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REPORT ON IMPACT ASSESSMENT METHODOLOGY D-1.3

Impact of Security Measures on Safety

Research conducted by:

UK Civil Aviation Authority International

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CASRA

An Agency of the European Union

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CAA International Limited (CAAi) was established in April 2007 as a wholly owned subsidiary of the UK CAA. The UK Civil Aviation Authority (UK CAA) is the UK's specialist aviation regulator, directly reporting to the UK Government's Department for Transport (DfT). Through its skills and expertise, it is recognised as a world leader in its field. CAAi provides access to the UK CAA's wealth of expertise and experience within the five operating groups of the UK CAA (Safety & Airspace Regulation Group, Consumers and Markets Group, Security Group, Strategy and Policy Group and International Group). Its primary focus is providing advisory, training, examination and licencing services to agencies, fellow National Aviation Authorities and industry in over 140 countries. CAAi's work involves assessment and delivery of targeted safety, security and environmental improvements and offer unparalleled expertise stemming from insights into best practices defined by the CAA.

Apave's core business is to help companies and government services managing their technical, environmental and human risks in the areas of Oil & Gas / Nuclear / Industry / Transportation. In aviation, Apave is committed to offering a range of civil and military aviation safety services, covering oversight authority tasks, audits, technical control, training and consulting services, through specialized and dedicated entities. Apave's staff in aviation enjoy extensive knowledge of the International and European regulatory framework, with a focus on Airworthiness, Flight Operations and Safety Management Systems In 2022 Apave has strengthened its portfolio through the acquisition of Oppida a cyber-security specialist in many highly regulated domains and safety and security exposed businesses. Apave has organised its civil and military aviation risk management consulting services around a unique value proposition with a dedicated entity: Apave Aeroservices (hereafter referred to as ''Apave") has been designated in 2009 as the Group centre of excellence to provide risk management solutions to the Aviation community, including aviation authorities, Air Operators, Industry, Maintenance Organisations (MROs - Maintenance, Repair & Overhaul) and Training Organisations.

APSS Software & Services Ltd is part of the Center for Adaptive Security Research and Applications (CASRA), which was founded in 2008. CASRA emerged from the Visual Cognition Research Group of the University of Zurich, which was founded by Adrian Schwaninger in 1999. Today, CASRA APSS has a workforce of around 35 people, comprising of psychologists, economists, computer scientists, imaging specialists, software developers, aviation security experts, and more, most of which have an academic degree. The main objective of CASRA is to increase security and facilitation at airports and other environments involving people and technology. Through their studies and research on human – machine interaction, it was identified that visual abilities and training determine largely screeners' performance. As such CASRA has been working with a number of aviation security authorities and airports on selection, training and competency assessment processes providing advisory and research as well as their solutions globally.

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ABBREVIATIONS

ACRONYM	DESCRIPTION
AFM	Aircraft Flight Manual
AMM	Aircraft Maintenance Manual
BEIS	Department for Business, Energy & Industrial Strategy
CAMO	Continuing Airworthiness Management Organisations
CBA	Cost – Benefit Analysis
CCS	Civil Contingencies Secretariat
CDC	Centres for Disease Control and Prevention
CDCCL	Critical Design Configuration Control Limitation
CDL	Configuration Deviation List
CESER	Office of Cybersecurity, Energy Security, and Emergency Response
CMM	Component Maintenance Manual
COMAH	Control of Major Accident Hazards
CS	Certification Specifications
DOA	Design Organisation Approval
DOE	Department of Energy
DPIA	Data Protection Impact Assessment
EBA	European Banking Authority
EC	European Commission
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
EIB	European Investment Bank
ENCS	European Network for Cyber Security
ENISA	EU Agency for Cybersecurity
ENSREG	European Nuclear Safety Regulators Group
EPA	Environmental Protection Agency
ERCC	Emergency Response Coordination Centre
ESA	European Space Agency
ESPON	European Spatial Planning Observation Network
EU	European Union
EWIS	Electrical wiring interconnection system
FCA	Financial Conduct Authority
FCC	Federal Communications Commission
FDA	Food and Drug Administration
FEMA	Federal Emergency Management Agency
FSA	Food Standards Agency

FSOC	Financial Stability Oversight Council
GAO	Government Accountability Office
HF	Human Factors
HIRA	Hazard Identification and Risk Assessment
HMI	Human Machine Interface
HSE	Health and Safety Executive
IA	Impact Assessment
IAEA	International Atomic Energy Agency
ICO	Information Commissioner's Office
IPA	Infrastructure and Projects Authority
IPO	Input-Process-Output
LCA	Life Cycle Assessment
MCA	Multi-Criteria Analysis
MCDM	Multi Criteria Decision Making
MMEL	Master Minimum Equipment List
MRO	Maintenance, Repair and Overhaul
NCSC	National Cyber Security Centre
NIST	National Institute of Standards and Technology
NRC	Nuclear Regulatory Commission
OECD	Organisation for Economic Co-operation and Development
OMB	Office of Management and Budget
ONR	Office for Nuclear Regulation
OSD	Operational Suitability Data
PSA	Probabilistic Safety Assessment
REACH	Registration, Evaluation, Authorisation, and Restriction of Chemicals
RIA	Regulatory Impact Assessment
SEA	Socio-Economic Impacts
SIA	Safety Impact Assessment
SeMS	Security Management System
SME	Subject Matter Expert
SMS	Safety Management System
SoTA	State-of-the-Art
SRM	Stakeholders Relationship Management
TEM	Threat and Error Management
TIA	Territorial Impact Assessment
UK	United Kingdom
US	United States
WHO	World Health Organisation

1. Executive summary

Problem area

Ensuring the effectiveness of security measures within the civil aviation sector is paramount to maintaining overall safety outcomes. The final delivery of task one is methodology to measure the impact of the previously listed security measures on safety. This deliverable seeks to address the challenge of assessing the impact of identified security measures on safety outcomes. This report also seeks to establish a framework that enables both Operators and Regulators to evaluate the impact of security measures (both existing and future ones) on safety. The goal is to facilitate better informed decision-making in this regard.

Furthermore, where interdependencies between security measures and safety outcomes have been identified, this report endeavours to outline the nature and scope of these impacts, facilitating a relative assessment of their significance. This relative assessment enables consideration of priorities in enhancing the aviation sector's safety and security landscape.

In summary, task 1.3 addresses the critical need to balance security measures and safety outcomes within the civil aviation sector. By analysing the impact of security measures on safety and establishing a robust assessment methodology, we are in a position to provide valuable insights to guide holistic decision-making and enhance the overall safety - security paradigm.

Impact Assessment

Impact assessment within the civil aviation sector entails a systematic evaluation of potential outcomes resulting from events, decisions, or alterations encompassing safety, operations, finances, reputation, and other facets within the intricate aviation domain. This important process aids aviation entities, regulatory bodies, and stakeholders in comprehending the consequence of their actions and external influences. Given the intricate interdependencies within aviation, impact assessment assists regulatory bodies and organisations in forecasting repercussions, mitigating adverse effects, resource allocation, bolstering safety measures, considering stakeholder interests and assessing both immediate and enduring impacts of implemented strategies. Impact assessment is often undertaken as part of the wider risk management and risk assessment framework and extends across diverse realms including technological advancements, regulatory changes, environmental impacts, and aviation safety and security. By ensuring well-informed choices that account for comprehensive implications, impact assessment reinforces transparency and informed decision-making throughout the industry.

Extensive research has been conducted encompassing a broad spectrum of impact assessment methodologies across different domains both within and beyond aviation. The initial segment of this report delves into a comprehensive analysis of impact assessment theory, exploring its practical applications across various industries.

Security measures, whether pre-existing or newly proposed, can exert both direct and indirect impacts on safety. The assessment of these measures aims to pinpoint potential safety repercussions, providing transparency regarding affected domains. This empowers regulatory bodies and entities under their jurisdiction to devise mitigation strategies should adverse impacts be identified and allows for:

- Anticipating consequences
- Minimising negative effects
- Efficient resource allocation
- Enhancing safety

- Contingency planning
- Regulatory compliance
- Stakeholder consideration
- Long-term evaluation
- Financial impact assessment

Several analysed methodologies employ risk assessment principles to evaluate impact. Integrated risk assessment intricacies will be explored further in Task 4 of this research study. Common elements shared by various approaches and methodologies include:

- Problem definition and scope
- Stakeholder identification
- Data collection and analysis
- Solution identification and selection
- Ongoing data review

It is imperative to note that the examined frameworks extend beyond assessing one domain's influence on another. They often employ a blend of qualitative and quantitative analyses for comprehensive impact evaluation, with a significant emphasis on stakeholder involvement in some proposed methodologies.

In conclusion, the primary goal of this task is to develop a user-friendly tool for regulators and entities to assess how security measures affect safety. The integration of diverse methodologies forms a framework for evaluating this impact, with Stakeholder Relationship Management and Input-Process-Output methodologies exhibiting promise for favourable outcomes.

Proposed methodology

The second part of this study introduces a proposed methodology tailored to assess the impact of security measures on safety. The assessment process begins by defining security measures that will undergo safety impact assessment. Stakeholder/subject matter experts' involvement is pivotal to foster collaboration within the civil aviation community, ensuring that impact assessments draw from all pertinent areas of safety.

