Preliminary Business Model of the Risk Observatory

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Short abstract: Future Sky Safety is a Joint Research Programme (JRP) on Safety, initiated by EREA, the association of European Research Establishments in Aeronautics. The Programme contains two streams of activities: 1) coordination of the safety research programmes of the EREA institutes and 2) collaborative research projects on European safety priorities.

This deliverable is produced by the Project P4 "Total system risk assessment" of Future Sky Safety (FSS). The main objective of the work documented in this report is the definition of a preliminary business model of the Risk Observatory.

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Acronyms

Acronym	Definition
ACI	Airport Council International
ADS-B	Automatic Dependent Surveillance - Broadcast
AEB	ASIAS Executive Board
AIP	Aeronautical Information Publication
ANSP	Air Navigation Service Provider
ASIAS	Aviation Safety Information Analysis and Sharing
ATCO	Air Traffic Controller
CAA	Civil Aviation Authority
CAST	Commercial Aviation Safety Team
CFIT	Controlled Flight into Terrain
EASA	European Aviation Safety Agency
EC	European Commission
ECAC	European Civil Aviation Conference
ECAST	European Commercial Aviation Safety Team
ECCAIRS	European Coordination Centre for Accident and Incident Reporting
EPAS	European Plan for Aviation Safety
EREA	European Research Establishments in Aeronautics
ESSI	European Strategic Safety Initiative
EU	European Union
FAA	Federal Aviation Administration
FDM	Flight Data Monitoring
FOQA	Flight Operations Quality Assurance
FSF	Flight Safety Foundation
FSS	Future Sky Safety
FY	Fiscal Year
GAO	Government Accountability Office
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IT	Information Technology

JRC	Joint Research Centre
JRP	Joint Research Programme
MoU	Memorandum of Understanding
MT	Management Team
NASA	National Aeronautics and Space Administration
NDA	Non-Disclosure Agreement
NOTAM	Notice to Airmen
OIG	Office of Inspector General
RO	Risk Observatory
ROO	Risk Observatory Organisation
SOP	Standard Operating Procedure
SPI	Safety Performance Indicator
STEADES	Safety Trend Evaluation, Analysis & Data Exchange System

Glossary of terms

Safety data	Facts or figures derived from safety management sources such as occurrence reports and FDM programmes. For example, the number of unstabilised approaches or loss of separation events in a period. Safety data is rarely useful by itself until it is processed and organized in a specific context, which then becomes safety information.
Safety information	Safety data organized and processed in a specific context, allowing the recipient of the information to make decisions on future actions. Example: “there is no significant reduction in the rate of unstabilised approaches for runway 99 at XYZ despite the Crew Memo issued 12 months ago reminding crews about the established Standard Operating Procedure.”
Safety intelligence	Knowledge and comprehension of the Aviation System, generated from investigation and reflection over safety information and safety data. Safety intelligence is necessary to assist aviation safety practitioners to effectively manage safety. Example: “The published NDB approach for runway 99 at XYZ is offset from the runway centre line, inducing low level manoeuvres which are in conflict with the stable approach criteria. Feedback from crews involved in these events suggest they are aware of the SOP conflict but decide to continue the approach due to the low perceived risk for the aircraft.”

EXECUTIVE SUMMARY

Problem Area

While the Risk Observatory (RO) is described in the FSS P4 project as a support tool for safety management, it requires an actual organisation to deliver and maintain the RO services. The objective of this task within the project is to develop a preliminary business model describing organisational, operational, financial and legal aspects of setting up and maintaining an organisation that manages the RO. This deliverable also contains ideas for incentives for stakeholders to assure data sharing. The business model will develop iteratively with the development of the RO prototype. Hence, the current document will be updated in a later stage of the project.

Description of Work

Four sources of information were used in the development of the preliminary business model. First, a Business Model Canvas was used as a template to describe the key elements of the Risk Observatory Organisation's (ROO) business model. Secondly, a review of identified business requirements (from D4.1) was conducted. Thirdly, a review of the Aviation Safety Information Analysis and Sharing (ASIAS) programme, the EASA feasibility study into a big data programme for aviation safety, and mandatory occurrence reporting schemes was performed to identify lessons learnt for the ROO. Finally, interviews with three stakeholders were conducted to further collect ideas and suggestions for the ROO.

The preliminary ROO business model describes the value proposition, customers, customer relationships, communication channels, key activities, resources, partners and the cost and revenue streams. An early key decision will be the selection of the host organisation to house the ROO. The report describes five options for the selection of the host organisation. For the implementation of the ROO it is envisioned that a management team can be established by joint government-industry cooperation, with terms of reference, a budget, timescales and agreed deliverables. It is expected the initial ROO will start small, but the scalability of scope and ambition is addressed in this report.

Success factors for the viability and for achieving the value proposition of the ROO are identified. A roadmap describes the activities to assure the success factors for the ROO will be met. Stakeholder involvement in the oversight and management of the ROO activities is a key success factor and therefore this report presents suggestions for the governance structure of the ROO.

Results & Conclusions

It is recommended that one ROO will be established in Europe to efficiently and effectively use resources and avoid duplication of effort. There should be one entity, one organisation or a cooperation of organisations, to deliver and maintain the RO. This is not necessarily the prototype RO developed in the

project P4. It is recommended to frame the ROO as the European central safety intelligence organisation, which brings together a collective wisdom on aviation safety, with analytical capabilities and data that the industry partners, on their own, may not be able to create.

The first initiative in such a direction seems to be taken by EASA with the feasibility study and proof of concept of a European big data programme for aviation safety, called Data4Safety. It is not the intention of the FSS P4 project to launch a ROO as a competitor to existing programmes. Indeed, the FSS P4 project shall assure that the research and development taking place in the project is complementary to, and consistent with, for example the mentioned EASA initiative. Ideally, the outcomes of Project P4 will be exploitable towards operational use by EASA in the short term.

A number of key decisions need to be taken regarding the implementation of the ROO, e.g. regarding the organisation that will deliver the RO, (long-term) funding structure and stability, and ambition level of the ROO. It is also concluded that important lessons can be learned from ASIAS and the experience with mandatory occurrence reporting schemes.

The ROO should receive aviation safety data under formal agreement with the European aviation community, and analyse the safety data for safety information and safety intelligence. Primary incentives for stakeholders to share data to the ROO are:

- Provision of safety intelligence, enabling risk analysis and defining safety performance indicators;
- Provision of safety intelligence in systemic risks across multiple operators and domains (i.e. total aviation system approach);
- Access to dedicated safety studies, benchmark analyses, shared lessons learnt, and best practices.

Recommendations are formulated for the FSS P4 team, including:

- Develop a strategy to interact with, complement and strengthen the EASA's Data4Safety programme. It will be beneficial to both programmes to exchange information on progress, use cases and analytical capabilities developed.
- Carefully develop, plan and perform promotional activities to consult and inform potential stakeholders about the RO value proposition and the RO prototype. As part of the promotional activities, explore data protection opportunities and challenges for different stakeholders. This recommendation should be followed up as soon as possible within the FSS P4 time schedule.
- Review the follow-up on the recommendations in this report when preparing the business model for operational deployment of the ROO (FSS deliverable D4.9.3).

Applicability

This document provides recommendations to the FSS P4 project team and specific work packages that should be addressed in the remainder of the project and for the final business model.

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1 INTRODUCTION

1.1. The Programme

The European Commission (EC) Flight Path 2050 vision aims to achieve the highest levels of safety to ensure that passengers and freight as well as the air transport system and its infrastructure are protected. However, trends in safety performance over the last decade indicate that the ACARE Vision 2020 safety goal of an 80% reduction of the accident rate is not being achieved. A stronger focus on safety is required. Therefore a Joint Research Programme (JRP) on Aviation Safety – Future Sky Safety (FSS) – has been started in the beginning of 2015, aiming for Coordinated Safety Research as well as Safety Research Coordination. Future Sky Safety has the goal to coordinate research and identify innovation actions targeting the highest levels of safety for European aviation [1].

1.2. Project context

In the FSS project P4 "Total System Risk Assessment" a working and practical prototype Risk Observatory (RO) is developed as a support tool for safety management. The RO will acquire, fuse and structure safety data and translate it to actionable safety information: output that helps the user to distil safety intelligence to allow the implementation of appropriate measures to positively influence safety, i.e. reducing the serious incident and accident probability. The core of the RO is formed by a risk assessment framework that integrates risk assessment models specifically developed to represent a certain domain. The framework is fed by different safety data inputs: e.g. normal operational data from the aircraft operator domain (e.g. originating from Flight Data Monitoring (FDM)) and ANSP domain, but also occurrence and incident data. The RO will offer important insights in safety performance to safety analysts, which can be used in the risk assessment of new aircraft and systems and in safety assurance by identifying safety trends, key risk areas, and efficient mitigation measures. The RO's scope includes the EASA Member States and the operations performed by service providers within the EASA Member States.

1.3. Research objectives

The objective of this task within the project is to develop a preliminary business model which relates end-user needs with responsibilities and roles in the management of the Risk Observatory (RO). The preliminary business model identifies and describes organisational, operational, financial and legal aspects of setting up and maintaining an organisation that manages the RO. This deliverable also contains first ideas on incentives (or the RO's value proposition) to assure data sharing. It is expected that the business model will develop iteratively with the development of the RO. Hence, the current document will be updated in a later stage of the project.

While the Risk Observatory is described in FSS project P4 [1] as a support tool for safety management, it is acknowledged that the essential prerequisite is that the RO products and services are delivered by an actual organisation. In the remainder of this document a distinction will be made between:

- The Risk Observatory (RO), which is the whole of the data, the risk models, dashboards with safety performance indicators, safety information and safety intelligence. This includes all hardware, software, databases, networks, ICT infrastructure, etc. that will be required to establish, maintain and support the RO. One could say that the core business of the RO is to transform data into safety information and intelligence.
- The Risk Observatory Organisation (ROO) is the entity that establishes, runs, maintains and supports the RO. In order to "design" and describe a viable ROO, a business model needs to be prepared, which describes the various aspects that have to be considered, including for example: roles and responsibilities; organisational characteristics; management or governance of the RO; the set-up, implementation and continuation of the ROO.

1.4. Approach

The Preliminary Business Model for the Risk Observatory Organisation (ROO) was developed using a combination of sources:

- The Business Model Canvas [2] as a template for the ROO business model;
- A review of identified business requirements (from D4.1) [3];
- A review of the Aviation Safety Information Analysis and Sharing (ASIAS) programme, the EASA feasibility study into a big data programme for aviation safety, and mandatory occurrence reporting schemes to identify lessons learnt for the ROO;
- Interviews with stakeholders (KLM, Lufthansa, CAA UK).

The Business Model Canvas

The Business Model Canvas is used as template in the development of the ROO business model. The canvas is a visual chart with elements describing a product's value proposition, infrastructure, customers, and finance. It assists in aligning the activities envisioned for the ROO by illustrating potential interactions between the various elements of the business model. As illustrated in Figure 1, the various elements of the Canvas are ordered around one focal element: the Value Proposition.

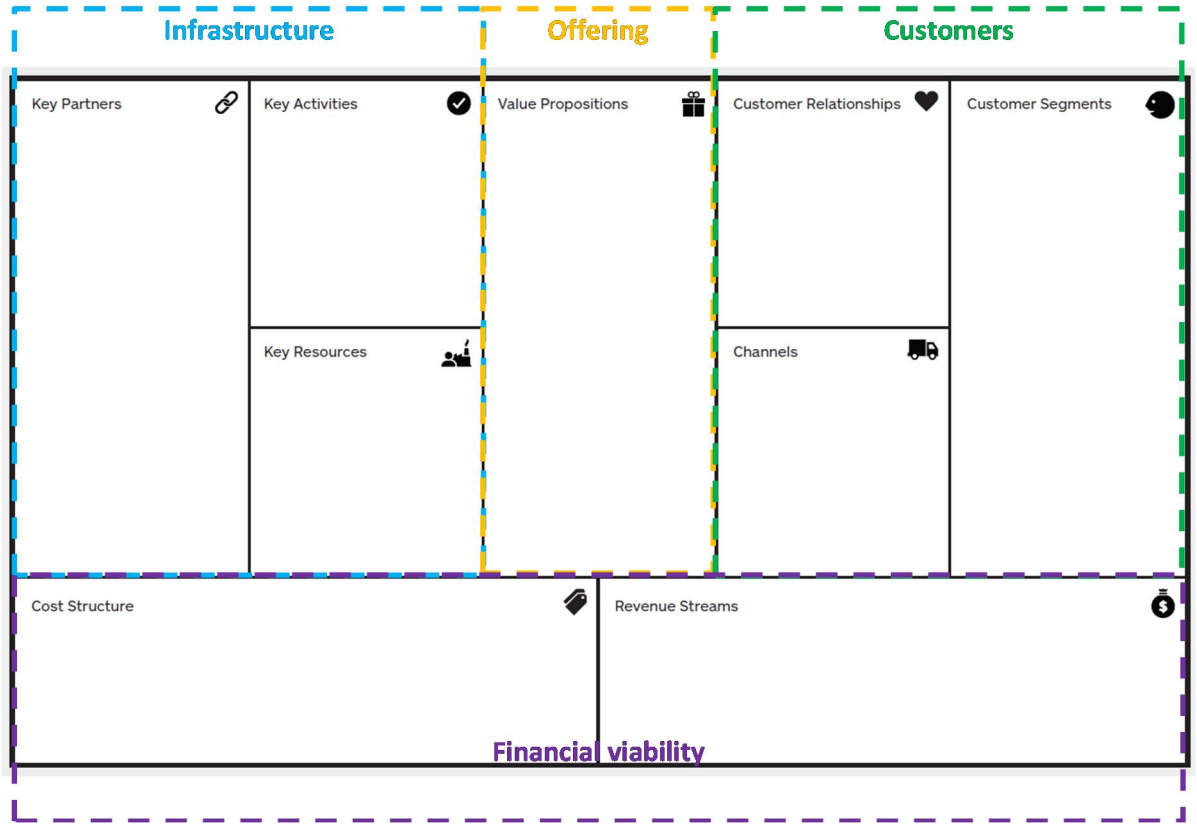

Figure 1: Business Model Canvas: nine business model building blocks.

The nine building blocks of the Business Model Canvas comprise the following four groups:

Offering:

- The central part of the Canvas is the Value Proposition, i.e. the value that is being delivered to the customers. It addresses the questions: which one of our customers' problems are we helping to solve? What services are we offering to each customer segment? Which customer needs are we satisfying?

Customers:

- Customer Segments describe for whom the business is creating value: who are our most important customers?
- The Customer Relationships describe the type of relationships with the Customer Segments. What type of relationship does each of our Customer Segments expects us to establish and maintain with them? Which ones have we established? How are they integrated with the rest of our business model? What is the cost of establishing and maintaining relationships?

- The Channels define through which Channels the Customer Segments want to be or need to be reached. How are we reaching them now? How are our Channels integrated? Which Channels work best, and are most cost-efficient? How are we integrating them with customer routines?

Infrastructure:

- Key Activities describe what key activities are required to deliver the Value Proposition. In describing Key Activities the (distribution) Channels, Customer Relationships and Revenue streams are taken into account.
- Key Resources define what key resources are required to deliver the Value Proposition, and the (distribution) Channels, Customer Relationships and Revenue Streams.
- Key Partners describe who the Key Partners and Key Suppliers are. Which Key Resources are we acquiring from partners, and which Key Activities do partners perform?

Financial viability:

- The Cost Structure identifies the most important costs inherent in the business model. Which key resources are most expensive, and which key activities are most expensive?
- The Revenue Streams define for what value the customers are really willing to pay. For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenue?

It should be noted that the way each element is defined and evolves may affect other elements of the business model. So whenever a change takes place in one of these elements, the effects on the other elements should be assessed. Each of the nine business model building blocks will be described in detail and the options and their implications for the RO will be given.

A review of identified business requirements

The second input to the preliminary business model consists of the business requirements that were identified in D4.1 [3]. These are the requirements for the RO from the viewpoint of the business needs and are generally formulated as “what” the RO should deliver, rather than “how” it should work. A number of business requirements are relevant for the business model, see Appendix A.

