D1.4 – SOCIO-ECONOMIC IMPACT ASSESSMENT METHODOLOGY (NEW RELEASE)

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Abstract

The OPTICS D1.4 document in its second release presents the assessment Framework exploited by the OPTICS Project to determine the Socio-Economic benefits of safety research in Europe. The Framework is the result of an iterative process taking into consideration project objectives, extensive literature studies, and insights from previous projects of a similar nature, together with a first pilot application of these upon a small sub-set of ongoing research. For the benefit of this impact assessment, its indicators are derived from the European vision of Air Transportation (Flightpath 2050). The Framework is structured in 3 areas of analysis which represent the three main areas of societal well-being (societal benefits, economic impacts and research capacity) and includes a total of 24 indicators. Guidance for subsequent improvement and consolidation work are also provided and the establishment of a unique Societal Return on Investment indicator for the quantification of the added value delivered by research to society is presented.

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Acronyms and Terminology

Term	Definition
ACARE	Advisory Council for Aeronautics Research and Innovation in Europe
ACAS-X	Airborne Collision Avoidance System
AG	Advisory Group
ALIAS	Addressing the Liability Impact of Automated Systems
A-PIMOD	Applying Pilot Models for Safer Aircraft
ATM	Air Traffic Management
BRAINFLIGHT	BRAIN-controlled aircraft FLIGHT using multiple feedback mechanisms
CSA	Coordination and Support Action
DBL	Deep Blue
DG	Directorate-General
DOTNAC	Development and Optimization of THz NDT on Aeronautics Composite Multi-layered Structure
EASA	European Aviation Safety Agency
EASN	European Aeronautics Science Network
EC	European Commission
FAA	Federal Aviation Administration
FP	Framework Programme
FSS	Future Sky Safety
FTE	Full Time Equivalent
GDP	Gross Domestic Product
H2020	Horizon 2020
HAIC	High Altitude Ice Crystals
IATA	International Air Transport Association
MAN4GEN	Manual Operation for 4th Generation Airliners
MISSA	More Integrated Systems Safety Assessment
NASA	National Aeronautics and Space Administration
NINA	Neuro-metrics Indicators for ATM
NLR	Netherlands Aerospace Centre
OPTICS	Observation Platform for Technological and Institutional Consolidation of research in Safety
PROSPERO	Neuro-metrics Indicators for ATM
PU	Public

RTD	Research and Technology Development
SAFECLOUD	Secure and Resilient Cloud Architecture
SEIA	Socio-Economic Impact Assessment
SESAR	Single European Sly ATM Research
SPRU	Social and Technological Policy Research Centre
SRIA	Strategic Research and Innovation Agenda
SROI	Social Return on Investment
SUPRA	Simulation of Upset Recovery in Aviation
TD	Technological Determinism
TRAVEL	TiltRotor ATM integrated Validation of Environmental Low noise procedures
WP	Work Package

Executive Summary

The OPTICS D1.4 document in its second release presents the methodology, approach and assessment Framework exploited by the OPTICS Project to determine the Socio-Economic benefits of safety research in Europe.

The **SEIA Framework** (Socio-Economic Impact Assessment Framework) is the result of an iterative process taking into consideration project objectives, extensive literature studies, and insights from previous projects of a similar nature, together with a first pilot application of these upon a small sub-set of ongoing research. The Assessment Framework pursues the ambitious purpose of providing evidence of the broader benefits that safety research can bring to society and the economy, and to help relate strategic research policy decisions to high level goals. The indicators of the Framework are derived from the European vision of Air Transportation (**Flightpath 2050**).

The SEIA Framework is an instrument of analysis for measuring the societal impact of European Aviation Safety Research. It is structured in *3 areas of analysis* comprising a total of *24 indicators*. The three areas of analysis represent the three main areas of societal well-being and gather those aspects regarded as being more relevant for society and of greatest interest in Europe. The first area '***Societal Benefits***' explores the impact of science on society as well as its actual contribution to safety improvements. It aims to address two questions: '*Does European Safety Research contribute to well-being of society?*' and '*Is European Aviation Safety Research actually addressing European top safety risks?*'. The second area '***Economic Impact***' investigates the economic impact of science and aims to address the question '*Is European Safety Research giving Europe a competitive edge in the global market?*'. The third area '***Research capacity***' explores the resources and capabilities required to maintain top-level education and excellence in research facilities and skills. '*Are we well-equipped to do world-leading Safety Research?*' is the question addressed by this third and last area of analysis.

This document also provides a foundation upon which subsequent work may be performed to further improve and consolidate the overall Framework. An interesting and promising path could be the attempt to answer a fifth high level question '*What is the societal return on investment in Aviation Safety Research?'.* This requires establishing a unique Societal Return on Investment (SROI) indicator aiming to identify and/or quantify the relation between investments and additional non-financial benefits delivered to society.

1 INTRODUCTION

1.1 Background

The democratisation and facility of access to air transportation services has offered society benefits not only allowing the expansion of personal and professional horizons, but also generating close to 9 million skilled jobs and contributing 600 billion Euro to Europe's GDP. Would this success have been possible without convincing passengers and society at large that, despite inherent fears, greatly increased volumes of traffic, and threats to security, transportation by air is safer than ever before, and remains the safest form of transportation?

Air transportation today has an excellent reputation with regard to both the safety and the security of its operations. For the most part society places its trust in what has now become an indispensable means of transport for both people and goods. Amongst the professionals and those very close to the sector, safety is perceived as an inherent quality within the air transport system today, and indeed the track record confirms the claim. Through the concerted efforts of the actors within the sector, be it by the airframe and engine manufacturers, the aircraft systems, vehicle maintenance, airline operators or the air traffic managers, significant improvements in accident and incident rates have been achieved over the last decades.

How does research contribute to these societal and economic benefits? Research remains an obscure activity with much of the non-professional population unaware of its impact towards their everyday lives. Indeed, while the professionals of the sector generally acknowledge the necessity for research, there is little direct evidence justifying the magnitude of the investments, nor of the resultant safety impact that research has achieved.

The OPTICS Project has been created to shed some light in this area by addressing two overarching questions: **are we doing the right research, and are we doing the research right**?

While the OPTICS Deliverable D1.3 addresses the former through a comprehensive review and assessment of ongoing aviation safety research with respect to its ability to deliver against safety strategy and goals, the Societal Impact thread of activity aims to identify whether safety research contributes to the socio-economic well-being of EU citizens, and ultimately, if the direct benefits justify the investments made in such research.

To ensure the relevance of the socio-economic impact assessment, the OPTICS Project has developed an assessment Framework comprising a number of indicators derived from the European vision of Air Transportation – Flightpath 2050. This report, delivered by a group of high level aviation personalities [1], underlines the priorities for the relevant policy, research and innovation to meet the needs of EU citizens and the European market as well as maintaining global leadership in aviation. These socio-economic indicators relate to the five main areas identified in the report:

1. Meeting societal and market needs;
2. Maintaining and extending industrial leadership;
3. Protecting the environment and energy supply;
4. Ensuring safety and security;
5. Prioritising research, testing capabilities and education.

Relating to this publication, ACARE, the Advisory Council for Aviation Research and Innovation in Europe, generated the Strategic Research and Innovation Agenda (SRIA) in the following year. This report breaks down the high level goals described in Flightpath 2050 for each research area and

specifies necessary achievements towards reaching them from a short (2020), medium (2035) and long term (2050) perspective.

The OPTICS Project is linked to the fourth focus area of Flightpath 2050 "Ensuring safety and security". It is a Coordination and Support Action (CSA) aiming to provide a comprehensive overview of EU safety-related research and innovation activities. These research efforts are assessed against the long term goals for aviation safety formulated in Flightpath 2050.

1.2 Objectives and scope

The new release of OPTICS Deliverable D1.4 'Socio-Economic Impact Assessment Methodology' presents the Socio-Economic Impact Assessment (SEIA) Framework developed in Work Package 1.4. It describes the methodology and approach underlying the Framework, illustrates the sets of indicators and metrics constituting it, and provides guidelines to perform the assessment, as well as how to analyse and interpret the results.

The SEIA Framework has the ambitious aim to:

- Support the understanding and provide evidence of the broader benefits safety research may bring to society and economy,
- Help to relate strategic research policy decisions to high level goals such as Europe 2020.

On the basis of the results and lessons learnt from the first pilot assessment cycle, the Framework has been reviewed and restructured in order to stabilise it, improve its effectiveness, and provide a closer mapping between the major objectives identified within Flightpath 2050. Particularly, the revised Framework is intended to be an instrument capable to assess the broad societal impact of research, thus to provide answers to four questions:

1. *Does European Safety Research contribute to the well-being of society?*
2. *Is European Safety Research giving Europe a competitive edge in the global market?*
3. *Is European Aviation Safety Research actually addressing European top safety risks?*
4. *Are we well-equipped to do world-leading Safety Research?*

The SEIA Framework will be further evaluated within a second cycle of assessment that will be performed on a batch of selected research projects.

This document represents the current status of our work providing a foundation upon which subsequent work may be performed to further improve and consolidate the overall Framework. An interesting and promising path could be the attempt to answer a fifth high level question '*What is the societal return for investments in Aviation Safety Research?'*, thus to establish a unique Societal Return on Investment (SROI) indicator aiming to identify and/or quantify the relation between investments and extra-financial benefits delivered to society.

1.3 Document structure

This document consists of seven sections, including this introduction, and three annexes. The core of this Report intends to provide a concise overview on the methodology and the assessment framework:

- The Conceptual Framework is described in *Section* ***Errore. L'origine riferimento non è stata trovata.***;
- The Methodology and Assessment Framework are presented in *Section 3*;

- The Assessment guidelines are provided in *Section 4*;
- Conclusion and Recommendations are stated in *Section 5*;
- References are provided in *Section 6*.

The annex sections aim to provide additional information. Appendix I reports the questionnaire and the list of questions used for data collection at a project level, while Appendix II contains the Universities & Research Institutes Survey. Lastly, Appendix III provides an overview on the techniques and methods to measure the social return for investment of research.

2 Socio-Economic Impact Assessment of Research: Framing the Problem

The SEIA Framework has been developed for the purpose of shedding light on the beneficial impact that research has on societal domains. However, the impacts upon society remain abstract, difficult to specify and often very hard to measure. The fact that direct and indirect impact in the area of science is often not presented separately makes it particularly difficult to capture. Moreover, various possible areas of research impacts could be identified (European Commission, 2012). Figure 1 depicts the so-called "impact zones" specified by Emerald Group Publishing (2014) [3].

Figure 1: Various "impact zones" of science [3]

A better understanding of the impacts has the power not only to direct science in a more effective way but also to radically transform our society in ways none of us can imagine[8].

