Operational Mindfulness Manager

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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 TCD within P5, Reducing the organisational accident. The Safety Mindfulness model advocates on active flows of relevant and useful information that support decision and action to effectively mitigate risk both directly within operations as well as in the management of system improvement. The main objective is to validate the Safety Mindfulness model and the related technologies in two case studies. To do so, a multiple-case study methodology has been used to evaluate the conditions under which the 'mindfulness' phenomenon is likely to be found, across multiple cases.

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Acronyms

Acronym	Definition
AZ	Alitalia
MUAC	Maastricht Upper Area Control Centre
OSMS	Organisational Safety Mindfulness Survey
SM.App	Safety Mindfulness solution/application (designed for MUAC)

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EXECUTIVE SUMMARY

Problem Area

Future Sky Safety WP5.2 "Safety Mindfulness" has the objective to develop and demonstrate a concrete and practical method of maintaining safety mindfulness in operational situations. The idea is that if operational staff are aware of the possible threats that can occur in their day-to-day activities, they can anticipate (most of) them. While operational staff are certainly aware of most of the risks, there are two sources of risk for which they may not have current information. The first is risk information that is taken from a wider pool of information than the operational layer (including supervisors) traditionally has access to. Risks may be identified by looking across several organisations or even across an industry. Such information is relevant but may take a long time to filter back down to operational staff in organisations. The second source of risk information concerns new risks that may have been noticed by one or two individuals during their daily work, but have not yet been passed up the chain and identified as risks that operational staff need to be concerned about. Such risks may be passed on from one individual to another, but this will be an ad hoc process rather than formal, and may not reach the person who really needs it in time. Both these types of risk information may eventually reach the right people, but this can take too much time, and an incident can occur before existing processes have identified, analysed and processed such information, and disseminated it to the collective workforce.

Safety Mindfulness, as it has been conceptualized within Future Sky Safety, is more than a state of mind of individuals. It involves the flow of information/knowledge within the organization that primes one's expectations of potential issues that arise even if highly unlikely. Safety Mindfulness involves a process of soliciting and gathering information worth sharing, then processing and distributing that information to support the planning and action of individuals across the system. It's about the 'action', and the consequence of that action – i.e. to enable people to act in the proper way, and evaluate the impact of that. The flow of information generates mindful awareness that supports appropriate action (at operational or management level), producing outcomes. Making this cycle (knowledge – action – outcome) transparent both validates the knowledge and makes the actions accountable. In fact, the overall objective is to use that knowledge to improve the functioning of the system. Hence, Safety Mindfulness illustrates a structure/steps of intervention to enhance the system's capabilities to remain safe. It creates the conditions that encourage informed and accountable action at all levels across the system. The basic principle applies at all levels: support all legitimate people with the best possible information and make their actions transparent. This enables both feedback and accountability to stimulate the highest possible levels of performance.

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Description of Work

Safety Mindfulness produces an improved situation within the two selected case studies, and the outcome of this can be compared and/or contrasted. This document presents the research undertaken to apply and test Safety Mindfulness in two distinctive organisations. The two cases included the (1) MUAC Case Study and the (2) ALITALIA Case Study. This means to support 'literal replication' – i.e. to be able to predict similar results across multiple cases. The multiple-case study approach was used in order to be able to obtain a fuller picture of the extent to which The Safety Mindfulness model advocates active flows of relevant and useful information that support decision and action to effectively mitigate risk both directly within operations as well as in the management of system improvement.

The Safety Mindfulness model has been operationalised, and following its principles and functional concepts, generic software solutions have been developed for the two case studies. These software applications are of two types:

- Reporting any issue from normal operations and generating narratives for circulation and comment
- Implementing improvement in an accountable manner

Results & Conclusions

The research carried out in the two case studies led to the following results:

1. In MUAC ATC Centre (Netherlands), TCD research demonstrated the need for the gathering and circulation of potential risk related narratives amongst air traffic operational staff in order to heighten safety mindfulness in this ultra-safe sector, ensuring effective feedback loops of relevant information into the operation. The case study has been designed, the software prototype developed and the trial implementation phase is planned to commence following the final preparation meetings that took place in October 2017. Full implementation trials are provisionally planned for the first quarter of 2018.
2. Alitalia Ground Operations (Italy): TCD 'big data' risk pattern analysis of audit reports identified poor pre-turnaround briefing as a precursor of other operational failures which in turn were associated with actual safety incidents. This has initiated a case study centred around improving turnaround briefings and mindful performance. It will deploy two applications designed to create a mindful improvement initiative:
    a. An Implementation Manager that supports the recording of all improvement and effective handovers

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b. Operational reporting to ensure continual information flow and feedback as the initiative continues.

This initiative is beginning its implementation phase since late October 2017, involving a full handover of methods and tools in support of the case study, leading to full implementation in the first quarter of 2018.

Applicability

The potential applicability of this approach covers not only all sectors of aviation, but also all industries that carry a significant operational risk, including health and social care, emergency services, financial services and other transport modes. The applicability of these ideas across these domains has been demonstrated through teaching and research at masters level with risk, safety and change professionals across these industries (TCD MSc in Managing Risk and System Change), though no formal market analysis has yet been done in advance of the initial concept demonstration in the current case studies.

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1 INTRODUCTION

1.1. The Programme

Future Sky Safety[1] is an EU-funded transport research programme in the field of European aviation safety, with an estimated initial budget of about € 28 million, which brings together 33 European partners to develop new tools and new approaches to aeronautics safety, over a four-year period starting in January 2015.

Future Sky Safety contributes to the EC Work Programme Topic MG.1.4-2014 Coordinated research and innovation actions, targeting the highest levels of safety for European aviation in Call/Area Mobility for Growth – Aviation of Horizon 2020 Societal Challenge Smart, Green and Integrated Transport. Future Sky Safety addresses the Safety challenges of the ACARE Strategic Research and Innovation Agenda.

Future Sky Safety will also help coordinate the research and innovation agendas of several countries and institutions, as well as create synergies with other EU initiatives in the field (e.g. SESAR, Clean Sky 2). Future Sky Safety is set up with four years duration, and started on the 1st of January 2015.

Future Sky Safety, established under coordination of EREA, is built on European safety priorities around four main themes, each consisting of a small set of Projects:

- Theme 1 (New solutions for today's accidents) aims for breakthrough research with the purpose of enabling a direct, specific, significant risk reduction in the medium term.
- Theme 2 (Strengthening the capability to manage risk) conducts research on processes and technologies to enable the aviation system actors to achieve near-total control over the safety risk in the air transport system.
- Theme 3 (Building ultra-resilient systems and operators) conducts research on the improvement of Systems and the Human Operator with the specific aim to improve safety performance under unanticipated circumstances.
- Theme 4 (Building ultra-resilient vehicles) aims at reducing the effect of external hazards on the aerial vehicle integrity, as well as improving the safety of the cabin environment

1.2. Project context

The objective of Project P5 "Resolving the organisational accident" is to reduce the likelihood of organisational accidents in aviation via development and implementation of a Safe Performance System. P5 answers to Future Sky Safety Theme 3, which aims at

[1] See https://www.futuresky-safety.eu/ accessed 15JAN2016.

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strengthening the resilience to deal with current and new risks of the humans and the organizations operating the air transport system.

TCD is leading the strand related to 'Safety Mindfulness' within Project P5 'Resolving the Organisational Accident'. P5 has the high-level objective to reduce the likelihood of organisational accidents in aviation through the development and implementation of a Safe Performance System. Safety focus has traditionally been on technical failures and human error as they occur in operations. New and promising approaches consider the overall socio-technical system in the full operational and organizational context. The research FSS P5 is advancing addresses effects of organizational structures, processes and cultural phenomena on safety performance in aviation organizations.

Specifically, TCD is responsible for developing and demonstrating a concrete and practical method/approach to maintain safety mindfulness in operational situations. In Year 1 an extensive literature review regarding the original concept developed by Weick and colleagues has been provided, and an integrated FSS Safety Mindfulness concept was advanced to address the weak areas of the original concept. The proposed approach comprises different aspects which will support both the operational, supervisory and middle management layers to better understand the system they work in, and share safety knowledge-based information. In Year 2 the concept has been promoted in two distinctive cases to support the specification of the concept and collect requirements to define a 'Safety Mindfulness model', able to support the definition of mindful organisations and to leverage change. In Year 3 the consolidated model, and the technology designed and developed by TCD to apply the underlying model's principles, was tested in two distinctive organisations. These include: (1) an ATC company based in The Netherlands, and (2) an airline company based in Italy. TCD was in charge to design, develop and execute the two above-mentioned case studies.

In 2017/18 FOI conducted an independent case study at 3 European Area Control Centres – the analysis of which is ongoing (at the time of the submission of the present deliverable). This work is described in Section 5, and will be reported at a later stage. This work is part of the WP5.2 research, and represents an additional case study to collect more data and shed more light on the Safety Mindfulness concept.

1.3. Research objectives

The high-level objective of the research conducted in Year 3 was to apply the consolidated Safety Mindfulness model, and test the extent to which safety mindfulness supports an improved flow of information/knowledge able to generate mindful awareness for appropriate action (at operational or management level), and related outcomes. The over-riding research questions have been the following:

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- Does the Safety Mindfulness model and related technologies support/leverage a wider 'mindfulness' within the organisation?
- Is the flow of information/knowledge put in place, relevant, accountable, and able to leverage the functioning improvement of the system? Does it support horizontal and vertical escalation?
- Do the Safety Mindfulness conditions created support and encourage informed and accountable action at all levels across the system (i.e. an 'obligation to act)?
- Does the designed Organisational Safety Mindfulness Survey (OSMS) support the testing of the Safety Mindfulness in organisations?

Specific research questions have been addressed in each case study.

In MUAC, TCD intervention and implementation of a Safety Mindfulness model/application is meant to **increase** the MUAC collective mindfulness, and support the ATCOs **continuous learning from peers' experiences and best practices.** The 'MUAC case study' specific research questions include: (1) Does the proposed Safety Mindfulness IT App (SM.App) increase the ATCOs' collective knowledge/mindfulness facing critical relevant safety-related situations happening in their daily activity? (2) Does the proposed Safety Mindfulness IT App (SM.App) make sense from an operational (i.e. usability, functionality and integration of technology), and broader safety perspective?

In ALITALIA, the Ground Operations have turnaround issues in safety and performance terms. These have been investigated with big data analysis. The result is to facilitate Safety Mindfulness with real applications of new processes dedicated to the Turnaround processes and safety of the operations. In practice Alitalia will test three software tools revolving around and **facilitating capacity in Safety Mindfulness**. A quasi-experimental test (no control samples) will **monitor change and expected safety and performance variations**. The 'ALITALIA case study' specific research question is: Does the use of dedicated software applications facilitate consistently the flow of safety knowledge seamlessly in the total organisation?

Some dedicated Safety Mindfulness metrics, combined with Audit performance measures will monitor any change in attitudinal and behavioural terms. The key research questions addressed are two-fold:

1) Is Safety Mindfulness measureable with a metric?

2) Is safety mindfulness measurable to a performance level criterion?