A review of similar initiatives

A third input to develop the business model is to review similar initiatives and experiences with occurrence reporting schemes to identify lessons learnt. In the United States, the Aviation Safety Information Analysis and Sharing (ASIAS) programme was established and has now been active for almost a decade. Lessons can be learnt from the business model and approach taken to set up the ASIAS programme. In Europe, the European Aviation Safety Agency (EASA) has recently completed a feasibility

study into a big data exchange programme for aviation safety, called Data4Safety, and EASA is now setting up a proof of concept phase. This activity is relevant to consider in the ROO business model. Likewise, a review of lessons learnt regarding the organisation of occurrence reporting schemes, required analysis capabilities and challenges in occurrence data collection are considered from an organisational viewpoint. Hence, it is identified what enablers the ROO's business model should include to benefit from previous experiences.

Interviews with stakeholders

Finally, interviews with stakeholders (KLM, Lufthansa, CAA UK) were held to collect viewpoints, experience and ideas for the business model and ROO set-up. Informal discussions have been held with others.

1.5. Structure of the document

The structure of the document is as follows:

- Chapter 2 summarises lessons learnt and experiences from similar initiatives as the RO, with a focus on identifying lessons learnt and organisational aspects that can be considered for the ROO.
- Chapter 3 describes the business model for the ROO using the business model canvas template.
- Chapter 4 defines a preliminary roadmap for establishing the ROO, and provides a few options for the ROO organisation implementing and ambition levels.
- Chapter 5 presents the conclusions.
- Chapter 6 includes the recommendations.
- Appendix A shows the relevant business requirements from work package 4.1.
- Appendix B provides a list of the required capabilities for the ROO to provide added value.
- Appendix C lists identified stakeholders in the ROO.
- Appendix D explains channels for marketing and distribution.

2 REVIEW OF SIMILAR INITIATIVES

2.1. What can FSS P4 learn from ASIAS?

2.1.1. Introduction to ASIAS

The Aviation Safety Information Analysis and Sharing (ASIAS) programme is a collaborative industry – government initiative in the United States, to share safety data and information, and to conduct analyses in order to improve aviation safety. ASIAS was started in 2007 and as of 24 February 2015 has 84 members (including 45 air carriers, 20 General Aviation members, 11 industry associations, 5 government organisations, 2 Maintenance, Repair and Overhaul (MRO) organisations and one academic body) [4, 5].

ASIAS is managed by the MITRE Corporation, a not-for-profit organisation with no commercial interests, with support from Crown Consulting Inc. The role of MITRE in ASIAS is to collect and store data from operators, to integrate data sources, to conduct statistical analyses, to facilitate collaboration (assist in developing policies, procedures and legal agreements) and share results [8, 11]. MITRE hosts the dashboards with data and information that the members can access. Crown Consulting provides technical support to ASIAS in the area of analytics, aviation subject matters, and systems expertise to perform safety analyses and enhance the information sharing and analytic capabilities of ASIAS [12].

In ASIAS the governance structure (Figure 2) includes the ASIAS Executive Board (AEB) with representation from government and industry, which develops the policy, prioritises and approves safety analyses or directed studies[1], and reviews and disseminates the analysis results. The AEB also interacts with the Commercial Aviation Safety Team (CAST). CAST is a government – industry partnership focused on reducing accidents by using a proactive, data-driven strategy to enhance safety in the National Airspace System (NAS). ASIAS provides de-identified findings at a national level to CAST, while CAST provides metrics for analysis to ASIAS, e.g. to monitor effectiveness of safety enhancements [6].

The AEB has three co-chairs: the Federal Aviation Administration (FAA), a member from the industry, and the Joint Implementation Measurement Data Analysis Team (JIMDAT). Members of the AEB include government and industry: the FAA, the Air Traffic Organisation (ATO) and the National Aeronautics and Space Administration (NASA) on the government side, while the industry members include pilot and air traffic controller unions, a manufacturer, ATA (Air Transport Association) and AIA (Aerospace Industries Association).

The ASIAS Issue Analysis Team has three co-chairs (representatives from industry, government and MITRE) with members of Air Line Pilots Association (ALPA), NASA and stakeholder airlines [5]. The ASIAS participants sign a Memorandum of Understanding (MoU) with MITRE outlining the responsibilities between parties for the collection, storage, use and dissemination of shared data [8].

[1] Directed studies are in-depth assessments of special topics of interest to the ASIAS participants.

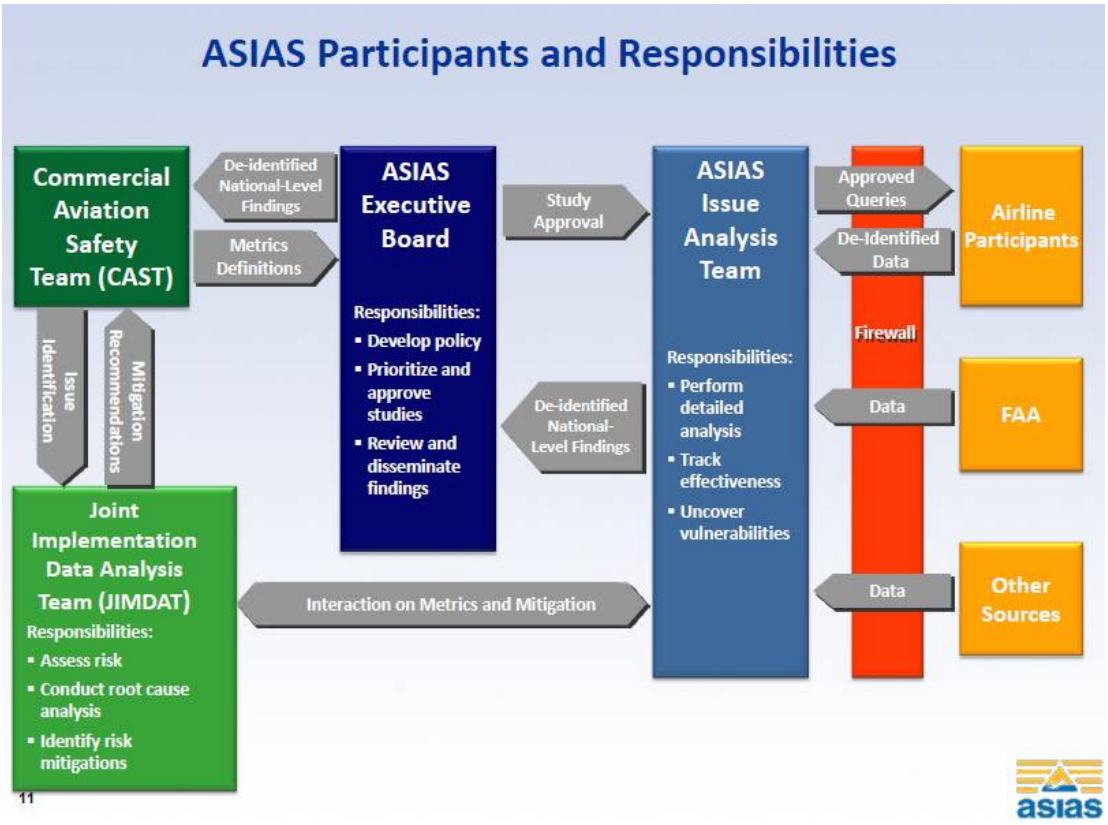

Figure 2: Governance structure of ASIAS [6].

The ASIAS principles or members' obligations [5, 6, 7] include:

- ASIAS data is used solely for the advancement of aviation safety. Safety issues/mitigations can be shared within the organisations for the purpose of improving aviation safety.
- Data cannot be used for commercial, competitive, punitive, or litigation purposes.
- Data is considered confidential and proprietary and cannot be shared without permissions.
- ASIAS procedures and policies are established through collaborative governance supported by industry participants.
- Members cannot discuss or share information using any form of social media.
- The programme assures balanced interests of all stakeholders. All members are treated equally, regardless of fleet size and type of operation.

Ref. [7, 11] mention benefits for ASIAS members:

- Access to web-based portal and dashboards (for ASIAS members only).
- Understand the safety issue trends.
- Participate in InfoShare: a confidential, private two-day event for the safety community to share and discuss aviation safety concerns or safety issues and mitigations. This is according to ref. [11] likely the most interesting experience for ASIAS members.

- Directed studies: members can participate in and/or propose ASIAS directed studies.
- Results through CAST's safety enhancements: involvement at the outset in developing broad aviation industry safety enhancements.
- (Commercial / General Aviation) Systemic safety improvements.

Ref. [9] mentions that members have access to data through a secure portal, where data is presented on dashboards. The dashboards present information on for example:

- CAST metrics, high level accident types such as approach and landing, CFIT, Mid-air collision, loss of control.
- Flight Operations Quality Assurance (FOQA), i.e. Flight Data Monitoring (FDM), benchmarks.
- Daily operational reviews (airport daily overview, arrival winds overview).
- Detailed dashboard on unstable approaches: missed approach details, missed approach initiation points on glideslope and localiser, per runway, with possibility to query within a time frame, and advanced filtering available to the user.

ASIAS collects data from confidential, proprietary sources and data in the public domain. Safety data sources are shown in Table 1 [6]. The types of analyses undertaken by ASIAS are listed in Table 2 [5].

Table 1: ASIAS data sources.

Proprietary data: - Aviation Safety Action Program (ASAP) - Flight Operations Quality Assurance (FOQA) - Air Traffic Safety Action Program (ATSAP) - Manufacturers data - Avionics data	**Safety data:** - Aviation Safety Reporting System (ASRS) - Runway Incursion - Surface Incident - Operational Errors/ Operational Deviation - Pilot Deviation - Vehicle or Pedestrian Deviation - National Transportation Safety Board - ICAO safety reports - FAA Accident/Incident Data System - FAA Service Difficulty Reports
ATC information: - Traffic Management Reroutes and Delays - Airport Configuration and Operations - Sector and Route Structure - Procedures - Surveillance Data for En-Route, Terminal and Airport - NOTAMs	**Other information:** - Bureau of Transportation Statistics - Weather / Winds - Terrain and Obstacle Data

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Table 2: Types of analyses conducted by ASIAS.

Analysis Type	Description
Vulnerability Discovery	Identification and validated assessments of previously unknown issues or accident precursors.
Directed Studies	In-depth assessments of special topics of interest to the ASIAS participants.
Known-Risk Monitoring	A set of continuously performed analyses to monitor known safety risks of interest to ASIAS participants.
Safety Enhancement Assessments	Development of metrics to identify and continuously monitor hazards and mitigating actions by industry and government participants to address known risks.
Benchmarks	Development of industry metrics applied to national, aggregated data sets to create a baseline for follow-on assessments of operations by ASIAS participants.

2.1.2. Lessons from ASIAS that may be applicable to the Risk Observatory

The FSS P4 project considers the ASIAS programme as an established safety analysis model that is well-regarded and has also been subjected to independent audit with recommendations for improvement [8]. In this section the lessons for the RO and ROO from the ASIAS programme are explained for the topics: business model and value, data collection, data quality, data protection, data integration, data analysis, governance, role of the regulator and authority, and partnerships.

Business model and value

In late 2013, the Office of the Inspector General (OIG) published an audit of ASIAS which summarised the status of the ASIAS programme as [8]: '*We found that FAA has made significant progress with implementing and encouraging participation in ASIAS since 2007, and the program now captures key confidential voluntary safety data from 95 percent of all Part 121 operations. However, FAA's plans to use ASIAS to predict safety risks are still years away, and the program does not yet contain data from non-commercial sectors of the aviation industry that could also benefit from ASIAS's safety analyses. In addition, we found that FAA does not allow its inspectors and analysts to use ASIAS's confidential data for air carrier oversight due to complex data protection agreements*'.

Thus although data collection has progressed well, the actual use of the data is still quite limited, for example the overwhelming majority of CAST initiatives are derived via mechanisms other than an ASIAS-derived predictive need to take action. That is not to say that ASIAS is of no value in these situations, as it is a potentially valuable integrated data source to support analysis.

The ASIAS business model provides an indication of what is considered acceptable in general cost-benefit terms at least in the United States. ASIAS requires a substantial funding stream and is clearly managed under a reliable, longer-term vision of potential performance - the ASIAS budget allocation for FY2014 was US$15 million. This investment will ultimately need matching in the ROO proposals as it is unlikely that very much can be achieved unless there is a realistic acceptance of financial performance needs and

timescales. However, that is not to say that funding needs to be government-based. Alternative models are possible, for example through co-operative industry sharing initiatives such as the IATA Global Aviation Data Management (GADM) process.

Lessons for the ROO:

- The European perspective is likely to be similar regarding cost-benefit as for ASIAS, and thus the ROO should set a similar scale of ambition for the risk observatory. It would however be necessary to start at a limited scale, with a scalable business model that permits growth as confidence in utility increases.
- A clear strategy for implementing safety improvements or risk mitigation measures based on outcomes from the risk observatory will be an important part of the ROO business model.
- ASIAS started with directed studies of interest to members of ASIAS. In the beginning, the ROO shall conduct safety studies that are proposed by stakeholders, and receive interest and approval from the stakeholders. This is a good starting point to deliver "quick wins" and value to the members. That will be essential in increasing confidence that the RO will work, and thus increasing participation by stakeholders.
- The ASIAS business model is government funded. Long-term funding and (financial) stability is essential to be able to build and employ the capabilities for such a programme. The European aviation community (government and industry) should consider the long term funding strategy for the ROO as a critical success factor.

Data collection

The ASIAS business model has permitted the substantial collection of sensitive data which is fundamental to the operation of a risk observatory. The acquisition of data within ASIAS takes place within a framework that clearly provides sufficient protection for participants but also in an environment that provides the incentive to participate. Initially the focus of ASIAS was on commercial air transport, but recently the scope was extended to General Aviation (including business aviation) and there is a plan for a phased expansion to other domains such as the helicopter industry.

Lessons for the ROO:

- The ROO shall develop a strategy to encourage the provision of data for the risk observatory. This will be absolutely crucial to its success.
- The ROO should develop a multi-year plan for the scope and ambition regarding the coverage of the data collection (airlines, types of operations, aircraft types, regions) and domains to include in the scope of data collection. Coverage of occurrence reports should be the whole range of flight operations: from maintenance, to dispatch, both cockpit and cabin operations. Although this is an ambitious scope, it will be required for a total aviation system safety analysis approach.

Data quality

ASIAS suffers predictable issues of data quality and data format standardisation. The U.S. Government Accountability Office (GAO) assessed the FAA's capacity to use available data to oversee aviation safety. In their final report [10] GAO highlights the need for high-quality (reliable, complete and accurate) safety data, and mentions the challenges encountered in practice in data quality control and efforts to improve data quality. Although the FAA has taken some measures to control and improve data quality, further action is recommended by the GAO report to address data challenges.

Lessons for the ROO:

- Given the lessons from ASIAS the ROO shall consider standardisation of data collection practices from the start. The ROO is to set data standardisation objectives that whilst challenging are realistically achievable at an initial level. There needs to be a process to improve standardisation over time.
- The ROO shall establish data quality control procedures: a process to identify, report and correct data errors, and a mechanism that ensures that data are correctly entered in the database. The EU regulation No.376/2014 on occurrence reporting, which prescribes the taxonomy and data format for submitting mandatory occurrence reports, is a step in the right direction to achieve data standardisation. Still, this will not solve all data quality issues: the amount of information, level of detail and quality of the data will vary.
- The ROO shall develop a protocol for sharing FDM data.
- Finally, the ROO should communicate with stakeholders about quality concerns and potential corrective actions on a continuous basis.

Data integration

Data integration is a challenging task, especially when data are not (well) coded and not standardised. After almost a decade of operation ASIAS still needs capabilities to improve data integration and FAA is planning to improve capabilities [10].

Lesson for the ROO:

- The lesson for the ROO is to plan a gradual capability development, cooperate with similar initiatives, bring together collective technical and scientific expertise, and arrange sufficient funding for data integration.

Data protection

ASIAS has arranged data protections to safeguard the proprietary and confidential data shared with ASIAS, and to guarantee that data is solely used for safety improvements and information sharing. It is important

to protect proprietary interests to ensure the confidence of the members in the programme, continuing participation and data sharing [8, 10]. ASIAS information is deliberately restricted to a small number of people within FAA to maintain data protection, however this needs to be balanced with the need to supply effective tools to the regulatory process as noted in the OIG report [8]. Some ASIAS information has been provided outside of the ASIAS membership under formal arrangements [14].

Lesson for the ROO:

- ASIAS has achieved good industry membership with the data protection on offer. It is a matter of speculation that an acceptable level of industry involvement might have been achieved with less protection. Data protection will be a key issue for the ROO as well. Since data protection is a fundamental cornerstone of the ASIAS initiative it seems prudent for the ROO to adopt a similar approach. This is likely more challenging for the ROO than for ASIAS as the ROO will have to arrange adequate data protection in a European environment, with stakeholders from different countries, under different national data protection laws and cultural aspects.