Each proposed step of the methodology includes the objective of the step, essential elements that have to be followed and additional elements to consider. In summary, the proposed impact assessment process comprises the following steps:

Step 1. Security measure to be assessed. The objective of this step is to clearly state what security measure will undergo the assessment.

Step 2. Identification of safety domain and selection of safety experts. Objective of this step is the identification of the safety domains potentially affected by the security measure under assessment. This step will enable the (a) identification of the safety areas and (b) the selection of relevant stakeholders or subject matter experts that will be involved in the SIA process.

Step 3. Assessment. Next stage is to assign specific criteria that will enable to rate the impact and provide rationale for selection. This will be based on a variety of available data and information for example, occurrence reports but also general knowledge relevant to the specific field, issues that are anticipated in case of proposed new security measures. Description of known conflicting safety requirements, any known duplications of regulatory requirements that may lead to divergent requirements in the future, in case of existing measures, implemented mitigating measures or training that is required to reduce the negative effect or in case of new measures, anticipated mitigating measures or required training to prevent negative impact.

Step 4. Impact rating. Evaluation of the negative impact to determine whether it could result in an accident, or a serious incident.

Step 5. The outcome. Analysis of all the answers and rating of negative impact to establish where the impact may be severe and lead to an accident or serious incident. Acceptance, treatment or rejection of assessed security measure. Recommendations for reduction of impact.

2. Methodology

The research methodology comprises four key phases aimed at establishing a comprehensive Impact Assessment (IA) framework tailored for evaluating the impact of security measures on safety within the aviation sector.

- **State-of-the-Art (SoTA) Research:**
    - Conduct an extensive literature review to identify and examine various Impact Assessment methodologies in use across diverse sectors, encompassing domains beyond aviation.
    - Analyse the strengths and limitations of each identified methodology, highlighting their benefits and challenges in assessing impacts.
    - Categorise and compare these methodologies to extract relevant insights applicable to the aviation context.
- **Evaluation of Current Methodologies:**
    - Select a subset of methodologies from the SoTA research that demonstrate relevance and potential suitability for assessing security measures' impact on aviation safety.
    - Evaluate each chosen methodology in-depth to ascertain its compatibility with the aviation sector's unique characteristics and requirements.
    - Identify specific challenges and limitations that might arise when applying these methodologies to aviation safety and security scenarios.
- **Stakeholder survey to assess the current picture**:
    - Develop a survey to aviation stakeholders to assess if impact of security measures on safety is currently being undertaken.
    - Collect and examine stakeholders’ feedback to assess to what extent IA is undertaken and what are the main considerations including what methodologies are currently being utilised in the industry.
- **Development of IA Framework for Aviation Safety Impact Assessment:**
    - Synthesise the insights gathered from the SoTA research and evaluation phase to formulate a new Impact Assessment framework tailored to the aviation industry's safety and security context.
    - Define the key components, steps, and criteria to rate the impact that will constitute the proposed IA framework.
    - Incorporate best practices and adapt methodologies to address the specific challenges and intricacies of assessing security measures' impact on aviation safety.
    - Presentation of the methodology to the industry stakeholders and incorporation of feedback provided.

Throughout the research methodology, a systematic approach was adopted, involving literature review, critical analysis, and expert validation to ensure the resulting IA framework is robust, effective, and aligned with the unique needs of aviation safety assessment in the context of security measures.

3. Context

The European Union Aviation Safety Agency (hereinafter "EASA") is an agency of the European Union, which has been given specific regulatory and executive tasks in the field of aviation safety. The Agency constitutes a key part of the European Union's strategy to establish and maintain a high uniform standard of safety and environmental protection in civil aviation at European level.

As part of the Horizon Europe Work Programme 2021-2022 on Cluster 5 Climate, Energy and Mobility, the European Commission has entrusted EASA with the management of one specific research action entitled "impact of security measures on safety".

As a result, EASA has awarded a public contract to a consortium of 3 companies:

- CAA International
- Apave Aéroservices
- CASRA

The contract details the four main tasks which are specified in order to achieve the expected outcome which is to understand the nature and extent of the interdependencies between safety and security in order to assess the impact of security measures on safety. In doing so, the research project should identify which processes and job roles are affected by safety–security interdependencies and which certification requirements and licensing activities are affected. In the medium term, safety risk management techniques that can be applied to security will produce harmonised risk assessment methods and support integrated policy and decision-making processes at national and EU level.

The project aims to develop a comprehensive knowledge base for the evaluation of the potential impact of security measures on the safety performances of aviation systems, personnel and operations, including the leading indicators for measuring such an impact (positive or negative) as well as the main factors playing a role in such security-safety dependencies.

The four main tasks are:

- Task 1: Identify the interdependencies between security and safety
- Task 2: Assessment of the impact of security measures on safety
- Task 3: Analysis of certification standards
- Task 4: Integrated risk management

4. Objective of the document

Scope

This report represents deliverable 'D1.3' of the Impact of Security Measures on Safety (EASA.2022.HVP.04). The work presented here represents the output from 'Task 1' which includes identification of the safety areas affected by security measures (Task 1.1), identification of job roles with safety and security function (Task 1.2) and the methodology that will be used in further tasks to assess whether the impact of security measures on safety, is positive, neutral or negative.

Scope context

To gain a comprehensive understanding of Task 1.3, it is important to contextualise its scope within the broader framework of the project. This involves recognising how the outcomes of Task 1.3 will be utilised throughout the project and understanding its synergies with other tasks.

Task 1.1 laid the groundwork by delineating the interdependencies between safety and security, pinpointing areas of safety influenced by security measures. Eight primary safety areas were identified, each comprising more detailed elements, along with a description of the nature of safety-security interdependencies. It must be noted that while the review of the regulatory framework provided a structured starting point, it may not offer a complete overview of safety-security interactions and potential operational challenges.

Task 1.2 subsequently examined these safety areas to identify pertinent job roles encompassing safety and security functions. Together, Tasks 1.1 and 1.2 established an initial framework for understanding safety-security interdependencies, serving as the cornerstone for a knowledge base intended for operators and regulators.

Tasks 2 and 3 will evaluate the impact of security measures on safety. To facilitate this assessment, the development of an effective methodology is an essential next step. Task 1.3 aims to define this methodology, starting with an exploration of existing impact assessment methodologies in the aviation domain and beyond, such as the critical infrastructure approach to impact assessment. The subsequent phase involves deciding whether to adopt an existing methodology or develop a new, more fitting framework for effective assessment.

The establishment of criteria and indicators to evaluate the impact—determining whether it is negative, neutral, or positive—is an integral part of Task 1.3. The methodology developed in Task 1.3 will be employed in Task 2.3 for actual assessment, with potential refinements based on testing and outcomes. In Task 2.3, a detailed assessment of the impact of security measures on safety will be undertaken. It is noteworthy that the implementation of regulatory changes or adjustments resulting from this assessment is outside the scope of this project.

Once tested and verified to provide desired outcomes, the methodology will be issued in form of a guidance to operators and regulators. Task 1.3, as an indispensable element of risk assessment and management, will integrate into a more comprehensive approach to safety and security risk management, forming the core of Task 4 of this research study.

The following outline represents an accessible and simplified context of this research.

The initial three tasks facilitated the establishment of a foundation for the knowledge base. This included an initial exploration of the interdependencies between safety and security, along with the compilation of a list of safety domains potentially affected by security measures. Additionally, a comprehensive list of security threats that may impact the aircraft safety was also developed.

D1.1
List of safety areas affected by security

D1.2
List of job roles with safety and security functions

D2.1
List of threats to the aircraft safety

The subsequent phase involves formulating the methodology for evaluating the impact of security measures on safety. Task 1.1 has catalogued 64 safety – security interdependencies where the effects on safety may occur, whether positive or negative. To pinpoint the actual nature and severity of these impacts (undertaken in Task 2.3), Task 1.3 will focus on developing the necessary methodology for assessment.

D1.3
Methodology to assess the impact of security measures on safety

Upon the completion of the methodology development, the assessment phase will commence. This involves the practical evaluation of the impact of security measures on safety, as well as a direct assessment of certification standards.

D2.2 D2.3
Assessment of the actual impact of security measures on safety

D3.1 D3.2 D3.3
Detailed assessment of aircraft design, safety and security certification processes

Recommendations for integrated approach to safety – security risk assessment and management will be undertaken in the last part of this study.

D4.1 D4.2 D4.3
Provisions for integrated risk assessment and management

Figure 1. Context of task 1.3 and this research framework.

5. Introduction

General considerations

The regulation of aviation security has predominantly evolved in response to successful or thwarted acts of unlawful interference, leading to the introduction of security measures aimed at reducing system vulnerability and preventing similar incidents from happening again. From a broader perspective, each security measure has a positive impact on safety, enhancing protection against unlawful interference and diminishing the risk of harm. However, when examining individual security measures at a more detailed level, there is the potential for impacts on aviation safety operations, systems, equipment, or human factors, introducing conditions that may elevate safety risks or diminish the effectiveness of mitigation strategies. Simultaneously, certain security measures may positively influence safety. The objective of this study is not to question the overarching need for implemented security measures but to scrutinise the interactions between safety and security, pinpointing and analysing areas of dependency.