Beside the direct and indirect benefits identified by the European Commission, there are also relevant impacts in the sector of publicly funded research. Since safety research is often financed not only from national and industrial sources but from public sources as well, different impacts and consequences can be identified for research, society and economy. Salter and Martin (1999) recognise at least six categories of benefits from publicly funded research:

- Increasing the stock of useful knowledge;
- Training skilled graduates;
- Creating new scientific instrumentation and methodologies;
- Forming networks and stimulating social interactions;
- Increasing the capacity for scientific and technological problem-solving;
- Creating new firms.

Salter and Martin (1999) explicitly state that their study and the identified impacts primarily refer to basic research and that all benefits are more of economic nature than of social, environmental or cultural nature. However, the six categories mentioned above seem valid for research environments

and societal and cultural factors [7][9]. These insights served as a basis for the development of indicators and metrics in the context of EU safety research.

Building upon the intensive literature research, OPTICS broadened its understanding of the socio-economic indicators in the field of safety research by conducting a number of internal and external workshops and discussions with partners within OPTICS. The meetings and literature studies resulted in an iterative development and identification process with new implementations, adaptions, and reductions.

Flightpath 2050 and the Strategic Research and Innovation Agenda (SRIA) – provided by the Advisory Council for Aviation Research and Innovation in Europe (ACARE) – proved to be the most applicable reference schemes for the Framework. The current structure of the SEIA Framework and indicators are derived from the five main areas identified in Flightpath 2050 and further developed within the ACARE SRIA:

1. **Meeting societal and market needs**, enabling safe, seamless and reliable door-to-door travel in a sustainable, resilient and customer-centric environment.
2. **Maintaining and extending industrial leadership,** addresses the technological dimensions driven by innovations, exceptional solutions and ground-breaking new instrumentations.
3. **Protecting the environment and energy supply,** ensuring that environmental impacts have been mitigated at a rate outweighing the effects of increasing traffic levels.
4. **Ensuring safety and security,** maintaining or improving levels of safety and security while assuring equity in access to all air vehicles.
5. **Prioritising research, testing capabilities and education,** to ensure Europe's aviation sector is underpinned by world class capabilities and facilities in research, development, test and validation, and provide the current and future employees of the sector with a top level education that is adapted to the sector's needs.

3 METHODOLOGY & ASSESSMENT FRAMEWORK

After providing a brief description of the OPTICS Assessment Approach and Methodology (Sub-Sections 3.1 and 3.2), this Section offers a detailed presentation of the Socio-Economic Impact Assessment (SEIA) Framework developed in Work Package 4. The overall Framework is depicted in Sub-Section 3.4, while a comprehensive description of each category of analysis, indicators and related metrics is provided in Sub-Section 3.3.

3.1 The Assessment Approach

The approach for the Socio-Economic Impact Assessment of OPTICS is based on three main cornerstones:

- The adoption of Flightpath 2050 and of ACARE Strategic Research and Innovation Agenda as the reference to define the nature and type of socio-economic impact to be explored.
- Using research projects and initiatives as the principle "unit of analysis" of the assessment. The benefits of this choice are (i) to make impact traceable and (ii) to adopt a unit of analysis which is consistent with the other major strand of work in OPTICS, i.e. the evaluation of the state-of-the-art of safety research and innovation.
- However, the focus on specific projects has the risk of missing long-term impact, and in general all the forms of indirect impact. To address this latter issue, some indicators are added which go beyond projects, addressing institutions and organisations, public perception, or aspects linked to research only on a long-term indirect scale (e.g. standards, EU incident rates, etc.).

3.2 The Methodology

The principal steps of the Socio-Economic Impact Assessment methodology are described in the following sub-sections as follows:

- Project Screening: from the OPTICS project repository, identify a broad selection of projects that may be contacted to collect data on socio-economic impact. The projects should cover the complete range of SRIA "enablers" and offer differing levels of maturity. Evidence of previous cooperation with the OPTICS Team should also be considered as an important factor for success.
- Project questionnaire: contact the coordinators of the selected projects and distribute the SEIA questionnaire.
- Follow-up interviews: in order to validate questionnaire data and collect more qualitative information, follow-up interviews with project coordinators will be carried out.
- Institutional Assessment: this step will contact the EASN network and collect data on the "International Recognition and Attractiveness" indicator within the Research Capacity area of analysis. The main points of contact will be the Institution department heads.
- Investment analysis: collect economic and financial data (EU and USA) in order to measure the Research investment and the Dispersion of Investment part of the Research Capacity area of analysis.

- Data Analysis: in this step, all the results of the questionnaires, interviews and internet search will be collated and analysed. To ensure a consistent method of analysis and find synergies between SEIA and SoA, the other members of the OPTICS Team will be involved.
- Synthesizing Results: results will be consolidated and main conclusions and recommendations will be drawn.

3.3 The SEIA Framework

The SEIA Framework is an instrument of analysis for measuring the societal impact of European Aviation Safety Research. It is structured in **3 areas of analysis** comprising a total of **24 indicators**. These indicators are the outcome of an extensive revision of the first version of the Framework developed within the first phase of OPTICS and tested throughout the first assessment cycle.

The three areas of analysis represent the three main areas of societal well-being and gather those aspects regarded as being more relevant for society and of greatest interest in Europe.

- **Societal Benefits**: This area explores the impact of science on society as well as its actual contribution to safety improvements. It comprises areas of concern for society such as environmental sustainability, passenger comfort and the feel safe factor. It aims to address two questions: '*Does European Safety Research contribute to well-being of society?*' and '*Is European Aviation Safety Research actually addressing European top safety risks?*'.
- **Economic Impact**: This area explores the economic impact of science. It aims to address the question '*Is European Safety Research giving Europe a competitive edge in the global market?*'.
- **Research capacity**: This area explores the resources and capabilities required to maintain top level education and excellence in research facilities and skills. It aims to address the question '*Are we well-equipped to do world-leading Safety Research?*'.

For a comprehensive analysis of the societal impact of research, the assessment has to go beyond the measurement of the positive effects produced by the European Aviation Safety Research. The assessment is extended to key contextual aspects as well as to the resources required to enable the production of those positive effects. The SEIA Framework is characterised by the coexistence of indicators with different natures. The majority of the indicators are labelled as '***Impact indicators***' measuring the effects generated by the Aviation Safety Research conducted in Europe. A second set – labelled as '***enabler indicators***' – aim to assess the means needed to carry out safety research. The third and final set – labelled as '***foundation indicators***' - analyse high level contextual aspects upon which the aviation safety research is built.

The SEIA Framework is depicted in Figure 2 where the indicators are listed on the right hand side and colour-coded according to their nature (foundation indicators are blue, enabler indicators are light blue, impact indicators are orange).

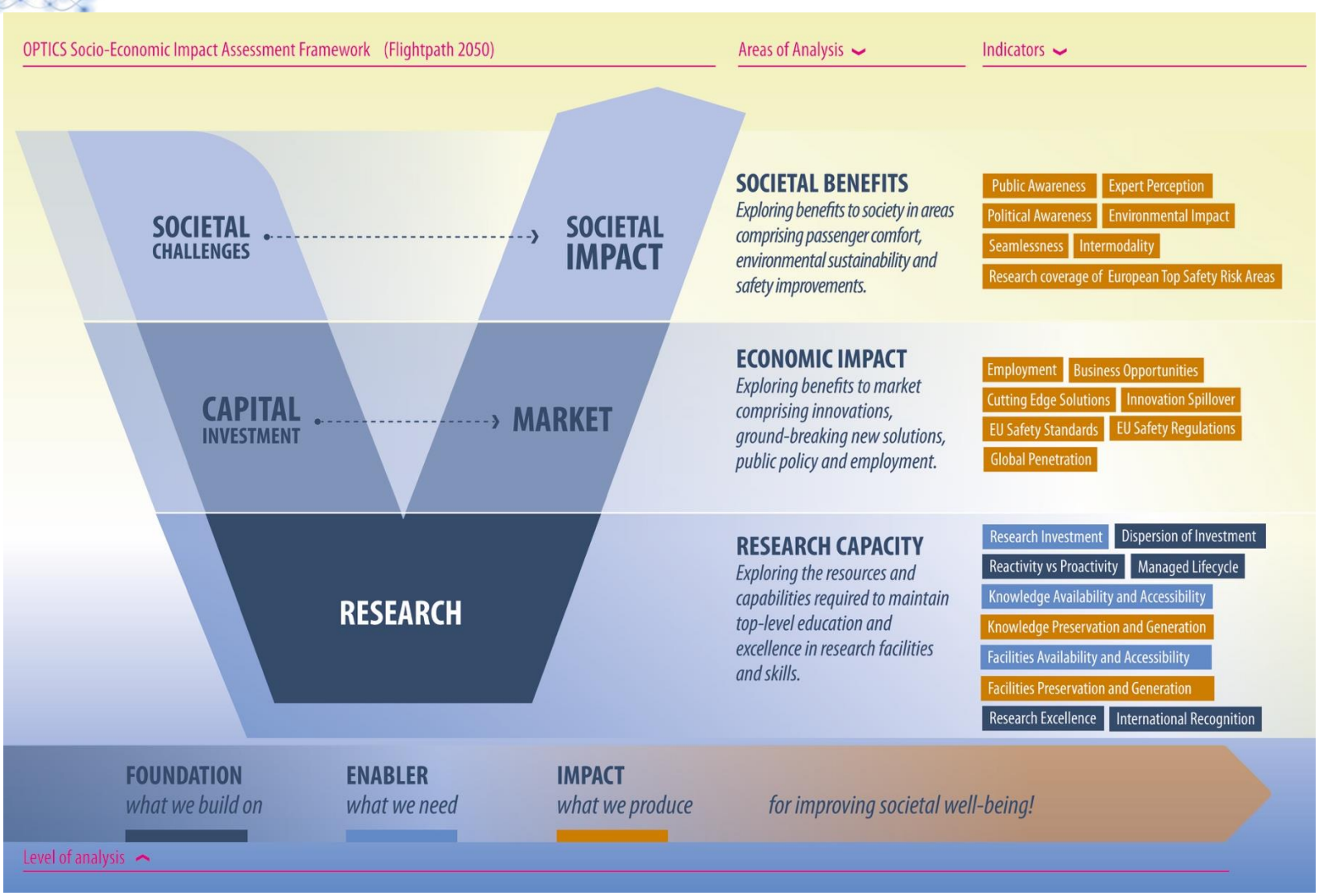

Figure 2: The SEIA Framework

3.4 Indicators & Metrics

This Section is in three parts, one for each category of analysis of the SEIA Framework, and offers a detailed and structured description of each indicator:

- **Definition**: synthetic description of the indicator and its aim,
- **Data source**: where/who to find/ask for data/information,
- **Instrument for data collection**: questionnaire, follow-up interviews, or internet,
- **Metrics**: chosen standards of measurement,
- **Characteristics**: categorisation of indicators in terms of:
  - **Type**: qualitative or quantitative,
  - **Level of analysis**: foundation, enabler, or impact,
- **Actions for Cycle 2**.