Data analysis

ASIAS started with directed studies of interest to members of ASIAS rather than predictive analysis or future risk assessment [8]. The use of advanced, integrated data analysis to support safety improvements on a predictive basis is challenging [13]. Notably in the data integration/aggregation process there is the risk of losing the context of an incident and thereby making inappropriate safety improvement interventions, which may be ineffective, or worse, counterproductive. Ref. [8] reports that the predictive analysis capability is a challenge, and that the automated capabilities and analytical methodologies need enhancements. In addition, standardisation of data collection practices needs to be further developed. Ref. [10] underscores that in order to meet data challenges and to develop needed analytical approaches, FAA will also have to identify staff with both aviation operational experience and statistical expertise to effectively analyse aviation safety data in the future.

Analysis is shared through 'InfoShare' meetings (twice a year) providing opportunities for exchange of best practice in safety data collection, and for consideration of safety studies and safety improvements. Invitations to oversight agencies may be restricted with the intention of encouraging open discourse.

Lessons for the ROO:

- The lesson for the ROO is that it shall deliver value to its members in the early years of the programme by conducting studies and producing results on request of the stakeholders.
- Arranging regular user group meetings (like the ASIAS InfoShare) will be an attractive and good means of communication with stakeholders to establish confidence and interact directly with users, to better understand at both sides the needs, benefits, type of data needed and available, type of analysis that can be conducted, etc.

- The overall strategy of the ROO (in terms of deciding what to analyse) will not be limited to just the data that happens to be available at the time. The strategy should focus on data that might be available longer-term and on methodologies that are best suited to longer-term safety improvement aspirations.
- The ROO shall define staff qualifications that combine domain expertise as well as analytical skills (e.g. statistical, programming, modelling and data science skills).
- The ROO shall cooperate with similar initiatives, academia, research institutes in the development and application of predictive analyses techniques to make use of best practices and to avoid "to reinvent the wheel".

Governance structure

The ASIAS governance structure, with clear independence, is likely a key factor in driving effectiveness. ASIAS implementation being undertaken through an executive body within the framework of the existing aviation safety infrastructure such as CAST is of significance. The ASIAS governance structure includes an ASIAS Executive Board with government and industry representatives that determines the procedures and policy, prioritises and approves safety studies and dissemination of results. This structure seems to work well for ASIAS and provides confidence to the members that the data is used appropriately, is protected and that interests are balanced.

Lesson for the ROO:

- Stakeholder involvement in the oversight and management of the ROO activities is a key success factor. The governance model of ASIAS seems to be applicable to the ROO although the situation in Europe will be more complicated than in the United States. The challenge for the ROO will be to develop and implement a governance structure in Europe, considering the number of Member States, different legal frameworks, and possibly national interests.

Role of the regulator and authority

The FAA has limited access to ASIAS analyses and no access to confidential data in ASIAS, and misses an opportunity to get information for (risk based) safety oversight, according to the OIG report [8]. The report mentions that the FAA does not allow its inspectors and analysts to use ASIAS confidential data for oversight. It recommends to the FAA to "establish a mechanism for providing access to aggregated, de-identified ASIAS trends (…), and to develop and issue guidance on how inspectors are to use aggregated, de-identified ASIAS trends to enhance air carrier safety risk identification and mitigation (…)".

Lessons for the ROO

- The ROO governance structure and terms of reference shall make clear what the role of EASA and national aviation authorities will be in relation to the access to data and analysis results in the RO. One question that needs to be addressed is what sort of data and what sort of analysis results the regulator and authorities are allowed to access. The answer could be: no data at all, only aggregated aviation system level results (e.g. at a national or EU level), or results at the level of individual organisations (e.g. airline X, ANSP Y, aerodrome operator Z).
- A lesson from ASIAS is that this guidance needs to be defined by the EASA and aviation authorities on how their personnel is allowed and supposed to make use of the RO data and results. For instance, the RO data and results can be used for safety risk identification, safety performance monitoring and risk-based oversight. This guidance shall cover both non-confidential or open source data and the aggregated, de-identified data that is shared and contained in the RO. Non-confidential or open source data include for instance weather data, airport data, safety data published by organisations such as Eurocontrol, EASA and aircraft manufacturers.

Partnerships

ASIAS results are shared with government – industry safety teams, such as CAST after approval by the AEB [10]. CAST will then review the issues to decide whether to develop safety enhancements to mitigate the defined safety issues.

Lesson for the ROO

- The interaction between the ROO and European or national safety initiatives should be defined to ensure that there is maximum benefit on both sides. The ROO should develop a process and means to interact with initiatives such as the European Plan for Aviation Safety[2] (EPAS), the European Strategic Safety Initiative[3] (ESSI), including the European Commercial Aviation Safety Team (ECAST). Outside Europe, collaboration with ASIAS, the IATA STEADES programme and a similar initiative in the Asia-Pacific region is recommended. It is envisioned that the ROO can support ESSI and EPAS in identifying safety risks, monitoring safety performance and evaluating the effectiveness of the EPAS actions. In turn the ESSI and EPAS may submit analysis requests to the ROO.

[2] The EPAS is a five year action plan developed by EASA, Member States and industry to work together in improving aviation safety.
[3] ESSI is an aviation safety partnership between EASA, other regulators and the industry. ESSI's objective is to further enhance safety for citizens in Europe and worldwide through safety analysis, implementation of cost effective action plans, and coordination with other safety initiatives worldwide.

2.2. What can we learn from EASA feasibility study into a European big data programme for aviation safety?

Feasibility study

EASA conducted a feasibility study into a big data programme for aviation safety [15, 21]. The FSS P4 project team conducted an interview with EASA to learn about the outcome of the feasibility study and the plans for further development of this big data programme. Three factors drive the need for such a programme: to make the European aviation system even safer, to safeguard Europe's status as a world safety leader and to enhance European know-how in big data [15]. EASA acknowledged the problem that many aviation safety related data are fragmented in Europe (i.e. FDM, occurrences, radar data, weather, but also OEM data, maintenance data). The first goal of the programme is to bring together these various data sources with sufficient volume and coverage of operations, domains etc. The second goal is to develop the analytical capabilities for safety analysis.

During the feasibility study consultation with stakeholders (e.g. airlines, manufacturers, ATC, SESAR, Eurocontrol, airports) it appeared that there was extensive support for such a data exchange programme. The main interests of stakeholders to participate in the data exchange programme are the ability to benchmark safety performance and to learn from experiences from others. For example, airlines are interested to learn the sort of issues that other operators of the same aircraft type encounter. Or, for example, if an airline starts an operation at a new airport, they would like to know what issues they can expect.

The data exchange programme will be a voluntary collaborative partnership. Mainly two concerns were observed during the stakeholder consultation. The first is that data may be used in a punitive manner, and secondly, airlines have a concern that the authorities use the data for oversight purposes or that the data are used for commercial purposes.

The governance structure is important to ensure that data will be used for safety only and to build trust in the programme. The governance structure will be different than in ASIAS given the different situation in Europe. It is expected that the governance will be formed by a governing board, co-shared by EASA and one industry partner. The board should be a fair and balanced representation of stakeholders in Europe and it is foreseen that 12-15 members will be part of the board. The members should sign up to the terms of reference (or charter) and agree with the procedures and data handling protocol. The details of the governance structure will be worked out in the near future.

Proof of concept phase

Currently EASA is setting up a proof of concept project for the big data programme with participation of a limited number of organizations (the founding stakeholders). They want to test the governance structure and to build trust with the aviation community. Furthermore they want to better understand the required

Information Technology (IT) infrastructure, costs, constraints, software, etc. Funds are available from the EC for starting the proof of concept phase.

The project will address two "platforms". One platform is the big data platform for the collection and processing of data. The platform includes the big data IT infrastructure, software, servers, an IT big data organisation, architecture of data, visualization tools etc. The second platform is the analysis platform with a combination of domain experts and data scientists. They are going to develop use cases with input from stakeholders and conduct analyses on the big data platform. The analysis platform includes at a minimum dashboards and directed studies, and possibly vulnerability discovery in the future. In the proof of concept phase the analysis platform's primary function is to define use cases and required output. EASA is planning to set up various task teams to work on the approved use cases. A task team will bring together the relevant experts and data analysts to design the algorithms (coding, modelling, implementation etc.).

In the proof of concept phase the starting point will be FDM data and occurrence data[4] (European Central Repository). The intention is to include radar data and weather data later on in the programme.

EASA is using ASIAS as inspiration and to learn lessons for the European programme. One lesson that will be incorporated is that EASA wants to start with data fusion from the start of the programme, which means data cannot be de-identified directly, but only after data fusion has taken place.

Lessons for the ROO

- The outcome of the feasibility study conducted by EASA and the roadmap for the development of the big data exchange programme for aviation safety are in line with the interim results in the FSS P4 project, e.g. regarding value proposition, governance structure.
- EASA is planning to arrange the organisational framework (ensure stakeholder buy-in, develop governance, draft charters etc.) and a proof of concept for the technical aspects, while the FSS P4 project is conducting research into technical capabilities to transform data into safety information and intelligence. The prototype RO that is being developed in the FSS P4 project has similarities with the two platforms that EASA is planning to develop and test. It should be avoided that multiple, similar initiatives develop separately as this will reduce the willingness to support such (a) data exchange programme(s). It will be important to keep in touch with the EASA big data exchange programme "to join forces" when and where possible. One area where the P4 project could complement the EASA big data programme is in the "analysis platform", use cases and risk modelling.

[4] The European Coordination Centre for Accident and Incident Reporting Systems (ECCAIRS) provides the European Central Repository (ECR) for accident and incident reports in aviation.

2.3. What can we learn from mandatory occurrence reporting schemes?

2.3.1. Introduction

Since 2005, stakeholders in the European aviation industry have been required to report occurrences, mandated by Directive 2003/42/EC. This Directive has been replaced in 2014 by Regulation No 376/2014 on the reporting, analysis and follow-up of occurrences in civil aviation. The primary purpose of this Directive and Regulation is to improve aviation safety by ensuring that relevant safety information relating to civil aviation is reported, collected, stored, protected, exchanged, disseminated and analysed by a competent authority.

2.3.2. Lessons from mandatory occurrence reporting schemes that may be applicable to the Risk Observatory

Following the implementation of Directive 2003/42/EC, several investigations have been performed to evaluate the effectiveness of the Directive and the efficiency of the competent authorities responsible for the collection, storage, protection, exchange, dissemination and analysis of safety information. The findings from these investigations are relevant to the business model of the ROO and grouped as follows: promotion, data reporting (data sharing), data protection, analysis, and dissemination.

Promotion

The competent authorities that have been established to follow-up on Directive 2003/42/EC have conducted various promotional activities to inform stakeholders in the sector about the implementation of the Directive and its purpose. In the Netherlands, for example, this has been done by means of leaflets and dedicated workshops. This has led to a better understanding and mutual trust between stakeholders affected by the Directive and the competent authority [16]. Another evaluation report [19], however, indicates that the Directive, due to different interpretations, has been implemented differently, incorrectly and ineffectively by the EASA member states.

Lesson for the ROO:

- Promotional activities shall be carefully planned and performed, ensuring that there is a common understanding of the RO purpose and added value.

Data reporting (data sharing)

Several evaluation reports have identified a lack of data quality as the cause of the lack of relevant analyses [17, 18, 19]. Some organisations filter their raw data before it is shared (e.g. only high risk occurrences or final reports are submitted), whereas other organisations share all their data (e.g. also preliminary reports). Also a lack of standardisation has been identified as a cause of insufficient data

quality [19]. Apart from the data quality, the activities performed by the competent authority are under pressure due to: a lack of manpower and experience, and manual input of reports, which requires a lot of time [17].

Lesson for the ROO:

- Clear arrangements and standards have to be defined for data input quality, so that the ROO can collect and analyse the data more efficiently and effectively. This may imply that specific reporting forms have to be established, in which required data is uploaded.
- The ROO should keep the effort for data delivery by data providers to a minimum and provide support for the activities necessary for correct, useful data delivery.
- An automatic quality check for data input may be developed (e.g. completion of fields filled out in the reporting form).
- Sufficient manpower has to be provided with relevant, high quality experience in the aviation industry. The ROO must be able to offer significantly more in the way of analysis expertise than the individual aviation organisations. ROO reputation is an important matter to establish and maintain.
- Automatic electronic data input and analysis has to be developed.

Data protection

In the Netherlands, as an example, the Government has expressed its concern that the support for, and willingness to report safety issues would diminish should criminal prosecution take place based on reported safety issues [16]. Uncertainty about the role of the judicial authorities may lead to a decreased trust and openness about safety issues [17, 19, 20]. To prevent this situation, consultation has been established between the judicial authorities, the competent authority responsible for the follow-up on Directive 2003/42/EC and stakeholders in aviation. This has resulted in clearer definitions of roles and responsibilities.

Lesson for the ROO:

- Within each EASA member state the roles and responsibilities between the judicial authorities, stakeholders and the ROO have to be clearly defined to protect and foster the support from data providers. Of course, the highest degree of commonality of approach is desirable and there is a risk that functionality of the ROO is limited to the lowest national standard, at least initially until clarification develops. These roles and responsibilities have to be clearly communicated to all stakeholders.
- Assure that data shared with the ROO are protected against misuse for purposes other than safety (e.g. commercial interest, prosecution or liability).

Data analysis

To assess the analyses made and to advise about reports, in the Netherlands for example, a feedback group [16, 18] has been established consisting of stakeholders' representatives and the competent authority responsible for the follow-up on Directive 2003/42/EC. This feedback group is especially important to provide highly relevant analyses to all stakeholders. Provision of highly relevant analyses is, however, not only dependent on a feedback group, since the quality of data input defines the quality of the analyses' output. In the evaluation reports, three shortcomings were identified with regard to the data provided for analysis:

1) a lack of categories for coding of occurrences [16, 17, 19];
2) a lack of risk classification of occurrences [16, 17, 19]; and
3) in the development of ECCAIRS, it has been insufficiently taken into account how to transfer raw data into safety information [17].

Expertise from aviation authorities may provide added value to the analyses and promulgation of safety information by identifying focal points [17]. Also other interfaces may provide knowledge, experience and focal points with the potential to improve the analysis and dissemination of safety information, like interfaces with other partners within the European Union and the Joint Research Centre [16].

Lesson for the ROO:

The lessons learnt are that the ROO should:

- Establish a user or feedback group to assess the analysis made, to advise about reports and to develop specific safety recommendations.
- Provide for adequate categories for coding of occurrences, preferably derived from existing coding systems from occurrence reporting schemes currently in use with stakeholders. It is noted that the point is that occurrences are coded according to a taxonomy that is uniformly and consistently applied by the analysts. A lack of categories could hamper proper coding and analysis. On the other hand, too many categories could impede the uniform and consistent coding of events, and may lead to too much diversity or detail in event classifications.
- Provide for training in coding of occurrences to ensure consistency in coding.
- Provide for a risk classification of occurrences.
- Provide for a quality check (peer review) on coding and risk classification.
- In the development of the RO, constantly take into account the purpose of the RO, which is to increase aviation safety; focal point is how to transfer raw data into safety information.
- Develop a framework for the collection, storage, protection, exchange, dissemination and analysis of safety information.
- Explore cooperation and consultation opportunities with EASA and other stakeholders to provide added value in its analysis capabilities and to increase its effectiveness and efficiency.

Dissemination

Several evaluation reports indicate that the implementation of the Directive 2003/42/EC has not led to an evident contribution to aviation safety [17, 18, 19]. The willingness to report is high but is under pressure due to demotivation caused by system deficiencies, resulting in a lack of feedback and lack of results [17, 20].

Lesson for the ROO:

- It is of utmost importance to demonstrate the value of the RO early on. During the RO implementation, a strategy shall be developed to achieve "quick-wins", e.g. by conducting high potential studies that have direct support and interest from the stakeholders. Ideally, the proof-of-concept RO should already produce some tangible results that encourage the stakeholders to support the RO.