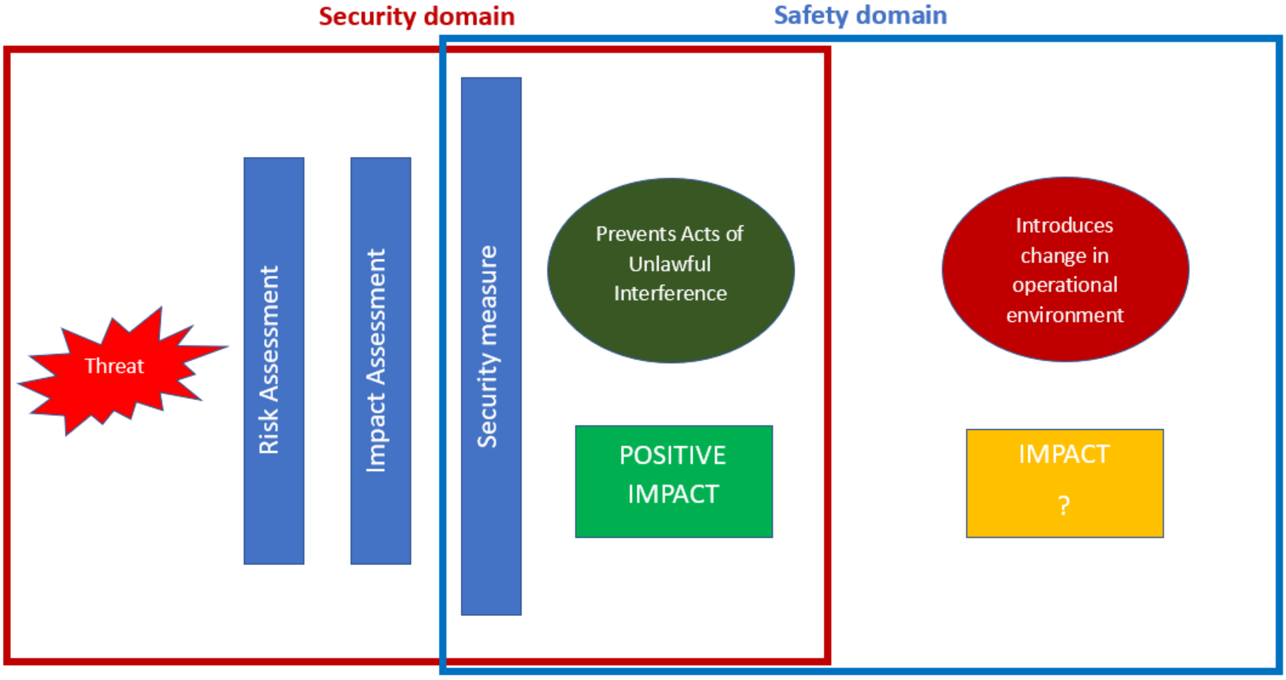

Figure 2. Security vs Safety impact of security measures

This task aims to develop an Impact Assessment methodology that serves the dual purpose of allowing regulators to assess the impact of security measures on safety, when new security measures are proposed, but also to allow regulated entities to evaluate the effects of security measures on safety and establish appropriate mitigating actions (through risk assessment and management) to counteract potential adverse consequences of such measures. Through an undertaken survey and research initiative designed to build a foundational knowledge base, it became evident that the context in which impact assessments are conducted may vary between National Appropriate Authorities (NAAs), regulatory bodies, and the entities they regulate.

Currently, Regulatory Impact Assessments (RIAs) are predominantly conducted by the entities proposing new legislation, such as EASA RIA, UK CAA IA, and other critical infrastructure agencies, following a formalised IA approach endorsed by the government. These models typically incorporate a blend of qualitative and quantitative methods, often including Cost-Benefit Analysis and stakeholder engagement as part of a broader IA framework. These assessments are critical in determining the overall impact of proposed regulations on various aviation entities. While safety considerations are part of this evaluation, there is presently no one single dedicated methodology exclusively focused on assessing the impact of security measures on safety.

The context in which regulated entities undertake impact assessments diverges notably. As indicated by a survey distributed among aviation stakeholders, impact assessments are not as commonly practiced, often taking the form of risk assessments mandated within Safety Management Systems. When new measures are introduced, risk assessments generally enable entities to evaluate and define the nature of associated risks, as well as ascertain the need for additional countermeasures.

This safety impact assessment methodology serves as a foundation for fostering coordination and communication between two domains. Its primary objective is to establish a well-organised framework for facilitating communication, engaging stakeholders, and cultivating a shared understanding among safety and security experts.

This methodology will be initially deployed within the scope of this project, specifically for assessing the impact of security measures on safety and identifying potential safety hazards arising from security measures (part of task 2.3 of this project). By implementing this methodology during the research phase, the research team will be able to uncover additional challenges and areas requiring refinement. Once validated for its fitness for purpose, the methodology will be disseminated to regulators and operators as guidance.

Definition of Impact Assessment

Impact assessment (IA) is a structured and evidence-based procedure that enables the evaluation of a proposal, whether it be a proposed legislation or a project, in relation to its effects on a specified audience. As described by the OECD, IA serves two main purposes: looking ahead at potential effects before making decisions (ex-ante impact analysis) and evaluating the actual effects after implementing decisions (ex-post impact assessment). Ex-ante analysis helps in planning and informing policy choices, while ex-post assessment helps in understanding the outcomes and making improvements[1].

Ex-post impact assessment goes hand in hand with evaluation, aiming to comprehend how well a policy intervention addresses the intended problem. This involves looking at effects, intervention design, cost-efficiency, unintended consequences, and how to improve future interventions based on experience. Though it is useful to distinguish between impact assessment and evaluation, they often overlap, and impact assessments can contribute to broader evaluation questions.

However, in this approach, it is important not to mix up impact assessment and evaluation. Impact assessments are narrower, focusing mainly on the effects of interventions, often emphasising economic impacts. They are not meant to answer as many questions as evaluations, which consider a wider array of factors.

Impact assessments are not neutral tools; they can influence what they're observing. This is called the "observer effect." In aviation, this effect is seen in performance-based research funding systems, where observation leads to improved performance. Impact assessments can even be used as policy interventions themselves.

In summary, impact analysis in the aviation sector involves understanding and foreseeing the effects of decisions before they're made (ex-ante) and evaluating their actual outcomes afterward (ex post)[2]. Impact assessments are influential tools for informed decision-making in aviation industry.

International Association for Impact Assessment defines Impact Assessment as "*the process of identifying the future consequences of a current or proposed action*.[3]" Impact assessment in the aviation sector refers to the systematic evaluation and analysis of the potential consequences that various events, decisions, or changes can have on safety, operations, finances, reputation, and other aspects within the aviation industry. It is a

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[1] OECD (2014), *What is impact Assessment?* at: What-is-impact-assessment-OECDImpact.pdf
[2] OECD (2014), What is impact Assessment? at: What-is-impact-assessment-OECDImpact.pdf
[3] International Association for Impact Assessment at: IAIA The leading global network on impact assessment

process that helps aviation organisations, regulatory bodies, and stakeholders understand the potential effects of their actions or external factors.

In the scope of this research study, and as highlighted in Task 1.1, several interdependencies between safety and security have been identified. In these instances, security measures can potentially have both direct and indirect impacts on safety. The assessment (IA) conducted for security measures, whether already in place or new, seeks to pinpoint the potential repercussions of implementing these measures on safety aspects. This process aims to provide a transparent understanding of the domains that might be affected. By doing so, it empowers both regulatory bodies and the entities under their oversight to develop appropriate mitigation strategies in the event that any adverse impacts are identified.

The aviation sector is highly complex, involving numerous interconnected systems and processes. When making decisions, implementing changes, or preparing for potential risks, impact assessment allows regulatory bodies and entities to:

Anticipate consequences: By assessing the potential impacts of different scenarios, aviation entities can foresee the potential outcomes of their decisions not only on their own organisation but also on the potential stakeholders. This helps in making informed choices that align with their goals and priorities.
Minimise negative effects: Impact assessment helps identify potential negative effects early in the decision-making process. This allows entities to take mitigating actions to minimise harm to safety, operations, and reputation.
Allocate resources efficiently: Understanding the potential impacts of decisions helps allocate resources (such as budget, personnel, and time) more effectively. Resources can be directed towards areas that are most likely to be affected or require attention.
Enhance safety: Safety is paramount in aviation. Impact assessment helps identify potential safety risks and evaluate the potential consequences of safety-related decisions, ensuring that measures are in place to prevent accidents or incidents.
Plan for contingencies: By understanding the potential effects of different scenarios, aviation organisations can develop contingency plans. These plans outline steps to be taken if certain events or changes have a significant impact.
Adhere to regulations: Impact assessment helps ensure compliance with aviation regulations. Regulatory bodies often require impact assessments for significant changes or projects to ensure that safety, security, and operational standards are maintained.
Consider stakeholder interests: The aviation industry involves various stakeholders, including passengers, employees, communities, and investors. Impact assessment considers their interests and concerns, leading to more inclusive and transparent decision-making.
Evaluate long-term effects: Impact assessment is not limited to immediate consequences; it also considers long-term effects. This is particularly important in aviation, where decisions can have far-reaching effects that extend beyond the immediate future.
Evaluate financial impact: Regulatory changes inherently affect various categories of aviation stakeholders, each varying in terms of their nature and complexity. These changes, once implemented, possess the potential to exert a substantial impact on the stakeholders, particularly when substantial financial investments are necessitated. An assessment of the financial impact stemming from regulatory change is indispensable in comprehending which stakeholders will bear the brunt of these alterations. Furthermore, it aids in determining whether the outcomes of the change should be refined to mitigate the adverse repercussions of imposing a substantial financial burden on diverse organisations within the aviation sector.