3.4.1 Societal Benefits

The first area of analysis relates to the **"Meeting Society and Market Needs"** segment of Flightpath 2050. It aims to explore the benefits that the European Aviation Safety Research delivers to society. Based on the SRIA, meeting societal needs is about enabling safe, seamless and reliable door-to-door travel in a sustainable, resilient and customer-centric environment. The seven indicators identified and grouped under four sub-areas, are deemed essential for the assessment of Europe's societal well-being.

"Feel Safe Factor"

The first sub-area of analysis aims to cover the people's perception of the Aviation Safety Research conducted in Europe. It includes three indicators in order to capture the 'feel safe factor' at different levels: general public, politicians and safety professionals.

PUBLIC AWARENESS	
Definition	This indicator measures the public perception of aviation safety as well as its awareness of the aviation safety research activities conducted Europe. Thus, it aims to capture both the people's feelings of safety and the degree to which the contribution of research to air transport safety is available and understandable to the general public.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire
Metrics	Figures on project dissemination activities (e.g. number of press releases, appearance on mass media, etc.)
Characteristics	Type: quantitative & qualitative

	Level of analysis: impact
Actions for Cycle 2	Collect and collate data on awareness of European aviation safety research activities. Integrate report.

POLITICAL AWARENESS	
Definition	This indicator relates to both the political perception of aviation safety and the political awareness of Aviation Safety projects and activities carried out at European level. It intends to be an intermediate level between public awareness and expert perception.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Figures on mentions of project by policy makers (e.g. meetings with policy makers, project findings directly/indirectly mentioned in a policy brief or presentation, influences on policy maker actions, influences on policy, regulations, directives outcomes and/or implementation, etc.).
Characteristics	Type: quantitative & qualitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data on political awareness of European aviation safety research activities. Integrate report.

EXPERT PERCEPTION	
Definition	This indicator investigates the perception amongst professionals of both air transport safety and the research activities conducted in Europe in the field. This expert category includes anyone who has acquired knowledge and skills through study and practice over the years and may therefore be able to express a more objective opinion about the state-of-the-art and the quality of the Aviation Safety projects and activities carried out at European level.
Source	Experts' opinions and perceptions
Instrument for data collection	Workshop
Metrics	Expert's perception of aviation safety.

	Expert's opinion on European Aviation Safety Research.
Characteristics	Type: qualitative Level of analysis: impact
Actions for Cycle 2	Integrate report.

"Feel Good Factor"

The second layer of analysis mostly relates to environmental sustainability. It includes only one indicator and aims to investigate the degree to which Research takes into account the cross-impact of aviation safety and environmental concerns.

ENVIRONMENTAL IMPACT	
Definition	This indicator aims to investigate the degree to which Aviation Safety Research projects have taken into consideration the environmental impact during the development, evaluation and validation process of their outcomes.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Degree to which the project has factored environmental impact into its activities.
Characteristics	Type: qualitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Update report.

Integrated Transport System

The third layer of analysis investigates a relevant issue for the transport sector in general. It includes two indicators and aims to measure the extent to which European Aviation Safety Research contributes to the achievement of the 'Integrated Transport System' goal.

SEAMLESSNESS	
Definition	This indicator investigates if Aviation Safety Research projects have taken into consideration the seamless mobility goal (both passenger and freight) during the development, evaluation and validation process of their outcomes and/or contributed to its achievement.
Source	Coordinators of selected European Research projects

Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Physical infrastructure improving customer safety while supporting a seamless mobility (e.g. did you address the role of transport hubs for the passenger's experience?). Immaterial infrastructure supporting a seamless mobility (e.g. did you address passengers' services, like baggage handling?).
Characteristics	Type: qualitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Integrate report.

INTERMODALITY	
Definition	This indicator investigates if Aviation Safety Research projects have contributed to all aviation segments (airport, airborne, ATM, maintenance, etc.) and to transport modes other than aviation (rail, road, maritime, etc.).
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire
Metrics	Aviation segments addressed (airport, airborne, ATM, maintenance?). Other transport modes addressed.
Characteristics	Type: quantitative & qualitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Integrate report.

Safety improvement

This last sub-area of analysis includes only one indicator and aims to investigate whether European Aviation Safety Research actually addresses the priority issues in air transport safety.

RESEARCH COVERAGE OF EUROPEAN TOP SAFETY RISK AREAS	
Definition	This indicator aims to investigate trends in aviation safety incidents [1] and their relationship with ongoing or recently terminated safety research to establish an image of coverage.
Source	European Central Repository using the template provided in regulation (EU) No 376/2014, EASA Annual Safety Review, FAA/NASA data, Japan data, IATA Safety Report 2015, Airbus "Statistical Analysis of Commercial Aviation Accidents 1958-2015", others.
Instrument for data collection	Instrument search
Metrics	Top Safety Risk Areas comparison with safety research focus.
Characteristics	Type: quantitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Integrate report.

3.4.2 Economic Impact

The second area of analysis mostly relates to the **"Maintaining and Extending Industrial Leadership"** segment of Flightpath 2050. Innovation is becoming the major competitive differentiator not only in the European Research Area but worldwide. The future of air transport relies on persistent and even increased investment in the safety technologies of tomorrow as the market demands shorter cycles for the integration of new technologies and international competitors enter the market with an aggressive approach on prices. In this regard, seven indicators are identified, and grouped under four distinct sub-areas, with the aim to explore the benefits that European Aviation Safety Research delivers to market.

Employment

The first sub-area of analysis includes one indicator and aims to investigate the degree to which Research contributes to labour market growth.

EMPLOYMENT CREATION	
Definition	This indicator investigates the contribution of Aviation Safety Research Projects in employment creation and preservation.
Source	Coordinators of selected European Research projects (*) Experts' opinions (**)

Instrument for data collection	Questionnaire (*) Follow-up interviews (**)
Metrics	Number of FTE's directly and indirectly created by the project (*) Number of people hired for achieving the project's objectives (*) Trend in engagement (number of people doing safety research) (**) Subjective assessment of the potential for job creation post-research (**) (i.e. industrialisation/operation of results)
Characteristics	Type: quantitative (*) & qualitative (**) Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Update report.
The symbols (*) and (**) are used to show the sources of information and the instruments for data collection that will be used for each of the chosen metrics. These also indicate the nature of the information that will be collected (qualitative or quantitative).	

Leadership of safety innovations and technology

The second sub-area of analysis investigates the contribution of Aviation Safety Research to European Aviation industry developments and includes two indicators.

CUTTING EDGE SAFETY SOLUTIONS & TECHNOLOGIES	
Definition	This indicator aims to investigate the potential for the introduction of truly innovative processes, technologies and services resulting from European Research projects in the aviation safety industry.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Project coordinators expectations towards industry uptake of research outcomes (low, medium high) (*). Number of patents (expected, pending, or actual) (**).
Characteristics	Type: qualitative (*) & quantitative (**) Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Update report.

BUSINESS OPPORTUNITIES	
Definition	This indicator aims to investigate the potential new business opportunities and commercial spin-offs resulting from European Research projects in the aviation safety area.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Number of business cases developed by the project. Number and description of potential business opportunities, as identified by a business case. Number of business plans developed as a result of business cases evidences (planned, or actual). Number of spin-off companies, or commercialisation activities (expected, or actual).
Characteristics	Type: qualitative & quantitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Update report.

Innovation Spill-over & Penetration

The third sub-area of analysis aims to go beyond the assessment of the impact of research on the European Aviation industry development. Based on two indicators, it looks at the positive effects of research on other safety critical domains and outside Europe.

INNOVATION SPILL-OVER	
Definition	This indicator aims to investigate whether Aviation Safety Research Projects produce results of potential relevance to safety critical sectors other than aviation (such as other transports modes as well as healthcare, oil & gas, nuclear, etc.).
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Number and description of transport modes and/or safety critical industries other than aviation that can be addressed using results from the project. Number of coordination with other safety-critical industries already in place to ease the transfer.

Characteristics	Type: qualitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Integrate report.

GLOBAL PENETRATION	
Definition	This indicator aims to investigate the influence of EU Aviation Safety Research at a global level. It includes evidence of the world-wide impact of European research activities, such as replication of projects, business opportunities outside Europe, adoption of standards/regulations, communication and dissemination.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Qualitative assessment of project impacts on parties outside the EU. Quantitative figures on project impacts (e.g. number of citations and mentions, number of invitations to international events, number of coordination with non-European actors already in place, etc.).
Characteristics	Type: qualitative & quantitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Update report.

Standardisation & Regulation

The fourth and last layer of analysis aims to investigate the potential influence of European Aviation Safety Research on the standardisation and regulatory process. It includes two indicators.

EU SAFETY STANDARDS	
Definition	This indicator aims to investigate the impact of Aviation Safety Research on the development or improvement of industry safety standards. This indicator strongly relates to the legal ease of adoption of the project.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews

Metrics	Project coordinator expectation of project impact on existing/new EU aviation safety standards.
Characteristics	Type: qualitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Update report.

EU SAFETY REGULATIONS	
Definition	This indicator aims to investigate the impact of Aviation Safety Research on the development, revision or improvement of EU Aviation Safety Regulations. This indicator strongly relates to the legal ease of adoption of the project.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Project coordinator expectation of project impact on existing/new EU aviation safety regulations.
Characteristics	Type: qualitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Update report.

3.4.3 Research Capacity

The third area of analysis mostly relates to the "**Prioritising Research, Testing Capabilities**" segment of Flightpath 2050. It addresses a broad dimension gathering all the resources and capabilities nowadays required to maintain top-level education, excellence in facilities and skills, and thus market leadership and competitive advantages. Decisions regarding research and technology development are likely to impact the ability of this complex system to respond adequately to new challenges. In fact, Europe's aviation sector must be underpinned by world-class capabilities and facilities in research, development, test and validation, and should provide the current and future employees of the sector with a top-level education that is adapted to the sector's needs (ACARE 2012). Ten indicators are identified and grouped under four distinct sub-areas.

Investment in Research

The first sub-area of analysis explores the financial resources allocated to the Aviation Safety Research in Europe. It includes two indicators and aims to evaluate the magnitude of funds as well as identifying trends and investigate dispersions.

RESEARCH INVESTMENT	
Definition	This indicator aims to evaluate the magnitude of funds invested in Aviation Safety Research in Europe and to perform an international comparison.
Source	OPTICS Repository CORDIS data and other internal sources (for EU data) FAA and NASA figures (for USA) Source to be found (for Japan)
Instrument for data collection	Internet search
Metrics	Total cost of European Aviation Safety Research Projects Total Investment in monetary terms (sum of € Contributions) Overall figures on safety budget provided by the Commission. Comparison of overall EU figures with non-EU figures.
Characteristics	Type: quantitative Level of analysis: enabler
Actions for Cycle 2	Collect and collate data. Update report.

