


Figure 5: Tornado Diagram for PESCARA CBA Scenario

Implementing ADS-B will avoid non-optimal vertical flight efficiency profile for the affected flights in the current situation. As can be clearly seen, if the variable “Max flights per year with NVFEP (non-optimal vertical flight efficiency profile)” is altered, the value of the project is considerably affected - dropping to € 12 M if only 10.000 flights a year in the future are subject to optimised trajectory but rising to € 20 M if 21.350 flights a year in the future are subject to optimised trajectory.

If the NM savings for departures has a value of 20 NM compared to the base case of 15 NM, the benefit increases by about € 1 M.

The risk analysis of the project is shown in **Error! Reference source not found.6**. The net present value of the project was determined by the model as being between € 11.72 M and € 21.00 M with a confidence interval of 80%.

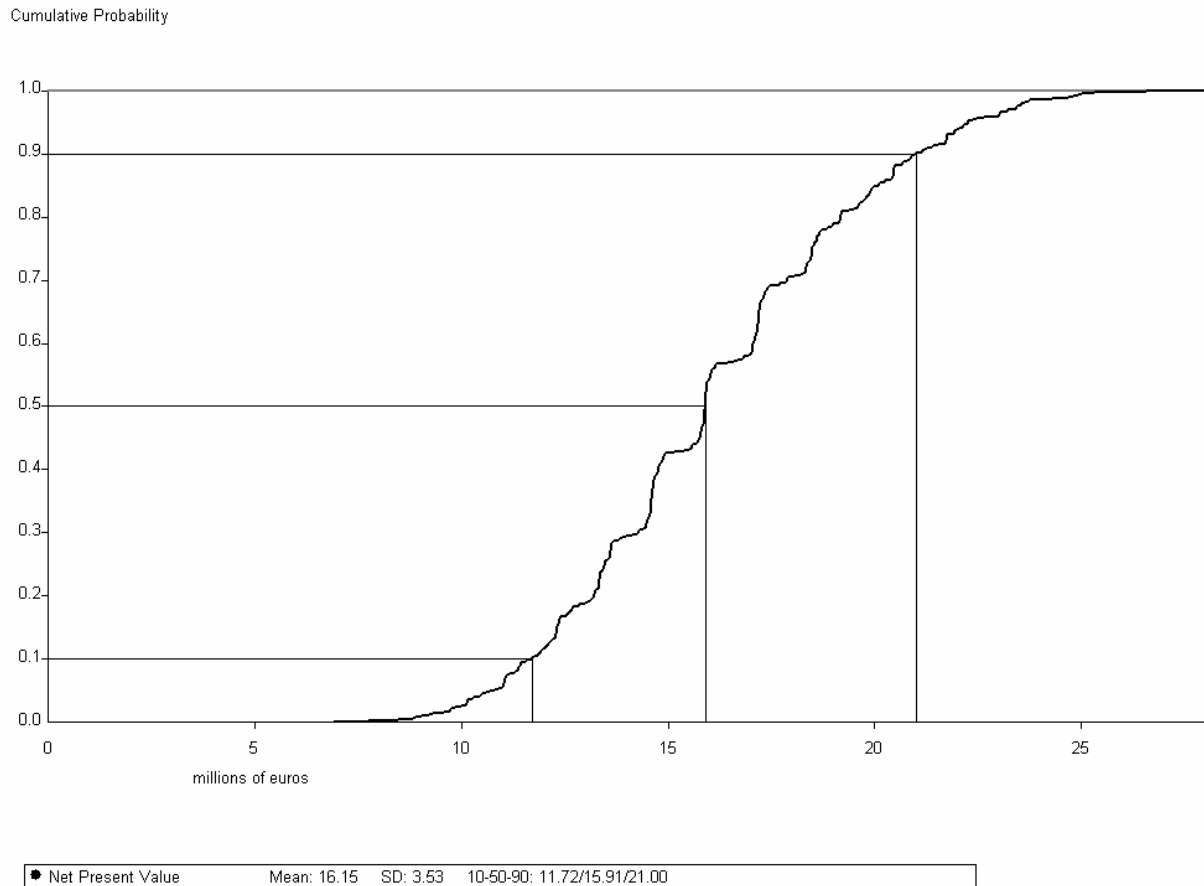


Figure 6: PESCARA CBA Scenario Risk Analysis

The mean net present value of the project was determined as being 15.91 M. The analysis shows there is:

- No risk of losing money on this project.
- 10% probability of earning less than 11.72 M.
- 90% probability of earning less than 21.00 M.

3. CONCLUSIONS

The ADS-B implementation enables ENAV to have its own surveillance source at a very low cost at Pescara Airport. This allows Airspace Users net benefits over a 20-year period calculated as the economic value of the better quality of service provided by ENAV in the Pescara TMA and at the Airport. ENAV benefits result from both gains in safety, operational efficiency and controller workload reduction.

The net present value of the scenario as calculated by the model is € 15.91 M which could be considered a significant return for a relatively small investment.

It should be noted that the baseline model is limited in its scope - the CBA does not account for benefits other than quantitative benefits. These may include:

- More efficient) ATC by providing controllers with better situational awareness.
- Obtaining information about any significant deviation by aircraft from their ATC clearances.
- Environmental savings in terms of reduces CO₂.

Given both the quantitative and the qualitative benefits, the Pescara ADS-B implementation should be considered a key investment.

Making this investment in ADS-B at Pescara will not only bring positive benefits but also the experience gained through implementation of ADS-B will influence consideration of installing this low cost surveillance technology at other Italian airports that do not have the benefit of surveillance.

4. REFERENCES

Ref 1: EUROCONTROL CASCADE WEB PAGE

http://www.eurocontrol.int/cascade/public/standard_page/Cristal.html

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