3 RISK OBSERVATORY BUSINESS MODEL

3.1. Value proposition

The ROO provides a central safety intelligence organisation bringing together a collective wisdom on aviation safety with analytical capabilities and data that the larger industry partners may not be able to bring together on their own. The ROO will receive aviation safety data under formal agreement from the European aviation community, and analyse the safety data for safety information and safety intelligence. The ROO provides value by:

- Providing safety risk management and safety performance monitoring capabilities for systemic safety management, across domains, stakeholders and Europe. The added value of the RO to current initiatives, such as STEADES, a mandatory occurrence reporting scheme, or what organisations are doing individually, is that the RO assesses systemic safety risks. It connects data silos that normally are not analysed in an integrated way. In the total aviation system approach, the RO is unique: the aggregation of heterogeneous data (data fusion) and analyses of different integrated datasets across multiple operators and domains.
- Providing individually tailored results to participating organisations, using their data and appropriate data from other participating organisations.
- Providing safety data and information to national aviation authorities and EASA. Note that industry will have concerns about what safety data, safety information or intelligence will be available to authorities and EASA. This needs to be sorted out during the development and implementation phase of the ROO.
- Providing a summary European safety performance data to the European Commission.
- Undertaking dedicated safety studies into safety issues on request of stakeholders or other organisations (possibly worldwide).

Incentives for stakeholders to participate in the RO are:

- Intelligence in risks and causal factors of both high-risk low-probability and low-risk high-probability events, enabling predictive risk analysis and defining safety performance indicators. The increasing volume, variety and fusion of all sorts of data creates value for organisations that have less data or exposure.
- Intelligence in systemic risks across multiple operators and domains, enabling to compare safety performance.
- Access to dedicated safety studies, based on a larger amount of data than individual organisations can provide, thereby making the results more robust.
- Access to shared lessons learnt, best practices, hazards, risk mitigation measures etc. from other aviation organisations.
- Access to data that is difficult to get themselves from a variety of sources.

- Demonstration by participation in ROO that the stakeholder takes safety seriously and is an active participant in state-of-the-art safety initiatives.

It is essential that the ROO products and services are regularly evaluated on their relevance to the customer segments. Changes within the customer segments may require a review of the ROO's added value and may demand adaptations in the ROO's business model. To keep providing added value to similar activities, the ROO should continuously provide and further develop the capabilities identified in D4.1 [3] stakeholders' interviews and listed in Appendix B.

3.2. Customer segments

In describing the customer segments the ROO intends to serve, it should be noted that the designation of 'customers' of the ROO does not necessarily mean that they are paying for the ROO services. Therefore, the designation of 'customers' should be interpreted as 'stakeholders in the ROO'. The preliminary list of potential customers or stakeholders is presented below. An extensive list of stakeholders is available in Appendix C.

1. Aviation industry within EASA Member States, consisting of:
    a. Airlines (including airline alliances);
    b. Airports;
    c. Air Navigation Service Providers;
    d. Ground Service Providers;
    e. MRO Organisations;
    f. Manufacturers;
    g. Lessors;
    h. Aviation Training Organisations;
2. Regulators and authorities;
3. EASA;
4. European Commission;
5. Accident investigation boards;
6. Insurance companies;
7. Aviation industry outside EASA Member States or outside EU;
8. Unions;
9. Independent research centres or organisations (e.g. EU Joint Research Centre, IATA, universities, etc.);
10. Miscellaneous organisations (e.g. consultancy firms, non-government organisations, etc.);
11. Media;
12. General public.

Some of these stakeholders, e.g. the aviation industry, are regarded as the primary stakeholders that will share data and information and may have access to (de-identified) data. Next to those primary users, there could be secondary users, such as the general public, that may have access to particular information under certain conditions. It is foreseen that some of the information, like de-identified statistics, could be published in an annual safety report or media briefings. Some stakeholder may not approve that their data will be shared with other stakeholders and this issue needs to be arranged as part of the governance set-up.

To develop and maintain an attractive proposition to the customer base of the ROO it is recommended to conduct a more detailed customer analysis that at least identifies:

- Customer segment characteristics;
- Potential customers (by name/organisation);
- Customer needs (specific for organisations or at least for the segment/domain);
- Service appraisal (how do customers appraise the ROO product and services);
- Loyalty (how loyal are customers to the ROO product and services); and
- Conditions, constraints and willingness related to sharing data with other parties (what data can be shared, under what conditions and controls).

It is noted that customer needs of airlines, airports, ANSPs and manufacturers have already been identified by means of interviews and are described in D4.1 [3].

3.3. Customer relationships

Next to the value proposition, developing and maintaining sustainable customer relationships is very important for the ROO to be successful in its purpose and viability. It is foreseen that the customer relationships that will be developed and maintained by the ROO will evolve in parallel with the growth of its services and the number and types of channels that are used. With regard to loyalty, it is assumed that data providers to the ROO will be loyal to the ROO services as long as the data security is guaranteed and output is meaningful and of value to them. It is expected that the demonstration and experiencing the added value of the RO will be a stimulus to join or become more actively involved in sharing data with the ROO.

The relationship with stakeholders will be defined in the governance structure (refer to section 4.4). It is expected that the stakeholders want some sort of influence in the governance of the ROO to ensure their interests are met. The customer relationship with data providing customers has to be built on mutual trust and protection mechanisms for data exchange and protection. When this basis of trust is guaranteed, data providers and the ROO staff work in close coordination to build a secure and reliable RO.

For each customer, the relationship has to be regularly assessed on its appropriateness and effectiveness. For example, a small organisation with little resources for safety management may be in need of

dedicated personal assistance, whereas a large airline may be well resourced to share data and use the RO independently. It is also imagined that stakeholders could provide analysts to the ROO (perhaps under some form of secondment) for specific safety studies.

For other customers, like data users and partners, different relationships may be developed and maintained, which is also dependent on the size of the ROO (see section 4.3). Examples of relations are:

- Personal assistance (e.g. a helpdesk, on-demand analyses, training, or workshops). This requires a considerable investment in personnel, time, training, etc. for staff responsible for customer contact, data analysis and RO promotion activities like workshops. The investment to be made is commensurate with the number of customers requiring personal assistance.
- Self-service or automated service (e.g. dashboards, regular safety publications). Self-service or automated services are considered to require less investment, since the costs associated with these activities largely relate to the initial set-up and maintenance of dashboards and preparation of regular safety publications for instance.
- User group meetings and communities, e.g. sector safety meetings with EASA (within ESSI) Eurocontrol or Airport Council International (ACI) - Europe. When customer relations are fostered in user group meetings or sector communities like Eurocontrol, ACI, ESSI, it would require investment in personnel, time, travel costs, etc. It will be commensurate with the number of sector communities, working groups etc.
- Cooperation with academia and research institutes. A similar investment as for the sector communities has to be made when relationships with these stakeholders are developed and maintained.

3.4. Channels

The channels are the means or methods to reach the customers for either marketing purposes or the distribution of the ROO services. It should be realised that the channels to be developed are largely defined by the type of relationship the ROO needs to establish with its customers.

Different channels may be used for the input to the ROO and the output from the ROO. Channels for sharing data and safety information (input) may consist of:

- Automatic upload of data and information.
- Manual upload at regular intervals, i.e. the data provider will need to send data, upload data through technical means (email, portal, file transfer) to the ROO.

Channels for exchange of safety information (output) may consist of amongst others a web-based interactive dashboard, regular safety publications (reports), safety study reports dedicated to a certain safety issue. It is noted that the information provided on these platforms should be regularly updated with news, analysis results, etc., to keep attracting potential customers.

For marketing purposes, other channels may be used, like:

- Focus group meetings with key aviation stakeholders;
- Attendance at conferences, seminars, etc.;
- Advertisements in sector magazines, e.g. Flight International;
- Advertisements in targeted e-mails about aviation news, e.g. Curt Lewis & Associates, LLC;
- Development and maintenance of a dedicated ROO website.

Appendix D describes channels for marketing and distribution in more detail.

Delivery of the generic safety information provided by the ROO to e.g. the media and general public will be open source, meaning that general safety analyses are available to everybody willing to access that information. Monthly, quarterly or yearly trend analyses will be published on the ROO open source website. These trend analyses may also be forwarded by targeted e-mails to potential or existing customers.

For targeted output, e.g. studies for general public, sectors or individual parties, a dedicated internet portal is established that grants password protected access to data providers and users.

Next to web-based promulgation of safety information, other means may be provided by the ROO as well, like (on-demand) workshops, training, webinars, seminars and conferences. This way of promulgation of safety information will have an additional impact on the number of resources needed to ensure continuous delivery of these services.

3.5. Key activities

3.5.1. Overview of main tasks and key activities

The key activities describe what activities are required to deliver the value proposition, including the distribution channels, relationships, etc. These activities can be regarded as the tasks of the ROO. Several activities will be required to offer the value proposition, now and in the future, not only to continue service provision, but also to improve the service quality, maintain customer relationships and acquire new customers.

In D4.1 [3] the following tasks of the ROO have been defined:

- Receive aviation safety data under formal agreement from the European aviation community.
- Analyse the safety data for safety implications.
- Provide individually tailored results to participating organisations, using their data and appropriate data from other participating organisations.
- Provide safety data to national aviation regulatory authorities and EASA. Note that industry will have concerns about what safety data, safety information or intelligence will be available to authorities and EASA.

- Provide summary data on the European safety performance to the European Commission.
- Undertake safety studies internationally on a cost recovery basis.

To accomplish these tasks, the following activities are defined:

- Data acquisition;
- Data processing and data fusion;
- Data storage and access;
- Data analysis;
- Data visualisation;
- Distribution of safety information;
- System administration and ICT-management;
- Maintenance;
- Provide training, guidance and consultancy;
- Knowledge development.

3.5.2. Data acquisition

This activity encompasses the collection of data from various sources. Data may be submitted to the ROO by the stakeholders. For example airlines may submit on a weekly basis data to the RO, or ANSPs may share radar data. Other data may need to be collected by the ROO through arrangements with other parties, e.g. for meteorological data, airport infrastructure data, etc.

3.5.3. Data processing and data fusion

Data processing is the activity of cleaning, formatting, structuring, labelling, calibration, interpolation, filtering and correction/removal of corrupt or missing data (signals). Data fusion is the activity of combining a variety of data and relating different datasets.

The data that are received during the data acquisition will have different formats and characteristics (e.g. they can be structured, unstructured, different file formats, different parameters, etc.). During the data processing, the raw and/or pre-processed data that are received from stakeholders will be transformed into a certain format that will be stored in the RO data repository.

An important issue is the harmonisation of data, i.e. the application of a standard taxonomy and data format to all data, so that a standardised data analysis can be conducted. If different taxonomies and standards are used, the analysis results may be of limited value for comparison as it would lead to comparing apples and pears. It is therefore important for the ROO to not only understand the ROO data storage system limitations, but also the limitations of the occurrence reporting systems the ROO receives data from.

3.5.4. Data storage and access

Data storage in (relational) databases and data warehouses is a continuous process as data comes in at regular intervals. The management of the access to the databases and the security of data is another key activity in this context. The management of user accounts, access to data (which user may use which data) and database security need to arranged and be kept in good order. Access to the databases to extract information (e.g. through queries) by ROO analysts needs to be designed and maintained.

An important element in the key activity of data storage and access is defining who owns which data. Based on the fact that the RO is fed with data from stakeholders and provides output in the form of analyses, publications etc., the ownership of both the data and analysis results is a matter for consideration during the implementation of the ROO.

3.5.5. Data analysis

The analysis activity includes the (trend) analyses of data to feed the RO dashboards with safety information (e.g. information on occurrences, risks, mitigation measures, best practices). Safety information and safety intelligence based on data, lessons learnt, best practices, and the interpretation of available information falls under this activity. Part of the analysis is the task of testing and validating the data and analysis results. It is expected that two types of analyses will be produced by the ROO. First of all, standardised analyses will be conducted on the data and the results will be published on dashboards and/or in regular publications. The types of analyses that can be conducted will be partly limited by the available data sample. The level of detail, quality, completeness, etc. of the data will determine the type of analyses that can be conducted. The available analysis techniques will also determine what information can be extracted from the data. The second type of analysis that the ROO may conduct is a dedicated, on-demand safety study into a safety issue, for example on request of a stakeholder or a third party. The output of such a dedicated study could be a safety study report.

It has yet to be determined which party owns which data and which output of the RO. This topic should be worked out during the development of the governance structure and the ‘terms of reference’. It should address the ownership of output generated by the RO, and by the stakeholders using RO data.

3.5.6. Data visualisation

Visualisation is an aid in communication about safety information extracted from data. For the presentation of data in graphs, diagrams or risk matrices and so on, the ROO may use a web-based dashboard, safety reports, newsletters, presentations, etc.

3.5.7. Distribution of safety information

This activity concerns the sharing of data (upload to the RO) and analysis results and dashboards with different stakeholders through channels: e.g. a dedicated web-based dashboard, a portal, website or another communication means. It can take the form of standardised safety information such as newsletters, monthly reports, yearly overviews of the safety performance of domains, or of non-standard, specific safety information, e.g. on a particular safety issue.

3.5.8. System administration and ICT-management

Under this topic a range of activities can be defined:

- Activities related to the implementation of the RO and its services, IT-architecture, system management, account management, updates and maintenance to the hardware and software;
- Configuration management;
- Administrator tasks for users (e.g. updates, password resets, helpdesk etc.);
- Provision of user manuals, supporting documentation for users for the RO dashboard (channel), the upload and sharing of information;
- Daily IT-support to troubleshoot problems related to database and web-based applications;
- Acquisition, upgrade, management of hardware and software applications, independent of specific RO applications (e.g. operating system, firewall);
- Back-up and restore of data;
- Monitoring the performance of the RO systems (requiring tools and log data);
- IT and data security.

3.5.9. Maintenance of hardware, software, database

The maintenance of all hardware, software, applications, database infrastructure, etc. is a continuous activity.

3.5.10.Provide training, guidance and consultancy

This activity encompasses the provision of support, guidance and consultancy to stakeholders. The scope of the activity will be focused on aviation safety, safety information and safety intelligence and safety data sharing. The ROO will provide support to data providers with regard to collection of data, data preparation, data sharing, data formats, upload procedure, etc.

The ROO may provide guidance and best practices to the stakeholders about data collection, standardisation of taxonomy and data formats, about processing of data and (trend) analyses, etc. It is expected that the ROO will be(come) an experienced team in processing large amounts and a variety of

data, data fusion, safety data analyses, etc. Therefore the ROO expertise and experience may develop into guidance material or best practices for safety management, in particular for safety data analyses and safety performance monitoring.

The ROO may undertake dedicated consultancy tasks to support a specific organisation with challenges, problems, or questions they face.

3.5.11.Knowledge development

In order to keep the RO up-to-date and adapt to on-going technical and operational developments, the RO staff will need to maintain its knowledge related to all key activities and supporting hardware, software, risk models, operational developments, etc. This requires that the ROO staff invests in development of knowledge, skills, and research.

As the volume and variety of data will grow during the lifecycle of the RO, the ROO should exploit new developments in hardware, software, and analyses techniques.

Knowledge development can be stimulated by making open source data sets available to for example universities. The conditions under which these data sets can be shared should be specified and agreed upon by the data owners.

3.6. Key resources

3.6.1. Definition of resources

The key resources define what resources are required to deliver the value proposition, the (distribution) channels, customer relationships and revenue streams. The ROO has two unique resources in the sense that these resources are fundamental to the RO objectives:

- The data, which include all forms of data, e.g. digital, analogue, text (reports), audio, video, etc. from various domains, stakeholders, countries.
- The risk models and analysis techniques. The risk models and analysis techniques transform the safety data into safety information or safety intelligence and are key to the RO.

The resources described below can be regarded as general resources that many organisations will identify like staff, hardware, software, facility, etc.

Staffing

The personnel working with the RO will be a key resource. Both technical and non-technical staff are required to operate and maintain the RO. Obviously, it requires technical and scientific personnel to collect, process, store, and analyse data and report and visualise results. At the same time, the

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organisation needs administrative, legal, and human resource management support for example. Some of these supporting staff could be outsourced.

It is the quality of analysis that is key to the effective functioning of the ROO and this needs skills that are not normally to be found in the safety departments of airlines. The analysis capability should be world-class, comparable or equated in some way to the work by experts in quantitative analysis employed by financial organisations, whose complex models are essential for the financial success of their organisations. The staff working directly on the data processing and analysis will need to be composed of a multidisciplinary team of specialists in domains such as data science, big data technology, with programming and analytical skills, statistical and modelling skills. The team shall include (safety) analysts with a proper aviation and aviation safety knowledge from different domains (airline operations, air traffic management, ground operations, maintenance, etc.) to understand, interpret and validate data and analysis results.

A relevant aspect will be language skills of the staff. Since the RO is a pan-European data repository and analysis platform, it is expected that communication and consultation with stakeholders across Europe will take place regularly. In addition, submitted data may contain text reports in various European languages. In order to be able to understand and interpret these data sources the analysts shall possess the relevant language skills. Having a multi-cultural team (but with a common corporate vision) with different language skills and access to additional interpretation/translation services is required.