DISPERSION OF INVESTMENT	
Definition	This indicator aims to investigate the dispersion of investments in Aviation Safety research across Europe by looking at trends and distributions.
Source	OPTICS Repository CORDIS data Other internal sources
Instrument for data collection	Internet search
Metrics	Trend of € contributions per year & funding programme Distribution of € by type of organisation

	Distribution of € by geographical area Trend per enabler / capability / sub-capability Distribution by enabler / capability / sub-capability Distribution by enabler / capability / sub-capability & Maturity level Distribution by enabler / capability / sub-capability & Ease of Adoption
Characteristics	Type: quantitative Level of analysis: context
Actions for Cycle 2	Collect and collate data. Update report. Enrich OPTICS Map.

Strategic Management of Research

The second sub-area of analysis explores how European funds allocated to Aviation Safety Research are strategically managed. It includes two indicators.

REACTIVITY *vs* PROACTIVITY	
Definition	This indicator aims to analyse how Safety Research balance between current safety issues (short-term goals) and strategic goals (medium and long-term goals).
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Project coordinators evaluation of their projects in terms of mapping on the ACARE time horizons and strategic safety goals (*). Experts' perception on current distribution of budget between short, medium, and long-term goals (**). Experts' opinion on the ideal balance between short, medium, and long-term goals (**).
Characteristics	Type: qualitative (*) and quantitative (**) Level of analysis: context
Actions for Cycle 2	Collect and collate data. Update report.

MANAGED LIFE-CYCLE OF RESEARCH AND INNOVATION	
Definition	This indicator aims to investigate the degree to which research activities rely on and exploit project results from earlier stages of the Research & Innovation lifecycle.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Degree of re-use/exploitation of previous research results. Degree of awareness of related activities.
Characteristics	Type: quantitative Level of analysis: context
Actions for Cycle 2	Collect and collate data. Update report.

Resources

The third sub-area of analysis explores the core part of research capacity comprising skills, knowledge and research facilities. It includes four indicators and aims to investigate the extent to which Aviation Safety Research contribute to maintain a leading edge in knowledge and research capabilities.

KNOWLEDGE AVAILABILITY & ACCESSIBILITY	
Definition	This indicator aims to assess the degree to which Aviation Safety Research exploits previous knowledge and how generated knowledge is shared.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Availability of existing knowledge (e.g. deliverables, reports, papers) generated during past research projects for re-use. Ease of access to past projects' key personnel (e.g. exchange of information and/or cooperation).
Characteristics	Type: qualitative Level of analysis: enabler
Actions for Cycle 2	Collect and collate data. Update report.

KNOWLEDGE PRESERVATION & GENERATION	
Definition	This indicator assesses the contribution of Aviation Safety Research projects to the development of expert knowledge and of technical and non-technical skills.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Count and trend of: Number of master, doctoral, and post-doc persons (theses) (*); Number of papers (*); Number of PU (public) deliverables and reports and % of availability of developed knowledge; Professional advancements during the project (if traceable) (**).
Characteristics	Type: quantitative (*) & qualitative (**) Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Update report.

FACILITIES AVAILABILITY & ACCESSIBILITY	
Definition	This indicator investigates the availability and accessibility to the projects of relevant testing and validation facilities (both infrastructures and methods) for the achievement of their objectives.
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Level of availability of necessary validation facilities. Ease of access to necessary validation facilities.
Characteristics	Type: qualitative Level of analysis: enabler
Actions for Cycle 2	Collect and collate data. Update report.

FACILITIES PRESERVATION & GENERATION	
Definition	This indicator aims to investigate the development, within the projects, of validation facilities and methods truly capable of improving the European Aviation Safety Research capacity to fulfil the research needs and achieve safety-related goals (are we building the right system?).
Source	Coordinators of selected European Research projects
Instrument for data collection	Questionnaire & Follow-up interviews
Metrics	Number and description of validation facilities and methods developed within the project and their accessibility beyond the project.
Characteristics	Type: qualitative Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Integrate report.

International standing

The last layer of analysis aims to explore how the Aviation Safety Research Community is seen and perceived at international level. It includes two indicators.

RESEARCH EXCELLENCE	
Definition	This indicator aims to analyse the quality of the EU safety research.
Source	Coordinators of selected European Research projects Internet (e.g. ELSEVIER, etc.)
Instrument for data collection	Questionnaire & Follow-up interviews Internet search
Metrics	Impact factors of top 5 publications of the project (*). Number of citations of top 5 publications (*). Project coordinators' perception of the impact of the project publications on other safety research (**).
Characteristics	Type: qualitative (*) & quantitative (*) Level of analysis: impact
Actions for Cycle 2	Collect and collate data. Update report.

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INTERNATIONAL RECOGNITION & ATTRACTIVENESS	
Definition	This indicator aims to analyse the international recognition and attractiveness of the EU Universities and Research Institutes.
Source	Coordinators of selected European Research projects (only about their own organisation) University Department Heads identified from the EASN University network Internet
Instrument for data collection	Follow-up interviews University Survey Internet search
Metrics	Ranking of EU Research Centres and Universities. Percentage and trend of students (undergraduates and masters), PhD students and researchers from outside the EU.
Characteristics	Type: quantitative Level of analysis: context
Actions for Cycle 2	Collect and collate data. Update report.

4 SOCIO-ECONOMIC IMPACT ASSESSMENT (CYCLE 2)

The revised SEIA Framework will be applied on a batch of selected research projects (see Section 4.1 for the list). The aim of this second cycle of assessment is twofold: producing assessment results on one side, and further testing and evaluating the robustness and consistency of the Framework itself.

The application of the SEIA Framework will rely on:

- Data, information and opinions of the Coordinators of the selected projects, to be collected via questionnaire and follow-up interviews;
- Data and information available on the web, e.g. Safety Report, databases, etc.
- Data, information and opinions of experts in field.

For more information on the specific sources of each indicator and metric, see the indicators tables provided in Section 3.4. More details about data collection and analysis, and results reporting are provided in the following Paragraphs 4.2 and 4.3, respectively.

4.1 Selected projects

The second cycle of Socio-Economic Impact Assessment will be performed on a total of 21 Aviation Safety Research EU Projects methodically selected by the OPTICS Team. This is a balanced sample which is broader than the one used for the first cycle of trial assessment. As shown in Table 1, this sample covers the large range of SRIA “enablers” and gathers projects with different levels of maturity and sources of funding.

Table 1: Sample of Projects for SEIA Assessment Cycle 2

ENABLERS / *PROJECTS*	[1] System-wide Safety Management	[2] Safety Radar	[3] Operational Mission Management Systems	[4] System Behaviour Monitoring and Health Management	[5] Forensic Analysis	[6] Standardisation and Certification	[7] Resilience by Design	[8] Human Centred Automation	[9] New Crew and Team Concepts
A-PIMOD			■				■	■	■
ACAS-X			■						
Aircraftfire		■				■	■		
ALIAS						■			
BRAINFLIGHT								■	■
DOTNAC							■		
FLYBAG II							■		
FSS-P4	■				■				
FSS-P5	■								■
FSS-P6									■
HAIC		■	■			■	■		
MAN4GEN	■						■	■	■
MISSA						■	■		
MYCOPTER			■					■	
NINA								■	■
PROSPERO	■	■					■		
Resilience2050							■		
SAFECLOUD	■			■					
SCALES				■			■		
SUPRA						■			■
TRAVEL	■		■	■					

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4.2 Data collection

The data collection phase is a key step to a successful assessment. The acquisition of reliable information and data requires a direct involvement of the coordinators of the 21 selected projects. Furthermore, the broad scope of the SEIA Framework leads to an extensive data collection phase aimed to gather and collate both quantitative data and personal expectations and perception.

The nature and characteristics of the information sought justifies the choice of a mixed set of instruments for data collection. Indeed, this phase will be carried out by four different means:

1. **Project questionnaire**: This is intended for the 21 Project Coordinators and represents the main means for data collection. It is composed of 45 questions organised in 8 sections:
    - ***Section 1: General information*.** This includes 4 general questions to enable the traceability of results.
    - ***Section 2: Objectives and scope of the Project***. This includes 8 questions and aims to frame the project covering its goals and coverage.
    - ***Section 3: Composition of the Project workforce***. This includes 3 questions and aims to cover the number of researchers per partner involved in the project, together with their competence and professional qualifications.
    - ***Section 4: Input from past projects and access to research facilities***. This includes 4 questions and aims to cover the input to the project, in terms of key personnel, research results and validation facilities.
    - ***Section 5: Scientific output of the Project***. This includes 9 questions and aims to cover the scientific output of the project in terms of new facilities, publications and presentations.
    - ***Section 6: Results and opportunities generated by the Project***. This includes 13 questions and aims to cover the higher level impact of the project, in terms of employment creation, career and educational advancement, contributions to safety standards and regulation, and business opportunities.
    - ***Section 7: Project visibility to the outside world***. This includes 2 questions and aims to cover the penetration of the project results beyond the EU.
    - ***Section 8: General comments***. This includes 2 questions asking for feedback.

    The questionnaire will be sent in an electronic form in order to ease both the data collection and the analysis phases. It is estimated to take approximately 40 minutes to complete.

    The full questionnaire is available in Appendix I, which also explains how the questions trace back to the SEIA indicators and metrics.

2. **Semi-structured interviews**: the questionnaire will be followed by semi-structured interviews aimed to further investigate specific areas of analysis as well as to collect more subjective data about the project coordinators' perception and expectations of indirect project outcomes and socio-economic impacts. The interviews will also be an opportunity for project coordinators to clarify and further detail their answers provided via questionnaire.

    The interviews will take place upon conclusion of the questionnaire phase and will be carried out in person or via telephone.

The full version of the interview template is available in Appendix I, which also explains how the questions are traced back to the SEIA indicators and metrics. Each interview will then be customised on the basis of the results of the specific questionnaire.

3. **Internet search**: the analysis of some of the context indicators requires the search and collection of hard data. Part of the information sought is publicly available whilst other data are confidential and will be sought through internal sources. In particular, the internet search is aimed to cover the following indicators:
    - *Research coverage of European top safety risk areas*, whose analysis will be mainly based on the top risk areas reported by EASA;
    - *Research Investment & Dispersion of investment*, whose analysis requires economic and financial data for all the European Safety Research Projects as well as overall safety research figures for USA and Japan. CORDIS data, Project documents, SESAR Data and EC overall figures will be the main sources for the collection of European data, while internal sources may be the most promising means for the acquisition of USA and Japan economic and financial information.
    - *Research excellence*, whose analysis will be based on internet searches counting citations of EU safety research project publications.
    - *International recognition*, whose analysis will consider recognised world ranking of EU Research Centres and Universities, and data on percentage and trend of students and researchers from outside the EU.
4. **Universities & Research Institutes Survey**: A questionnaire composed of 10 questions represents the main means for data collection. It will be sent to points of contact in departments related to Aerospace Sciences at 113 EU Universities and includes:
    - Four questions that are general questions to enable the traceability of results.
    - Two questions that cover the main domains of aviation safety and the composition of the department.
    - Two questions that address the number of students, and the extent to which they can find work after their study.
    - Two questions that address the objectives of the department's ongoing safety research.