In the aviation sector, impact assessment can apply to a wide range of areas, including changes in operational procedures, airport expansions, introduction of new technology, regulatory changes, environmental considerations, and security measures. Whether it is evaluating the effects of changes in flight schedules, introducing new aircraft, or implementing safety or security policies, impact assessment helps ensure that decisions are well-informed and consider the holistic implications for the aviation industry and its stakeholders.

6. Management of Impact in different environments

The objective of this section is to scrutinise the approach to impact assessment across various domains, encompassing aviation and beyond. The research team initially identified in which areas impact assessments are typically undertaken and subsequently examined these areas, evaluating distinct approaches to impact assessment. Impact assessments are prevalent in a broad spectrum of fields, including critical infrastructure, environmental agencies, and various domains within aviation. The purpose of this section is to establish the most prevalent approaches to impact assessment, which will be further elaborated upon and can serve as a foundation for developing an appropriate approach to assess the impact of security measures on safety. Identified methods, which will be elaborated upon in section 7, form a foundation for developing an appropriate methodology to evaluate the impact of security measures on safety.

6.1 Critical Infrastructure Impact Assessment

Various industries and sectors, such as chemicals, civil nuclear, communications, emergency services, energy, finance, food, government, health, space, transport, and water, require comprehensive impact assessments to identify vulnerabilities, mitigate risks, and ensure continuity of essential services. The following presents an analysis of impact assessments conducted in the European Union (EU), the United Kingdom (UK), and the United States (US) for each critical infrastructure sector. It focuses on the methods of impact assessment used and their respective benefits and challenges. The analysis of these methods can help to inform on the methodology that will be best suited to assess the impact of security measures on safety.

The following areas have been examined:

- Chemicals
- Civil Nuclear
- Communications
- Emergency Services
- Energy
- Finance
- Food
- Government
- Health
- Space
- Transport
- Water

Chemical Industry

The assessment and management of chemical risks are paramount in today's global society, as production and utilisation of various chemicals have expanded across industries. Different regions and countries have developed distinct models for evaluating the potential impacts of chemicals on human health, the environment, and communities. These models, such as the European Union's REACH (Registration, Evaluation, Authorisation, and Restriction of Chemicals) framework, the United Kingdom's COMAH regulations, and the United States Environmental Protection Agency's (EPA) risk assessment approach, each offer unique perspectives on addressing chemical hazards and their associated risks. Socio-economic analysis (SEA), life-cycle assessment (LCA) or green degree method are amongst those used to determine the impacts of chemicals on the environment.

EU Model - Method of Impact Assessment: The EU follows a risk-based approach under the REACH (Registration, Evaluation, Authorisation, and Restriction of Chemicals) framework. It involves hazard identification, exposure assessment, and risk characterisation to evaluate potential risks to human health, the environment, and communities. SEA was introduced as a tool for the assessment of impact and authorisation requests or restriction proposals[4].

Benefits: This method provides a comprehensive evaluation of chemical risks and informs appropriate risk management measures. It promotes safer chemical usage and supports the protection of human health and the environment.

Challenges: The risk assessment process can be time-consuming and resource intensive. The assessment may involve uncertainties due to limited data availability for certain chemicals.

UK Model - Method of Impact Assessment: The UK's Health and Safety Executive (HSE) assesses chemical risks under the Control of Major Accident Hazards (COMAH) regulations. It involves scenario-based analysis and risk quantification for major accident hazards.

Benefits: Scenario-based analysis provides insights into potential accident scenarios, enabling targeted risk reduction measures. It enhances safety planning and preparedness for chemical-related emergencies.

Challenges: This method may focus primarily on major accident scenarios, potentially overlooking lower probability but high-consequence risks.

US Model - Method of Impact Assessment: The US Environmental Protection Agency (EPA) conducts risk assessments based on chemical properties, toxicity, and potential harm to human health and the environment.

Benefits: EPA's risk assessments inform regulatory decisions and help prioritize chemical safety measures. It uses a science-based approach to assess chemical risks.

Challenges: The EPA's risk assessment process can be time-consuming and resource intensive. It may face challenges in data availability and uncertainties in estimating certain risks.

Conclusion

In the complex realm of chemical risk assessment and management, it is evident that no one-size-fits-all solution exists. The European Union's comprehensive risk-based approach under REACH stands as a testament to the dedication toward safeguarding human health and the environment. The UK's scenario-based analysis through COMAH regulations emphasises preparedness for potential emergencies and major accidents. Meanwhile, the US EPA's meticulous evaluation contributes to informed regulatory decisions and a science-driven understanding of chemical risks. Furthermore, impact assessment is incorporated into a broader risk assessment framework, serving a distinct role in bolstering the risk management process and enhancing comprehension of particular environmental and health risks.

Ultimately, the US EPA's approach may be too scientific to apply to methodology of assessing the impact of security measures on safety as security measures are not as scientific or accurate in comparison to the chemical industry. However, a combination of the REACH and COMAH methodologies could prove to be a useful foundation for our methodology providing the challenges faced by these methods can be overcome.

Various methodologies employed in the chemical sector integrate both qualitative and quantitative assessments, utilising multi-criteria and multi-step methods to evaluate environmental impacts. It's noteworthy that quantifying qualitative information and specific indicators is less challenging in the chemical domain, given its ease of representation through numerical values. However, across diverse methodologies, common steps involve establishing a clear framework with a number of defined steps, formulating criteria and indicators based on qualitative information and available data, and quantifying data with the assignment of average values.

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[4] J.K. Verhoeven et al. (2012), From risk assessment to environmental impact assessment of chemical substances Methodology development to be used in socio-economic analysis for REACH, National Institute for Public Health and the Environment at: https://rivm.openrepository.com/bitstream/handle/10029/260300/601353002.pdf?sequence=3&isAllowed=y

Civil Nuclear

Technological advancements have led to the widespread use of nuclear energy, the assessment of nuclear safety and security has become an imperative for nations across the globe. Different regions and countries have developed distinctive models for evaluating the potential impacts of nuclear incidents, ensuring the protection of both citizens and the environment. The European Union's collaboration through the European Nuclear Safety Regulators Group (ENSREG), the United Kingdom's Office for Nuclear Regulation (ONR), and the US Nuclear Regulatory Commission (NRC) each offer unique approaches to nuclear impact assessment. These models provide insight into the landscape of nuclear risks and the scope of impact of incidents in this area would be on a similar scale of press coverage with aviation therefore these styles of impact assessment may prove a useful model for our methodology.

EU Model - Method of Impact Assessment: The European Nuclear Safety Regulators Group (ENSREG) collaborates with the European Commission to assess nuclear safety and security in the EU. They follow guidance from the International Atomic Energy Agency (IAEA) which involves Probabilistic Safety Assessment (PSA) to estimate the likelihood and consequences of nuclear accidents. IAEA described the approach to impact assessment in *"Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programme*" report which aims to assist states in developing an effective environmental impact assessment in new nuclear power programmes. In this approach an impact assessment is only a part of a series of reports required under the wider framework. This approach also permits states to refer to different IA methodologies to calculate environmental impacts. Provided examples include dispersion and dose modelling for radiation impact, economic modelling for regional economy impact, social trend projections for people and society impact. The methodology for assessing the significance of an environmental impact incorporates qualitative, quantitative, and intangible parameters. Examples of these parameters include probability, reversibility, geographical and population extent, intensity, duration, uncertainty, and cumulative impact over time, including contributions from sources beyond the specific project under consideration[5]. Common denominatives of different approaches are scope of the assessment, data collection, definition of impact components and criteria for identifying significant impacts or stakeholder involvement.

Benefits: PSA provides insights into potential accident scenarios, enabling targeted safety improvements. It allows for risk-informed decision-making in nuclear safety.

Challenges: PSA requires significant data and expertise, making it resource intensive. The method may have limitations in addressing new and emerging risks.

UK Model - Method of Impact Assessment: The UK's Office for Nuclear Regulation (ONR) conducts rigorous impact assessments to ensure safety and security in the UK's civil nuclear infrastructure. It includes scenario-based analysis and compliance checks with safety regulations.

Benefits: Scenario-based analysis helps identify vulnerabilities and assess accident scenarios. Compliance checks ensure adherence to safety standards.

Challenges: This method may focus primarily on known risks and may not fully address novel or complex threats.

US Model - Method of Impact Assessment: The US Nuclear Regulatory Commission (NRC) conducts PSA to estimate the likelihood and consequences of nuclear accidents.

[5] IAEA (2014), *Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes,* IAEA Nuclear Energy Series, Vienna, 2014 at: Pub1625_web.pdf (SECURED) (iaea.org)

Benefits: PSA enhances understanding of nuclear safety risks and supports risk-informed regulatory decisions. It contributes to continuous improvement in nuclear safety.

Challenges: PSA requires substantial technical expertise and data, making it resource intensive. The method may face challenges in addressing low-probability, high-consequence events.