1.4. Methodological approach

The multiple-case study method was used to apply and test Safety Mindfulness in the two selected organisations. The two cases included the (1) MUAC Case Study and the (2) ALITALIA Case Study. The multiple-case study has proven to bring more compelling

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evidence, and the overall study is regarded as more robust (Herriot & Firestone, 1983). In particular, the multiple case design approach proposed by Yin (Yin, 2009, 2012) has been followed. The rationale for a multiple-case design refers to the kind of replication to be studied. The replication logic used is theoretical replication – i.e. where the cases were designed to cover different theoretical conditions. Each case served applied and tested Safety Mindfulness, by means of two TCD IT solutions. To be able to compare and 'replicate' the findings of the two case studies included in the multiple-case study design, a structured process and procedure was proposed. This supported the collection, analysis of data to implement the proposed Safety Mindfulness model and related technologies, promoting the model capabilities and reducing all the possible risks of technology non-acceptance.

1.5. Structure of the document

This document divides into several different sections:

- **Section 2** presents the consolidated Safety Mindfulness model, and specifies the components that it entails. This is critical to provide an overview of what will be applied and tested. Further, out of this model, three technologies have been designed and developed. An introduction to these technologies will be given in this Section.
- **Section 3** presents the methodological framework underpinning the field research that has been planned, developed and implemented in two case-organisations to test the Safety Mindfulness model. A presentation of the Organisational Safety Mindfulness Survey (OSMS) is then introduced.
- **Section 4** provides the results of the multiple-case study, and the evaluation of the Safety Mindfulness model and principles.
- **Section 5** provides the FOI case study in three Area Control Centres (ACCs).
- **Section 6** presents the conclusions.
- **Section 7** includes the references.

In addition, several appendices are provided along with a list of references.

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2 APPLYING THE SAFETY MINDFULNESS MODEL

2.1. Introduction

This section provides an overview of the Safety Mindfulness model, how it evolved over time (from Year 1 to-date), what it claims to achieve, and what gaps it intends to address in comparison with the Collective Mindfulness approach advanced by Weick and Sutcliffe (see also D.5.2 "FSS Safety Mindfulness", Section 2: *Literature Review on the Mindfulness Concept*). First, a description of how the concept evolved into a model is presented. Then a presentation of its 'operationalised' application in IT solutions is given.

2.2. Where we are coming from – Tracking the concept/model evolution

2.2.1. Year 1. A novel concept is advanced

In Year 1 (2015) an extensive literature review provided the background to advance a novel Safety Mindfulness concept. The safety mindfulness concept developed by McDonald, Callari (McDonald, Callari, Baranzini, Woltjer, & Johansson, 2015) included the mindfulness principles following the work of Weick and Sutcliffe (2007) and Vogus and Sutcliffe (2012), and additional mindfulness aspects, consisting of a situation awareness model, temporal and specificity aspects, and learning cycles. The safety mindfulness principles developed by Weick and Sutcliffe (McDonald et al., 2015) are the following:

1. *Preoccupation with failure and success* - Organizational understanding of actual working conditions and the resulting work-as-done in everyday operations to identify recommendations/best practices by learning from all situations/events occurred which led to a failure or a success. This would feed a shared bottom-up system to support the organisational collective mindfulness.
2. *Reluctance to simplify interpretations* - Developing a nuanced understanding of the context so that variation in the environment can be grasped and different interpretations can be given in relation to the specific situation/event presented.
3. *Sensitivity to operations* - Organizations are dynamic and nonlinear in nature. As a result it becomes difficult to know how one area of the organization's operations will act compared to another part. Constant interaction deepens people's understanding of the interdependent workings of the complex system itself. This supports people to cope more effectively with unexpected surprises. To enable the operational people to understand the changes and the complexity of a novel (unexpected) situation/event, interdisciplinary and inter-departmental activity should be promoted, so that an integrated "big picture" of collective mindfulness is established.

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4. *Commitment to resilience* - Resilience requires that operational people are mindful about errors that have already occurred and to correct them before they worsen and cause more serious harm. It can be supported by training to build people's skills and mindset in mentally simulating different events/situations, how they can unravel, and how they might be corrected. This requires leadership within the organization to reinforce commitment to resilience.
5. *Under-specification of structure* - Deferring to expertise rather than authority when making important decisions. Expertise is relational, is an assemblage of knowledge, experience, learning, and intuition which is seldom embodied in a single individual. Credibility, a necessary component of expertise, is the mutual recognition of skill levels and legitimacy.

In addition to the safety mindfulness principles, McDonald et al. (2015) included the following other safety mindfulness aspects:

- *Situation awareness* - Fundamentally, collective mindfulness is about being proactive, about having the best and most up-to-date information when carrying out the task. It is about having shared situation awareness in teams, including (1) a high level of SA in individual team members for aspects of the situation necessary for their job; and (2) a high level of shared SA between team members, providing an accurate common operating picture of those aspects of the situation common to the needs of each member. Necessary situation awareness aspects include (a) looking ahead to the future and anticipating events, (b) monitoring and diagnosing the present, (c) deciding and acting, and (d) learning from the past. Individual safety mindfulness can be seen as an individual's situation awareness of risks related to a work situation, such that the individual is aware of possible threats/risks and is actively thinking about them in a given situation.
- *Learning cycles* - To promote a collective mindfulness within the organization possible approaches of knowledge building can be undertaken – i.e. top-down, bottom-up and horizontal approaches. These approaches have the high-level objective to expand knowledge and situation-awareness within different layers of the organization, to improve the information flow between the units/departments, the system efficiency, and ultimately to leverage change for improved safety performance.
- *Temporal and specificity aspects* - Several temporal and specificity layers can be distinguished. At the operational level transmission of safety information can be very fast, ranging from real-time to within several days, e.g. telling colleagues immediately, during a break, at the end of a shift, or when they next come on shift. Such information has immediacy, is highly contextual, and is understood by those who receive it. At middle management level, information from operations is

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weighed in terms of its importance and its specificity, and it may be transmitted back down to ensure that all relevant operators are aware. This process typically takes anything from several days to a month. At the upper management level, the information is analysed and judged in the context of an overall risk picture. The feedback to operations, mediated through the middle layer, is typically in the range of months to years

The concept advocated on active flows of relevant and useful information that support decision and action to effectively mitigate risk both directly within operations as well as in the management of system improvement. See Figure 1: Safety Mindfulness concept (Year 1) below.

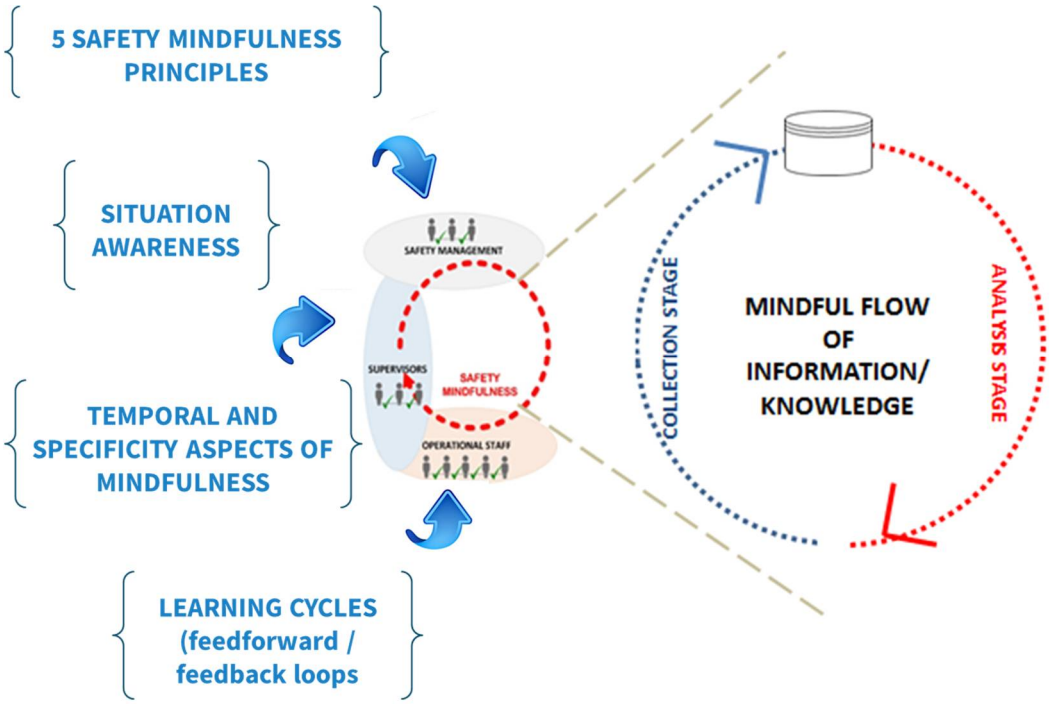

Figure 1: Safety Mindfulness concept (Year 1)

2.2.2. Year 2. A draft model is designed

In Year 2 the concept was further developed, enriched with features, and user and functional requirements collected in two case studies to specify it (McDonald et al., 2016).

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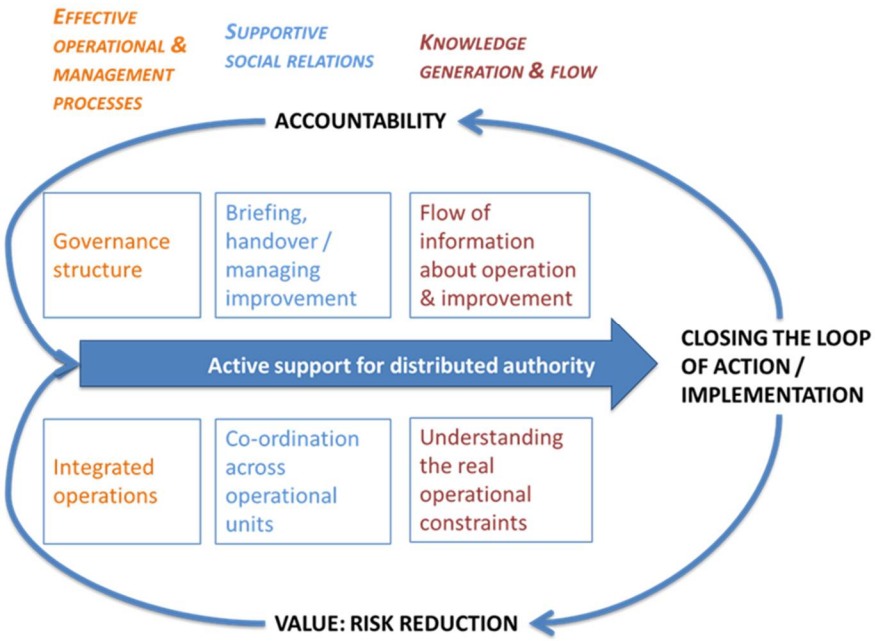

Figure 2: Safety Mindfulness concept/model (Year 2)

Overall it is argued that a collaborative concept of organizational mindfulness is required – creating a purposeful flow of information that actively supports people's capability to act to fulfil their particular role and authority (at whatever level). This is the principle of 'Distributed Authority' – authority to act is distributed throughout an organization and this needs to be actively supported to ensure a safe and effective organization. However it is not enough just to act with best intentions, those actions need to have the consequence of an improved functioning of the operation. Good governance requires that this is done in an accountable way – that actions done to ensure safety are transparently in conformity with best practice and in turn contribute to best practice - actions and their consequences need to be made transparent. Those with specific responsibilities for safety should be fully in the loop so that this becomes an integral part of the organisation's capability for safety. Distributed Authority and Accountability are two sides of the same coin comprising a self-regulatory system of governance capable of constantly improving its standards of performance. The value that is delivered may concern safety, operational effectiveness, efficiency or sustainability of the service delivered to the customer. In summary, good governance actively supports the *Authority* of all to act to fulfil their responsibilities that is *distributed* throughout the system, in order to achieve *Value* in improved and more reliable system performance, at the same time reinforcing *Accountability* for such actions in the control of risk.

