



Project no. 12242

ASICBA

Aviation Safety Improvement using Cost Benefit Analysis

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1 PROJECT EXECUTION

1.1 Project objectives

The objective of this project is to improve aviation safety through the development of a novel safety approach. This approach will allow aviation stakeholders (from EASA, to civil aviation authorities, airlines, airports, air traffic control, and manufacturers) to:

- Understand and manage the effective risk reduction when adopting a safety measure;
- Prioritise their safety investments when multiple options are potentially feasible;
- Increase safety as much as possible within the limiting budgets available;
- Justify investments in safety from a cost perspective.

The safety approach consists of a methodology enabling aviation stakeholders to assess the effects of their technical, managerial and political decisions at safety level, together with the associated costs and benefits. The approach will support decisions such as whether or not to introduce a safety measure, by making priorities for investments in safety, based on the most beneficial outcome. The methodology will be implemented in a Decision Support System (DSS), providing a step-by-step procedure that will support the user throughout the different phases for assessing the cost effectiveness of safety measures. The DSS will incorporate a data pool for the estimation of risk reduction and costs related to the implementation of specific safety measures.

Cost benefit analysis of safety measures is a relatively new concept in the aviation community and decisions on safety related matters are taken without knowing precisely what will be their final effect. This project provides the means for taking decision at different levels (i.e., policy, procedures, and operational level) in order to understand the consequences on safety from both viewpoints: policy makers and regulators on one side and industry on the other. While for policy makers and regulators the objective is safety with affordability as a requirement, for the industry the objective is affordability with safety as a requirement.

The main objectives of this Specific Target Research Project are:

1. To identify the current practices and processes that aviation stakeholders follow to assess the viability and desirability of safety measures, and the role that cost benefit analysis has in those practices and processes;

2. To single out the limits of the current practices and processes encountered by the whole spectrum of aviation stakeholders, and identify their needs for a novel approach;
3. To compare these needs against existing approaches incorporating cost-benefit analysis, but which have never been applied to real cases;
4. To derive a set of functional requirements for the development of a methodological approach and a tool enabling all aviation stakeholders to apply effective risk reduction when adopting a safety measure by means of cost-benefit analysis;
5. To develop a methodological approach that will allow the treatment of safety and cost aspects in such a way to support decisions on whether to introduce safety measures;
6. To develop a methodological approach that will allow making priorities for investments in safety based on the most beneficial outcome;
7. To develop a decision support tool, that will facilitate the use of such a methodology;
8. To provide the necessary information on risks and costs for applying the methodology to real cases;
9. To verify the applicability of this safety approach, to contribute to its optimization and to appraise the feasibility of broad take up by the industry;
10. To capitalise the results issued from the application of this approach into a data set, which will gradually expand while the method is being used and make these data accessible to all interested parties;
11. To disseminate the findings of the approach to the industry;
12. To create a standard by providing a common reference so that data can be used by industry for benchmarking.

1.2 Contractors involved

Participant Role	Participant no.	Participant name	Participant short name	Country
CO	1	D'Appolonia	DAPP	IT
CR	2	National Aerospace Laboratory	NLR	NL
CR	3	Airclaims	Airclaims	UK
CR	4	ECORYS	ECORYS	NL
CR	5	Politecnico di Milano	PoliMI	IT
CR	6	Meridiana	Meridiana	IT
CR	7	LOT – Polish Airlines	LOT	PL

Participant Role	Participant no.	Participant name	Participant short name	Country
CR	8	GEASAR	GEASAR	IT

1.3 Work performed

The project has been structured in 7 Work Packages (WPs) enabling the achievement of the project objectives, as illustrated in Figure 1.