    The full questionnaire is available in Appendix II.
5. **Expert workshop/interview**: The involvement of experts or other relevant actors (e.g. passengers) may be required in order to integrate the bottom-up assessment (at project level) with a top-down view and thus be able to draw high level conclusions and recommendations.

4.3 Analysis of Data & Synthesis of Results

The next step will be the processing, analysis and interpretation of all collected data and information and the synthesis of the results.

To assure transparency of results and to allow future optimisation of the assessment Framework, the rationales of all evaluations need to be recorded. Commentary relating to the outcome of the analysis of each indicator will be developed in order to provide the basis for the final report. Based upon the commentary and rationale, a set of recommendations will be drawn.

5 CONCLUSION & RECOMMENDATIONS

The SEIA Framework presented in this new release of D1.4 '*Socio-Economic Impact Assessment Methodology*' seeks to cover the major areas of concern for society and economy. It is aimed to support an extensive measurement of the societal impact of European Aviation Safety Research in order to provide evidence of the benefits that research is capable to bring to society and economy. This evidence is deemed essential to understand the rationale underlying past strategic research policy decisions and it also intends to provide a hint for future political decisions and actions.

In order to provide a comprehensive mapping of the societal impact, it was decided to cover also aspects related to medium/long-term goals (e.g. seamlessness, environmental impact, etc.). The collection of sufficient data to draw meaningful conclusions may not be possible at present, but these are envisaged as key aspects for the near future. Therefore, for future application of the SEIA Framework, it is recommended to further develop the indicators covering those aspects which analysis may be premature at present.

Furthermore, the ambitious nature of the goals of the second cycle of SEIA has been acknowledged and the challenge of providing comprehensive answers to the five high-level questions has been taken into account. It is expected to achieve good results for what concerns the first four questions, while the answer to the fifth one may require further development of the methodology. Methods and techniques to measure the social return on investment of research has been analysed and the SROI method (Social Return On Investment) has been identified as a very promising one to address this challenging question (for more information see Appendix III). Thus, for future application of the SEIA Framework, it is recommended to further develop the SEIA methodology by taking the cue of the SROI concept.

Lastly, for a complete assessment, it is recommended to apply the SEIA Framework to all the Aviation Safety Research projects and integrate this bottom up flow with a top-down view obtainable via interviews and targeted workshops with experts or other relevant actors. Furthermore, to ease both data collection and analysis phases, it is suggested to streamline the questionnaire and make it part of the final publishable report in order to generate a self-sustainable repository for assessing the societal impact of research.

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APPENDIX I – THE PROJECT QUESTIONNAIRE AND FOLLOW-UP INTERVIEWS

This appendix lists the questions that are included in the questionnaire and the follow-on interviews, and traces each question to their corresponding SEIA indicators and metrics.

Socio-Economic Impact Assessment

General information

1. Given name: *

2. Family name: *

3. Organisation name: *

4. Project name: *

Questions 1 through 4 are general questions included for traceability of the results. In the report, all answers will be treated anonymously.

Objectives and scope of the Project

5. Is your project oriented more towards **short-term or long-term safety goals**? *

- ○ Short-term goals
- ○ Long-term goals
- ○ Both

6. *For both short-term and long-term goals, please specify:*

	Time horizon envisaged (years)	Project budget (%)
Short-terms goals		
Long-terms goals		

Questions 5 and 6 refer to the following metric:

- '*Project coordinators evaluation of their projects in terms of mapping on the ACARE time horizons and strategic safety goals*' for Indicator 'Reactivity vs proactivity'.

For background on ACARE strategic goals, see e.g. http://www.acare4europe.com/acare-db.

Potential follow-on questions are:

- Why did your project put more emphasis on short term goals (/ long term goals)?
- Would you have distributed part of the actual budget/asked for more budget in order to cover safety issues / long term goals considered relevant for your project?
- Overall, what is your perception of the distribution of budget between current safety issues and strategic goals? In your point of view, what would be the right balance?

7. Which **aviation segments** are **addressed** by the activities of your project? *

- ☐ Airport design and operations
- ☐ Air Traffic Management operations
- ☐ Airline and crew operations
- ☐ Maintenance
- ☐ Aircraft structures and design
- ☐ Avionics
- ☐ Meteo services
- ☐ No specific segments
- ☐ Other (please specify) [ ]
- ☐ Other (please specify) [ ]

Question 7 refers to the following metric:

- '*Aviation segments addressed (airport, airborne, ATM, maintenance?)*' for Indicator '<u>Intermodality</u>'.

No follow-on questions were deemed necessary to address this. Note that Questions 10 and 11 address other aspects of this indicator Intermodality.

8. To what extent does your project take into account the **seamless mobility goal** (i.e. combining different modes of transport in a seamless travel experience - both passenger and freight) for the development, evaluation and validation process of its outcomes? *

Not at all	Low	Medium	High
○	○	○	○

9. *For answers different from "Not at all", please specify the type of contribution provided:*

- ☐ Contribution to the understanding of the demand (seamless customer expectations)
- ☐ Contribution to the seamless transfer between transport modes
- ☐ Contribution to the efficiency of physical infrastructure supporting seamless mobility (e.g. transport hubs facilities)
- ☐ Contribution to the efficiency of immaterial infrastructure supporting seamless mobility (customer services such as baggage handling, intermodal information, communication and management systems, etc.)
- ☐ Other (please specify) [ ]

Questions 8 and 9 refer to the following metrics:

- '*Physical infrastructure improving customer safety while supporting a seamless mobility*' and
- '*Immaterial infrastructure supporting a seamless mobility*' for Indicator '<u>Seamlessness</u>'.

Potential follow-on questions are:

- Which modes of transport are addressed in your project in relation to seamless mobility?
- If you selected more than one option at question 9, which option gets the highest contribution from the project?
- [In case you answered 'Not at all':] Would any of the options listed at Question 9 have been interesting / appropriate to consider for your project?
- [In case answer at 'Other' is not clear yet:] Could you expand on your answer?

10. Does your project aim to contribute to safety aspects of **transport modes other than aviation**? *

- ○ Yes
- ○ No

11. *If yes, please specify the industry and the segments of interest.*
Segment examples - Rail: operation, traffic control, rail infrastructure, signalling, throughput, etc.
Segment examples - Road: automotive, road infrastructure, throughput, etc.
Segment examples - Maritime: search and rescue, cargo, ferries, fishing, traffic control, etc.

	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Rail					
Road					
Maritime					
Enter another option					

Questions 10 and 11 refer to the following metric:

- '*Other transport modes addressed*' for Indicator '<u>Intermodality</u>'.

No follow-on questions were deemed necessary to address this.

12. To what extent does your project take into account **environmental aspects**? *

- ○ Not at all
- ○ They are considered, but environmental impact is not formally assessed
- ○ They are an integral part of the project activities and environmental impact is assessed

Question 12 refers to the following metric:

- '*Degree to which the project has factored environmental impact into its activities*' for Indicator '<u>Environmental impact</u>'.

Potential follow-on questions are:

- Can you explain how your project takes environmental impact into account?
- What kind of environmental impact is considered? (E.g. noise, emissions, climate change, use of alternative energy sources)
- Does your project consider environmental impact during development, or during evaluation or during the validation process of the outcomes? (Multiple answers possible).

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13. How many **researchers** (Full-Time Equivalent, FTE) per partner are directly engaged in your project? Please also specify the partner's **main area of expertise** within the project.

	Partner name	Number of researchers (FTE)	of which Female (FTE)	Competence
1				
2				
3				

Question 13 refers to the following metric:

- '*Number of project partners: in total, per nation, per cluster of enablers (i.e. action area)*' for Indicator 'Dispersion of investment'.

Follow-on questions are not deemed necessary, but an internet search will be done to further address this metric.

14. Please provide an indication (number) of the **professional qualifications of the staff** directly engaged in your research project:

	Number
Students	
Bachelors	
Masters	
Diploma	
PhDs	
Enter another option	

15. How many **experts** beyond the project's core team are associated with the project (e.g. advisory board), and what is their professional qualification?

	Number
Students	
Bachelors	
Masters	
Diploma	
PhDs	
Enter another option	

Questions 14 and 15 refer to the following metric:

- '*H-Index of principal investigators*' for Indicator 'Research excellence'.

In hindsight, no follow-on questions were deemed necessary. The results will be complemented by Internet search. Note that Question 23 addresses other aspects of indicator Research excellence.

Input from past projects and access to research facilities

16. Within your project, do you use as input **any result from related safety research** (previous or ongoing, aviation and - only if relevant - other safety critical domains)? *

- ○ Yes
- ○ No

17. *If yes, please specify:*

	Project name	Degree of importance [Please use: Low - Medium - High]	Rational for this qualification	Ease of access to project documentation (e.g. deliverables, reports, papers) [Please use: Low - Medium - High]	Accessibility to key personnel (e.g. for exchange of information or cooperation) [Please use: Low - Medium - High]
1					
2					
3					

Questions 16 and 17 refer to the following metrics:

- '*Availability of knowledge (e.g. deliverables, reports, papers) generated during past research projects for re-use*',
- '*Ease of access to past projects' key personnel (e.g. exchange of information and/or cooperation)*' for indicator '<u>Knowledge Availability and Accessibility</u>' and
- '*Degree of re-use/exploitation of previous research results*' for Indicator '<u>Managed life-cycle of research and innovation</u>'.

Potential follow-on questions are:

- To what extent was the information that you used already available within your consortium?
- To what extent was the key personnel that you needed access to already available within your consortium?
- To what extent did the success of your project depend on the availability of the information / key personnel?

18. Are there other **results from previous or ongoing related aviation safety research** that could be an important input for your project but are not used? *

- ○ No
- ○ Yes, because they are not accessible
- ○ Yes, because I wasn't aware of them at the appropriate time
- ○ Yes, because of other reasons (please specify)

Question 18 refers to the following metrics:

- *'Degree of re-use/exploitation of previous research results' and*
- *'Degree of awareness of related activities'* for Indicator 'Managed life-cycle of research and innovation'.

Potential follow-on questions are:

- What is the impact on your project of not having used these other results?

19. Please explain which **validation/testing facilities or methods** are required, and explain whether they are already **available** and **accessible** to the project.

	Facility/Method	Description	Availability [Please use: Yes/Partially/No]	Accessibility [Please use: Yes/Partially/No]
1				
2				
3				

Question 19 refers to the following metrics:

- *'Level of availability of necessary validation facilities'* and
- *'Ease of access to necessary validation facilities'* for Indicator 'Facilities availability and accessibility'.

Potential follow-on questions are:

- To what extent does the quality of the outputs of your project depend on the availability of validation / testing facilities, infrastructures or methods?
- Were these validation facilities available within your consortium?
- If not, how did you get access?