In summary, self-regulation depends on the different aspects of the socio-technical system working together to create the conditions that support effective implementation in operations and improvement. The flow of information and the sharing and

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transformation of knowledge that is fully grounded in real operational constraints represent the core activity. This requires nurturing by supportive social relations: both good co-ordination and leadership across relevant operational units, as well as amongst management groups and teams dedicated to improvement. Clear and effective operational and management processes provide an institutional governance structure enabling accountability for all this activity and its outcome across all the operational linkages between interdependent service processes.

One way of describing this self-regulatory governance model is in terms of a process, a mechanism and an outcome. Taking these in reverse order, the outcome concerns the value produced – the creation of mindful and improved operations. The mechanism concerns the way in which information is produced, circulated, transformed and put to work. The process is the sequence of activities and stages through which an initial state (e.g. identification of a problem) is transformed into the final state (the implementation of a successful solution).

We have defined *Value* in terms of improved and more reliable system performance. There are actually three levels at which we can describe this value: Each successful improvement initiative delivers its own potential value; the reproducibility of successful change initiatives creates a sustainable value that derives from the embedding of the process and its information flows in the social organization; this in turn creates a knowledge base that creates the capacity to speed up the learning – reflecting on what has worked in the past together with more profound knowledge of how the system functions can enable more powerful solutions implemented more effectively. This is a kind of 'double-loop learning' (Argyris & Schön, 1996). The aim is to enable an exponential virtuous cycle of value creation.

Closing the loop of action or implementation in this way is what demonstrates value from an improved operation – greater reliability, functioning more effectively. This value may be expressed in terms of safety, but equally it is applicable to dimensions of quality, cost of service, environmental impact etc. In fact this approach lends itself to an integrated strategic risk management framework in which all significant risks to an operation are analysed and prioritized; potential conflicts and synergies can be addressed; responsibility for agreed programmes of action can be allocated, with clear accountability for the outcome being realized in due time.

2.3. Year 3. The 'Safety Mindfulness' model is mature and operationalised

In Year 3 the Safety Mindfulness model is mature, and technologies are designed, developed and preliminary implementation based on the model performed.

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Figure 3: Safety Mindfulness model (Year 3)

The FSS Safety Mindfulness model is built around the proposition that the **obligation to act** is a basic precondition of good governance at all levels from the operational sharp end to strategic management. Six principles define the conditions for realising the obligation to act in a way that works throughout the system at all levels from local performance management to the strategic management of risk.

The principle of relevance contextualizes data and information within the overall operational space, allowing large amounts of data, from planning and operations, to define events and actions around common dimensions, and providing a framework for the feedback of relevant information that can stimulate appropriate action.

Leverage transforms understanding of a problem space from as-is to to-be, identifying what needs to be done. This can be at different levels, for example, locally relevant operational actions as compared to underlying system dimensions that may need to be improved.

Providing relevant knowledge of what needs to be done is predicated on a distribution network of who needs what knowledge when in order to inform action – this is Distributed Authority. This combination of the right people knowing what to do begins to generate a compelling obligation to act on that knowledge.

Accountability involves making the link between action and outcome fully transparent. This reinforces the reciprocal character of the obligation to act amongst all the users of the information system. The corollary of well-informed action is to ensure that that action and its consequences in turn generate information that is shared.

Applying these principles allows for escalation in two ways:

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Horizontal escalation extends the gathering of information across the whole operational space according to where risk-inducing interdependencies can be found. This can often cross organizational boundaries, in which case getting knowledge and leverage over shared risks creates an incentive to collaborate.

Vertical escalation extends accountability from the lowest operational level to the highest level of regulation and oversight. The transparency of action and outcome at all levels is the basic building block of a strategic risk management capability that is founded on evidence of effective action.

2.4. Strengths of the model

This is based on a simple concept: if people are provided with relevant information and support, and made accountable for their actions, this creates a compelling obligation to act to solve the problems they face. This principle can be applied at all levels of the system and across all the interacting interdependent systems that generate shared risks. This creates a virtuous cycle that adds value through verified outcomes.

Applying the five mindfulness principles implies being well informed, using one's knowledge and understanding in a deliberate and focused way and always being alert to new relevant information that can inform one's professional judgement.

Developing the organizational mindfulness concept involves developing and mobilizing the collective knowledge of the organization to actively support this kind of mindfulness amongst its members and those they work with. In this way the organization can be said to have 'a collective mind' and can act mindfully as an organization. Within this concept, mindfulness is more than just a 'state of mind' – it involves an intention to act and to carry through that action, mindful of the consequences. In fact, seeking to optimize the consequences. This action can be at local level in playing one's operational role or it can be at a management level in carrying out a traceable improvement initiative, for example. It is this action, these actions collectively, that provides the key evidence to reinforce an renew to collective mindfulness – what happened, what was the outcome, what was the context – this is what we need to share with others in order to understand how to act more effectively, mindful of the context of our action and the consequences that could follow.

The opportunity is thus to construct a seamless information flow and transformation to create a self-regulating productive governance system. This is based on a simple concept: if people are provided with relevant information and support and made accountable for their actions, this creates a compelling obligation to act to solve the problems they face. This principle can be applied at all levels of the system and across all the interacting interdependent systems that generate shared risks. This creates a virtuous cycle that adds value through verified outcomes.

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2.5. IT solutions to apply the model within the organisational contexts

The underlying principles of the Safety Mindfulness model -as it has been consolidated - have provided the basis to design IT solutions/apps. These solutions have been further developed, adjusted to the specific case study context (i.e. in MUAC and ALITALIA – these are presented in a Confidential Deliverable).

An improvement initiative is an attempt to change the way a system or an organisation works. In order to support the process we designed the improvement manager. An improvement initiative can be triggered by:

- A report or a set of reports
- A data analysis
- A trend analysis on KPI
- Expert judgment

An improvement initiative is a complex process that involves many people and often has the time window of months or maybe years. **It is important to have a tool that supports the operations in order to keep everybody updated and avoid that the day-to-day activities overcome the initiative**.

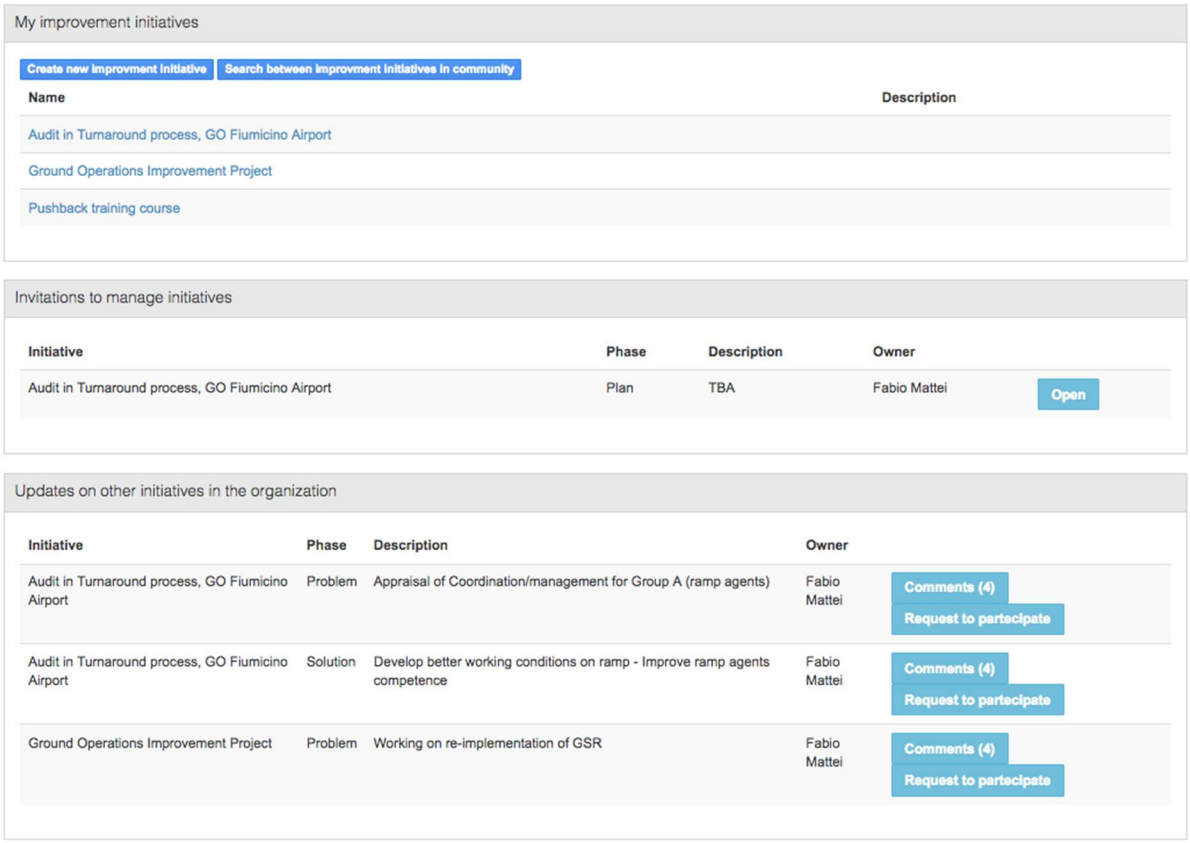

Figure 4: Improvement Manager: main panel

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The main panel helps the user to keep track of what is happening. The improvement initiatives, in which the user is participating, are visible. Also visible in the lower sections are the invitations to other initiatives and the public updates about other initiatives the user is not directly involved in.

The initiative generally is inter-departmental and requires the attentions of different managers. In a complex organization different departments are involved at different phases – e.g. the initiative goes from an accountable manager to another manager through a handover process that helps the negotiation and the spreading of information.

Each improvement/implementable initiative moves between different phases:

- Problem
- Solution
- Development
- Plan
- Implementation
- Verification

We designed a procedure supporting the handover process and the negotiation that happens when an initiative goes from manager to manager.