Conclusion

The European Union's collaboration through ENSREG exemplifies a concerted effort to assess nuclear safety and security through probabilistic safety assessment, enabling risk-informed decision-making and targeted safety improvements. The UK's ONR, with its rigorous impact assessments, ensures the integrity of the nation's civil nuclear infrastructure through scenario-based analyses and compliance checks. Meanwhile, the US NRC's commitment to PSA enriches the understanding of nuclear risks and informs regulatory decisions, fostering continuous enhancement in nuclear safety.

In a world where emerging threats and unprecedented scenarios continue to arise, no model is without its challenges. These models, while effective in their focus areas, may face limitations in addressing evolving risks and uncertainties. While impact assessment methodologies may vary, they generally adhere to similar principles. These encompass defining the scope, establishing relevant criteria, collecting and evaluating data, and consistently involving stakeholders.

Communications

In our digitally interconnected world, the security and integrity of communication networks are of paramount importance. With the rise of cyber threats and the potential risks they pose to critical infrastructure, different nations have developed unique models to assess the impact of cybersecurity and data protection vulnerabilities. The European Union's Agency for Cybersecurity (ENISA), the UK's National Cyber Security Centre (NCSC), and the US Federal Communications Commission (FCC) each employ distinct methods to evaluate potential risks to communication networks. These models, rooted in vulnerability assessments, threat intelligence, and regulatory oversight, play a vital role in safeguarding the functionality and security of communication systems. Therefore, may prove to be useful examples to influence our final methodology for assessing the impact of security measures on safety.

EU Model - Method of Impact Assessment: The EU Agency for Cybersecurity (ENISA) assesses cybersecurity and data protection risks to critical communications networks. It uses vulnerability assessments, threat modelling, and risk analysis to evaluate potential risks.

Benefits: This method identifies vulnerabilities and potential cyber threats, enabling targeted security measures. It enhances the resilience of critical communication networks.

Challenges: The rapid evolution of cyber threats may challenge the timeliness of impact assessments.

UK Model - Method of Impact Assessment: The UK National Cyber Security Centre (NCSC) assesses cybersecurity and data protection risks to communication infrastructure. It uses threat intelligence, incident data analysis, and vulnerability assessments.

Benefits: Threat intelligence informs proactive risk management. Incident data analysis supports response planning and lessons learned.

Challenges: Reliance on historical incident data may not fully capture emerging threats.

US Model - Method of Impact Assessment: The US Federal Communications Commission (FCC) ensures public safety and homeland security in communication infrastructure.

Benefits: The FCC's impact assessments contribute to the resilience of critical communication networks. It facilitates regulatory oversight and promotes industry best practices.

Challenges: The FCC's impact assessments may face challenges in assessing rapidly evolving cyber threats.

Conclusion

The European Union's ENISA employs a comprehensive approach to assess cybersecurity risks, utilising vulnerability assessments and threat modelling to identify potential vulnerabilities and threats to critical communication networks. The UK's NCSC, with its emphasis on threat intelligence and incident data analysis, excels in proactive risk management and response planning, fostering a more resilient communication infrastructure. Meanwhile, the US FCC's regulatory oversight ensures public safety and promotes industry best practices, bolstering the security of communication networks.

However, the rapid evolution of cyber threats is a challenge that transcends these models. Emerging threats may challenge the timeliness of impact assessments, and the reliance on historical incident data might not capture the full spectrum of emerging risks. This would be the same in aviation therefore to address these challenges, a culture of continuous learning and knowledge sharing is essential.

Emergency Services

Emergencies can strike at any moment therefore the effectiveness of emergency preparedness and response is a critical determinant of a nation's resilience. Various regions and countries have developed distinct models for assessing the impact of emergency response capabilities to ensure the safety and security of their citizens. The European Union's Emergency Response Coordination Centre (ERCC), the UK's Civil Contingencies Secretariat (CCS), and the US Federal Emergency Management Agency (FEMA) each employ unique methods to evaluate emergency preparedness and response. These models, rooted in scenario-based exercises, multi-agency coordination, and after-action analysis, play a vital role in fortifying a nation's ability to manage crises. Aviation is susceptible to emergency situations so understanding how these are assessed may give insight into how we should design out methodology for assessing the impact of security measures on safety.

EU Model - Method of Impact Assessment: The Emergency Response Coordination Centre (ERCC) oversees emergency preparedness and response assessments across EU member states. It employs scenario-based exercises, after-action reviews, and peer reviews to evaluate response capabilities.

Benefits: Scenario-based exercises enable realistic testing of emergency response plans. Peer reviews encourage knowledge sharing and learning from best practices.

Challenges: The effectiveness of the assessment may depend on the level of participation and collaboration among member states.

UK Model - Method of Impact Assessment: The UK Civil Contingencies Secretariat (CCS) ensures emergency services' readiness and response capabilities. The UK Government produce guidance in the form of a National Risk Register on how people and businesses can better prepare for emergencies. It involves multi-agency exercises, risk assessments, and continuous improvement processes.

Benefits: Multi-agency exercises enhance coordination among emergency services. Risk assessments identify potential vulnerabilities and inform risk reduction measures.

Challenges: Resource constraints, time limitations and location may impact the scope and frequency of exercises.

US Model - Method of Impact Assessment: The US Federal Emergency Management Agency (FEMA) conducts assessments to evaluate emergency services' capabilities. It includes national-level exercises, regional drills, and after-action reports.

Benefits: National-level exercises test coordination among federal, state, and local agencies. After-action reports facilitate lessons learned and improvements in emergency response.

Challenges: Assessing emergency services' capabilities across a diverse nation may present logistical challenges.

Conclusion

The European Union's ERCC stands as a collaborative hub that assesses emergency preparedness across member states, fostering knowledge exchange and enhancing response capabilities through scenario-based exercises and peer reviews. The UK's CCS, with its focus on multi-agency coordination and continuous improvement, strengthens emergency services' readiness by identifying vulnerabilities, testing coordination, and encouraging adaptive learning.

Similarly, the US FEMA, through its national-level exercises and regional drills, addresses the unique challenges posed by a diverse and expansive nation. The utilisation of after-action reports further facilitates a culture of improvement by capturing lessons learned and driving iterative enhancements in emergency response strategies. However, each model faces its own set of challenges, from encouraging participation and collaboration to managing resources and logistics. From an aviation perspective a peer review system could prove a useful model to base our methodology on providing there is acceptance, resources are made available and a willingness to participate.

Energy

Different regions and countries have developed unique models for assessing the potential impacts of threats on energy infrastructure security. ENISA in collaboration with the European Commission, the UK's Department for Business, Energy & Industrial Strategy (BEIS), and the US Department of Energy's (DOE) Office of Cybersecurity, Energy Security, and Emergency Response (CESER) each employ distinct methods to evaluate the vulnerabilities and risks in energy systems. These models, rooted in penetration testing, scenario modelling, and sector-specific planning, play an essential role in safeguarding the reliability and resilience of energy infrastructure.

EU Model - Method of Impact Assessment: ENISA collaborates with the European Commission on energy infrastructure security and resilience. It uses penetration testing, risk assessments, and industry consultations.

Benefits: Penetration testing helps identify vulnerabilities in energy systems. Industry consultations provide insights into specific risks and mitigation measures.

Challenges: The fast-paced evolution of cyber threats may necessitate frequent reassessments.

UK Model - Method of Impact Assessment: BEIS conducts impact assessments related to energy security in the UK. It uses scenario modelling and consultations with energy industry stakeholders.

Benefits: Scenario modelling helps evaluate potential risks and impacts on energy supply. Stakeholder consultations ensure industry perspectives are considered.

Challenges: The method may face challenges in accounting for rapidly changing energy technologies.

US Model - Method of Impact Assessment: DOE has the Office of CESER for energy infrastructure assessments. They provide the Emergency Response Playbook for States and Territories. It employs risk assessments, vulnerability assessments, and sector-specific planning.

Benefits: Sector-specific planning ensures tailored assessments for different energy sectors. Vulnerability assessments help identify critical assets and potential risks.

Challenges: The interconnectivity of energy systems may pose challenges in identifying and mitigating systemic risks.

Conclusion

The European Network for Cyber Security (ENCS) stands as a testament to international collaboration, employing penetration testing and industry consultations to identify vulnerabilities within energy systems. BEIS underscores the importance of scenario modelling and stakeholder engagement, allowing for a comprehensive assessment of potential risks to energy security. The US DoE's Office of CESER emphasizes sector-specific planning, vulnerability assessments, and risk assessments to tailor their approach to the unique challenges faced by different energy sectors. Despite the strengths of these models, they must confront the rapid evolution of threats, which necessitates a flexible and adaptive approach to assessment and mitigation.

Just like aviation there is not a one size fits all impact assessment methodology for energy. However, creating something like the Emergency Response Playbook in the field of aviation, may be a good way to ensure multiple aspects are considered while defining our methodology.

Finance

Different regions and countries have developed unique models to assess the potential impacts of risks to financial stability. The European Banking Authority (EBA) in collaboration with the European Union, the Bank of England and the Financial Conduct Authority (FCA) in the UK, and the US Federal Reserve and the Financial Stability Oversight Council (FSOC) each employ distinct methodologies to evaluate the vulnerabilities and risks within their financial systems. These models, rooted in stress tests, risk assessments, and macroprudential analysis, play a pivotal role in safeguarding the integrity and sustainability of financial markets.

EU Model - Method of Impact Assessment: The European Banking Authority (EBA) conducts stress tests and risk assessments to ensure financial stability in the EU. It uses scenario-based modelling and data from financial institutions.