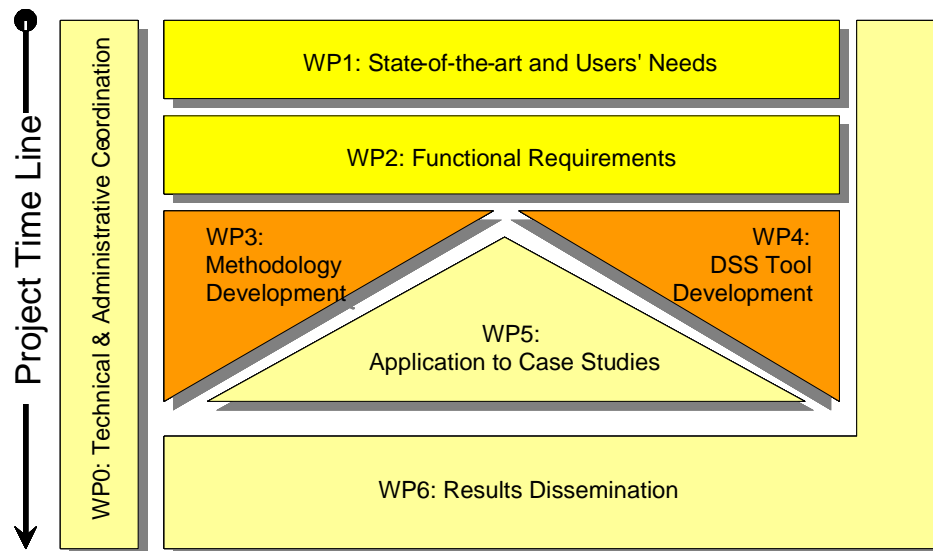


Figure 1: Overall structure of the project

All Work Packages have been started during the first year of the project. WP1 and WP2 were developed and finalized during the first six months of Year 1, while all other WPs reached their end during Year 2. The Gantt chart represented in Figure 2 provides a detailed overview of activities schedule, including the indication of project’s major achievements.