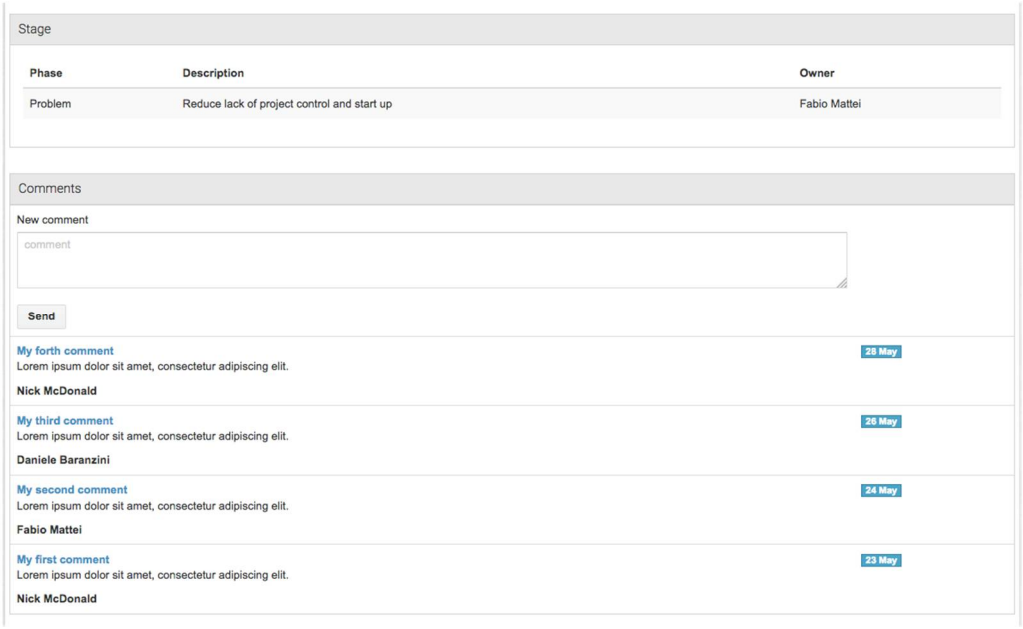

Figure 5: Improvement Manager: discussion panel for handover process

The handover procedure is a two-step procedure. This includes

1. Invitation: the manager selects who is going to be invited to manage the next phase;

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2. Acceptance: the invited manager can discuss the work that has been done and eventually accept to manage the next phase.

Each phase has a panel that helps the manager and all the other users to follow the operations. This panel contains a section for messages, a task list, and a file exchange area. All these contents are related to a single phase of the initiative and help to follow the operations but also to keep a log about the work.
It is possible for the manger to assign team members to a phase and to constantly update the data that summarise the distinctive phases of the initiative.

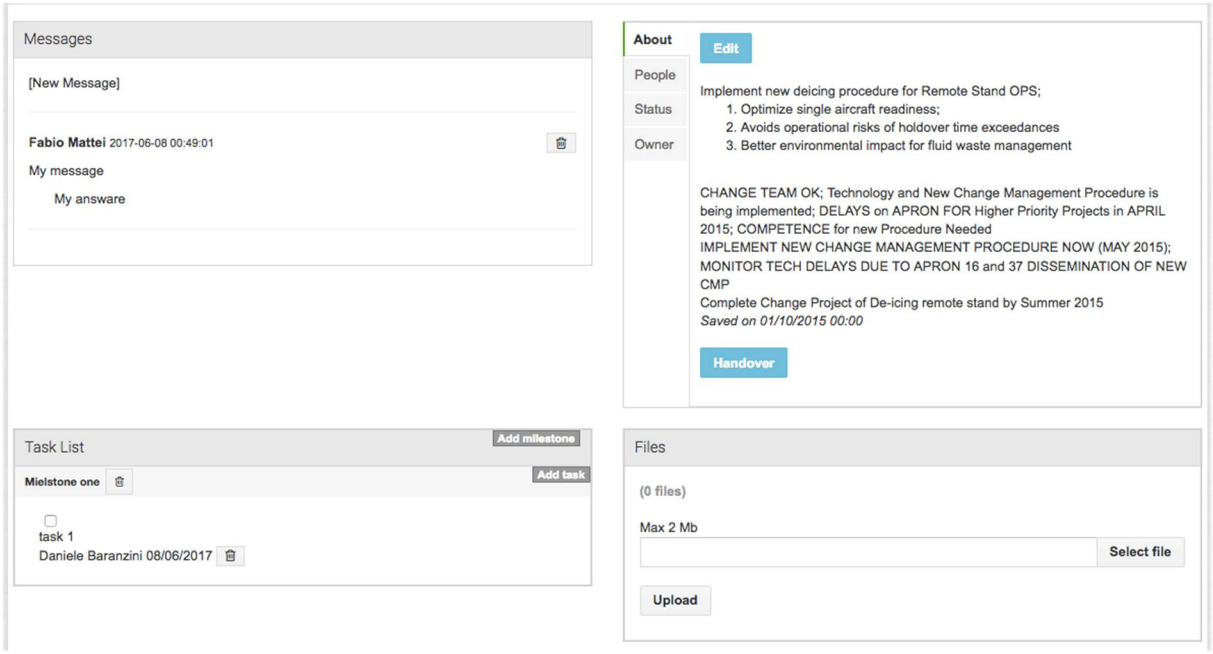

Figure 6: Improvement Manager: phase management panel

Each phase has a public section. This allows the manager to share information with the rest of the organization but also to give the manager the control about the information that is shared. The public (in terms of the organization) content helps to encourage the exchange of knowledge and information, in order to exit the silos and collaborate even between different departments.

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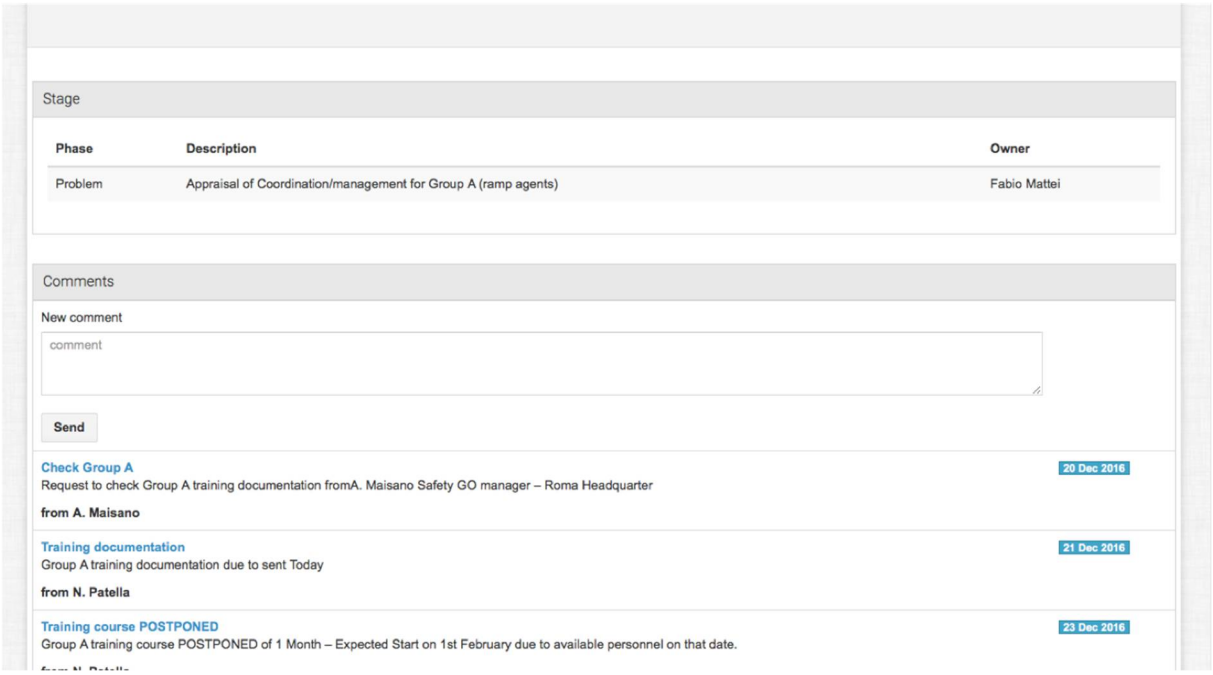

Figure 7: Improvement Manager: public discussion panel

The public content allows comments. Sometimes managers of different departments are facing the same issues. The comment area helps to share experiences and to keep a spirit of collaboration across different departments.

2.5.1. Reporting system

The main idea behind the reporting system is to create a tool that allows the operator to report simply and quickly information and, at the same time, allows the operator to suggest corrective actions. The tool provides a simple project management section for handling the corrective actions because it is important that every open issue gets its corrective actions implemented and closed.

Once the corrective actions are implemented the final step is to notify the reporter about the closed issue in a way that he/she is encouraged to report again in the future.

The reporting form includes three sections. The first section collects data (e.g. about the flight). Theoretically, this data could be fetched by other systems. The second section allows the user to define the problem. The operator can do that answering the guideline questions. See below.

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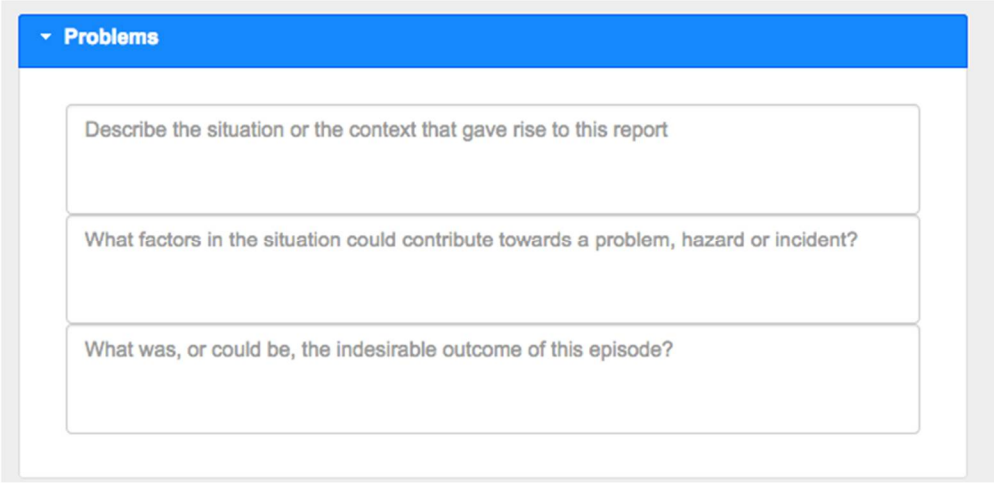

Figure 8: Reporting System: problem description form

The third section of the reporting panel allows the operator to suggest a corrective action.

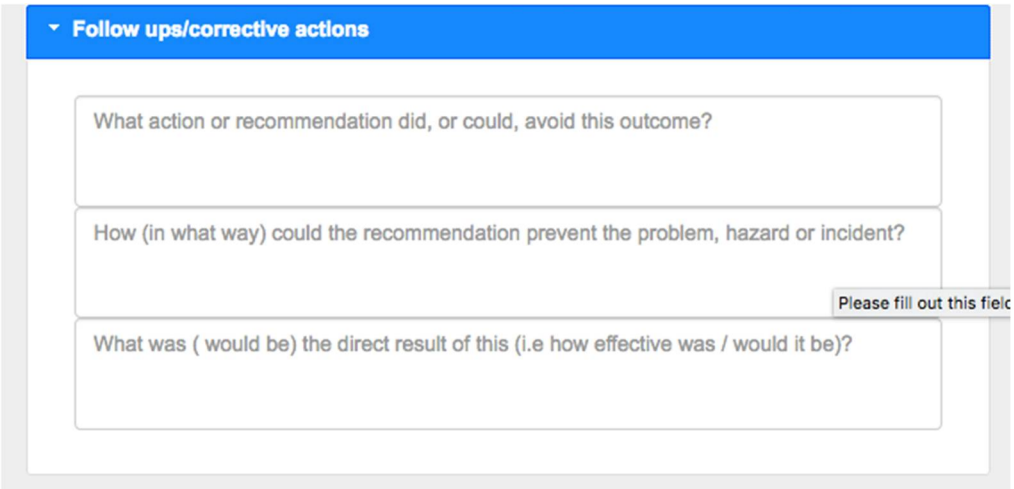

Figure 9: Reporting System: corrective actions form

Once the report is submitted, it is time for the validator the take actions. The validator will make sure that the data collected in the report is correct and will assign a risk index to the report using a risk matrix.