Marketing and business development skills should also be available within the ROO staff for promotion, marketing and developing the business of the ROO. It is envisioned that account managers deal with the communication, coordination, Non-Disclosure Agreements (NDAs), etc. with providers of data, promote the RO and maintain the network, attract new partners and data providers to the RO.

Hardware and infrastructure

All facilities and means that support the services and processes of the ROO. This includes IT hardware, databases, networks, servers, laptops, etc.

Software

Different software tools will be necessary to operate the RO. Besides standard office software, special analytics software, processing software and visualisation software is required. Many of the software applications required will be commercially available. However, given the unique character of the RO, a significant portion of the RO application will be developed and maintained in-house, using these software

packages to develop the RO functionalities and user interface. “Big data” technologies for data processing, analytics and visualisation may be required as well.

Office space

The ROO needs office space for its staff and IT hardware, including off-site back-up facilities. An important element of the facility and the hardware is the security of these resources, both the physical site security as well as IT security. Note that the country where the databases are located may have influence on possible legal consequences e.g. freedom of information act, prosecution, data collection after an accident etc.

Budget/funding

The ROO needs a funding structure to operate, maintain and develop the RO, see sections 0 and 3.9.

Intellectual property

Intellectual property rights, patents, copyrights on the technologies and analytical techniques are part of the resources.

3.6.2. Estimate of resources

The resources required depend on the ambition level of the RO and level of activities foreseen. When the ROO starts small with a limited number of dashboards a few specialist RO supporting staff could be sufficient. If the ROO will be conducting safety studies and more in-depth analyses of safety data, safety analysts will be required. Depending on the scale and activities of the ROO 4-8 analysts may be required for a small to medium scale ROO. However, if the ROO will expand both in members, scope, collected data and activities such as training or consultancy, the staffing should be expanded with for instance commercial-marketing specialists. Note that ASIAS is currently an order of magnitude greater. Administration and management staff would also be required. It is recommended that the estimated resources are further detailed in the final version of the business model.

3.7. Key partners

Although one legal entity should have the ultimate responsibility for the ROO, it cannot operate in isolation. Partnerships are essential in the success of the RO. Partners are needed to collect and share data, to keep the processing and analytics up to date and state-of-the-art, and to maintain and further develop the RO's value to the aviation industry. Last but not least, partners are needed to establish and maintain good relationships across the aviation stakeholder community in Europe and abroad.

It is envisioned that the ROO will be a partnership between aviation stakeholders, such as aircraft operators, ANSPs, airport operators, aircraft manufactures, national civil aviation authorities, weather data providers, EASA, EC, and possibly other partners.

Key partners can be subdivided into four different groups:

- Data providers (not necessarily users);
- Users (not necessarily data providers);
- Strategic partners;
- Academia, research and development (R&D) institutions;

Table 3: Data providers partnership.

Type of partner	Data providers, i.e. stakeholders that share data with the RO.
Description	Partners in data sharing, i.e. these organisations share data (in various forms, e.g. flight data, radar data, best practices, hazard databases etc.) with the RO.
Partners (examples)	Airlines, ANSPs, airports, meteorological institutions, civil aviation authorities, EASA, Eurocontrol.
Key resource	Aviation safety data, exposure data, contextual information (like weather data, airport data, NOTAMs).
Key activities	Making available and uploading data at certain intervals.

Table 4: User partnership.

Type of partner	Users.
Description	Organisations making use of the RO services.
Partners (examples)	Airlines, ANSPs, airports, meteorological institutions, civil aviation authorities, EASA, Eurocontrol.
Key resource	Aviation safety data and information.
Key activities	Obtain safety data and information from RO (access RO dashboards, publications, etc.). Propose safety studies to the RO and possibly employ other services from the RO, such as training of consultancy.

Table 5: Strategic partnership.

Type of partner	Strategic partners.
Description	Strategic partners provide aviation community support to the RO. They strengthen the relationships between the RO and the stakeholders. Strategic partners provide confidence to the community they represent that the ROO serves their interests and will be of value to them.
Partners (examples)	Association of European Airline, European Cockpit Association, unions, ECAC, ACI Europe, European Authorities Coordination Group on Flight Data Monitoring (EAFDM), European Strategic Safety Initiative (ESSI), , European Helicopter Safety Team (EHEST), European General Aviation Safety Team (EGAST), Safety Management International Collaboration Group (SM ICG), Flight Safety Foundation, Skybrary, Eurocontrol, EASA, JRC, manufacturers, etc.
Key resource	Representation of its members, access to organisations, access to best practices and current developments, consultation for standardisation/harmonisation of data sharing.
Key activities	Commitment to the RO mission and support to and promotion of the RO. Coordination / harmonisation of safety initiatives with the RO.

Table 6: Research and development partnership.

Type of partner	Academia and research and development institutions.
Description	Partners for knowledge, research and development of software, risk models, processing and analysis techniques, and applications. Partners to maintain and develop capabilities in data processing, storage, analysis and visualisation. Partnerships with research establishments and academia will ensure the ROO is a centre of excellence in safety data analysis.
Partners (examples)	EREA members (Association of European Research Establishments in Aeronautics), universities, research institutes.
Key resource	Scientific, technological expertise, knowledge, methods, techniques, tools.
Key activities	Exchange of personnel, internships for PhD or BSc/MSc students, cooperation in research projects.

3.8. Cost structure

The cost structure of the ROO describes the costs associated with the provision of the value proposition. The costs are broken down into fixed cost items and variable cost items.

Fixed costs items

- Salaries (salary, pension, insurance, social security, taxes etc.);
- Software (acquisition, licences);
- Facility (office rent, etc.);
- Training of staff;
- Hardware (office hardware, technical hardware, i.e. computers, servers, network, storage);
- Legal, HR, financial and administration/office support (possibly outsourced);
- Travel costs of staff;
- (ICT) Security costs.

Variable costs items

- Cost of increasing the processing and analysis capabilities throughout the life time of the ROO. Further investment, development and research into new data processing and analytics techniques, modelling, etc. ;
- Costs associated with processing of data and the storage of data, as this is dependent on the volume of data received over the year;
- Costs of dedicated safety studies.

What are the most important costs inherent in our business model?

The most important running costs (post start-up) are staffing, ICT related hardware and software costs.

Which key resources are most expensive?

The ROO key activity of processing and analysing data requires technical and scientific personnel. As already identified as a key resource, the staff working directly on the data processing and analysis will need to be composed of a multidisciplinary team of specialists in domains such as aviation safety, data science, big data technology, with programming and analytical skills, statistical and modelling skills. The team shall include (safety) analysts with comprehensive aviation and aviation safety knowledge from different domains (airline operations, air traffic management, ground operations, maintenance, etc.) to understand, interpret and validate data and analysis results. In order to attract and employ such

specialists, their activities should be rewarded accordingly by means of salary and terms of employment that at least correspond with aviation industry standards.

Which key activities are most expensive?

Processing data and analysis of data will be the most expensive activities, requiring a lot of manpower, expertise and knowledge, as these are the most complex and time consuming parts of the process. Data quality assurance and development of analytical capabilities are challenging and will require significant resources (see also the lessons from ASIAS).

3.9. Funding source and revenue streams

3.9.1. Funding source and requirements

ASIAS operates with an annual budget of US$ 15 million (2014) which excludes start-up costs. ASIAS is of an order of magnitude greater (at least initially) than that envisaged for the ROO, which is proposed to start as a modest operation but with a scalable structure to adjust intelligence output according to demand. The feasibility study of a European big data programme for aviation safety (refer to section 2.2) concluded that a proof-of-concept phase would require an estimated budget of €13 million, while the full deployment would require a budget estimate of € 18 million per year [15].

In general terms, for most services, it is the service user who pays. The exceptions (and there are many) tend to share the costs at a society level if there is collective societal benefit. This could be the case for the ROO. It is suggested that the user is the travelling public, primarily European, although a substantial proportion will come from outside Europe. It could be noted that there is an additional user; the non-traveller who remains on the ground but who benefits from reduced risk of being involved in an aircraft accident (resulting from an aircraft crashing to the ground) but this is a comparatively small factor.

One option is to fund the ROO through the EC, EASA and/or national governments given the societal function of the European community. This is a pragmatic approach for the short-term and the initial set-up of the ROO. It will need start-up funding, which should be funded at European collective level for a defined start-up period.

A second option is “cost sharing” which may keep the costs at an acceptable level. Stakeholders could share the cost of the ICT infrastructure between the participating stakeholders and put together a team of analysts and data scientists from the stakeholders to form analyses teams for specific studies (in-kind contribution).

A third form of funding could be to introduce a subscription fee to access dashboards, databases and analyses results. A pragmatic way is to source funding from airlines, where the costs may be passed on to the travelling public. It is recognised that this should be a longer-term aspiration. Other users (e.g. ANSPs, aerodrome operators) should also contribute.

It is recommended to study the feasibility of each option, and to identify the advantages and disadvantage of each option of funding.

The ROO shall be value-driven (i.e. focused on value creation) from the beginning as the expectation from stakeholders sharing data will be to get actionable safety information in return. The initial focus should be on delivering "value for data", demonstrating that the collection and integration of the variety of (safety) data provides additional safety information or intelligence that is useful for stakeholders' operations. When the RO has proven its value, it will be easier to convince other stakeholders to contribute both with data and finance.

A concern is the financial stability of the RO when it comes to its funding. As users may join or leave the RO "membership" or may not be longer willing to contribute financially, the continued existence of the ROO may be endangered. It is expected that a portion of the funding will always come from the EC/Member States to ensure the stability, independence, and continuity of the ROO. The next section proposes some ideas to generate revenue streams as an additional funding source for the ROO.

3.9.2. Revenue streams

The revenue streams describe how the ROO could generate revenue by providing its services to paying customers. It should be the intention that the revenues cover costs. The non-profit model used by ASIAS is attractive for the ROO to adopt, and minimises a potential disincentive for the free provision of safety data from the aviation industry. Data providers likely do not want others to make a profit from their data. Costs to European users however may be subsidised by commercial activities undertaken for aviation organisations outside of Europe.

Revenue streams can be anticipated from the commercial supply of services:

- Much analysis of a routine nature may be automated but "manual" safety studies will require considerable effort. Conducting specific safety studies on behalf of organisations may provide an opportunity for subsidy of costs (through cost-sharing, contribution in kind or a charge) and may partly recover start-up costs. These studies would have to be approved by the ROO steering committee when data from the RO is used for external parties.
- Providing consulting services to (primarily) the aviation community. The ROO staff could provide advice to organisations in the areas of safety data collection, processing and safety analyses. The ROO staff may be employed to conduct safety studies with stakeholder's own data, separate from the RO databases. This may be attractive for aviation organisations that do not have the resources to conduct certain data activities or data analyses.
- Providing training to stakeholders in data collection, data processing, safety risk analysis, safety performance monitoring, etc. The expertise of the ROO staff could be attractive to organisations to provide training to safety analysts or safety managers.

- The publishing of articles, possibly in a ROO magazine, with advertising may generate income through sales and advertisement incomes.
- Specialist books that target other data-rich environments that may be suitable for 'technology transfer' such as medicine.

The ROO has to offer sufficient added value of appropriate quality that users will wish to pay for their services. Whilst for the users, the contracting of the ROO will be an additional cost (unless some users choose to effectively outsource their safety analysis to the ROO), there may be reduction in their insurance costs through participation in the RO. This idea of lower insurance costs needs further validation with involved stakeholders.

Participation in the RO is in itself a form of insurance policy, being able to demonstrate in the event of any accident, that participation in the best quality and safety intelligence gathering was undertaken. Non-participants would be vulnerable to that challenge in the event of an accident.

4 IMPLEMENTATION AND ROADMAP

4.1. Options for the implementation of the Risk Observatory Organisation

A key early decision will be the selection of the host organisation to house the ROO. The selection will be an exercise of some complexity to achieve the right balance to position the ROO acceptably. The host organisation shall offer practical and technical support, academic credibility, and aviation industry acceptability. It will be important to ensure that the ROO is perceived as European in character, as independent and with assurance that the output is of state-of-the-art quality, indeed substantially better than individual aviation organisations will be able to do by themselves. The benefit of a host organisation is that many administrative human resources matters will already be established, such as recruitment and staff management. It is most likely that the host organisation will operate in the not-for-profit sector to minimise ethical concerns. The selection of the physical location of the ROO would ideally be co-located with the host organisation but need not be if good communications and acceptable administrative arrangements can be constructed.

Three options for the foundation of the ROO are identified:

Option 1: Establish a new, central body in the EU tasked to carry out the RO. This body shall be independent and not-for-profit.

Option 2: Accommodate the ROO within an existing, independent, not-for-profit organisation. Considering the ASIAS organisational model, there is no obvious not-for-profit MITRE equivalent on a pan-European basis that might be used in a similar way. The following possible solutions are identified:

- Option 2A: The EU Joint Research Centre (JRC) houses a number of relatively independent research institutes, which might be worth considering as an appropriate model in more detail. There is an existing pan-European aviation safety function provided by JRC through the maintenance of the European Coordination Centre for Accident and Incident Reporting (ECCAIRS).
- Option 2B: Given the need for independence and non-profit character, EREA partners could be candidates to house the RO. A significant benefit would be the availability of highly skilled staff in various aviation safety related subject matters, and a solid technical and scientific expertise.
- Option 2C: Given the need for independence, a university could be an option to house the RO, but it would best be placed as a European resource rather than being individual-nation based. A significant benefit would be the availability of technical and scientific expertise and skills (e.g. data science, statistics, modelling, programming) – similar to option 2B.

Option 3: Accommodate the ROO within an existing organisation that is part of the government, industry, or part of the government-industry cooperation. It is noted that setting-up the RO at existing organisations that are part of the government or industry will create additional challenges with regards to independence, separation of responsibilities, and conflict of interest. ASIAS is 'hosted' by an independent

organisation in the United States (MITRE) and not with the FAA for that reason. Similarly, EASA has acknowledged that for the Data4Safety programme an independent governance needs to be set-up including a charter about how the programme can use the data, what data can be disclosed, what data a user gets to see, what not, etc. When data is shared and analysed by existing organisations that are part of the industry or a specific domain, it could lead to a conflict of interest in the data analyses or lack of integrated, total aviation system approach in the data analyses. These issues will need to be discussed with e.g. EASA, Eurocontrol, national authorities and industry members, before being able to conclude on whether or not they could be considered as favourable options to host the RO. In any case, and as a minimum, they are crucial and should be indispensable partners of the RO and governance structure (see section 4.4).

4.2. ROO implementation management team

In general it is expected that an implementation management team will be set-up to prepare for the ROO as described below. In fact, EASA is taking some of these steps in the Data4Safety initiative.

The implementation of the ROO requires a Management Team (MT). It is envisioned that the MT can be established by a joint government-industry cooperation, with terms of reference, a budget, timescales and agreed deliverables. The representatives from the government (EC, EASA, national authorities) and the industry stakeholders can be organized in a steering committee to oversee the operation of the MT and the implementation of the ROO. The terms of reference should be drafted by this steering committee.

The MT will manage practical aspects of planning and executing the ROO development, implementation and the transition to a “standard” business operation. The MT should be composed of members with experience in project management, enterprise launching, finance, etc. A key member will be a Technical Director to ensure that the practical arrangements will permit the intended technical functionalities of the ROO to take place effectively. The MT will be responsible for the allocation of resources, the identification and management of risks and will bring significant issues to the steering committee. The MT will define the ROO’s initial corporate strategy right through to the tactical level of initial workflow arrangements. The MT will have a defined lifetime and will manage the transition to a conventional executive body (with the organisational or governance structure defined by the MT) responsible for the day-to-day operation of the ROO. It may be the case that MT personnel form significant elements of that executive body.

The activities of the MT include:

- Selection of a host organisation and physical location to house the RO (see section 4.1).
- Establish a Launch Plan for the ROO which will cover the time period to ROO initial operation. This will include recruitment of initial staffing.
- Establish an Analysis Launch Plan for the ROO. This plan will define the initial data to be collected and initial analyses to be conducted. Clear, timely goals will be an integral part of the plan. It will

also consider information dissemination for the initial results and engagement with stakeholders at a working level (e.g. through workshops).

- Plan for scalability of the ROO to allow it to grow in a controlled manner according to evolving needs.