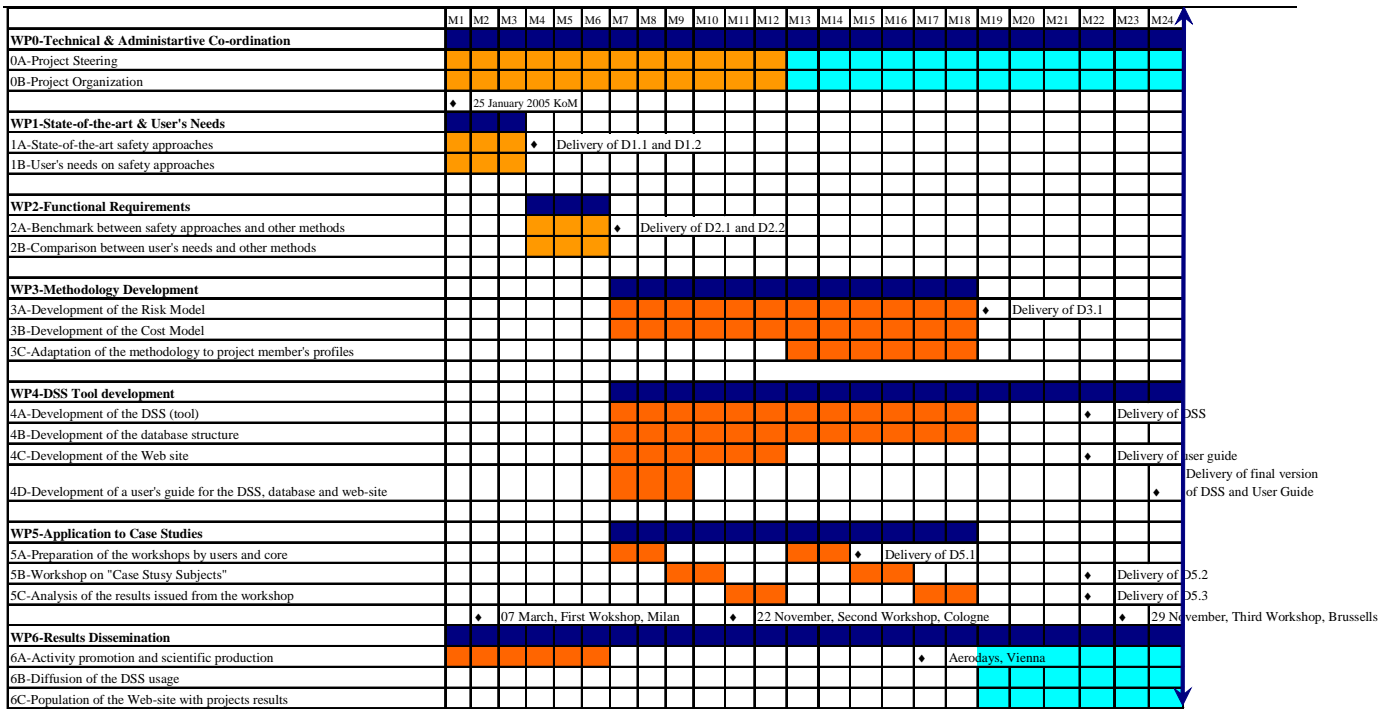


Figure 2: Project Gantt

The following sections summarize the activities performed during the whole project lifetime, detailed at Work Package level.

1.3.1 WP0: Technical and Administrative Co-ordination

WP0, led by D'Appolonia, handled both the Technical and Administrative co-ordination of the project. The Technical co-ordination was devoted to making strategic decisions on matters relevant to the success of technical project, like project specific planning and adjustment, timing control and corrections, number of additional meetings, redistribution of resources and dissemination strategies. The Administrative co-ordination took care of organisational issues such as: amendment letters, progress reports, financial statements, meeting organisation, cost reporting and communication with the other partners. The WP lasted for the whole duration of the STREP.

1.3.2 WP1: State-of-the-art and Users' Needs

WP1, led by NLR, has analysed the current practices and processes followed by aviation stakeholders in decisions that can influence safety, as well as the role played by cost benefit analysis in those practices and processes. In addition it has been identified the current limitations which are encountered while performing this kind of activities. The analysis has been focused on strengths and weaknesses of the current approaches, with particular attention on those followed by the stakeholders that are members of the project.

1.3.3 WP2: Functional Requirements

In this WP, led by POLIMI, the current safety approaches have been compared against methods, such as the ASTER, for each user level (i.e. regulatory, airline, airport etc.). The end-user provided a wish-list for functional requirements. These joint comparisons have consolidated a list of desiderata that has been translated into functional requirements for the development of the novel methodological approach and the Decision Support System (DSS) tool implementing this approach.

1.3.4 WP3: Methodology development

This WP, led by NLR, developed a novel methodological approach to enable aviation stakeholders the application of the effective risk reduction, by adopting a set of proposed safety measures within the limiting budgets available. The approach can contribute to decisions such as whether or not to introduce a safety measure, but additionally will be able to make priorities for investments in safety, based on the most beneficial outcomes. The approach developed in this WP effectively combines the technical issues of risk reduction with the economic issues of benefits of improved safety, taking into account the benefits of not having an accident, i.e. the savings that result from improved safety. An interdependency modelling for the existing aviation system has also been developed.

1.3.5 WP4: DSS tool development

This WP, led by D'Appolonia, has developed a Decision Support System (DSS) tool, which implements the methodology developed in WP3 with the purpose of incorporating safety effects and associated costs and benefits into decisions about safety measures. In other words, a user-friendly layer has been built around the safety approach developed in WP3, combined with the availability of necessary data sets that are used in the approach. The tool has been designed to match the needs of all aviation stakeholders (i.e., from Policy Makers to Regulators, and Industry). The tool takes the form of an Electronic Handbook providing a step-by-step procedure that will support the user throughout the different phases necessary for taking a decision about the implementation of safety measures, including cost benefit analysis. The tool also incorporates a data pool for the estimation of costs, benefits and risk reduction related to the implementation of specific safety measures. A dedicated user's guide, an interview and a report in a film format have been developed in order to help all possible users use the tool in an effective way.