Once the report is validated it will be visible on the implementation manager panel. For each report, the risk index associated colour will be visible. Hence, the implementation manager will be able to know which report is to prioritize. The implementation manager can then create a project to support the corrective actions implementation. Each project will contain a list of the reports the project is related to, and a message board for internal communication.

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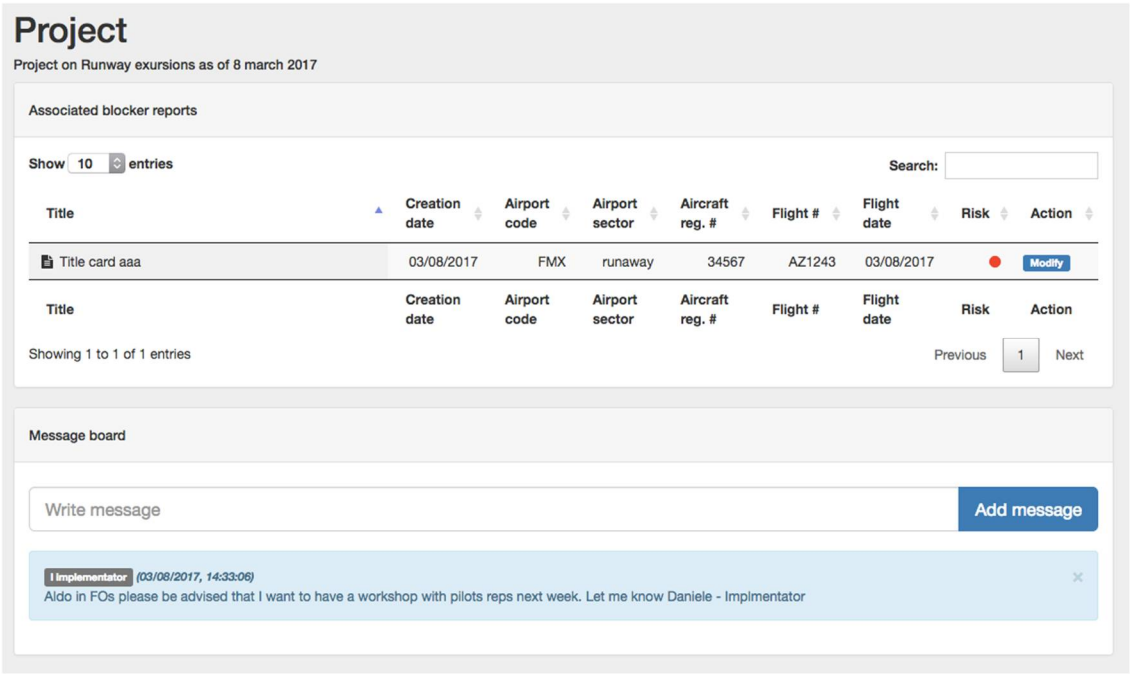

Figure 10: Reporting System: project management panel

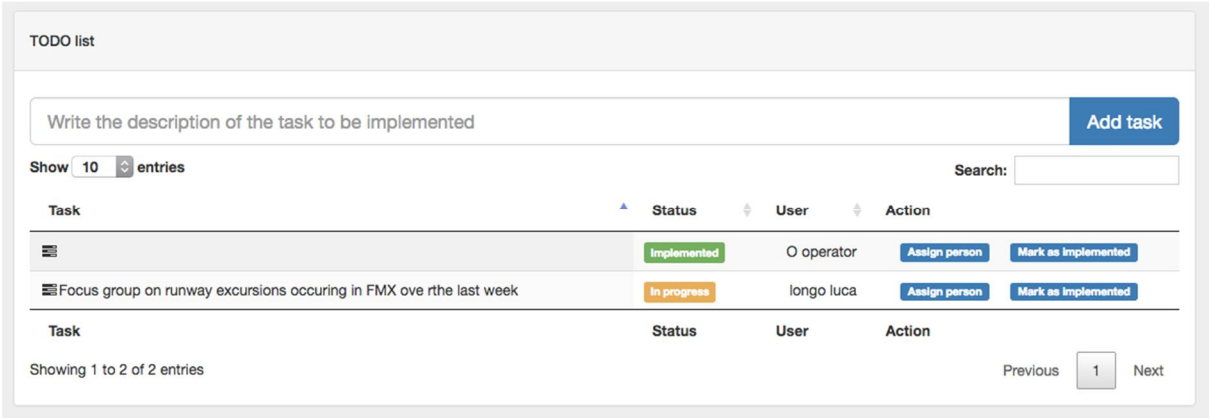

Figure 11: Reporting System: tasks management

A project contains a list of corrective actions that needs to be implemented. At the end of the implementation project the reporter gets notified about all activities.

2.6. Discussion

WP2 has reworked this concept to reinforce the idea that 'mindfulness' is more than just a state of mind; it is about the gathering and flow of information to ensure awareness and appropriate action, both at the operational level and amongst middle management in ensuring improvements are effectively implemented. A novel Safety Mindfulness model has been advanced to convey an organisational context for its implementation, based on the behavioural-economic principle that being well informed about an issue,

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having an effective and practical solution and being accountable, creates a compelling obligation to act in an appropriate manner.

Generic prototype software applications have been developed to operationalise and evaluate the new mindfulness concept. These software applications are of two types:

- Reporting any issue from normal operations and generating narratives for circulation and comment
- Implementing improvement in an accountable manner.

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3 METHODOLOGY

3.1. Introduction

This section presents the methodological framework underpinning the field research that has been planned, developed and implemented in two case-organisations to test the Safety Mindfulness model. In particular, first information about the choice of the investigation method will be provided. This regards the multiple-case study method (Yin, 2009, 2012, 2014). The use of multiple cases strengthens the results by replicating the patterns thereby increasing the robustness of the findings (Yin, 2012). To be able to compare and 'replicate' the findings, a structured process and procedure is proposed. This includes: (1) specification of the case characteristics, and the unit of analysis; (2) definition of theoretical propositions guiding the field research design, data collection and analysis; (3) definition of the over-arching research questions; (4) use of a structured intervention framework to show the way the system improvements are realised; (5) specification of the logic linking data to theoretical propositions; and (6) identification of criteria for interpreting findings. Each step will be explored in detail to describe the rationale used to prepare and implement the Safety Mindfulness multiple-case approach in each organisation. Finally, the Organisational Safety Mindfulness Survey (OSMS) will be introduced. This represents a dedicated survey designed to assess the extent to which the Safety Mindfulness principles expressed through the specific IT solutions (developed by TCD within Future Sky Safety, in WP2) have brought improvements within the selected case-organisations.

3.2. Multiple-case study approach

3.2.1. Background information

The multiple case study approach is useful when we are examining several cases in different contexts to either, "(a) predict similar results (a literal replication) or (b) predict contrasting results but for predictable reasons (a theoretical replication)" (Yin, 2014, p. 47).

In Year 2, the multiple case study approach was used to the investigate the safety mindfulness concept as *a social process in its organizational environment, by means of capturing of the emergent and immanent properties of contexts, and the room for improvement towards a safer organisational goal* (Gerring, 2007; Simons, 2009; Yin, 2009, 2012). The multiple case study design was used to produce detailed descriptions of the mindfulness phenomenon using theoretical concept-related statements to guide the collection and analysis of data in each case study. The replication logic used was theoretical replication – i.e. where the cases were designed to cover different theoretical conditions. The two cases included the (1) MUAC Case Study and the (2) ALITALIA Case

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Study. Each case served to collect requirements to specify/operationalise a Safety Mindfulness model. Critically, to support the above, a Qualitative Content Analysis method was used (Bengtsson, 2016; Krippendorff, 2013; Schreier, 2012). Data recording and analysis was supported by NVivo (v.11 Pro for Windows, © QSR International) (Bazeley, 2007). Outcome of this approach was the specification of the Safety Mindfulness model.

In Year 3, the multiple-case study method (Yin, 2012, 2014) supported the application of the model by means of the proposed TCD solutions within the case-organisations involved in Year 2 – i.e. the MUAC and ALITALIA organisations. The Safety Mindfulness model advocates active flows of relevant and useful information that support decision and action to effectively mitigate risk both directly within operations as well as in the management of system improvement. The Safety Mindfulness theoretical propositions and framework stated and guided the conditions under which the 'Mindfulness' phenomenon is likely to be found. This means to support 'literal replication' – i.e. to be able to predict similar results across multiple cases.

3.2.2. Specification of the cases, and definition of the unit of analysis

The selection of the cases for this year followed a criterion and convenience strategy (Shakir, 2002). This included the two case-organisations involved in Year 2 - i.e. MUAC and ALITALIA. Both organisations have agreed to apply and test the proposed Safety Mindfulness model/solutions and assess the impact of this implementation.

In MUAC, the context of testing will be the OPS Room, and the main direct target users are the ATCOs and Supervisors. A Safety Mindfulness solution/application (SM.App) has been designed and demoed to support/increase the ATCOs collective mindfulness in the OPS Room.

The ALITALIA case study addresses Ground Operations and in particular the Turnaround activity in Fiumicino Airport (Rome, Italy).

3.2.3. Theoretical propositions guiding the research

The theoretical propositions are necessary elements in case study research in that they serve to define the boundaries of the scope of the study. Each proposition conveys a distinct focus and purpose and helps guide the research design, data collection/analysis and discussion. The theoretical propositions can be raised from a literature review about the target phenomenon, or, as in our case, from the Safety Mindfulness principles/components, as described in Section 2 – Applying the Safety Mindfulness model. Hence, each Safety Mindfulness component has been operationalized, into possible statements to guide the application of the model in the two case studies (see Table 1 below). Overall, the model follows a holistic approach – i.e. all components are inter-linked, so that the application of each supports the so-called 'obligation to act'.

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Safety Mindfulness creates the conditions that encourage informed and accountable action at all levels across the system. This enables both feedback and accountability to stimulate the highest possible levels of performance, hence an 'obligation to act'.