Scientific output of the Project

20. Has the project developed any **new facilities for validation or testing,** such as new ***infrastructures***, ***methods***, ***tools***, or ***processes***? *

- ○ Yes
- ○ No

21. *If yes, please list the facilities developed, describe them briefly and identify their level of accessibility beyond the project.*

	Type of facility *(e.g. infrastructure, method, tool, process, etc.)*	Short description	Level of accessibility beyond the project [Please use: Confidential - Restricted to specific users only - Public - Commercial product]
1			
2			
3			

Questions 20 and 21 refer to the following metric:

- '*Number and description of validation facilities and methods developed within the project and their accessibility beyond the project*' for Indicator 'Facilities Preservation and Generation'.

Potential follow-on questions are:

- [If not clear yet:] Could you briefly describe the validation facilities and methods you listed here?
- Were the facilities built from scratch? To what extent were they based on existing developments?
- What is their level of completion when the project ends? Do they require additional development beyond the project before they can be used?
- What are your exploitation plans for these facilities?
- In your point of view, how relevant and useful are these facilities in addressing safety needs and goals for the overall community (research, industry, regulator) (are we building the right system)?

22. Please indicate the number of **dissemination outcomes**:

Conference papers	
Journal papers	
Citations	
Invited talks	
Appearances in mass media	
Press releases	
Presentations to policy makers (or EASA, NSAs, other relevant parties)	
Dissemination events (workshops, conferences etc. organised by the Project Consortium)	
Other (please specify)	

Question 22 refers to the following metrics:

- '*Figures on dissemination activities (e.g. number of press releases, appearance on mass media, etc.)*' for Indicator 'Public awareness',
- '*Figures on mentions of project by policy makers (e.g. meetings with policy makers, project findings directly/indirectly mentioned in a policy brief or presentation, influences on policy maker actions, influences on policy, regulations, directives outcomes and/or implementation, etc.)*' for Indicator 'Political awareness'
- '*Count and trend of: Number of papers*' for indicator 'Knowledge Preservation and Generation'.

For the first metric, no follow-on questions were deemed necessary.

For the second metric, potential follow-on questions are:

- Which kinds of policy makers were addressed in the presentations mentioned?
- Do you think the project presentation may have influenced the further actions of the policy maker?

- After the presentation, did you have a follow-on exchange with the policy maker (e.g. meeting, communication by phone or email)?
- In the period after the presentation, did the policy maker mention the project or its findings in e.g. a presentation, a policy brief or other publication?

For the third metric, potential follow-on questions are:

- Did the project develop remarkable expert knowledge that, for some reason, will not be disseminated by one of the means mentioned in Question 22? What kind of expert knowledge?

23. Please list the project's **top 5 best publications**:

1 [ ]
2 [ ]
3 [ ]
4 [ ]
5 [ ]

Question 23 refers to the following metrics:

- '*Impact factors of best 5 publications of the project*' and
- '*H-Index of principal investigators*' for Indicator 'Research excellence'.

Potential follow-on questions are:

- Please explain how you interpreted the term "best".
- To what extent are these publications public?
- To what extent did these publications have an impact on other safety research?
- Would you be able to provide an estimate of the number of citations for these five publications (excluding self-citations, but including future citations)? E.g. (0-5), (6-20), (21-100), more than 100.
- Would you be able to provide other objective indicators of the quality of the research described in these five publications?

The results will be complemented by Internet search.

24. Are the **Project deliverables and reports** containing the main scientific and/or technical results publicly **available**? *

- ○ Yes, all of them
- ○ Yes, some of them
- ○ None

25. *If yes, please specify:*

	Number of PU (public)
	Number of non-PU
	Percentage of the developed knowledge that can be regarded as publicly available

Questions 24 and 25 refer to the following metric:

- '*Count and trend of: Number of PU deliverables and reports and % of availability of developed knowledge*' for Indicator '<u>Knowledge Preservation and Generation</u>'.

Potential follow-on questions are:

- You indicated that [??]% of the developed knowledge is not publicly available. What type of knowledge is it in this percentage?
- Why is it not going to be captured in any project document?
- How do you intend to capture this percentage of knowledge in order not to lose it? Perhaps is it going to be captured via other means (e.g. papers)?
- In general, do you think there is an increasing or a decreasing trend to make deliverables publicly available? Please explain your answer.

26. If any, please indicate the number of **expected, pending or actual patents** of findings, inventions, technologies, any other innovation developed within the project and describe them briefly.

	Description	Status [Please use: Expected - Pending - Actual]
Patent 1		
Patent 2		
Patent 3		

Question 26 refers to the following metric:

- '*Number of patents (expected, pending, or actual)*' for Indicator '<u>Cutting edge safety solutions and technologies</u>'.

Potential follow-on questions are:

- [If answer is not sufficiently clear yet:] Could you briefly explain the patents developed within the project?

27. Has your project generated **results that are considered relevant to safety critical sectors other than aviation** (e.g. other transport modes, healthcare, nuclear, oil & gas)? *

- ○ Yes
- ○ No

28. *If yes, please specify sector(s) and topic(s):*

	Sector	Topic
1		
2		
3		

Questions 27 and 28 refer to the following metric:

- *'Number and description of transport modes and/or safety critical industries other than aviation that can be addressed using results from the project'* for Indicator 'Innovation spill-over'.

Potential follow-on questions are:

- Does your project have a specific coordination with the other safety-critical industry in place in order to activate the results being picked up?

Results and opportunities generated by the Project

29. Did you or your project partners have to **recruit new personnel** to achieve the project's objectives? *

- ○ Yes
- ○ No
- ○ I don't know

30. *If yes, please estimate number of FTE's (Full-Time Equivalent):*

Questions 29 and 30 refer to the following metric:

- *'Number of people hired for achieving the project's objectives'* for Indicator 'Employment creation'.

Potential follow-on questions are:

- Could you explain the expertise of the newly hired personnel?
- Was the personnel hired exclusively for this project?
- After project completion, will the newly hired personnel remain employed, to work on other projects?
- Do you think there is an increasing or a decreasing trend in hiring new personnel for Safety Research?

31. Would you say that the project, thanks to its outcomes, has created **employment opportunities**? *

- ○ Yes
- ○ No

32. *If yes, would you be able to express them in FTE's (Full-Time Equivalent) value?*

Questions 31 and 32 refer to the following metric:

- '*Number of FTE's created by the project*' for Indicator 'Employment creation'.

Potential follow-on questions are:

- Could you explain how your project created employment opportunities?
- To what extent are the employment opportunities already concrete at present?

33. In your opinion, has this project provided **opportunities for career advancement**? *

- ○ Yes
- ○ No

34. *If yes, please indicate the number of people who got promoted:*

Questions 33 and 34 refer to the following metric:

- '*Count and trend of: Professional advancements during the project (if traceable)*' for Indicator 'Knowledge Preservation and Generation'.

Potential follow-on questions are:

- Could you expand on your answer? For example, which kinds of promotions were made?
- Were these promotions made within one company?
- To what extent were the promotions due to the developments in this project?

35. Please indicate the number of **PhD theses**, **Master's theses** and other theses that have resulted/will result from the project:

Number of Master's theses

Number of PhD theses

Other (please specify)

Question 35 refers to the following metric:

- '*Count and trend of: Number of master, doctoral, and post-doc persons (theses)*' for Indicator 'Knowledge Preservation and Generation'.

In hindsight, no follow-on questions were deemed necessary.

36. Do you expect that the results of your project will contribute to the **development/improvement of any existing/new Industry Safety Standards**? *

- ○ Yes
- ○ No

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37. *If yes, please briefly describe the main areas of standardisation concerned and highlight their applicability:*

	Standard	Applicability (area) [Please use: Technical - Processual]	Applicability (geo) [Please use: Global - Local]
1			
2			
3			

Questions 36 and 37 refer to the following metric:

- '*Project coordinator expectation/assessment of project impact on existing/new standards*' for Indicator '<u>EU Safety Standards</u>'.

Potential follow-on questions are:

- Will this concern safety standards for aviation, or other safety standards?
- Do you think the project results will be picked up easier, due to your influence on safety standards? (legal ease of adoption)

38. Do you expect the results of your project will contribute to the **development, revision and/or improvement of any Aviation Safety Regulation**? *

- ☐ Yes, National Aviation Safety Regulations
- ☐ Yes, EU Aviation Safety Regulations
- ☐ Yes, non-EU Aviation Safety Regulations
- ☐ Yes, Global Aviation Safety Regulations
- ☐ No

39. *If yes, please briefly describe the domain(s) of potential influence and the ways your project would affect the regulation:*

	Regulation	Type [Please use: National, EU, non-EU, Global]	Domain of potential influence	Foreseen influence (short description)
1				
2				
3				

Questions 38 and 39 refer to the following metric:

- '*Project coordinator expectation/assessment of project impact on existing/new EU aviation safety regulations*' for Indicator '<u>EU Safety Regulations</u>'.

Potential follow-on questions are:

- Do you think the project results will be picked up easier, due to your influence on safety regulations? (legal ease of adoption)
- Do you think the results of your project could contribute to non-Aviation Safety Regulation? Which kind?

40. Please evaluate the extent to which your research has contributed to the **identification and/or creation of new business opportunities** within and/or outside the EU:

	Number	Short description	Scope [Please use: Inside EU - Outside EU - Both]
1			
2			

Question 40 refers to the following metrics:

- '*Number of business cases developed by the project*',
- '*Number and description of potential business opportunities, as identified by a business case*',
- '*Number of business plans developed as a result of business cases evidences (planned, or actual)*' and
- '*Number of spin-off companies, or commercialisation activities (expected, or actual)*' for Indicator 'Business opportunities'.

Potential follow-on questions are:

- [In case the answer is not clear yet:] Could you briefly explain which potential new business opportunities or commercial spin-offs your project has contributed to?

41. What's your expectation towards **industry uptake** of the outcomes of your project? *

- ○ Low
- ○ Medium
- ○ High

Question 41 refers to the following metric:

- '*Project coordinators expectations towards industry uptake of research outcomes*' for Indicator 'Cutting edge safety solutions and technologies'.

Potential follow-on questions are:

- In what way do you think your project has potential for the introduction of innovative processes, technologies or services?
- Does the project or your organisation have any means in place to ensure industry uptake?

Project visibility to the outside world

42. If (a) project dissemination event(s) took place, did **representatives from outside the EU** participate in this (these) event(s)? *

- ○ Yes
- ○ No

Question 42 refers to the following metric:

- '*Qualitative assessment of project impacts on parties outside the EU*' for Indicator 'Global penetration'.

Potential follow-on questions are:

- If the answer to Question 42 is yes: What kind of dissemination event was this?
- Which types of representatives outside the EU participated?
- From which country / continent?
- Did they participate actively or as audience?
- Did they explicitly show their interest in specific outcomes of the project?
- In a more general sense: To what extent will your project have impact on parties (countries, industries, agencies, universities, etc.) outside the EU?
- Which types of parties?
- Which part of the world?

43. Has the project received an **invitation** to:

	Yes/No	How often (n)
Participate in an **international (within EU) event**?		
Present the project or its findings at an **international (within EU) event?**		
Participate in an **international (outside EU) event**?		
Present the project or its findings at an **international (outside EU) event**?		