4.3. The scalability or ambition levels for the RO

The expectations and possible ambitions of stakeholders with respect to the RO were first addressed in FSS P4 project work package 4.1. One of the identified business requirements (number 70) states that "The Risk Observatory shall be designed to be scalable against the growing number of users with respect to, at least: data processing times, data storage capacity, availability. An incremental growth of the Risk Observatory usage is foreseen and essential to achieve the required effectiveness." Business requirement 10 specifies the expectations regarding the activities in safety management that the RO shall support.

The ROO should be of sufficient size to conduct the required tasks with an appropriate level of administrative support including financial management. It should be staffed with highly qualified, experienced analysts in order to be able to provide better safety information and safety intelligence than currently available in organisations or safety programmes.

It is recommended to use an evolutionary approach, starting small with the explicit intention of demonstrating usefulness of the RO before starting to bid for more ambitious and large(r) budgets. There is a risk of damaging support for its launch and evolution if promoting too much of a grand vision for the ROO without any supporting evidence that it will work.

The scalability in ambition level applies to value proposition, services provided, and activities conducted. Apart from that, without changing the ambition level, the RO will be affected by an increasing participation by data providers. Technically, this requires capabilities to handle increasing data volume and data variety. Although in general all business model canvas building blocks could be affected by the level of ambition and scalability, this report will focus on the most relevant elements. For now, three levels are defined: a small, medium and large scale ROO.

Table 7: Ambition levels for the ROO: small, medium, large.

SCALE		S	M	L
Value proposition	Analyse the safety data for directed studies and dashboards			
	Provide individually tailored results to stakeholders			
	Provide safety data to CAAs, EASA, EC			
	Undertake safety studies on a cost recovery basis			
Customer relationships	Self-service dashboard			
	Automated or dedicated safety information			
	Personal assistance			
	User group meetings and communities			
	International cooperation			
Channels	Web-based dashboard			
	Manual upload and processing of data			
	Automatic B2B upload of data			
	Regular safety info publications			
	On demand safety studies			
Customer segments	Remains equal for all scales			
Key activities [1)]	Key activities (described in section 3.5.1)			
	Provide training, guidance and consultancy			
Key resources [2)]	Key resources (described in section 3.6)			
Key partners	Remains equal for all scales			
Cost structure [3)]	Fixed costs: increasing with scale			
	Variable costs: increasing with scale			
	Costs of safety publications			
	Costs of dedicated safety studies			
Revenue streams	Government funded (Fully (F) or possibly Partly (P))	F	P	P
	Revenue streams (possibly)			
	Fully self-supporting financially (possibly)			

Notes:

1. Key activities will take place in all three sizes of the ROO, although the larger the ROO the more extensive the activity may become.
2. Resources will be needed in all three sizes of the ROO, although the larger the ROO the more resources may be required.
3. Fixed costs will be spent in all three variants, although the larger the ROO the higher the costs for resources. Variable costs associated with processing, storage and analyses of data may be increasing with increasing data sharing.

4.4. Governance framework of the ROO

Stakeholder involvement in the oversight and (strategic) management of the ROO activities is a key success factor. However, it is not expected that stakeholders participate in the daily management of the ROO.

The ASIAS governance structure with clear independence and within the framework of the existing aviation safety infrastructure seems to drive the effectiveness of the programme and provides confidence to the members that the data is used appropriately, is protected and that interests are balanced. The governance model of ASIAS seems to be applicable to the ROO although the situation in Europe will be more complicated than in the United States. The challenge for the ROO will be to develop and implement a governance structure in Europe, considering the number of Member States, different legal frameworks, and possibly national interests.

It is suggested that the steering group is formed by a limited number of representatives of the aviation community, from both industry and government. For instance, the seats in the committee could be occupied by: EASA and a few national authorities, unions, association of European airlines, airports and ANSPs. Steering group areas of responsibility could cover:

- Define terms of reference, policy and procedures (e.g. on data protection, data handling, use of data, dissemination of results).
- Prioritisation and approval of studies and dissemination of study results.
- Determine the development/deployment strategy and future expansion goals.
- Oversee the management of the ROO.
- Coordination with strategic partners and safety initiatives worldwide (e.g. ASIAS, STEADES, similar data sharing initiative in other regions such as South America or Asia-Pacific).

It is suggested that a user group is formed of members that provide data to the RO and/or make use of the RO dashboards/results. Figure 3 shows a potential governance structure for the ROO.

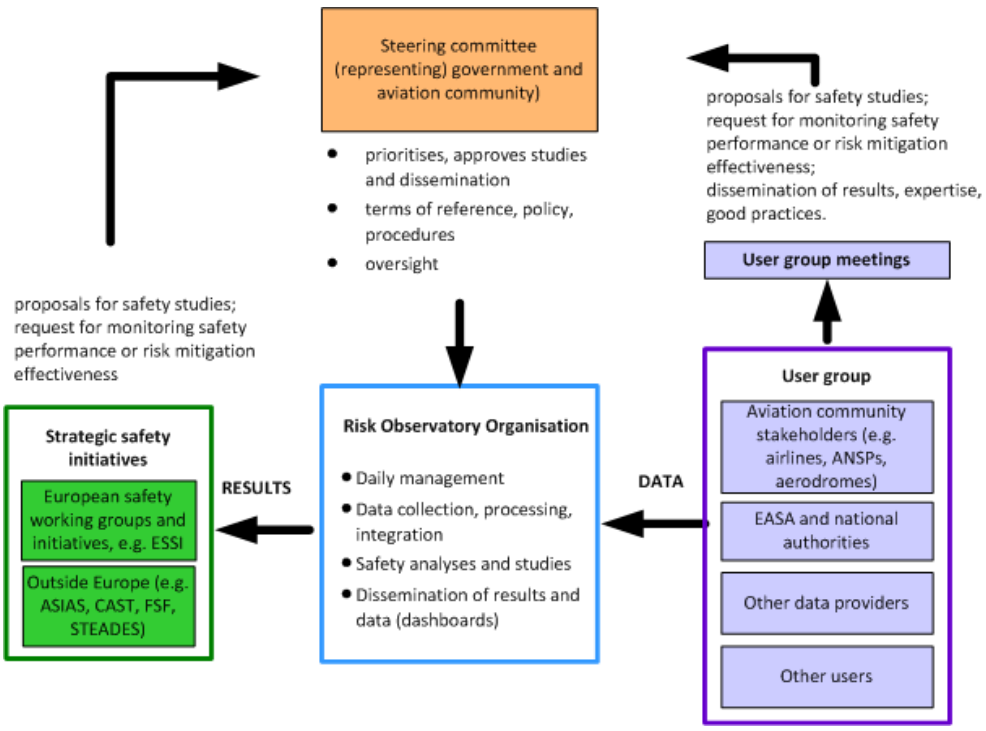

Figure 3: Potential governance structure for the Risk Observatory Organisation.

4.5. Success factors for the ROO

In order for the ROO to be successful in its value proposition, it is essential to obtain participation from sufficient (diverse) groups of stakeholders, sharing sufficient data with volume, variety and quality, in combination with technical capabilities to transform data into safety information. Technical capabilities include data processing, data fusion and analytics. In order to be successful in attracting stakeholders to join and share data, the RO must provide added value in addition to similar initiatives, like STEADES, and support the European occurrence reporting scheme (EC 376/2014) and EASA's big data programme for aviation safety (Data4Safety), which in turn increases stakeholder participation. Figure 4 illustrates that this is a cyclic process.

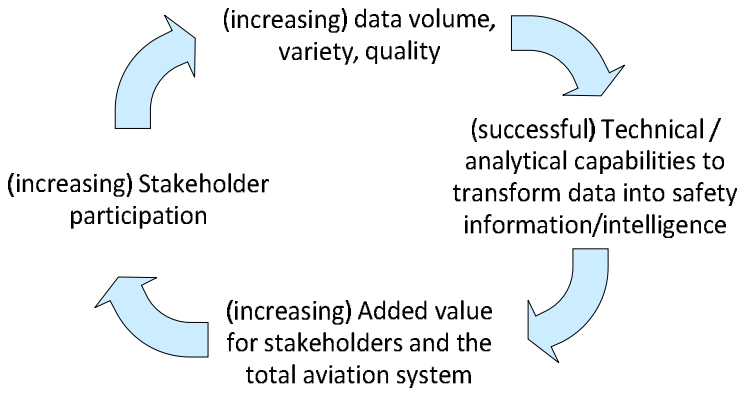

Figure 4: Dependencies in achieving a successful ROO.

A number of critical success factors or key principles for the RO and its organisation are identified. Critical success factors for the RO include:

- The stakeholders, data providers, must experience sufficient benefit and added value from sharing data, compared to existing practices within the organisations and similar data sharing initiatives.
- Data shall only be analysed for the purpose of improving safety, not for liability or apportioning blame (mindful of the objective of the accident/incident investigation according to ICAO Annex 13 Standards and Recommended Practices). The analysis shall neither include the behaviour and decisions of individuals, nor identify a particular organisation in the results. Only under strict conditions a safety publication may refer to an individual organisation.
- Data providers must be legally protected from negative consequences of sharing data, and/or the analysis of their data. Data shall not be used for business, commercial, punitive, competitive or economic purposes. Privacy and access to data should be protected and arranged.
- A good governance structure has to be established, balancing the interests of different stakeholders, mitigating concerns on the use of proprietary data. Stakeholders that share data must be part of the governance of the RO, and have a say in how data is being handled, analysed, and results are published.
- From a technical viewpoint the sharing of data shall require no/minimal effort for the data providers.
- The ROO is run as a cost-efficient organisation.

4.6. Roadmap for the Risk Observatory Organisation

4.6.1. Phases of the roadmap

To describe the general roadmap for the ROO the following phases are defined: research, development, implementation, operation, and expansion. The success factors and phases of the roadmap for the ROO have been combined in detailed roadmaps that describe the activities to be performed in four years to achieve the critical success factors, and to demonstrate the ROO's value proposition. Table 8 to Table 11 summarise the roadmap activities in the different stages. Figure 5 shows the proposed timeline. The FSS P4 project is regarded as the 'Research' phase for the ROO. The alignment in time of the ROO development with the FSS P4 project is to be determined. It is expected that the transition to a next phase will be gradually executed and not be as discrete as presented by the figure below.

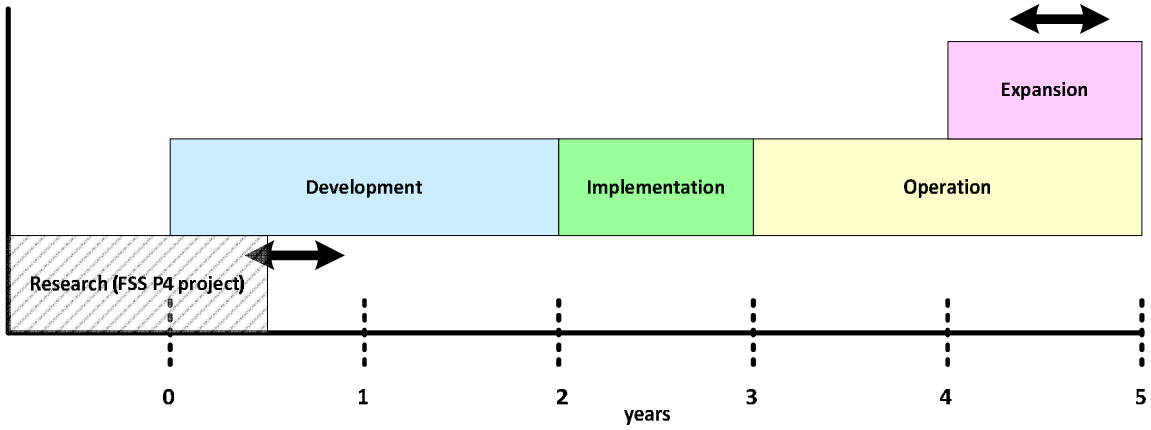

Figure 5: Roadmap and timeline.

4.6.2. Research

The FSS P4 project develops a RO prototype. The focus in the project is on the research of a RO, including the demonstration and evaluation of prototype technology to transform a large, heterogeneous dataset into relevant safety information. The development of technical capabilities for data processing, data fusion, proactive/predictive data analysis in combination with risk modelling, and visualisation techniques are central in the project. Chapter 6 provides recommendations to the FSS P4 project team. Figure 6 shows the relationship between these recommendations and the work packages in the project time line (the numbers relate to the respective recommendations).

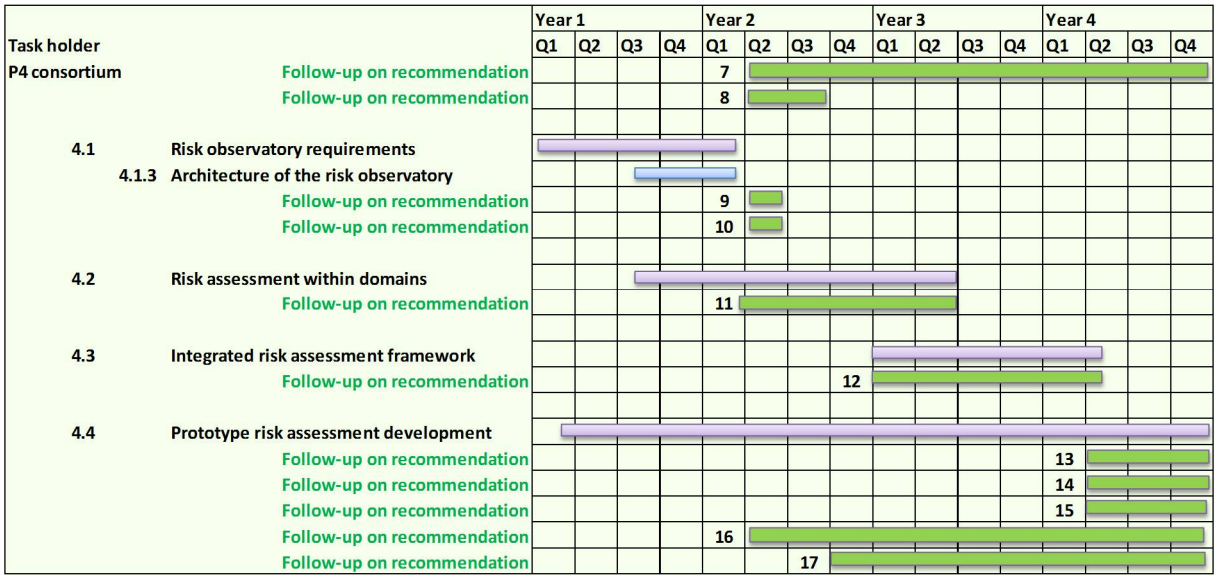

Figure 6: Gantt chart for project P4 with recommendations (numbered) to be taken up by the project.

4.6.3. Development

Ultimately, beyond the timeline of the P4 project, the ROO will be an operational organisation that collects, integrates, analyses data and disseminates analysis results. The organisation will manage and develop analytical capabilities and tools.

Table 8: Roadmap development.

Development – year 1 & 2	**Benefit**	• Develop a long list of potential safety studies (safety topics of interest) together with stakeholder representatives. Develop a short list from the long list for safety studies to conduct in the short-term.
	Appropriate use of data	• Set-up governance framework that approves studies, and decides on dissemination of results. • Develop terms of reference, policy and procedures regarding the use of data, purpose of analysis, access to data and results.
	Data protection	• Consult stakeholders to define terms and conditions for data sharing and required template of an MoU/NDA. Reach consensus with stakeholders about what data should be protected, and how it should be de-identified. • Address the legal aspects of data protection. Identify where legal frameworks may need to be further developed to ensure data protection. Establish an appropriate legal framework for data sharing and protection. • Develop a list of user profiles and data access authorisation. • Develop data security standards. •
	Data sharing	• Identify the data requirements, based on the proposed studies' objectives and scope. • Identify and assess data sources and data providers, assess data

		characteristics (structure, content, quality) and access to data. • Define technical requirements for data sharing, identify existing data standards, and define RO database data standards and quality control procedures. • Set-up of data transfer protocols. Test data processing of different data formats/standards.
	Governance	• Conduct regular workshops with stakeholders to define the governance structure. • Establish governance structure. Define terms of reference, policy and procedures (e.g. on data protection, data handling, use of data, dissemination of results). • Select the initial chair(s) and members for the steering committee. • Launch governance board/steering group.
	Partnerships	• Identify potential partners and establish point of contacts and a dialogue on the ROO.
	Communication	• Establish a promotion campaign to raise awareness, interest and buy-in from major stakeholders and strategic partners. • Conduct workshops with an early demonstrator to demonstrate added value of the RO. Consultation with and participation from stakeholders across aviation domains. • Reach out to the stakeholders and get participation and commitment from a few initial data providers (“launching customers”).
	Technology	• Finalise system requirements and develop software and hardware architectures. • Design and acquire software and hardware. Develop mechanisms, techniques and ICT architectures for data sharing, processing and analyses that handle different data formats, and allow effortless transformation of data formats into the RO databases. • Develop tools to format data and map data onto RO database structure. • Define, design and develop analytical tools, data storage, data security. • A proof of concept or test, implementing the technical infrastructure, capabilities for processing, analysis, etc. using data from one or more “launching customers” for testing.
	Cost effective organisation and resources	• Set-up initial ROO team, with a roadmap, action plan and funding to develop and implement the ROO. • Explore funding options and obtain funding. • Define required ROO resources, staff and qualifications and arrange resources (staff, facility, etc.). • Further detail the roadmaps provided for the scalable ROO activities and develop plans to create revenue.