Benefits: Stress tests assess the resilience of financial institutions under adverse conditions. Risk assessments inform regulatory decisions to enhance financial stability.

Challenges: The complexity of the financial system may require simplification in stress test scenarios.

UK Model - Method of Impact Assessment: The Bank of England and the Financial Conduct Authority (FCA) collaborate on assessing risks to the UK financial system. They use stress tests, macroprudential assessments, and risk analysis.

Benefits: Macroprudential assessments consider systemic risks across the financial system. Stress tests evaluate the robustness of individual financial institutions.

Challenges: Stress tests may not fully capture emerging risks in rapidly evolving financial markets.

US Model - Method of Impact Assessment: The US Federal Reserve and the Financial Stability Oversight Council (FSOC) assess risks to the US financial system. They use stress tests, market monitoring, and data analysis.

Benefits: Market monitoring provides real-time insights into financial market risks. Stress tests inform regulatory actions to address vulnerabilities.

Challenges: The interconnectedness of global financial markets may pose challenges in assessing systemic risks.

Conclusion

As the global financial landscape continues to evolve, the stability and resilience of financial systems remain at the forefront of economic priorities. The European Banking Authority (EBA) serves as a cornerstone of European financial stability, employing stress tests and risk assessments to evaluate the health of financial institutions under various scenarios. The collaborative efforts of the Bank of England and the Financial Conduct Authority (FCA) in the UK, through their stress tests and macroprudential assessments, strive to encompass both systemic and individual institution risks. The US Federal Reserve and the Financial Stability Oversight Council (FSOC) employ a combination of stress tests and market monitoring to ensure the stability of the US financial system. Despite their strengths, these models must grapple with the challenge of capturing emerging risks in rapidly evolving financial markets, as well as the interconnectedness of global financial systems.

A pattern is emerging from nearly all the impact assessment methodologies looked at so far. They all struggle to keep up with the impact of new and emerging threats. Therefore, whichever model is finally chosen as our methodology we need to insure there is continual review and ample opportunity to update and adapt to any new threats that emerge.

Food

Across different regions and countries, distinct models have been developed to assess the potential impacts of food-related risks. The European Food Safety Authority (EFSA) within the European Union, the Food Standards Agency (FSA) in the UK, and the US Food and Drug Administration (FDA) each employ unique methodologies to evaluate the safety of food products. These models, rooted in risk assessments, hazard identification, and exposure assessment, play an essential role in safeguarding consumers and fostering public confidence in the safety of their food.

EU Model - Method of Impact Assessment: The European Food Safety Authority (EFSA) conducts risk assessments to ensure food safety in the EU. It uses hazard identification, exposure assessment, and risk characterisation.

Benefits: The method provides a science-based evaluation of food risks. It informs food safety regulations and risk management measures.

Challenges: The assessment may face challenges in data availability for certain food contaminants or emerging risks.

UK Model - Method of Impact Assessment: The Food Standards Agency (FSA) is responsible for conducting risk assessments and ensuring food safety in the UK. It employs risk profiling, surveillance data analysis, and consultation with food industry stakeholders.

Benefits: Risk profiling helps prioritize food safety measures. Surveillance data analysis informs risk assessment and management.

Challenges: The method may require continuous updates to address emerging food safety concerns.

US Model - Method of Impact Assessment: The US Food and Drug Administration (FDA) conducts risk and safety assessments for food products. It uses hazard analysis, exposure assessment, and risk characterization.

Benefits: FDA's risk assessments inform regulatory decisions and risk communication to the public. It promotes science-based food safety measures.

Challenges: The method may face challenges in assessing risks from emerging foodborne pathogens or contaminants.

Conclusion

The European Food Safety Authority (EFSA) serves as a beacon of scientific rigor, employing a methodical approach to risk assessments that encompasses hazard identification, exposure assessment, and risk characterization. This approach not only informs regulations but also provides a strong foundation for risk management measures to protect consumers across the European Union.

The UK's Food Standards Agency (FSA), through its risk profiling, surveillance data analysis, and engagement with industry stakeholders, addresses food safety from multiple angles. This comprehensive method enables the identification of priority areas for intervention, while also keeping a finger on the pulse of emerging food safety concerns.

Similarly, the US Food and Drug Administration (FDA) employs hazard analysis, exposure assessment, and risk characterization to uphold the safety of food products in the United States. Despite their strengths, each model must navigate challenges related to data availability, emerging risks, and the evolving nature of food systems.

Government

Governments globally have established comprehensive methodologies to assess and mitigate potential impacts associated with their infrastructure, policies, and projects. The European Union (EU), the United Kingdom (UK), and the United States (US) each offer distinct guidance documents aimed at facilitating the appraisal of policies, programs, and projects. These documents provide structured frameworks for evaluating options, costs, benefits, and risks, ultimately ensuring the effective and informed decision-making central for successful governance.

EU Model - In the European Union, the European Commission (EC) and the European Investment Bank (EIB) provide guidance on appraising policies and projects. The EC produce Better Regulation Guidelines, these guidelines offer a comprehensive framework for assessing the impact of policies and legislative proposals. The EBI produce the Project Appraisal Guidelines, these guidelines focus on the appraisal of projects seeking financing from the bank. Both guidelines encompass various aspects, including economic, financial, technical, and environmental assessments, ensuring that funded projects meet stringent criteria for sustainability and success.

Benefits: Ensures that policies and regulations are well-designed, leading to more effective and efficient outcomes. Provides a structured approach to assess impacts, facilitating informed decision-making at the EU level. Promotes consistency in evaluating the impact of policies across different sectors and areas of regulation.

Challenges: The process may become complex due to the diversity of policies and regulations within the EU framework. Adapting the guidelines to emerging or rapidly evolving policy areas could be challenging. Adapting the guidelines to a wide range of project types and sectors might be complex.

UK Model - Method of Impact Assessment: The HM Treasury and the Infrastructure and Projects Authority (IPA) provide key guidance on policy, program, and project appraisal. They produce the Green Book which provides comprehensive guidance on evaluating policies, programs, and projects. It offers tools and techniques for assessing options, costs, benefits, and risks, supporting evidence-based decision-making across government.

Benefits: Encourages evidence-based decision-making by providing tools for thorough analysis. Ensures efficient allocation of resources by evaluating benefits, costs, and risks. Promotes transparency in decision-making processes through standardized appraisal practices.

Challenges: The comprehensive nature of the Green Book might lead to challenges in its implementation across various sectors and government bodies. Some aspects of appraisal, such as assigning monetary values to non-monetary impacts, may involve subjective judgments.

US Model - Method of Impact Assessment: The Office of Management and Budget (OMB) and the Government Accountability Office (GAO) provide critical guidance for policy, program, and project appraisal. The OMB produce Circular A-11 which guides US federal agencies in preparing and submitting budget requests. The GAO produce the Cost Estimating and Assessment Guide. It aids federal agencies in refining their cost estimating practices to ensure financial transparency and accountability.

Benefits: Promotes rigorous analysis of program and policy options, leading to well-informed decisions. Holds federal agencies accountable for their evaluations and choices. Ensures consistency in evaluation practices across federal agencies. Enhances financial transparency by improving cost estimation practices. Helps mitigate the risk of cost overruns and project failures.

Challenges: Requirements may involve bureaucratic processes that slow decision-making. Conducting thorough cost-benefit analysis and evaluations is resource-intensive. Project environments are dynamic, and estimates will need frequent updates to remain accurate. Availability of accurate data for estimating costs might be a challenge for some projects.

Conclusion

While the guidance documents offer substantial benefits in terms of informed decision-making, accountability, and resource allocation, they also present challenges related to complexity, adaptation, and resource intensity. Overcoming these challenges requires continuous improvement, stakeholder collaboration, and a commitment to refining the appraisal processes to achieve better governance outcomes.

Health

Safeguarding public health has become a global imperative as countries want to ensure the well-being of their populations. The European Centre for Disease Prevention and Control (ECDC) and the World Health Organization (WHO) collaborate within the European Union, the UK's Department of Health and Social Care and Public Health England, and the US Centres for Disease Control and Prevention (CDC) each employ unique methodologies to evaluate potential health threats and bolster preparedness. Rooted in epidemiological data, risk modelling, and response planning, these models play a vital role in enhancing health security.

EU Model - Method of Impact Assessment: The European Centre for Disease Prevention and Control (ECDC) and World Health Organization (WHO) collaborate to assess and mitigate health risks in the EU. They use epidemiological data, risk modelling, and preparedness planning to evaluate potential health threats.

Benefits: Evidence-based risk assessment informs proactive public health measures. Preparedness planning enhances response capabilities during health emergencies.

Challenges: Predicting and responding to emerging health threats can be challenging due to the constantly evolving nature of diseases.

UK Model - Method of Impact Assessment: The UK's Department of Health and Social Care and Public Health England conduct risk assessments for health infrastructure. They coordinate data analysis from surveillance systems, analyse disease trends, and develop response strategies.

Benefits: Surveillance data analysis enables early detection of health risks. Evidence-based strategies support effective health risk management.

Challenges: Limited resources and accuracy of data may impact the assessment's comprehensiveness.

US Model - Method of Impact Assessment: The US Centres for Disease Control and Prevention (CDC) assess health risks and resilience. They use scenario-based exercises, coordination mechanisms, and lessons learned analysis to enhance preparedness and response.