Question 43 refers to the following metric:

- '*Quantitative figures (e.g. number of citations and mentions, percentage of market penetration, etc.) (only if available and relevant)*' for Indicator '<u>Global penetration</u>'.

Potential follow-on questions are:

- If you received such invitation, did you actually go?
- Perhaps you did not receive an invitation, but did participate in these events. Which? How often?
- Did these concern active participations, or as part of an audience?
- Did you get feedback? What kind of feedback?

General comments

44. *Is there anything else you would like to add?*

45. *Please share with us any problems you encountered or feedback you might have.*

Questions 44 and 45 do not refer to a metric, but request for feedback on the questionnaire.

Some of the metrics are not covered in the questionnaire but will be addressed in follow-on interviews. These are:

- '*Ranking of EU Research Centres and Universities*' and
- '*Percentage and trend of students (undergraduates and masters) outside the EU, PhD and researchers*' for Indicator 'International recognition and attractiveness'.

Potential follow-on questions for these metrics are:

- When restricting to your own organisation: To what extent do you think your organisation is known and recognized internationally?
- What kind of expertise are you recognised for?
- Is your organisation actively looking for international recognition? If yes, how?
- Does your organisation employ students and researchers from outside the EU? How many? Is there an increasing trend or a decreasing trend?

The follow-on questions for these two metrics will be complemented by an internet search.

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APPENDIX II – UNIVERSITIES & RESEARCH INSTITUTES SURVEY

Some of the metrics will be covered by collecting University Expert's opinions. These metrics are:

- '*Trend in engagement (number of people doing safety research)*' and
- '*Subjective assessment of the potential for job creation post-research (i.e. industrialisation/operation of results)*' for indicator 'Employment creation'.

To address these metrics, the following survey will be sent to 113 EU University contacts in Aerospace Safety research:

1. Given name
2. Family name
3. Establishment
4. Department
5. Can you please indicate the **main domains of aviation safety** addressed by your establishment (multiple answers possible)?
    - Flight physics
    - Flight mechanics
    - Structures
    - Propulsion
    - Aircraft systems
    - Integrated design and validation
    - Airport operations
    - ATM (air traffic management)
    - Flight operations
    - Meteorology and climate change impact
    - Innovative concepts
    - Human factors
    - Other
6. Would you please provide an indication of the **composition of the department** where **aviation safety research** is performed:

	FTE (Full-Time Equivalent)	Of which women (FTE)	Of which extra-EU (FTE)
Bachelors			
Masters			
PhD			
Post Docs			

Others			

7. Can you please provide an approximate indication of the **annual intake** (number of new staff and students in FTE) of the department where **aviation safety research** is performed?
8. Can you please provide an estimation of the **percentage of students** involved in aviation safety research **who find jobs** within a year post study?
9. Can you please provide an indication of the **predominant source of influence** for any **safety research topics** performed by your establishment?
   - ACARE SRIA (Advisory Council of Aviation Research and innovation in Europe Strategic Research and Innovation Agenda)
   - EASA (European Aviation Safety Agency)
   - EC (European Commission)
   - Industrial needs
   - Other
10. Can you please provide an indication of the **ongoing safety research projects** to which your department contributes, together with their **main objectives**?

	Project name	Main objective 1	Main objective 2	Main objective 3
Project 1				
Project 2				
....				

Some of the metrics will be covered completely in Internet search. These are:

- '*Accident/Incident categories comparison with safety research focus*' for Indicator 'Research coverage of European top risk areas',
- '*Total Investment in monetary terms, obtained by summing all the safety research project budget (and if possible FTE)*',
- '*Overall figures of safety budget provided by the Commission*',
- '*Comparison of overall EU figures with non-EU figures*' for Indicator 'Research investment',
- '*Trend per FP6, FP7, H2020*' for Indicator 'Dispersion of investment'

For one indicator, i.e. 'Expert perception', no metrics were identified.

APPENDIX III – RETURN OF INVESTMENT IN AVIATION SAFETY RESEARCH

The measurement of the return of this bunch of investments has emerged as one of the current hottest topics for the European Commission. The possibility to develop a ROI indicator (Return On Investment) of Aviation Safety Research was investigated and the conclusions of this research are hereby reported.

RETURN ON INVESTMENT

The Return On Investment (ROI) indicator is a ***performance measure*** used by economists for ***evaluating the efficiency of investments***. It represents one of the most commonly used approaches for evaluating the financial consequences of business investments, decisions or actions.

The ROI indicator is used both for *estimating the expected returns* of future investments and for *calculating the actual payback* of assets already employed. In purely economic terms, it is a way of considering profits in relation to capital invested. The traditional ROI is calculated by diving the benefits of an investment – 'operating income' in technical words – by the costs of the investment.

ROI = (Gains from Investment – Cost of Investment) / Total Assets

The ROI is a very important metric in business and its calculation nowadays underlies any investment decision and ex-post evaluation. Nevertheless, the calculation of the true value generated with a specific investment has always been challenging. In fact, the estimated ROI of future investment by itself says nothing about the likelihood that expected returns and costs will appear as predicted. The ROI calculated ex-post, however, brings with itself other limitations concerning factors such as spill-over effects and time to pay-off.

On the basis of this information and general considerations on the traditional way of evaluating the efficiency of investments, the possibility to develop a ROI Indicator of Aviation Safety Research was investigated. '*ROI of Safety interventions*', '*ROI of Research*' and '*ROI of Safety Research*' are the three areas that were explored and on which the conclusions were drawn.

ROI of Safety interventions

For years, the measurement of safety investments' financial return has for years been a relevant topic for both Safety Institutions and Associations, Top Managers and Safety Personnel of many sectors. In particular, it is a sensitive topic for high-risk industries and much has been developed especially in the fields of ***healthcare***, ***electricity power***, ***construction*** and ***aerospace***.

A cross-domain search was conducted on the web showing a wide recognition of the effectiveness of investments in safety programmes and interventions. Nevertheless, a unique and widely accepted method for the calculation of the ROI of Safety hasn't been developed yet. Many methods and tools are available but no mutual agreement on the variables to consider has been reached. This situation can be attributed to two main types of factors:

- *Subjective factor*: the performance indicators discussed by safety executives typically differ from those discussed by corporate finance departments;
- *Objective factors*: the full understanding of costs and benefits (e.g. increased productivity, reduced costs, etc.) associated to safety interventions is often complicated.

In the domain of aerospace, the major contributions to the topic appear to come from the FAA. The USA Authority has indeed developed a prototype named '*ROI calculator*' for the prediction and/or measurement of safety and financial return of safety interventions. As shown in Figure 3, the FAA tool

calculates the ROI by deducting the costs from the net returns (given by the expected benefit times the probability of success) and then dividing it by the cost.

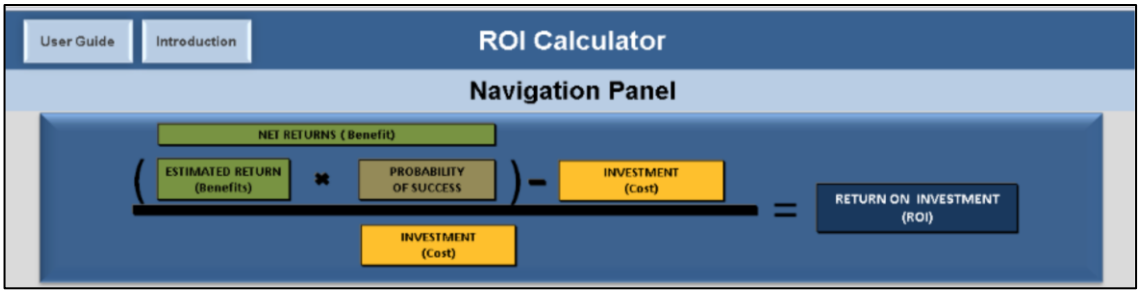

Figure 3: The ROI Calculator (source: FAA, 2012)

This calculator was used to measure the impact of different interventions and the results obtained were all positive. Although some of the ROIs came up with extremely high and unrealistic figures (Johnson, 2012), this tool is widely considered as a valuable instrument able to roughly quantify and thus highlight the obvious: safety is money! On the other hand, this significant leap forward in the measurement of ROI of safety further emphasises the already mentioned objective complexities in the estimation of benefits and costs.

ROI of Research

The estimation before the project and measurement afterwards of the funds allotted to research projects is another crucial topic worldwide. The need of research and its importance for the overall prosperity, health, environment and hence for the quality of everyone's life is widely acknowledged. It's not surprising that everybody agrees on the fact that a large component of modern economic growth has been driven by innovation and thus comes from new ideas and prototypes generated within research projects. However, the development of a method for evaluating the return of investments in research appears to be rather challenging.

The major contributions to this topic comes from the ***Pharmacological Research sector***, the ***New Technology industry*** and the ***Environmental Science field***. Despite everyone's desire to measure the ROI of research and the significant effort put into it, it seems that there is no uniform way to institutionalise such practice across all disciplines, or even within disciplines (Dingwell, 2013). These general difficulties in evaluating science can be attributed to the extreme complexity of the definition of costs and benefits of research. Although this is a complexity factor essentially common to any attempt to calculate ROI, in the evaluation of the return of investment in research it appears to be more challenging than any other area. This extreme complexity is mainly due to the following elements:

1. *Involvement of different actors with different approaches and diverging interests*. The ROI of Research is a hot topic not only for researchers, research centres and universities but also for many other actors such as politicians, economists, sociologists, industries, etc. To understand the magnitude of this angle of the problem, simply try to figure out the answers that these actors would give to the question 'which is the main economic return generated by an investment in research?'. The researches may answer 'knowledge', the economist 'GDP', the sociologist 'human capital', and so on. The finding of a common ground seems to be the first challenge which leads to this complexity;
2. *Long term effect of research and varying time-lag*.
3. *Spill-over effect*. The benefits from research often "spill-over" across organisations, sectors and nations. These are effects hard to measure and almost impossible to predict.

To conclude, despite many methods that have been developed, proposed and applied, to date there seems to be no common ground within both disciplines and sectors.

ROI of Safety Research

Knowing the state-of-the-art of the ROI of Research at a general level, the conclusion about the ROI of Safety Research should be pretty straightforward.

The interest on the topic is not questioned even though the web-search conducted didn't bring up any explicit sign of this concern. However, the already documented general acknowledgement of the relevance of both ROI of Safety and ROI of Research, leads to the assumption that ROI of Safety Research is a topic of high interest not only for the European Commission.

Also on the practical side, no attempts to develop structured methods for the evaluation of a ROI of Safety Research were found. It is very likely that the low maturity of its concept is due to the highly challenging nature of this evaluation. In fact, seeing the complexity factors described in the above sections, the complexity on which this indicator lies.