Table 1: Multiple-case study theoretical propositions

Potential Theoretical Propositions	Source **Safety Mindfulness model
[organizes data and provides context for action] • The generation of safety-critical logs/ experiences/ narratives from oneself and others is relevant and sufficiently important for legitimate users • The information spread is relevant and sufficiently important for legitimate users (i.e. top, middle, sharp-end people) to merit attention, and comment (if the case) • Legitimate users are informed with relevant information that primes one's expectations of potential issues that might arise even if highly unlikely	RELEVANCE
[transforms understanding to identify what is it to be done] • Each safe project includes structured steps of intervention to enhance the system's capabilities to remain safe • The shared knowledge is used to improve the functioning of the system • The value of the 'knowledge in use' impacts on the system, through better operational performance, and effective improvement actions • Safety-critical projects are managed and show a clear structure/steps of intervention to enhance the system's capabilities to remain safe	LEVERAGE
[supports informed action] • The solicited and gathered information that is worth sharing, processing and distributing supports the planning and action of individuals across the system	DISTRIBUTED AUTHORITY
[creates transparency of action and outcome]	ACCOUNTABILITY

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• The flow of information generates awareness (mindfulness) that supports appropriate action (at operational or management level), producing outcomes. • Making this cycle (knowledge – action – outcome) transparent both validates the knowledge and makes the actions accountable • It's about the 'action', and the consequence of that action – i.e. to enable people to act in the proper way, and evaluate the impact of that • Safety Mindfulness creates the conditions that encourage informed and accountable action at all levels across the system	
[extends across the whole interdependent operational system] • There is a sufficiently large number of operations generating relevant safety-critical logs/experiences from oneself and others to allow aggregation across a large number of operations • Aggregation across a large number of operations holds the possibility of generating sufficient relevant safety-critical logs/experiences that can pose the question: 'how well did we deal with all risks that we confronted/faced either directly or indirectly? • There is attention on interactions across boundaries, where propagation of variance and uncertainty can escalate problems • There is a focus on operational interdependencies between different parts of the system, thus enabling a 'whole systems' approach (horizontal escalation)	HORIZONAL ESCALATION
[extends accountability from operation up to regulatory authority] • Mindful safety information creates a 'cascade' of accountable activity across all system levels – strategic, tactical and operational • By creating accountability for jointly managing shared risks mindful safety information enables effective reporting relationships across the	VERTICAL ESCALATION

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system from top (strategic and regulatory) to bottom (operational)	

3.2.4. The over-arching research questions

The over-arching research questions for both case studies will include:

- Does the Safety Mindfulness model and related technologies support/leverage a wider 'mindfulness' within the organisation?
- Is the flow of information/knowledge put in place, relevant, accountable, and able to leverage the functioning improvement of the system? Does it support horizontal and vertical escalation?
- Are the Safety Mindfulness conditions created to support and encourage informed and accountable action at all levels across the system (i.e. an 'obligation to act)?
- Does the designed Organisational Safety Mindfulness Survey (OSMS) support the testing the Safety Mindfulness in organisations?

3.2.5. Applying the intervention framework

The conceptual framework serve as an anchor for the way the study will be realised. Further, it becomes the vehicle for generalizing to new cases. It supports the strategic level of controlling action of the researcher to specify the stages of the project (i.e. from the problem definition, into the validation, through the solution, plan/development, implementation, and verification). See Figure 12 below.

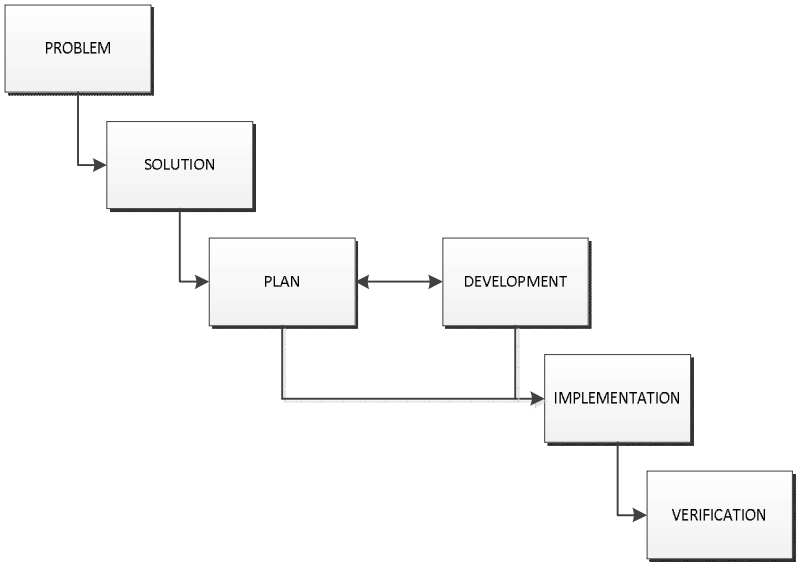

Figure 12: Cascade structure of the strategic intervention steps

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Within each stage probes of tactical level of managing action and consequences are defined. This includes (1) the context; (2) the mechanism; (3) the outcome. See Table 2 below.

Table 2: Breakdown of the tactical level of managing action and consequences, with probes

Strategic level	Tactical level	Probes
PROBLEM	Context	*What is the problem context?* *Who and what is involved, when and where?*
	Mechanism	*How did/does this cause the problem?*
	Outcome	*What is the outcome (actual or potential)?* *What outcomes have happened/could happen as a result?*
SOLUTION	Mechanism	*What could solve the problem?* *What else should change to support this?*
	Context	*How could the problem cause be effectively addressed?* *How effective would this be?*
	Outcome	*What outcomes would result?* *What else would need to change?*
PLAN	Outcome	*What are the critical outcomes that need to be achieved?* *What outcomes would result?*
	Mechanism	*How will they be realized? What else needs to change to support this plan?* *What are the critical measures that need to be implemented?* • Technologies, processes, procedures, structures, standards, etc. • Human resources • Information systems *How will they be implemented?* • Who, when, where
	Context	*What are the objectives that need to be achieved?* *What actions need to be taken to create a supportive context?*

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		• Prepare the ground • Reinforce the effectiveness • Sustain implementation • What cultural values & norms could impact on implementation?
DEVELOPMENT	Context	*Has the wider context for improvement been defined?* *What capabilities need to be developed?*
	Outcome	*Will these mechanisms support the required outcomes?* *What outcomes will they support?*
	Mechanism	*Have the key mechanisms for improvement been developed?* *What conditions need to be created for their deployment and implementation?*
IMPLEMENTATION	Mechanism	*What key measures have been implemented?* *How well have they been implemented?*
	Context	*Is there a supportive context for implementation?* • Support measures implemented • Cultural norms and values?
	Outcome	*What outcomes can be measured?*
VERIFICATION	Outcome	*What outcomes were achieved?* • Short term • Long term
	Mechanism	*Are the key measures fully implemented, routine and part of everyday practice?*
	Context	*Does the system as a whole support the operation of these measures in delivering the outcomes?*

At **operational** level the CUBE framework provides a methodology to compile a rich descriptive longitudinal account of an implementation case study. Critically, the CUBE framework supports: (1) the design and implementation of an intervention project by the development of specific 'incremental phases'– i.e. from solution into implementation and verification; (2) a descriptive account of each stage and transitions; (3) description and analysis of a range of socio-technical dimensions, and assessment of complex dynamic sociotechnical systems as a whole. By so doing, the framework supports the provision of punctual references to leverage change.

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Underpinning the CUBE principles is the activity cycle of socio-technical systems:

- Intentions give rise to actions (though these can sometimes fail – in error)
- Individual actions aggregate to system performance
- The system comprises the structure and processes that enable and constrain what can happen.
- The culture comprises the collective understanding of how things work
- This in turn informs intentions, and so on.

It is the relationships between these elements that are important –each provides the context for the others to work. The relationships are not just cyclical in a mechanistic way, thus they interact in different ways and in both directions.

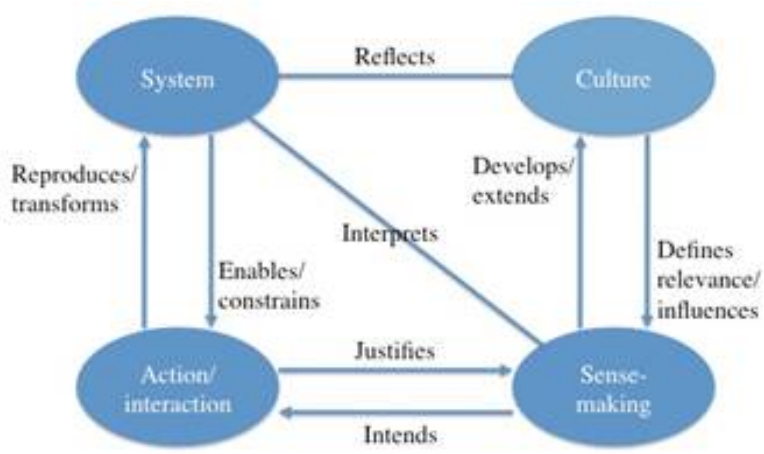

Figure 13: The CUBE's pillars

Starting from the sense-making, this provides the intentional force for action (whether it is successful or not), but also justifies action. Of course, that intentionality is informed by the broad influences of culture (values, norms and expectations) as well as the perception and interpretation of the contingencies of the system – what happens, what do people do and what are the consequences? Each of these provides a context for understanding intentional cognitive activity. **Sense-making and mindfulness are closely related concepts; it is the capacity for sense-making that underlies mindful organising** (Weick, 2006).

Actions do something. Acts create events, which bring about change in the world - transition of one state of affairs to another; initiating, transforming or ending a process. Actions need to be seen in terms of the intentions that inform them, as well as in terms of the system which they reproduce. There are many ways of describing activity in social systems – for example, in terms of movements and behaviours; in terms of effort and

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workload; in terms of rules, procedures and guides; or in terms of performance against expectations and targets.

Actions are part of continuous interaction that maintains the relationship between people and between people and their tools and machines. It is the actions of people that constantly reproduce the social system – it only exists because people behave and play their part. The system exists independently of us – it has a history leading up to the present – hence the system is a real constraint on what we can do, not least because of relationships of power and real social forces that maintain order. Nevertheless, it is also the actions of people that transform the system – but every change in one aspect can reinforce stability in other aspects – it is hard to comprehend total change. We are used to talking about systems in technological terms – where there are visible, tangible parts in dynamic relation to each other. Arguably the same principles apply to social systems.

The culture is a collective representation – a partially shared understanding – a reflection of the system. It is not different from the system, just a different way of looking at it. Its shared values, norms and understandings influence the sense-making of individuals and groups, but their sense-making in turn develops and extends the culture, often slowly but inexorably. Occasionally, in a crisis, there is a rapid collective reappraisal that becomes embedded over time. In this context, culture is the largely tacit, implicit and taken for granted background to what we do and we often only pay attention to it when something discordant happens, highlighting a contradiction between hitherto implicit values or a violation of unspoken rules.

Further, each pillar includes different functional mechanisms. These mechanisms make the system work. This includes:

Table 3: The CUBE Framework functional mechanisms

Mechanism	Main dimensions	Issues, questions, maps
Goals	Outcomes – product, service	Define overall system goals Express this as value delivered to customer/stakeholder Relate goals to challenges to achieve them in the organisation's environment
Process	Resources, tasks, critical points, dependencies	The key activity of the operation Tasks transform inputs to outputs with sequential links (can be //, Iterative, etc.) *Map the relevant aspects of the process*
Social relations	Team relations, accountability	People have roles & collaborate with others Who works with whom – across boundaries? Who reports to whom within a hierarchy

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		Map the social relations &/or organogram
Information & knowledge	Data transformation, knowledge cycle	Data is transmitted & transformed into information and knowledge. Knowledge is acquired & shared. Tacit knowledge is converted to explicit and back. *Map the flows of information – between both people & technology*
Technology	Technology functions / automation	Technology includes infrastructure, vehicles, equipment, parts, tools, including hardware and software. Technologies may be linked in automated systems.