Benefits: Scenario-based exercises simulate real-world health emergencies. Collaboration among health agencies improves response coordination.

Challenges: Ensuring coordination across diverse health agencies and addressing emerging diseases remain challenges.

Conclusion

In a world marked by the potential for health emergencies to transcend borders, protecting public health demands a collective and dynamic approach. The European Centre for Disease Prevention and Control (ECDC) and the World Health Organisation (WHO) collaborate to employ epidemiological data, risk modelling, and preparedness planning, ensuring timely evidence-based assessments of health risks and the capacity for effective response. Similarly, the UK's Department of Health and Social Care and Public Health England prioritise surveillance data analysis and evidence-based strategies to detect and manage health risks within the nation.

The US Centres for Disease Control and Prevention (CDC) leverage scenario-based exercises and coordination mechanisms to enhance preparedness and response to health emergencies. Challenges remain in coordinating efforts across diverse health agencies and addressing the ever-evolving landscape of emerging diseases.

Space

Across different regions and countries space exploration has evolved at different levels, therefore unique models have emerged to assess and manage potential impacts of space risks. The European Space Agency (ESA) in collaboration with national agencies, the UK Space Agency, and the US Space Surveillance Network and NASA each employ distinct methodologies to evaluate space-related risks and ensure the safety of space activities. These models, based of orbital debris modelling, space weather monitoring, and contingency planning, play an essential role in preserving the integrity of space infrastructure and operations.

EU Model - Method of Impact Assessment: The European Space Agency (ESA) and relevant national agencies assess and mitigate space risks in the EU. They employ orbital debris modelling, space weather monitoring, and contingency planning to safeguard space infrastructure. As a public sector intergovernmental organisation, ESA aims to prioritise environmental concerns in all its activities. Taking the first step toward this commitment involves a comprehensive analysis and understanding of the environmental impacts associated with space programs. This initiative is designed to equip ESA with the necessary expertise to play a proactive role in shaping legislation related to environmental considerations and fostering technical and scientific innovation within the European space industry. Through the project "*Environmental Impact Assessment Analysis*[6]," ESA seeks to enhance its knowledge of the environmental implications of its activities and integrate environmental aspects into the early design phases of space missions. Main methodology utilised in this project was Life Cycle Assessment.

Benefits: Space risk assessment prevents collisions and ensures satellite operations. Contingency planning enhances response to unforeseen space events.

Challenges: Unpredictable space weather events and international collaboration complexities can pose challenges.

UK Model - Method of Impact Assessment: The UK Space Agency collaborates with international partners to assess space risks. They use satellite collision avoidance strategies, space weather forecasts, and contingency planning to ensure operational safety.

Benefits: Collision avoidance measures protect satellite assets. Space weather forecasts enable timely response to potential disruptions.

Challenges: Rapid changes in the space environment require continuous monitoring and adaptation.

US Model - Method of Impact Assessment: The US Space Surveillance Network and NASA assess space risks. They track satellites, predict space weather, and coordinate with international partners to enhance space situational awareness.

Benefits: Global cooperation enhances space risk management. Satellite tracking and space weather prediction contribute to operational safety.

Challenges: Coordinating international efforts and addressing new space risks require ongoing collaboration.

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[6] Chanoine A., et all, (2017) Environmental impact assessment analysis. Technical Note D8: Executive summary Final version v2. Deloitte at: https://nebula.esa.int/sites/default/files/neb_study/1116/C4000104787ExS.pdf

Conclusion

In an era where humanity's reach extends beyond Earth's atmosphere, protecting the integrity of space infrastructure is a shared responsibility that transcends boundaries. The European Space Agency (ESA) and relevant national agencies, through their orbital debris modelling and space weather monitoring, contribute to collision avoidance and operational safety in space. Contingency planning enhances the ability to respond effectively to unforeseen space events.

The UK Space Agency leverages satellite collision avoidance strategies and space weather forecasts to ensure the operational safety of its space endeavours. Similarly, the US Space Surveillance Network and NASA, with their satellite tracking and space weather prediction efforts, enhance space situational awareness to mitigate risks.

As space environments and activities rapidly evolve, the challenge of continuous adaptation and global collaboration remains. By sharing insights, knowledge, and best practices across these models, nations can collectively enhance their capacity to navigate the complexities of space risk management. Through collaboration, innovation, and a steadfast commitment to safeguarding the space environment, these models shape a future where the wonders of space exploration are balanced with responsible stewardship, ensuring that the exploration of the cosmos remains a beacon of human achievement and collaboration.

Environmental concerns take precedence, and proactive efforts are underway to comprehend the environmental impacts associated with space projects. Deloitte proposes the utilisation of life cycle assessment, which aligns with the multicriteria approach, as one methodology to effectively evaluate the environmental impact of space projects[7].

Transport

Different regions and countries have developed unique models for assessing and managing risks in transportation, ensuring the reliability and safety of these critical networks. The European Commission and relevant agencies within the European Union, the UK's Department for Transport, and the US Department of Transportation in collaboration with local agencies each employ distinct methodologies to evaluate transportation risks and impacts and enhance the resilience of these systems. Examining traffic modelling, infrastructure vulnerability assessment, and safety analysis, these models play a key role in safeguarding transportation infrastructure and maintaining the flow of goods and people. Impact assessments in transport industry may vary depending what impacts are being assessed. The most common ones are environmental impacts where an Environmental Impact Assessment (EIA) is conducted or impacts of additional traffic on roads, public transport, cycle ways when new development such as shopping centre is proposed. Other methodologies include the Territorial Impact Assessment (TIA) or Input-Output (IPO) methodology[8].

EU Model - The European Commission (EC) and relevant agencies assess transport risks in the EU. They employ traffic modelling, infrastructure vulnerability assessment, and safety analysis to ensure transportation system resilience. From this they write regulation and directives then commission evaluations of these. The European Commission consistently advocates for the inclusion of a territorial dimension in impact assessments across various policy domains. Clear guidelines for integrating this dimension into impact assessment studies are provided by the European Commission. The TIA methodology is frequently employed within the European Spatial Planning Observation Network (ESPON) Programme, supporting policy analysis objectives, including those in the transport policy domain[9].

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[7] Ibid.

[8] Guzman-Valderrama A.F., (2013) *Modelling Impact Assessment of Transport Policies through a Multiregional Input – Output Integrated Approach.* At: Andres_Guzman_Valderrama.pdf

[9] Anastasios Magoutas, Dimitris Manolopoulos, Giannis T. Tsoulfas & Maria Koudeli. (2023) Economic impact of road transportation infrastructure projects: the case of Egnatia Odos Motorway. *European Planning Studies* 31:4, pages 780-801.

Benefits: Traffic modelling supports efficient transport planning. Infrastructure vulnerability assessment enhances risk reduction measures.

Challenges: Addressing traffic congestion and accommodating changing mobility trends can be complex.

UK Model - The UK's Department for Transport conducts transport risk assessments. They use traffic data analysis, infrastructure maintenance planning, and safety audits to ensure transportation system reliability. They commissioned guidance to be produced by the Tavistock Institute and AECOM which outlines a systematic approach to designing impact evaluations for transport interventions.

Benefits: Traffic data analysis informs congestion management. Infrastructure maintenance planning enhances reliability.

Challenges: Adapting to emerging transportation technologies and addressing urbanisation impacts require ongoing assessments.

US Model - The US Department of Transportation and local agencies assess transportation risks. They use traffic flow modelling, infrastructure condition assessment, and emergency response planning to ensure transportation system resilience.

Benefits: Traffic flow modelling supports efficient traffic management. Emergency response planning enhances resilience.

Challenges: Balancing transportation infrastructure improvements and addressing population growth can pose challenges.

Conclusion

The efficiency and resilience of transportation systems form the backbone of modern societies. The European Commission and relevant agencies, through traffic modelling and infrastructure vulnerability assessment, contribute to efficient transport planning and risk reduction. Similarly, the UK's Department for Transport leverages traffic data analysis and infrastructure maintenance planning to ensure the reliability of its transportation systems.

The US Department of Transportation, along with local agencies, employs traffic flow modelling and infrastructure condition assessment to enhance the efficiency of traffic management and infrastructure resilience. Yet, challenges persist in accommodating urbanization impacts, addressing changing mobility trends, and integrating emerging transportation technologies.

Water

Water systems play a fundamental role in sustaining life and supporting diverse human activities. Different regions and countries have developed distinct models for assessing and managing water-related risks, ensuring the availability and quality of this precious resource. The European Environment Agency (EEA) in collaboration with relevant national agencies, the UK's Environment Agency, and the US Environmental Protection Agency (EPA) each employ unique methodologies to evaluate water-related risks and bolster the resilience of water systems. Rooted in hydrological modelling, pollution monitoring, and risk communication, these models play a vital role in safeguarding water resources.

EU Model - The European Environment Agency (EEA) and relevant national agencies collaborate to assess water-related risks in the EU. They employ hydrological modelling, pollution monitoring, and emergency response planning to ensure water system resilience.

Benefits: Hydrological modelling predicts flood and drought risks. Pollution monitoring supports water quality management.

Challenges: Addressing the complex interplay of natural and human factors in water systems can be challenging.

UK Model - The UK's Environment Agency conducts assessments for water infrastructure. They utilize flood modelling, water quality analysis, and risk communication to ensure effective water resource management.