The web-search conducted has enabled to shore up the relevance of the ROI of Safety Research and the added value that its evaluation would bring into the overall Safety Science Community. Indeed, the understanding of the link between safety research and economic impact would be an important step towards enhancing research strategies and funds allotment can readily be imagined.

Besides this widely acknowledged relevance, the complex evaluation of this indicator was observed. This complexity was attributed to the difficulties in the definition of costs and benefits of research which are, in turn, mainly due to its broad effect, its time-lag as well as the diverging interests of the different actors involved.

This complexity needed to be addressed in order to find a way to respond to the interest on this topic shown by the European Commission. A further analysis was carried out and it was essentially led by three driving questions:

1. *What is the original concept of ROI?*

   ROI is a purely economic indicator which is defined as '*The earning power of assets measured as the ratio of the net income (profit minus depreciation) to the average capital employed (or equity capital) in a company or project*' (taken from businessdictionary.com). This is the way used by economist to evaluate the efficiency of investments and it takes into account only quantitative and tangible factors which are available in the annual financial statement.

2. *What is the outcome that can respond to the interest shown?*

   Two are two key points to consider in order to answer this question:

   a) The aim of the OPTICS Project is '*to provide a complete picture of how research and innovation is performing, confirming that the right research is being conducted and that research is delivering the **expected benefits to society**, drawing conclusions and providing recommendations for consideration by the European Commission and other stakeholders as research and innovation progress along the pathway to the vision*';

   b) The mentioned ***vision*** is the one of the **ACARE FlightPath 2050** which addresses two parallel objectives '*Firstly to serve **society's needs for safe**, **more efficient** and **environmentally friendly** air transport; and secondly, to **maintain global leadership for Europe** in this sector with a competitive supply chain including large companies and small and medium size enterprises.*'

On the basis of these two key points, it is assumed that the expected outcome is a synthetic indicator which gives a comprehensive overview on how the European aviation safety research is performing against the objectives.

3. *Does the ROI concept (point 1) match the expectations (2)?*

   Knowing that:

   - ROI is a purely economic indicator which takes into account quantitative factors only;
   - The OPTICS objectives are driven by the ACARE vision which goes far beyond the economic impact by considering also the societal, industrial and environmental impacts;
   - The OPTICS SEIA Team has already been producing a framework for a 360-degree' assessment of projects which is in line with the vision;
   - This framework consists of sets of indicators with both qualitative and quantitative natures.

   The conclusion drawn is that the development of a ROI indicator coherent with its economic conception may not square up fully with the expectations. Indeed, this traditional indicator fails to incorporate returns beyond the financial payback, such as the societal and the environmental ones which are key elements of the ACARE vision. As a Professor of a New York University Stern School of Business says: "*To claim that tangible assets should be measured and valued, while intangibles should not – or could not – is like stating that 'things' are valuable, while 'ideas' are not*" (Ernst&Young LLP, 1997). On the basis of the broad vision which leads the OPTICS projects' assessment, taking this direction may therefore be an understatement.

This conclusion led to the acknowledgment of the need of a broader indicator which covers all the spheres of the ACARE vision. This overarching indicator, which is presented and proposed in the following section, takes the cue from the third sector and is dubbed **Social Return On Investment (SROI)**.

SOCIAL RETURN ON INVESTMENT (SROI)

The **Social Return On Investment (SROI)** is a method developed for the purpose of capturing the huge value created with everyday actions and activities that cannot be captured by financial instruments and methods. To this day, there is a general tendency to measure and account for the financial value only, and that way many important things get left out. This method seeks to reduce inequality and environmental degradation and improve wellbeing by incorporating social, environmental and economic costs and benefits (The SROI Network, 2012). Put simply: **if ROI is about money, SROI is about value and it attempts to express it in money terms.**

The concept of SROI comes from the third sector which is a field where highlighting achievements is rather challenging and, at the same time, highly required. To an increased extent, non-profit organisations have to legitimise their operating and prove the social impact they have, as trust and appreciation by society is not enough to attract funding.

Social Return On Investment (SROI) can be defined as *a principles-based method for measuring non-financial value relative to resources invested.*

The SROI concept firstly appeared in 1996 when a US-based foundation (the Roberts Enterprise Development Fund) made its first attempts to demonstrate its success and thus to measure its performance. It rapidly became one of the most widely discussed methods for the social impact

measurement (Krlev G. et al., 2013). To facilitate the progressive evaluation of this method, in 2006 the SROI Network, today called Social Value UK, was founded. Today, the SROI method provides a consistent quantitative approach for the understanding and managing of the impacts of a project, business, organisation, fund or policy. It accounts for stakeholders' views of impact, and puts financial 'proxy' values on all those impacts identified by stakeholders which do not typically have market values. At the end, the SROI is expressed as a **ratio of the total impact and total investments**.

Before exploring the approach, it has to be highlighted that this method can be used retrospectively as well as to make forecasts:

- **Evaluating SROI**: it is based on actual outcomes that have already taken place;
- **Forecast SROI**: it is based on predictions of the social value that will be created if the activities meet their intended outcomes.

The approach which lies beneath the SROI method is structured in **5 steps** (The SROI Network, 2012) which are in broad terms described below. For more details, please see the SROI Guide.

1. Establishing **scope** and identifying **stakeholders** (beneficiaries and contributors);
2. Drawing the **impact map** with respect to each stakeholder identified. This map, which is sketched in Figure 4, is the core part of the SROI analysis since it details the relationship between:
    a. I**nputs**: all the resources deployed including both monetised inputs (e.g. financial resources, personnel, infrastructures, etc.) and non-cash inputs which have to be valued (e.g. volunteer time);
    b. **Outputs**: the tangible results of the activities put in place with those resources in order to generate benefits for stakeholders. These can be easily quantified and, for instance, are the number of training courses delivered, number of products created, etc.
    c. **Outcomes**: the benefits generated for each stakeholder through the outputs. The identification of outcomes is not always immediate and intuitive since sometimes distinguishing between outputs and outcomes might be tricky. For instance, if a training program aims to get people into jobs then completion of the training itself is an output, getting the job is an outcome.
3. **Demonstrating and valuing outcomes**. For each outcome at least one **indicator** is chosen that enables the understanding of whether the outcome has occurred and to what extent. Furthermore, for each outcome it has to be established how long its effect will last (the **duration** is usually expressed in years) and, most important, its **financial value**. This process of valuation is called monetisation since it essentially approximates and assigns monetary value to things that do not have market price.
4. **Establishing impact** by identifying how much of the outcome would have happened anyway and what proportion of the outcome can be isolated as being added by your activities. This requires the calculation of the so-called **deadweight** which is usually a percentage calculated through benchmarking. For instance, a way to calculate deadweight would be to look at the trend in the indicator over time to see if there is a difference between the trend before the activity started and the trend after that moment. For outcomes estimated to last more than one year, also the **drop-off** should be calculated since, as time goes on, the amount of outcome is likely to be lower and/or less attributable to the assessed project because of the emergence of other factors.

    At this stage, the impact for each outcome can be calculated as follows:

- Calculate the value of each outcome → (Financial proxy * Quantity of the outcome) - deadweight% = Total Value outcome *n*
- Add up the total → Total Value outcome X + … + Total Value outcome *n* = Overall Total Value.

5. **Calculating the SROI** by following the following steps:
   a. **Projection of the value of the outcomes into the future** on the basis of the duration established in step 3 and the drop-off calculated in step 4;
   b. **Calculation of the Net Present Value** (NPV) for which costs paid and benefits received in different time periods need to be added up (NPV = Present value of benefits – Value of investments). However, these have to be **discounted** first because of the so-called 'time value of money'. However, it should be remarked that this discounting process appears to be the weaker area of the method which is still under revision;
   c. **Calculation of the SROI ratio** = Present Value / Value of inputs or, alternatively, the **Net SROI ratio** = NPV / Value of inputs. For instance, the ratio can result equal to 3:1. This would mean that there are 3 euros of value for every 1 euro of investment.

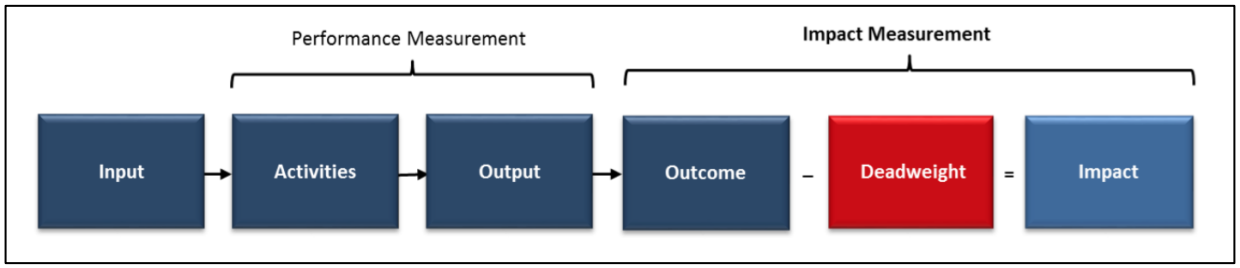

Figure 4: The SROI impact map (source: Simsa R. et al., 2015)

SROI: Benefits and limitations

It is widely acknowledged in the Third Sector that SROI is a valuable method and that its analysis could bring many beneficial effects. Two are the main advantages identified:

1. **It enables legitimacy**: the most widely acknowledged quality of SROI is its effectiveness as a communication tool. This capability is due to the fact that SROI reduces complexity by boiling the difficult task of communicating value down to one figure (Maier, F. et al., 2015);
2. **It enables rational resource allocation**: SROI analysis provides also a significant support for decision-makers and thus allows a better allocation of resources. For instance, it helps investors in identifying the best way to allocate their funds, it supports organisations in monitoring the value they are creating and so in pointing their actions and activities in the most profitable directions, it may also help policy makers in controlling the overall value creation (Maier, F. et al., 2015).

The SROI method, however, is not devoid of *limitations* which are below summarised:

1. **It is costly**: the SROI analysis is one of the most resource-intensive methods for measuring societal impact (Stevenson et al. 2010);
2. **It is based on proxies**: the quantification of qualitative issues requires approximations. This means that the quality of the results of the analysis highly depends on the quality of the approximations made. Furthermore, it is unavoidable that approximations bring with them subjective judgments that may not be embraced by everybody.

SROI & Safety Research

As previously mentioned, there is a clear need for an overarching indicator capable of capturing all the spheres of the ACARE vision. The SROI method presented in this Chapter has been developed to address a strong need to measure performance and demonstrate the success of a sector whose goals goes a way beyond the typical financial return. As already highlighted, this challenge of the Third Sector appears to be very close to the one we are attempting to tackle within this work.

Currently, the Third Sector recognises the SROI as the most effective and valuable method to address that challenge. In fact, its concept has reached a high maturity level which makes the SROI a rather solid method for capturing an intervention's full range of impacts.

Against this background, it was decided to take the cue from the SROI concept in order to develop the overarching indicator and thus fine-tuning the OPTICS SEIA Framework.

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