Further, the CUBE Framework supports the assessment of the overall intervention. See below for details.

Table 4: Assessment criteria

Mechanism	Assessment criteria	Probes
Goals	Key performance indicators and risk	Are there key outcomes that are recorded? Is it possible to put a value on these outcomes? Is there an assessment of risk?
Process	Variability, uncertainty, hazard	Are there any performance indicators that relate to task performance? Is performance assessed in any way?
Social relations	Co-ordination	Is there a handover, shift change, briefing or other structured co-ordination?
Information & knowledge	Operational data	What operational data is routinely recorded? What reports are generated from the operation? What documents or messages are inputted to the operation?
Technology	Automation	What data is generated or used by technology or automation to control of monitor its performance?

3.2.6. Data sources, data analysis, data-bases, and data reliability/validity

Case study methods involve using multiple sources of data and triangulation of evidence. Yin (2009, 2013) claims that in the context of data collection this will support the corroboration of the data gathered from other sources. Yin (2012) describes five

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techniques for analysis: pattern matching, linking data to propositions, explanation building, time-series analysis, logic models, and cross-case synthesis. The data collected should be organized in a data-base able to show the procedure used to derive evidence from the design/research question to the analysis process and conclusions. A systematic research process definition and traceability ensures validity and reliability (Callari, McDonald, Baranzini, & Mattei, 2017; McDonald et al., 2016).

Overall, in both case studies a mixed-methods approach was used. A protocol for data collection/test plan will be formalised to specify the procedure. The data collected was stored in an NVivo project (v.11 Plus for Windows, © QSR International), coding activity will be performed by two TCD researchers to assess coding reliability and project validity. The qualitative analysis will include pattern matching and QCA approaches (Callari et al., 2017; Schreier, 2012).

3.2.7. The logic linking data to propositions

Each case study consisted of a 'whole' study, where the findings indicated how and why the theoretical propositions was demonstrated or not demonstrated.

3.2.8. Criteria for interpreting the multiple-case findings – Literal replication

Across cases, the multiple-case findings will indicate the extent of the replication logic and whether the cases were able to predict/confirm certain results. The specific findings from the single cases will be converged in an attempt to understand the 'overall case'.

3.3. Metrics

3.3.1. Background information

The Organisational Safety Mindfulness Survey has been preliminarily described in D.5.6 'Safety Mindfulness Methodology' (McDonald et al., 2016) The Survey is intended to measure specific properties associated to the Safety Mindfulness concept both from an organisational as well as individual perspective and according to the FSS Project plans for 2017. AS stated in Del 5.6 "*The safety mindfulness concept developed by McDonald et al. (2015) includes the mindfulness principles following the work of Weick and Sutcliffe (2007) and Vogus and Sutcliffe (2012), and additional mindfulness aspects, consisting of a situation awareness model, temporal and specificity aspects, and learning cycles.*" (McDonald et al., 2016, p. 18)At this stage of analysis the survey is measuring knowledge and opinion of expectations on safety mindfulness practice and behaviour. This is shown in Annex 1: Organisational Safety Mindfulness Survey (OSMS)

3.3.2. The dimensions of the Organisational Safety Mindfulness Survey (OSMS)

The Survey design process has been accomplished by formulating the items according to the dimensions of the Safety Mindfulness Model as Presented in Figure 1 here above. The dimensions composing the various OSMS are presented in the Table below.

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Table 5: OSMS – Organizational Safety Mindfulness Survey (general dimensions and examples)

OSMS Survey
Escalation Exemplary item:" In general personnel in the organisation know what is happening to safety reports coming from the operational side"
Relevance Exemplary item: "Reading peers' experiences on safety fits in with my daily responsibilities"
Accountability Exemplary item: "7. In my company, there is full accountability to manage and control safety processes"
Leverage Exemplary item: "8. The organisation always apply lessons learned from safety events and provide effective "

3.3.3. Pre-test

3.3.3.1. Preliminary design

A preliminary set of 11 questions of the OSMS have been proposed in March 2017 by TCD and reviewed by SICTA, NLR and FOI Project Partners to validate a research and technical feasibility of each measure. After this preparatory process a group of 6 AZ Personnel in Alitalia and one from SICTA has been proposed between June and August 2017 to read, complete and provide feedback about the OSMS comprehension, ease of completion and rating process of each of the items of the measure. The AZ participants in this case reported further amendments and refinements. However, no major difficulties have been reported about the measures' usability levels and comprehension and rating systems proposed.

A pre-test on a small sample of 20 participants from AZ Company has been carried out to study scale and single item statistical properties like distribution, average values, error standards, as well as the selected type of scale measurement quality and appropriateness. This test performed in late October 2017 is fully detailed in the next section.

3.3.4. Validation

The application of OSMS has been tested in AZ according to the specific Case Study requirements. The submitted OSMS (Part 1) was composed by 9 questions on a Likert

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scale of five answers measuring 4 different aspects: Escalation, Relevance, Accountability, Leverage. The OSMS survey was submitted in October 2017 in AZ to 34 employees (16 Ground ops Managers and 18 Operators).

At end of January 2018 exploratory tests were performed; test item properties and reliability are described briefly here. Detailed results are included in the Confidential Annex to this Deliverable.

The preliminary results on the OSMS survey show that Safety Mindfulness is a measureable feature by the OSMS metric:

- According to the first results in AZ (see bullet 2, paragraph above), the OSMS is providing supportive ideas that the Safety Mindfulness dimensions are measurable and are providing some informative results by separating SM perception between Operations and Safety Managers versus Ground ops operators.
- Caution is to be considered as the items describing each dimension of the OSMS are under scrutiny.

In particular, as shown in Figure 14, although very exploratory (certainly stat low power due to sampling), a t-test identified a significant separation on the escalation dimension accounted by Job level (e.g., manager vs technician), $t(24,2) = 4.032$, $p<0.001$.

Following this exploratory phase, the OSMS survey has been reviewed, and the items revised and changed. The novel OSMS survey will be further tested and submitted both in AZ and MUAC in 2018 (from March 2018 onwards)

Apparently, Managers' perception about the Relevance concept is substantially higher than technicians. No interpretation is given presently but the OSMS seems to be capable to differentiate across different samples.

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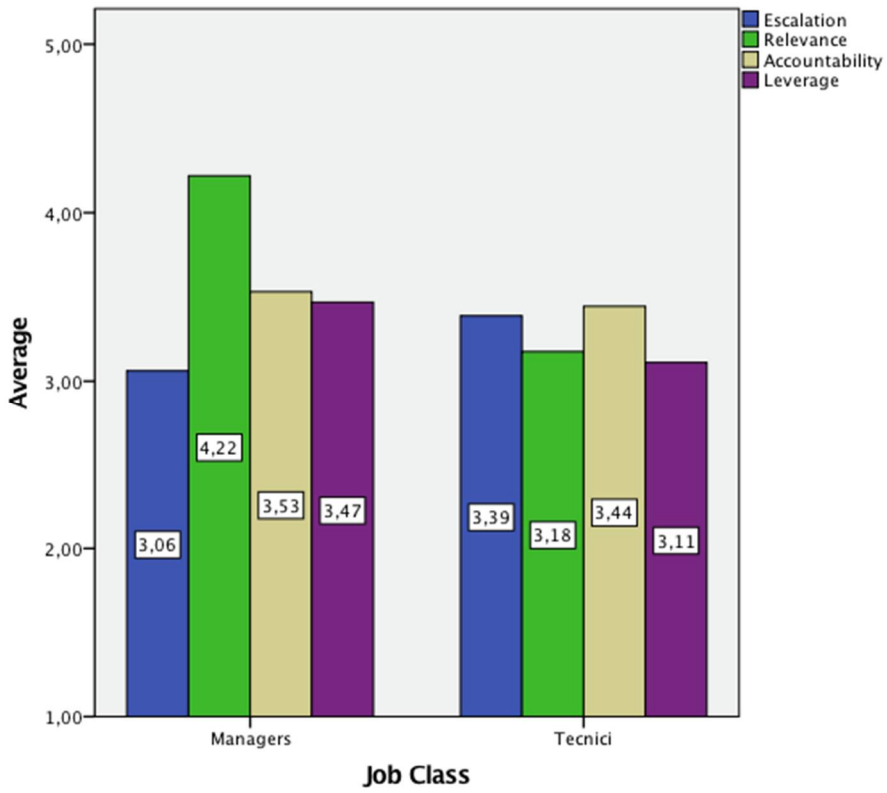

Figure 14: OSMS results /Exploratory phase ALITALIA

The next step includes - together with more reliability and validity tests- the OSMS correlation with performance level criteria. Regression models or other multivariate methods will be applied to uncover any OSMS and Turnaround Audit performance relationship.

3.4. Discussion

The two case studies conducted in the field enabled comparisons as well as they give the possibility to draw patterns across the cases and obtain more reliability in the overall results, and the evaluation of the Safety Mindfulness model and its technologies.

Finally, the application of the OSMS Survey is dedicated to measuring opinions and perception about Safety Mindfulness is the organisation. The intra-case study evaluations will check upon measure consistency and reliability. The expectation is also to obtain the capacity to differentiate and study differences across groups or levels of respondents. In AZ it will also be relevant to measure effects due to the use of IT software applications.

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4 LITERAL REPLICATION OF THE 'SAFETY MINDFULNESS' MULTIPLE-CASE STUDY

4.1. Introduction

This section reports the findings of the multiple-case study approach used to test and validate the Safety Mindfulness model and related software applications. The detailed case studies are reported in a confidential Annex.

4.2. Findings of the multiple-case study approach

The following has been demonstrated:

- The Safety Mindfulness concept has been operationalised and specified in a model. The FSS Safety Mindfulness is based on the proposition that having operationally relevant information, collected and distributed across all in the operation who have responsibility to act, gives leverage to act appropriately and to improve the operation in an accountable manner. This is scalable across all shared risks feeding an accountable system linking the operational core to strategic management. The core mechanism energising this model is the behavioural-economic principle – being informed, having a way forward, and being accountable together create a compelling Obligation to Act.
- Software prototypes have been built to support the trial implementation of the full mindfulness concept in operational contexts. The case studies will provide the opportunity to validate the functionality and usability of the software.
- The definition of a generic case study methodology has provided the framework for organising the development and implementation of two real-time operational case studies. It has also established the basis/experience for comparison of future case studies. This is part of a commitment to develop a scientific evidence base for implementation, in this case applied to the Safety Mindfulness concept and model.
- Two case studies have been developed in contrasting aviation organisations to implement and test this model and approach. This included (1) MUAC ATC Centre (Netherlands) and (2) Alitalia Ground Operations (Italy).
- The two case studies are distinct (not a literal replication of each other). The concept and tools developed are appropriate to the very different organisational contexts in each instance; yet they are also highly complementary in their approach to the concept of Safety Mindfulness: the one emphasising the circulation and open comment on operational information; the other emphasising a more structured improvement to create a more mindful process, the improvement process itself being open, collaborative and information rich (hallmarks of organisational mindfulness). Thus they are theoretically linked as

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complementary case studies, demonstrating features that can be combined according to contextual needs.