4.6.4. Implementation

The ROO will start small, with scalability to handle the growth in stakeholders and volume and variety of data that is shared and managed by the organisation.

It is envisioned that in the first couple of years the ROO will have a few "launching customers" who share data. The focus may be initially on collecting best practices, hazards, mitigation actions, safety issue risk assessment reports, incident reports, etc. The collection of occurrence reports, FDM data or other data may develop over time. Open source data (such as meteorological data, ADS-B data, AIP) can be collected from the beginning.

Table 9: Roadmap implementation.

Implementation – year 3	**Benefit**	• Initiate the safety studies with approval from the steering committee. • Demonstrate and communicate study results and experienced benefits together with stakeholders.
	Appropriate use of data	• Implement data handling procedures. Instruct stakeholders and staff on data handling, data usage, etc.
	Data protection	• Sign MoUs/NDAs with stakeholders and partners.
	Data sharing	• Initiate data sharing with a few "launching customers". • Review and refine data sharing procedures, data standards, etc.
	Governance	• Arrange steering committee meetings. • Coordination with strategic partners and safety initiates worldwide.
	Partnerships	• Establish NDAs and partnerships. • Form strategic alliances with similar initiatives.
	Communication	• Set-up and maintain user group meetings to discuss data available, how to make use of data effectively, to identify interesting studies, discuss limitations in analysis, etc. Consultation with and participation from stakeholders across aviation domains
	Technology	• Implementation of data processing, analytics/modelling, visualisation processes and tools. • Validation and verification of capabilities.
	Cost effective organisation and resources	• Implement the ROO, set-up office and staff. Contract staff / consultants / suppliers. • Execute plans to create revenue. • Ensure continuous funding.

4.6.5. Operation

In this phase the ROO is "up and running". On a regular basis data will be collected from the participating stakeholders. Data will be analysed to feed the standardised dashboards and safety studies will be initiated for specific topics of interest. Maintenance and upgrades of the technical capabilities (hardware and software) will be a continuous activity.

Table 10: Roadmap operation.

Operation – year 4 and further	**Benefit**	• Organise regular user group meetings to monitor the studies' progress and results. Demonstrate and communicate study results and experienced benefits together with stakeholders.
	Appropriate use of data	• Evaluate yearly the policy, procedures and conducted studies to ensure continued appropriate use of data, and data protection.
	Data protection	• Evaluate yearly the content of and compliance with MoU/NDA to ensure continued appropriate use of data, and data protection.
	Data sharing	• Data sharing with customers. Review and refine data sharing procedures, data standards, etc. Expansion of data in volume, variety, quality with entry of new data providers.
	Governance	• Prioritisation and approval of studies and dissemination of study results. • Determine the development/deployment strategy and future expansion goals. • Day to day operational management is handled by the ROO staff. The ROO steering committee oversees the activities, reviews and approves safety study proposals and study results.
	Partnerships	• The ROO maintains a dialogue with stakeholders and partners through a twice yearly user group meeting.
	Communication	• The primary means of communication are the RO dashboard, publications, and study reports on the web-portal. • The ROO staff will attend workshops, safety conferences, international working groups as applicable for RO promotion and dialogue with the stakeholders.
	Technology	• Maintenance, upgrades, and development of hardware and software, technical analytical capabilities and infrastructure (e.g. storage, processing, software).
	Cost effective organisation and resources	• Evaluation of ROO effectiveness and efficiency. • Ensure continuous funding. • Execute plans to create and maintain revenue.

4.6.6. Expansion

Over time more organisations may be joining the ROO. With the expansion of the number of data providers, and consequently the increasing volume and variety of data, there will be a need to scale up the technical capabilities and infrastructure to process, store and analyse all data. It is also envisioned that with increasing participation, the number of safety study requests will increase and additional services (e.g. training and consultancy) will be provided. The ROO shall therefore continuously develop knowledge, technical expertise and capabilities to remain effective and efficient.

Table 11: Roadmap expansion.

Expansion	**Benefit**	• Organise regular user group meetings to identify needs for expansion. Demonstrate and communicate the added value of expansion of the RO to stakeholders, especially to obtain support of further development of analytical capabilities.
	Appropriate use of data	• Evaluate and assess the policy, procedures and conducted studies to ensure continued appropriate use of data and data protection when (considering) expanding the ROO.
	Data protection	• Regularly review the data protection arrangements to ensure that they remain up-to-date, adequate and effective. It shall be considered whether the data protection limits expansion or requires adaptation to allow expansion.
	Data sharing	• Expansion of data in volume, variety, quality with entry of new data providers.
	Governance	• The ROO steering committee sets goals for the further development of the ROO and expansion to other organisations and domains (e.g. airlines from outside EU, helicopter industry).
	Partnerships	• Extend partnerships based on expansion goals and opportunities for collaboration.
	Communication	• The ROO shall regularly review its communication means. Other means of communication may become available or may be required in the future.
	Technology	• Further development of technical, analytical capabilities for the data chain (from data collection to analysis and reporting).
	Cost effective organisation and resources	• Additional resources may be required based on the increased amount of data, promulgation of safety intelligence and an increased number of activities (e.g. training and consultancy).

4.7. Risks for the Risk Observatory Organisation

This section summarises important business risks that could pose a threat to the success and viability of the ROO and hamper its development, implementation, and operation. Currently the risks are qualitatively described. The risk level, defined by the consequence and likelihood of it occurring, has not yet been determined. It is recommended to define in the final business model the risk levels in order to prioritise them, and secondly, to define risk mitigation strategies.

In literature the distinction is often made between several types of business risk, such as strategic risk, financial risk, operational risk, compliance risk, reputation risk, technology risk, political risk, legal risk, and human capital risk [22]. This breakdown can be applied to the ROO's business risk as well, with a note that the compliance risk could be interpreted as risk associated with compliance to the governance agreements, NDA's, and data protection agreements.

The failure to successfully develop and establish the ROO and the failure of the continuation of the ROO are considered the principal modes of failure. The Table 12 shows identified potential risks that could lead to the two principal failure modes. Obviously, the defined key success factors in section 4.5 reflect the business risks in the sense that if those success factors are not met, the ROO is expected to have limited success and viability.

Table 12: Summary of main business risks that could pose a threat to the establishment and continuation of the ROO

Type	Potential risk
Strategic	• Lack of visible, actionable or tangible safety information as output from the ROO. • The absence of a strategy for implementation of safety improvements based on the RO's output. • Lack of focus on quick wins and clear use cases. • Lack of proper partnerships to maintain good relationships with the aviation stakeholder community across Europe and abroad. • Strategy for provision of data by stakeholders is absent. Lack of coverage in domains.
Compliance / legal	• Misuse of data for purposes other than safety, e.g. oversight, prosecution, liability, commercial purposes etc. • Data or information is released to stakeholders without approval. • Roles and responsibilities between the judicial authorities, stakeholders and the ROO are unclear or undefined. • Unclear definition of roles, responsibility, rules, guidance for authorities in relation to access (de-identified) data and information in the RO.

Operational	• Data-sharing by stakeholders is time-consuming, complex and takes (too much) effort. • The "total aviation system" safety analysis approach is ineffective due to a limited data coverage of domains. • Lack of staff with the proper skill set (both domain expertise and analytical skills) and experience. • Lack of availability of sufficient manpower.
Political	• Lack of influence by stakeholders on the oversight and the strategic operation of the ROO. • Lack of influence by stakeholders on the ROO's services, e.g. sorts of analyses, use of data, publication of results. • Governance structure does not balance the interests of stakeholders properly.
Reputation	• The absence of a strategy to promote the ROO and ensure a common understanding of what the ROO entails. • Overselling the benefit and ambition of the ROO. • Ineffective or limited communication by the ROO with stakeholders and partners on data sharing, data quality, use cases. • The absence of a strategy to promote early successes in the early phase of the ROO operation. • Data and information leaks.
Technology	• Technical capabilities (e.g. processing, fusion, analysis, visualisation) are insufficient to transform data into relevant safety information. • The absence of a strategy to develop technical capabilities. • Lack of harmonisation of data, standardisation of data formats, events, safety performance indicators etc. • Lack of or insufficient data quality control procedures. • Low availability or poor system performance. • Lack of a well-developed user interface. • Lack of data, poor data quality, lack of variety in data and detail may limit the depth and scope of the analyses.
Financial	• Financial instability due to the absence of a long term funding strategy and lack of funding and revenue streams. • Insufficient revenue from revenue streams, e.g. workshops, training, consultancy. • Lack of investment in (technology) capabilities or human resources.

5 CONCLUSIONS

5.1. Overall conclusions

A preliminary business model has been developed that describes the organisational, operational, financial and legal aspects of setting up and maintaining an organisation that manages the RO. The business model is preliminary in the sense that several elements have to be worked out in more detail in the final version. Several sources have been used to develop the business model. The business requirements identified in D4.1 [3] have been used as context. Existing data sharing initiatives such as ASIAS, the EASA big data programme for aviation safety, and mandatory occurrence reporting schemes were reviewed to identify lessons learnt. Interviews with stakeholders have further refined the business model.

Critical success factors for the ROO to become and remain viable have been identified:

- Provide significant benefit and added value to stakeholders over existing data sharing and analysis activities.
- Establish data protection and data usage agreements that ensure that data are solely used for safety.
- Set-up a governance structure that balances the interests of different stakeholders and assures the use of proprietary data solely for the interest of safety. It should also provide confidence to the stakeholders about the management and operation of the ROO.
- Minimise efforts for stakeholders to share data.
- Establish a cost-effective organisation with a long term funding strategy.

It is recommended that there will be one ROO in Europe to efficiently and effectively use resources and avoid duplication of effort. The first initiative in that direction seems to be taken by EASA with the feasibility study and proof of concept of a European big data programme for aviation safety (called Data4Safety). It is not the intention of the FSS P4 project to launch a ROO as a competitor to existing programmes. Indeed, the FSS P4 project shall assure that the research and development taking place in the project is complementary to, and consistent with, for example the mentioned EASA initiative. Ideally, the outcomes of Project P4 will be exploitable towards operational use by EASA in the short term.

A number of key decisions need to be taken regarding the implementation of the European ROO:

1. What entity will run or host the ROO?
2. What entity will promote the ROO before its actual establishment?
3. What entity will provide the required funding for the ROO development and implementation?
4. How do we ensure long-term funding and (financial) stability of the ROO and what form of funding suits the ROO best (e.g. government funding, co-funding, membership fees, etc.)?
5. What is the ambition level of the ROO with regard to scale, scope and key activities?
6. What sort of data and what sort of analysis results are the regulator and authorities allowed to access? The options include: no data at all, only aggregated aviation system level results (e.g. at a national or EU level), or results at the level of individual organisations.

5.2. Lessons learnt from other initiatives

Important lessons can be learnt from similar initiatives such as ASIAS and mandatory occurrence reporting schemes. The main lessons learnt are:

- Long-term funding strategy is essential.
- Promotional activities have to be carefully developed and planned, and started as soon as possible.
- Added value has to be visibly demonstrated and proven as soon as possible.
- Data quality and quality control have to be ensured.
- Governance structure has to ensure data protection, proper data use and dissemination of results.

All lessons have been incorporated in the preliminary business model or have been included in the recommendations when lessons apply to other FSS P4 project tasks or when decisions have to be made that go beyond the P4 project team's area of responsibility.

The main challenges that are identified for the ROO and RO are:

- Development of a governance structure in Europe will be more complex than for ASIAS, considering the number of States, different legal frameworks, different languages and cultures, and possibly national interests.
- The ROO has to assure that stakeholders experience sufficient benefit and added value from sharing data compared to current practices. The RO shall be complementary to similar data sharing initiatives or analyses conducted already by the stakeholders themselves.
- The ROO needs to assure data quality to provide good quality analyses. Lack of data quality, lack of standardisation and other data processing issues (different taxonomies, corrupt data, lack of details, de-identification of data, etc.) may hamper the quality and depth of the analyses.

It is assumed that the set-up of a governance structure for the ROO is a task for the EC and EASA, and that requires addressing the first challenge mentioned above. The remaining two challenges will be considered by the FSS P4 project in the development of the prototype Risk Observatory.

5.3. Preliminary Business Model

The Canvas business model template has been used to create a baseline to describe and develop the various elements of the business model. For each of the elements of the business model, conclusions have been drawn.

5.3.1. Value proposition

The value proposition of the ROO is essential for its success. The ROO value proposition has to strengthen related initiatives run by the EC and EASA (Data4Safety), IATA (e.g. STEADES and FDX), and the FAA (ASIAS). Primary incentives for stakeholders to share data to the ROO are:

- Provision of substantially enhanced safety intelligence, enabling risk analysis and defining safety performance indicators;
- Provision of safety intelligence in systemic risks across multiple operators and domains (i.e. total aviation system approach) that has been largely unavailable to date;
- Access for aviation senior managers to specialist analysts to dedicated safety studies, benchmark analyses, shared lessons learnt, and best practices.

5.3.2. Customer segments

Several customer segments have been identified, of which the airline industry is considered to be the data provider that probably brings most data to the RO. ANSPs are the second stakeholder group that could provide significant data to the RO. It is expected based on ASIAS experiences that airlines will gain benefits from the RO due to its wide scope of interfaces with other airlines, airports, ANSP's, ground service providers and manufacturers. Therefore, initial promotional activities should be focused on airlines and thereafter extended to other customer segments in the aviation industry. Manufacturers and authorities could also benefit directly from safety information shared by airlines. To ensure an attractive proposition to the ROO customer base, a detailed customer analysis is needed.

5.3.3. Customer relationships

In defining and developing customer relationships, a distinction has been made between data providers and data users. The customer relationship with data providers has to be built on mutual trust and protection mechanisms for data exchange and proper usage of data. When this basis of trust is guaranteed, data providers and the ROO staff work in close coordination to build a secure and reliable RO. For data users that receive RO output, the customer relationship mainly consists of self-service or automated services (i.e. the RO interactive dashboards and safety publications).

User group meetings or ROO representation in sector communities have to be used for promotional activities and for delivering RO output that go beyond the scope of the outputs provided by the dashboards.

Coordination and interaction between the ROO, European or national safety initiatives, academia and research institutes has to be established to ensure maximum benefit for all stakeholders and to continue providing beyond state-of-the-art safety intelligence.

5.3.4. Channels

The primary channel for the ROO for sharing data and safety information will be web-based, using interactive dashboards, internet portals, apps for mobile devices, or targeted e-mails. For marketing purposes, various channels may be used, which depend on the decisions made with regard to the focus of promotional activities. Information provided on these platforms should be regularly updated with news, analysis results, etc., to keep attracting potential customers.

Expansion of the ROO's activities may introduce other channels, like (on-demand) workshops, training, webinars, seminars and conferences.

5.3.5. Key activities

Several activities have been defined that are required to achieve the value proposition, to continue service provision and to improve the service quality, maintain customer relationships and acquire new customers. Initial ROO activities include acquisition, processing and fusion, storage and access, analysis and visualisation of data, and distribution of safety information. Additional activities, based on the size of the ROO may include the provision of training, guidance and consultancy (possibly also to non-aviation but data-intensive industries such as medicine). To ensure continuous service delivery and support, the ROO needs knowledge development, maintenance of the technical ICT infrastructure (hardware, software), risk models and dashboards, system administration and ICT-management.

5.3.6. Key resources

The ROO has two key resources that are fundamental to the RO objectives: on the one hand the data, and on the other hand, the risk models and analysis techniques that transform the safety data into safety information or intelligence. Other resources are staffing, IT infrastructure, software, office space, budget/funding and intellectual property. The team shall include (safety) analysts with a proper aviation and aviation safety knowledge from different domains (airline operations, air traffic management, ground operations, maintenance, etc.) to understand, interpret and validate data and analysis results. Staffing, IT related hardware, and software costs are considered to be the highest costs in the ROO business model. These should be defined more precisely in the final business model.