1.3.6 WP5: Application to case studies

The objective for this WP5, led by ECORYS, is to apply the ASICBA approach to three case studies. The draft methodologies developed in WP3 and WP4 have been tested on three cases suggested by the users.

These cases have been extensively discussed in three workshops at user's premises, and have provided feedback to the WP3 and WP4 for further methodological refinement of the approach. Additionally, a workshop at EUROCONTROL has been organised, with the aim of presenting ASICBA and to collect their views on a CBA method for safety measures.

1.3.7 WP6: Dissemination of the Results

This WP, led by AIRCLAIMS, had the objective of transferring the Safety Approach philosophy and the usage of the Decision Support Tool to potential users outside the consortium. A continuous link with other Work Packages has been assured from the beginning of the process in order to report the scientific hypothesis and findings acquired in research activities. The dissemination process has been based on a specific marketing perspective through different channels; the following main activities have been performed:

- Presentation of project results at conferences;
- Organisation of three dissemination Workshops;
- Continuous population of the project Web site;
- Dissemination of project results via the existing network of contacts of the end-users.

1.4 Results achieved

1.4.1 User needs collection

Aviation transport involves different groups of stakeholders, each of them having a different perception of safety, and different requirements for its effective implementation. Different practices concerning decision-making methodologies are currently applied at different levels, each of them having an impact on safety.

In order to assess and harmonise those different viewpoints, ASICBA organised a dedicated Workshop, with the participation of 27 relevant stakeholders representing airlines, airport operators and manufacturers. The outcome of this workshop is represented by a list of needs expressed by the involved users, organized accordingly with the following categories:

- Purpose and Use;
- Input and data;
- Requirements concerning the Decision Support Tool;
- Other requirements.

Furthermore, a survey of relevant EC-funded ongoing research project, dealing with safety and cost-benefit analysis in aviation transport, has been conducted, in order to gather additional user needs which have integrated the list previously obtained from the workshop. In particular, the following projects and initiatives have been assessed:

- Supporting Platform for Airport Decision-Making and Efficiency Analysis (SPADE);
- Security of Aircraft in the Future European Environment (SAFE);
- Co-operative Air Traffic Management (C-ATM);
- Joint Safety Strategy Initiative (JSSI) Working Group on Occurrence Data Analysis (ODA) Specifications;
- HILAS.

1.4.2 Functional requirements

The functional requirements identified in the scope of ASICBA project represent the baseline for the definition of a novel methodological approach dedicated to risk assessment, which has been integrated into a Decision Support System (DSS).

The requirements have been defined on the basis of a review of relevant literature, and the identification of user needs related to safety approach, obtained through the organization of a stakeholders' interview campaign.

1.4.3 Risk and Cost Models

1.4.3.1 *Risk model*

The Risk Model, based on scenario analysis, allows to assess the impact of certain measures on the level of safety. The architecture for this model extends conventional risk analysis techniques, e.g. fault trees and event trees, by introducing a hybrid causal model of event sequence diagrams, fault trees and influence diagrams. Event Sequence Diagrams (ESDs) are used to define the context or scenario within which various causal factors would be seen as a hazard.

Thirty-one generic accident scenarios have been identified, including controlled flight into terrain (CFIT), mid-air collision, runway overrun, etc. These scenarios have been represented through the application of ESDs. The impact of each event included in a

scenario is assessed taking into account six groups of potential actors involved in the event (i.e. Aircraft, Occupants, Operation of aircraft involved, Other airlines/aircraft, Airport, Third parties).

The effect of a safety measure on the accident probability is determined by estimating the effect of the measure on the likelihood of occurrence of the initiating events and the pivot events. This will then result in a change in likelihood of the end states. The probabilities derived by the application of the model are incorporated as default values in a risk and cost database, which is used to feed the Decision Support System. However, these default probabilities can be changed by the user if this is thought necessary to more closely reflect a specific case that is being studied.