- In (1) MUAC, the focus of intervention has been within the OPS Room, and the need for the gathering and circulation of potential risk related narratives amongst air traffic operational staff. The research demonstrated that in MUAC the collection of safety-related events in the OPS Room is effectively supported by a number of instruments, but the circulation back to the ATCOs of proposed solution needs to be improved (see Research Findings in D.5.6: Safety Mindfulness Methodology – v.2.1 Appendix). Hence, in order to heighten safety mindfulness in this ultra-safe sector, effective feedback loops of relevant information into the operation need to be ensured. To do so, a case study has been proposed to support the design and development of a software solution able to collect and share meaningful safety-related stories/narratives relevant and sufficiently important for the ATCOs' daily work. The Safety Mindfulness 'repository' has the aim to sustain a collective mindfulness understanding of how the system works, and proposes, by means of shared comments, recommendations to enhance the system's capabilities to remain safe. The controllers interviewed during the trial field research (in October 2017) confirmed the need for informative stories carrying recommendations/solutions to day-by-day safety-related events (e.g. how to handle thunderstorm situations).
- In (2) Alitalia Ground Operations (Italy), TCD 'big data' risk pattern analysis of audit reports identified poor pre-turnaround briefing as a precursor of other operational failures which in turn were associated with actual safety incidents. This has initiated a case study centred around improving turnaround briefings and mindful performance. It will deploy two applications designed to create a mindful improvement initiative.
- Overall, the two case studies which tested the Safety Mindfulness model have proven the following:

Table 6: Testing of the Safety Mindfulness components in the two case studies

Safety Mindfulness component	Case Study (1) MUAC	Case Study (2) ALITALIA
Relevance	Gathers everyday issues and narratives. Comments on relevance and applicability	Analysis of audits identifies a clear operational issue. Opportunity to feedback on operational issues and state of improvement

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		generates current relevant information
Leverage	Implicit: relevant information should influence action	Clear commitment to improvement centred on pre-turnaround briefing
Distributed authority	Circulation across operation.	All staff involved, with clear information and guidance and opportunity to comment
Accountability	Indirect: Local actions become transparent through people noticing and commenting	Clear objectives for improvement initiative. Strong transition into implementation phase
Horizontal escalation	Direct: Larger number of safety-related narratives to be shared within the OPS Room. This is implemented in MUAC only – to-date there is no plan to 'escalate it' to other cases/domains	Focus on ground ops but can involve other groups with shared risks
Vertical escalation	This is an informal process but is transparent to accountable management and complements more formal safety management actions	Clear objectives with accountable handovers of responsibility make for strong vertical escalation of accountability
OBLIGATION TO ACT	Involves and empowers operational staff	Strong obligation at the level of improvement management needs to be translated into everyday activity at operational level

- The two case studies have been fully prepared and are ready for a full trial implementation stage.
- A tailored set of evaluation metrics has been developed to assess the penetration of the concept of Safety Mindfulness in the day-to-day experience of those

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involved in or affected by the case studies. This mindfulness survey (OSMS) is designed to complement other evaluation metrics, including functional use of the particular tools and methods, as well as performance indicators related to operational safety.

Structuring the case studies in this way invites replication in the future in other organisations and other contexts, progressively building an evidence-base of effective intervention.

4.3. Discussion

The Safety Mindfulness model and the related technologies have been successfully tested in the two case studies from the Problem, into the definition of a Solution (accepted by both case studies' managers), and design of a Plan and Development. The ground has been prepared to launch the Implementation phase. The Implementation phase would provide powerful evidence of the exploitation potential of FSS Safety Mindfulness model and outputs.

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5 ADDITIONAL CASE STUDY – 3 EUROPEAN ACCS

During the autumn of 2017 and the spring of 2018, FOI has undertaken a series of interviews at three Area Control Centres (ACCs), in a multiple-case study independent from the MUAC-ALITALIA multiple-case study performed by TCD. The analysis of this study is ongoing (at the time of the submission of the present deliverable) and will be reported at a later stage. The theoretical background and themes were based on the interview materials from the MUAC case study performed by TCD in 2016 (Year 2), and focus on the following theoretical themes (as described in Section 2.2.1 of this report):

- The safety mindfulness principles developed by Weick and Sutcliffe (McDonald et al., 2015),
- Learning cycles, and
- Temporal and specificity aspects.

The study of three ACCs comprised 27 interviews with different ACC roles such as air traffic controllers, watch supervisors, technical personnel and management roles during the period of October 2017 to January 2018. The study is currently in the analysis phase and can thus not be reported yet in this report.

The questions posed were based on the MUAC case study but had a modified protocol of semi-structured interviews that first focused more on the day-to-day processes and interactions that the various roles encountered in a typical day at work and then transitioned to other temporal scales of interaction. Based on the themes and concepts of the mindfulness principles, learning cycles, and temporal and specificity aspects, all interviews highlighted these themes to some degree, depending on the interviewees' roles, experience, and answers. It is expected that this independent case study of three ACCs will shed additional light on the constructs of the safety mindfulness concept and potentially the safety mindfulness model reported in this deliverable.

However, this independent Safety Mindfulness study as such is not a strict replication of the MUAC-ALITALIA multiple-case study because the purpose of the case study of these three ACCs was not specifically to elicit requirements for additional IT-support at the operational sites (although IT-support was discussed in the interviews as a potential enabler of safety mindfulness). Due to the study's access and timing opportunities and time available it focuses on breadth in the number of three ACCs and interviewees while providing depth with a single method (interviews) rather than fewer ACCs and more methods such as observation, tool analysis, document analysis and IT-support design (to the extent that the MUAC and Alitalia case studies did). This study of three ACCs is thus somewhat different in scope and should be regarded as a stand-alone multiple-case study but is intended as a viable complementary extension of the work reported in this deliverable, as close as practically possible to the work already reported, to collect more

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data and shed more light on the Safety Mindfulness concept. As such it is suitable for separate report writing outside this deliverable that focuses on the MUAC-ALITALIA multiple-case study.

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6 CONCLUSIONS

Mindfulness is a key integrating concept in resolving the organisational accident. It represents the sense-making role of people at the operational sharp end.

- Mindfulness is both the unique source of critical information about the normal operation – what went well (i.e. actions that were effective and are shared) and what could be improved
- as well as the key recipient of intelligence about the operation, ensuring that operational actions are always informed by the most current, relevant information about potential risks no matter how remote.

It is this circulation of information and knowledge throughout the organisation that is at the heart of the original conception of safety mindfulness of Weick and Sutcliffe, but which has never been operationalised as a practical and effective approach for complex ultra-safe systems.

WP2 has reworked this concept to reinforce the idea that 'mindfulness' is more than just a state of mind; it is about the gathering and flow of information to ensure awareness and appropriate action, both at the operational level and amongst middle management in ensuring improvements are effectively implemented. A novel Safety Mindfulness model has been advanced which provides an organisational context for its implementation, based on the behavioural-economic principle that being well informed about an issue, having an effective and practical solution and being accountable, creates a compelling obligation to act in an appropriate manner.

Generic prototype software applications have been developed to operationalise and evaluate the new mindfulness concept in two case studies. These software applications are of two types:

- Reporting any issue from normal operations and generating narratives for circulation and comment
- Implementing improvement in an accountable manner

Two case studies have been designed and developed using a multiple-case study approach:

1. MUAC ATC Centre (Netherlands): TCD research demonstrated the need for the gathering and circulation of potential risk related narratives amongst air traffic operational staff in order to heighten safety mindfulness in this ultra-safe sector, ensuring effective feedback loops of relevant information into the operation. The case study has been designed, the software prototype developed and the trial implementation phase is planned to commence following the final preparation

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meetings that took place in October 2017. Full implementation trials are provisionally planned for the first quarter of 2018.

2. Alitalia Ground Operations (Italy): TCD 'big data' risk pattern analysis of audit reports identified poor pre-turnaround briefing as a precursor of other operational failures which in turn were associated with actual safety incidents. This has initiated a case study centred around improving turnaround briefings and mindful performance. It will deploy two applications designed to create a mindful improvement initiative:
   - An Implementation Manager that supports a collective improvement effort and effective handover across implementation phases
   - Operational reporting to ensure continual information flow and feedback as the initiative continues.

   This initiative is beginning its implementation phase since late October 2017, involving a full handover of methods and tools in support of the case study, leading to full implementation in the first quarter of 2018.

The potential applicability of this approach covers not only all sectors of aviation, but also all industries that carry a significant operational risk, including health and social care, emergency services, financial services and other transport modes. The applicability of these ideas across these domains has been explored/commented through teaching and research at masters level with risk, safety and change professionals across these industries (TCD MSc in Manging Risk and System Change), though no formal market analysis has yet been done in advance of the initial concept demonstration in the current case studies.

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ANNEX 1: ORGANISATIONAL SAFETY MINDFULNESS SURVEY (OSMS)

As part of the EU funded FSS Project (https://www.futuresky-safety.eu/), a study on safety opinions at work is conducted. This questionnaire is part of this project action.

The purpose of this Project is strengthening organisational capacity on safety and improving safety management practice. The following questionnaire is addressing respectively the organisational and management aspects related with the ways the information and knowledge about safety propagate across the organisation.

In essence, there is a need to understand better the "social life of safety information revolving around you and your colleagues at work". And this could be seen as an opportunity to have a say on what counts most, safety at work.

The following OSMS survey comprises two Parts:

1. **Part I** - about your general opinion on safety information in the organisation
2. **Part II** - about your perception on the SM IT solution that you have been presented

There are no right or wrong answers, but your personal opinion on how safety information happens to be in your daily work life.

Generally what comes up first is the best answer!

Should you have any question about this survey, please feel free to contact the survey contact point: Dr. Daniele Baranzini, email: baranzd@tcd.ie

~~~ PART I~~~

Please read the items below and mark the response (e.g., agree) that best reflect your opinion. All questions refer to your organisation.

1. Everyone knows how safety reports are collected, used and followed up.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

2. Information about problems, solutions and changes affecting safety is taken seriously by everyone.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

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3. I promptly act on information that is shared with me about safety problems.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

4. Safety information and actions are shared amongst the different organisations we work with.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

5. It is my daily responsibility to be aware others' reported experiences of safety.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

6. Safety analyses always lead to good solutions that could improve the level of safety.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

7. The actions I take to solve safety problems are always done in a transparent and accountable way.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

8. I think that management is fully accountable for their control of safety processes.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

9. If I report my safety concerns this can improve safety rules and procedures.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

10. The organisation always applies lessons learned from safety events and identifies effective solutions.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

11. Safety is actively managed all the way from identifying problems to implementing solutions that actually solve the problems.

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Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

~~~ PART II~~~

Please read the items below and mark the response (e.g., agree) that best reflect your opinion. All questions refer to potential functions for a future IT solution for safety management.

1. Critical safety-related narratives should be spread across all system levels, from operations to senior management.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

2. The generation of safety-critical logs (experiences and narratives) is very relevant for my daily work.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

3. The circulation of safety experiences and narratives is very beneficial and increases safety awareness.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

4. Shared safety experiences improve awareness and accountability of how everyone acts and behaves.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

5. Shared information and knowledge enhance the organisation's capacity to remain safe.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

6. Learning is facilitated when colleagues experiences and best practices on safety are available.

Agree *Slightly agree* *neutral* *Slightly disagree* *Disagree*

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