5.3.7. Key partners

Key partners of the ROO have been identified and subdivided into data providers, users, strategic partners and academia, research and development institutes. Whereas data providers and users are directly involved in the ROO key activities, strategic partners support and strengthen the relationships between the ROO and stakeholders. Strategic partners such as associations, unions, European government-industry safety initiatives, provide confidence to the community they represent that the ROO serves their interests

and will be of value to them. Partnerships with research establishments and academia will ensure the ROO is, and remains, a centre of excellence in safety data analysis.

5.3.8. Cost structure

Processing data and analysis of data will be the most expensive activities, requiring a lot of manpower, expertise and knowledge, as they are the most complex and time consuming parts of the process. These costs will increase commensurate with the amount and content of the data provided to the ROO and with the number and content of the activities the ROO intends to deliver (e.g. number of directed studies, training, consultancy activities).

5.3.9. Revenue streams

In the development and implementation phase, the ROO needs to be funded by the EC or co-funded by the European national governments. After implementation, funding could be gradually replaced by cost-sharing structure or membership fee to access RO data. This idea needs further evaluation on feasibility and support amongst stakeholders.

Additional revenue can be generated from services such as providing training, consultancy, or safety analyses under contract. It is expected that the ROO always needs to be partially funded by the EC or governments to ensure its independence, stability and continuity.

6 RECOMMENDATIONS

The following recommendations were composed during the development of the business model, after review of similar initiatives, from lesson learnt from occurrence reporting schemes, and based on input from stakeholders. The recommendations are being considered in the continuation of the FSS P4 project.

General recommendations:

1. It is recommended that one ROO will be established in Europe to efficiently and effectively use resources and avoid duplication of effort. There should be one entity, one organisation or a cooperation of organisations, to deliver and maintain the RO. This is not necessarily the prototype RO developed in the project P4. It is recommended to frame the ROO as the European central safety intelligence organisation, which brings together a collective wisdom on aviation safety, with analytical capabilities and data that the industry partners may not be able to bring together.
2. Decide whether the ROO will be developed, implemented and operated in the EU by:
    a. A new, central, independent and not-for-profit body;
    b. An existing, independent and not-for-profit body;
    c. An existing governmental or industrial body;
3. Develop and implement a governance structure for the ROO in Europe. Clearly define the roles and responsibilities of stakeholders, the ROO management team, and the relation with aviation and judicial authorities within each State.
4. Initiate a ROO implementation team with funding, timescales, deliverables, staffed with experienced people in setting up organisations to prepare for and implement the ROO.
5. Develop a long-term funding strategy to ensure continuity of the ROO services. It is recommended to use an evolutionary approach, starting small with the explicit intention of demonstrating usefulness of the RO before starting to bid for more ambition and large(r) budgets.
6. Assure that data shared with the ROO are protected against misuse for purposes other than safety (e.g. commercial interest, prosecution or liability).

To the FSS P4 project consortium:

7. Agree on the scale and ambition level for the ROO at the start, and further develop the ROO implementation roadmap for that ambition level. In addition, provide a plan for scalability and estimates for the associated costs and resources.
8. Develop a strategy to interact with, complement and strengthen similar data sharing activities like the EASA big data programme for aviation safety (Data4Safety). The P4 project team should interact on a regular basis with the EASA programme to ensure that both activities complement each other. It will be beneficial to both programmes to exchange information on progress, use cases and analytical capabilities developed. The P4 project should avoid duplication of efforts done by the EASA initiative.

9. Continue the interaction with ASIAS to share experiences and lessons learnt. In particular, it would be helpful for the P4 project to better understand from the ASIAS programme:
   - the potential bottlenecks of delivering meaningful, actionable outputs;
   - what data standardisation ASIAS applied to overcome data quality issues, the limitations of such standardisation and areas for collaboration on this topic;
   - how ASIAS evaluated the effectiveness of the CAST safety enhancements, and what lessons can be learnt for the ROO to support the evaluation of actions in e.g. the European Plan for Aviation Safety;
   - the cost breakdown to understand which key activities have proven to be the most expensive;
   - what their practice and experience is in providing workshops, training, webinars etc. for knowledge sharing and supporting the user community;
   - what predictive capabilities were considered, and what results were obtained with these capabilities;
   - the sort of output (topic, scope, depth, usefulness, frequency) provided by ASIAS and how this output was received by its Members, and assess how a similar output from the RO would be valued by European stakeholders;
   - the experience with an "in-house" data centre versus using commercial cloud service providers, and the implications for security of data and perception of security by the data providers.
10. It is recommended to study the feasibility of each funding option mentioned in section 3.9, and to identify the advantages and disadvantage of each option.
11. It is recommended to develop risk mitigation strategies for the risks identified in the preliminary business model regarding the development, implementation and operation of the ROO.

To WP 4.1.3 Architecture of the risk observatory:

12. Aim for and facilitate automatic electronic data input (e.g. by regular, automatic exports to the ROO) and analysis (e.g. by regular, automatic, standardised queries) to support and stimulate (potential) stakeholders to provide data and decrease manual handling of data by ROO staff to focus their activities on the actual data analysis and promulgation of safety intelligence.
13. Ensure standardisation of RO in- and output by:
    a. Establishing a protocol for data standardisation, data quality control and sharing of data.
    b. Providing a quality check on coding of occurrences and risk classification.

To WP 4.2 Model development:

14. In the development of the RO, constantly take into account the purpose of the RO, which is to increase aviation safety by transferring raw data into safety intelligence. This should be the connecting thread throughout all activities performed in P4 and can be monitored by regular reflections on whether, and how, the activities and deliverables fulfil the P4 objectives.

To WP 4.3 Integrated risk assessment framework:

15. Ensure standardisation of RO in- and output by:
    a. Providing a common taxonomy (adequate categories for coding of occurrences) according EU regulation No.376/2014;
    b. Providing a common risk classification;

To WP 4.4 Prototype risk assessment development (especially work package 4.4.1, 4.4.2, and 4.4.5):

16. Review the follow-up on the recommendation in this report when preparing the business model for operational deployment of the ROO (FSS deliverable D4.9.3).
17. Perform a detailed customer analysis to develop and maintain an attractive proposition to the ROO customer base (FSS deliverable D4.9.3).
18. Define consequences and likelihoods of business risks in order to prioritise them, and secondly, to define risk mitigation strategies (FSS deliverable D4.9.3).
19. Develop a strategy for implementation and monitoring of safety interventions based on the RO's output. The P4 project team should develop an approach to assure that the RO's output deliver safety improvement or really have an impact on the total aviation system, e.g. through interfacing with existing European safety initiatives or safety working groups.
20. Develop a strategy to assure that the RO may use data that (could) become available in the longer term and may apply risk assessment methodologies to fulfil longer term safety improvement ambitions.
21. Carefully develop, plan and perform promotional activities to consult and inform potential stakeholders about the ROO value proposition and the RO prototype. As part of the promotional activities, explore data protection opportunities and challenges with stakeholders from different countries, under different national data protection laws and cultural aspects. This recommendation should be followed up as soon as possible within the FSS P4 time schedule.

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22.	Review of the Literature on Enterprise Risk Management, Ahmad Rizal Razali and Izah Mohd Tahir, Business Management Dynamics Vol.1, No.5, Nov 2011, pp.08-16, Society for Business and Management Dynamics.

Appendix A RELEVANT BUSINESS REQUIREMENTS

BRQ_005	Mission	The Risk Observatory shall be structured and marketed to be a framework for European aviation safety data analysis. This stems from the fact it is developed in a European context, with European partners.
BRQ_010	Business context	The Risk Observatory shall support activities in safety management, specifically: safety risk management, hazard identification, safety risk assessment and mitigation, safety assurance, safety performance monitoring and measurement, the management of change. These key areas derive from a mapping between issues and needs in stakeholders' interviews and the safety management framework of ICAO [3]. This allocation, from one side, creates a quick common understanding among stakeholders and from the other side enforces the idea of the Risk Observatory as support to safety management.
BRQ_014	Safety data collection - sources	The Risk Observatory shall be able to acquire safety data from different stakeholder domains in Europe. At least from: Aircraft operators, ANSPs, Aircraft manufacturers, Aviation regulators.
BRQ_015	Safety data collection – additional sources	The Risk Observatory shall be able to acquire safety data from the following additional stakeholder domains in Europe: Airports.
BRQ_055	Risk Observatory effectiveness evaluation.	The Risk Observatory shall track metrics that will enable the evaluation of its effectiveness. It would be important to build in tracking functions of some defined indicators to evaluate the Risk Observatory's ongoing effectiveness.
BRQ_070	Scalability	The Risk Observatory shall be designed to be scalable against the growing number of users with respect to, at least: data processing times, data storage capacity, availability. An incremental growth of the Risk Observatory usage is foreseen and essential to achieve the required effectiveness.
BRQ_075	Service Delivery	The Risk Observatory shall guarantee an appropriate service level to encourage stakeholder usage and feeding. If it is usable, its adopted taxonomy is clear, if stakeholders do not take much time to feed and to use it, its usage will increase.

BRQ_080	Trust	The Risk Observatory shall provide a suitable policy of data management to be agreed with stakeholders in order to facilitate framework use and data feeding. Safety information should be collected solely for the improvement of aviation safety, and information protection is essential in ensuring the continued availability of information.
BRQ_085	Maintenance organization	The Risk Observatory shall be maintained by an independent organization of sufficient size to conduct the required tasks with an appropriate level of administrative support, including financial management. The independence of the Risk Observatory's maintenance organization shall guarantee confidentiality and should encourage participation.

Appendix B CAPABILITIES TO PROVIDE ADDED VALUE

In D4.1 [3] interviews have been conducted with potential stakeholders to identify business problems, needs and capability gaps in the areas of safety data collection and exchange, safety risk management and safety assurance. For the ROO to provide added value and take a competitive edge over similar, competing activities, it should develop the capability to:

- Achieve a proactive approach to safety management;
- Share safety data and reduce the manual effort to process the data;
- Structure the use of external sources of data to make safety data flow information independent from manual input;
- Efficiently identify all hazards per organisation, and those that are shared or common to different organisations and/or domains;
- Prioritise hazards;
- Quantify risks of accident scenarios related to the identified hazards;
- Share hazard/risk information and related mitigating measures among organisations in the same domain and different domains;
- Determine how to optimally use the available resources to maximise risk mitigation; this includes the capability of defining the proper mitigations and their effect;
- Analyse interdependencies between risk control measures among different domains;
- Generate information to support business cases for mitigating overarching risks;
- Define proper and harmonised indicators for safety performance, making use of all available types of data, both internally and externally sourced;
- Perform comparison of SPIs among stakeholders within the same domain;
- Determine the effectiveness of mitigating measures.

These capabilities result in a ROO that:

- Standardises safety data collection and exchange;
- Creates a complete safety picture;
- Enables domain/Member State/EASA-wide safety interventions;
- Provides more accurate data on current and expected safety performance;
- Defines acceptable levels of safety performance;
- Enables change management across interfaces;
- Enables informed decisions on resource allocation for safety management (trade-off, what-if analysis);
- Shares best practices;
- Monitors the effectiveness of risk mitigation measures.

Appendix C DETAILED LIST OF STAKEHOLDERS

These stakeholders have been further specified as follows:

Users of the system itself and the services provided by the RO:

- Aircraft manufacturers: safety key actors, flight operational departments;
- Aircraft operators: safety departments, executive management (Postholders and accountable manager);
- ANSPs: safety departments, executive management (Postholders and accountable manager);
- Airports: safety departments, executive management (Postholders and accountable manager), and;
- Aviation regulators and authorities.
- Customers, which are the entities paying for the use of the RO or its outputs:
- Service providers (aircraft operators, ANSPs, airports);
- Aircraft manufacturers;
- Aviation regulators and authorities;
- Industry groups, and;
- Unions.

Beneficiaries, which are the people and organisations getting an improvement of their business in the above defined business contexts:

- Aircraft manufacturers;
- Airlines;
- ANSPs;
- Airports;
- Aviation regulators and authorities, and;
- General public, governments.

Contributors, which are the stakeholders providing data as input to the RO:

- Aircraft operators: pilots are in effect important contributors of data (also indirect, e.g. via FDM). Additionally data input is foreseen from maintenance personnel, cabin crew, and ground personnel;
- ANSPs: together with pilots, ATCOs are important contributors of data;
- Airports: maintenance personnel and ground personnel;
- External parties: e.g. meteorological companies providing weather data.

Appendix D CHANNELS FOR MARKETING AND DISTRIBUTION

In identifying and developing channels intended for marketing or distribution of the ROO services, the following phases are distinguished:

- Awareness: How do we raise awareness about the ROO products and services?
- Evaluation: How do we help customers evaluate the ROO value proposition?
- Purchase: How do we allow customers to purchase specific products and services?
- Delivery: How do we deliver a value proposition to customers?
- Aftersales: How do we provide post-purchase customer support?

Awareness

The first step is to raise awareness of the ROO products and services with the targeted customer segments. This can be done is several ways, depending on the already existing customer relationships. With existing customers, the RO may be introduced during regular meetings or dedicated appointments to provide the necessary background information of the RO prototype. To reach customer segments for which no relationship yet exists, other sources may be developed and used to inform them about the ROO products and services. These are, among others:

- Attendance at conferences, seminars, etc.;
- Advertisements in sector magazines, e.g. Flight International;
- Advertisements in targeted e-mails about aviation news, e.g. Curt Lewis & Associates, LLC;
- Development and maintenance of a dedicated ROO website.

It is noted that the information provided on these platforms should be regularly updated with news, analysis results, etc., to keep attracting potential customers.

In creating awareness of the ROO products and services, commercial and marketing skills are required to attract new customers, data providers, and to promote the RO.

Evaluation

After awareness has been created with customers, they have to be convinced that the ROO substantiates its value proposition. This can be accomplished in face-to-face meetings in which the RO is demonstrated and examples are given of instances in which the shared data has indeed provided added value or cost savings. When sufficient data has been acquired to provide monthly, quarterly or yearly trend analyses, targeted e-mails may be send to potential and existing customers to raise their awareness of the RO capabilities.

Purchase

When customers decide to purchase the RO products and services, arrangements have to be established. The purpose of such an arrangement is to define, agree and document the methodology, standards and

responsibilities for data sharing and promulgation of safety information. The following elements should be included in the arrangement:

- Description of the product/service to be delivered;
- Methodology/approach to be used;
- Non-disclosure agreement for data protection;
- Relevant standards or procedures related to the product/service;
- The individual(s) responsible for ensuring that the activities related to the product/service are carried out in accordance with the documented standards and procedures;
- Actions necessary to document and communicate the methodology, standards and responsibilities to all stakeholders;
- The individual(s) assigned to document and communicate the methodology, standards and responsibilities;
- Confirmation that actions have been completed and all elements are documented.

The ROO should be assigned responsibility for management, storage and analysis of safety data, as well as for promulgation of safety information.

Delivery

Prerequisite for delivery of safety information is sufficient data to conduct reliable analyses. Channels offered by the ROO and used by customers to supply data may take the form of business-to-business interfaces providing continuous, daily or weekly uploads of proprietary information. Similar business-to-business channels will be used for the delivery of safety information to customers. There will be a worldwide accessible internet portal, granting access to, for example:

- Standardised analyses;
- Safety projects;
- Safety campaigns;
- On-line forum;
- Frequently asked questions;
- “I want to know more about…”

Delivery of the generic safety information provided by the ROO to e.g. the media and general public will be open source, meaning that general safety analyses are available to everybody willing to access that information. Monthly, quarterly or yearly trend analyses will be published on the ROO open source website. These trend analyses may also be forwarded by targeted e-mails to potential or existing customers.

For targeted output, e.g. studies for general public, sectors or individual parties, a dedicated internet portal is established that grands password protected access to data providers and users.

Next to web-based promulgation of safety information, other means may be provided by the ROO as well, like (on-demand) workshops, training, webinars, seminars and conferences. This way of promulgation of safety information will have an additional impact on the number of resources needed to ensure continuous delivery of these services.

Aftersales

After customers take delivery of the ROO products or services, it is essential to keep a warm relationship with the customer and to regularly review whether the products or services are still satisfactory and may be improved. In addition, the process and activities to be executed when a customer or data provider discontinues its ROO membership needs to be defined.

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