1.4.3.2 Cost model

The core part of the cost model is represented by a database with default values for all relevant costs. The default values are determined based on average figures in the European aviation. All the default values can be modified by the user if more detailed data is available or more specific assumptions can be made by the user.

To assess the costs related to accidents, 24 heads of cost have been identified, based on a similar list that has been defined in ASTER project; the model is able to determine whether a single head of costs will impact on the groups of actors already introduced by the Risk Model (see Section 1.4.3.1). Furthermore, the model defines the cost associated to each event, detailed accordingly with the user category and the level of severity associated to the event itself.

Finally, the estimated costs are allocated to stakeholders. Not all accident costs are borne by the same stakeholder. In order to assess the viability of a safety measure for one particular stakeholder (e.g. an airline) only those costs have to be taken into account that are relevant for this stakeholder. The following stakeholders are distinguished:

- Airline;
- Passengers;
- Airport operator;
- (Safety) authorities;
- Third party / Society;
- Other airlines;
- Insurers;

- Aircraft manufacturers.

The risk model gives the likelihood of an accident and its expected severity (impact vector) both before and after the application of the safety measure. For each impact vector, the associated accident costs are calculated. By multiplying the difference in accident likelihood before and after the application of the safety measure with the associated accident costs, the effect of the safety measure is expressed in monetary terms. This can be considered the safety value of the measure, and is a benefit in the cost-benefit analysis (CBA) calculation.

1.4.4 Decision Support System (DSS)

The Decision Support System (DSS) is a tool designed for implementing the methodology for risk assessment and cost evaluation previously defined, in order to incorporate safety effects and associated costs and benefits into decisions about safety measures. The tool has been designed to match the needs of all aviation stakeholders (i.e., from Policy Makers to Regulators, and Industry). In particular, the scope of the DSS includes:

- Assist the user in the process of identifying risk model parameters and event sequence diagrams that are related to the safety measure under analysis;
- Assist the user by providing default data and allow him to change any data he wishes;
- Perform the calculations in order to obtain a “favourable/not favourable” evaluation of the safety measure.

The DSS shows a “pre-selection” of the event sequence diagrams that could be related to the safety measure to:

- allow the user to limit the project flow to a specific point of view
- allow the user to change all data supplied by the system, in order to match the user “reality”
- allow the user to “navigate” the event sequence diagrams selected, in order to give visual representation of the sequence of events, the relevant parameters and the end-state impacts.

The DSS provides a working report that allows the user to perform all the risk and cost calculations of the model; changing the data in the report, automatically changes the event probabilities, cost computation and safety measure evaluation.

1.5 Project Impact

The results achieved by the project are expected to have a short, a medium and a long-term impact, as it is described in the following.

Two different short-term impacts have been identified. The first type occurred already during the project duration, and just is related to the dissemination of the novel Safety Approach within the users of this consortium. In addition, it has improved stakeholder participation and inclusion through dialogue, workshops, reporting and transparent processes. Furthermore it increases international co-operation especially in the field of aviation safety research.

The second type of short-term impact is represented by the validation of the approach allowing Cost Benefit Analysis (CBA) of safety measures. In addition to this, the case studies subjects to which the approach has been applied provided valuable results for the users. While the objective of conducting the case studies is 'testing' the novel Safety Approach, the fact that the case studies address 'real world' problems, brought up by 'real world' users. The case studies have been carefully selected as to fit in current national and international research activities, such that these research activities can equally benefit from the case study results, and vice-versa.

A medium-term impact of the project is believed to be the fulfilment of an urgent but nowadays not very well formalised need of aviation stakeholders to manage in a cost-effective way their internal safety budgets.

DSS is a valuable tool that can support aviation stakeholders in their decision making process of budgets allocation. Moreover, the proposed project will define required research activities and research targets on a European level. Cost-benefit analysis of safety measures is a relatively new concept, and the practical application of the method to real world test cases will undoubtedly bring up important issues. Most importantly in this respect is also the development of a common data set that is accessible to all potential users of the method. Whereas the availability of such a common data set would provide a tremendous advantage to the European aviation industry, its development and exploitation will require a careful approach, as demonstrated with the development and implementation of the ECCAIRS (European Co-ordination Centre for Aviation Incident Reporting Systems) database.

This research project has primarily focused on the development of a framework for supporting all aviation stakeholders in the elaboration of their own safety management systems. Not only this framework enables CBA of safety measures, but it also provides all aviation stakeholders with effective means to set their own target

level of safety and measure the current ones. Furthermore, this framework supports them in the identification of the best ways to move from the current to the desired safety level, and to assess their feasibility.

On a long term, this novel Safety Approach can be used in other industrial sectors, especially within transports (e.g., railways, maritime) and therefore, it will provide an excellent opportunity for benchmarking and comparing different safety measures. Moreover, it could lead to the optimisation of safety of the transport industry as a whole.

2 DISSEMINATION AND USE

The results of ASICBA have been widely disseminated throughout the aviation community. The dissemination process has been based on a specific marketing perspective through different channels, such as the presentation of the project’s results at conferences and the continuous update of the project Website that reports the findings generated during the project duration. However, this type of dissemination is only one side of the coin. The other is represented by the publicity that users of the approach (airline, airport, ATC organisation, regulator, etc) have made when they understand the real aim of ASICBA project.

The dissemination activities will be continued by the Project Web-Site (www.asicba.org), which was set up by D’Appolonia and will be maintained for a minimum of two years following the completion of the project. This web site has been used as the focus of the projects dissemination activities. It includes a video demonstrating the use of the Decision Support Tool, the ability to download the DSS User Handbook and access the Decision Support Tool.

The web site contains a new web page created to highlight the DSS tool, with a specific link to the tool through which the users can practise with the DSS. The consortium members will also remain available to assist potential users of the DSS if there is a need to customize the approach in some way or if the user believes that other help is required.

2.1 Exploitable knowledge and its use

Exploitable Knowledge (description)	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable for commercial use	Patents or other IPR protection	Owner & other partners involved
CBA	DSS	<ul style="list-style-type: none"> • Aeronautical environment • Maritime environment • All transport sectors 	From February 2007 for two years		

Table 1 - Overview Table – Exploitable knowledge

2.2 Dissemination of knowledge

Planned/Actual date	Type	Type of audience	Countries addressed	Size of audience	Partner responsible/involved
07/03/2005	Workshop	Aviation stakeholders	World wide	15/20 persons	All ASICBA Consortium
22/11/2005	Workshop	Aviation stakeholders	World wide		D'Appolonia as Project Co-ordinator
03/03/2005	Project web-site	General public	World wide		D'Appolonia as Project Co-ordinator
03/03/2005	Contact form in Airclaims web-page	General public	World wide		Airclaims as WP6 Leader
From the beginning	Direct e-mailing	Aviation stakeholders	World wide		All Consortium partners
From the beginning	Flyer	Aviation stakeholders	World wide		All Partners
	Publications	General public			All Partners
19-21/09/2005	Second World Congress "Safety in Aviation"	General public	World wide		LOT ASICBA Team
19-21/06/2006	Aerodays 2006	Aviation stakeholders	World wide		D'Appolonia, POLIMI, NLR, ECORYS and Airclaims
24-28/06/2006	ICRAT conference	Aviation stakeholders	World wide		ECORYS
29/11/2006	Eurocontrol Seminar	Aviation stakeholders & others	World wide		All Partners
24/01/2007	ASICBA-SAFEE meeting	Reserved	Italy-France		D'Appolonia
13/02/2007	SAFEDOR meeting	SAFEDOR Partners	World wide		D'Appolonia

Table 2 - Overview Table – Dissemination of knowledge