Benefits: Flood modelling helps plan for extreme weather events. Water quality analysis informs contamination risk management.

Challenges: Ensuring accurate data for modelling and addressing urbanization impacts on water systems can be complex.

US Model - The US Environmental Protection Agency (EPA) and local agencies assess water risks. They use watershed modelling, water quality monitoring, and community engagement to ensure water infrastructure resilience.

Benefits: Watershed modelling informs land-use planning. Community engagement enhances water infrastructure resilience.

Challenges: Balancing urban development and water resource protection presents challenges.

Conclusion

The health of ecosystems and the well-being of societies are intrinsically linked to water resources, ensuring the sustainability of these systems is a shared responsibility. The European Environment Agency (EEA) and relevant national agencies, through hydrological modelling and pollution monitoring, contribute to predicting and managing flood and drought risks, as well as ensuring water quality. Similarly, the UK's Environment Agency employs flood modelling and water quality analysis to safeguard water infrastructure and resources, addressing the complex challenges posed by urbanization and contamination.

The US Environmental Protection Agency (EPA), in coordination with local agencies, leverages watershed modelling, water quality monitoring, and community engagement to ensure water infrastructure resilience and resource management. While each model demonstrates its strengths, the complexity of natural and human factors in water systems remains a challenge.

6.2 Data Protection Impact Assessment (DPIA)

A Data Protection Impact Assessment (DPIA) is mandated by the GDPR (within the EU) whenever initiating a new project with a potential "high risk" to individuals' personal information. The GDPR, comprising numerous regulations, necessitates organisations to adhere to stringent rules for safeguarding personal data, with penalties for non-compliance reaching substantial fines. To demonstrate GDPR compliance, organisations must prepare a DPIA for each high-risk data processing activity.

Article 35 of the GDPR introduces the requirement for DPIA's, aligning with the "protection by design" principle. The law specifies that if a type of processing, particularly involving new technologies and considering the nature, scope, context, and purposes, is likely to pose a high risk to the rights and freedoms of individuals, the controller must conduct a DPIA before the processing. While the law lacks specific details, examples of conditions necessitating a DPIA include the use of new technologies, tracking people's location or behaviour, large-scale systematic monitoring of publicly accessible places, processing sensitive personal data, making significant automated decisions about individuals, processing children's data, and potential physical harm resulting from data leaks. Even in cases where the high-risk standard is not met, it may be advisable to conduct a DPIA for minimising liability and ensuring robust data security and privacy practices in the organisation, as most data breaches trigger regulatory requirements.

In the UK, the Information Commissioner's Office (ICO) developed DPIA template to provide additional guidance to entities starting any major project that involves use of personal data[10]. Presented process comprises of 7 steps and integrates impact and risk assessment. The process involves:

Step 1: Identify the need for a DPIA
Step 2: Describe the nature, scope and context of processing
Step 3: Consultation process (stakeholder engagement)
Step 4: Assess necessity and proportionality
Step 5: Identify and assess risks
Step 6: Identify measures to reduce risk
Step 7: Sign off and record outcomes

Benefits: Users are given access to a template and guidance material to facilitate the undertaking of IA. The process is user-friendly, offering clarity through a set of explicit questions that require responses.

Challenges: Qualitative in nature which may lead to challenges related to subjectivity, lack of precision, difficulty in comparison between different projects or difficulty in data interpretation.

Conclusion

This approach serves as a prime example of qualitative impact assessment, with each step presenting a set of questions and providing space for qualitative descriptions. The general format of this model adheres to the most common steps typically encompassed in the IA process, such as the identification of context, scope, and objectives, as well as stakeholder identification and engagement. Moreover, it functions as a paradigm for the seamless integration of impact and risk assessments. This methodology not only guarantees compliance with data protection regulations but also enriches the overall comprehension and management of potential risks linked to substantial data processing initiatives.

6.3 Environmental Impact Assessment (EIA)

EIA is a systematic process used to evaluate the potential environmental effects or impacts of proposed projects, policies, programs, or developments before they are carried out. The main purpose of an EIA is to identify and assess the potential positive and negative environmental consequences of a project, with the goal of informing decision-makers and stakeholders and ensuring that these impacts are properly considered in the decision-making process[11].

The EU's Environmental Impact Assessment (EIA) Directive (2011/92/EU, amended by 2014/52/EU) requires thorough assessments of major construction or development projects across the EU to gauge their environmental impact before commencing. This includes projects like nuclear power stations, railways, roads, waste disposal, and dams. Other projects, such as urban or industrial developments, are subject to case-by-case EIA decisions by EU Member States or specific criteria.

EIA evaluates direct and indirect significant environmental impacts across various factors like population health, biodiversity, land, water, air, and cultural heritage. Project developers must submit comprehensive reports outlining project details, potential effects, alternatives, and measures to counter significant impacts. Strict protocols ensure public awareness and participation in the process, enabling challenges through the legal system.

[10] ICO, Sample DPIA template, at: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fico.org.uk%2Fmedia%2Ffor-organisations%2Fdocuments%2F2553993%2Fdpia-template.docx&wdOrigin=BROWSELINK
[11] COMMISSION STAFF WORKING PAPER IMPACT ASSESSMENT, at: EUR-Lex - 52012SC0355 - EN - EUR-Lex (europa.eu)

The overarching objective of EIA is to ensure transparency and environmental protection throughout the decision-making process for public and private projects. It emphasises the consideration of environmental concerns from project inception, engaging the public actively.

The EIA process typically involves the following key steps:

Screening: Determine whether a proposed project or activity requires a formal EIA based on predetermined criteria. Not all projects necessitate a comprehensive EIA; smaller projects might require a simpler process known as an Initial Environmental Examination (IEE).
Scoping: Define the scope and boundaries of the assessment. Identify the potential impacts that need to be studied and the environmental factors that will be considered. This step involves consultation with relevant stakeholders.
Baseline Data Collection: Gather information about the current environmental conditions in the area where the project will take place. This involves assessing air quality, water quality, soil conditions, biodiversity, social conditions, cultural resources, and more.
Impact Prediction: Identify the potential impacts of the project on the environment based on the collected baseline data and the project's characteristics. Both direct and indirect impacts are considered.
Impact Assessment: Assess the significance of the predicted impacts. This involves comparing the predicted impacts to established environmental standards, regulations, or guidelines.
Mitigation and Impact Management: Develop measures and strategies to mitigate or minimise the identified negative impacts. These could include changes to project design, operational practices, or compensation measures.
Environmental Management Plan: Outline a plan for managing and monitoring the project's environmental impacts during and after its implementation. This ensures that the necessary mitigation measures are put into practice.
Public Consultation: Engage with the public, local communities, and relevant stakeholders to gather input and address concerns regarding the proposed project's environmental impacts.
Review and Decision-Making: Submit the EIA report to regulatory authorities for review. Based on the assessment, the authorities will decide whether to approve, reject, or modify the project. Public feedback and consultation outcomes may influence this decision.

Benefits: By integrating environmental factors into the decision-making process from the outset, projects achieve heightened environmental sustainability. This proactive approach helps avert, alleviate, or offset negative impacts on the environmental elements.

Challenges: Inadequate screening procedures, frequent deficiencies in the quality and depth of EIA analyses, often overly descriptive with limited pertinent data. Additionally, the assessment of alternatives and process consistency among Member States display inconsistencies.[12]

Conclusion

EIA is a critical tool for sustainable development, as it helps prevent or mitigate adverse environmental impacts while promoting responsible economic growth. It ensures that projects are carried out in a way that respects ecological balance, protects natural resources, and takes into account the concerns of local communities and stakeholders. The specific regulations, guidelines, and procedures for conducting an EIA may vary from country to country, but the fundamental goal remains consistent – to ensure that environmental considerations are an integral part of decision-making processes. Part of this approach is Multi Criteria Analysis which allows assessing the impact in quantitative way providing the guidance for the best option.

[12] COMMISSION STAFF WORKING PAPER IMPACT ASSESSMENT, 3.3.2. Problems related to the insufficient quality and analysis of the EIA.

6.4 Regulatory Impact Assessment (RIA) in Aviation

Regulatory Impact Assessment (RIA) is a structured and systematic process used by governments and regulatory bodies to evaluate the potential effects and consequences of proposed regulations or policy changes before they are implemented. The goal of RIA is to make informed decisions by assessing the benefits, costs, and potential risks associated with new regulations. It involves gathering and analysing relevant data, consulting stakeholders, and considering both the intended and unintended impacts of regulatory actions. RIA helps ensure that regulations are well-designed, effective, and proportionate, ultimately leading to better policy outcomes and a more balanced regulatory environment. Examples of this may include developed by EASA Regulatory Impact Assessment, UK CAA Impact Assessment undertaken in the field of Aviation Security.

EASA RIA

EASA has developed a RIA process that is a structured approach used to evaluate the potential impacts of proposed regulatory changes in the aviation sector. It involves systematically analysing the consequences of new regulations on various aspects such as safety, operations, economics, and society as a whole. The process aims to ensure that regulatory decisions are well-informed, balanced, and considerate of their broader effects.

The Regulatory Impact Assessment serves as a decision-making aid. Its purpose is to identify the optimal approach for achieving the objective of a rulemaking endeavour while mitigating possible adverse effects. It involves a sequence of five systematic stages that provide a structured framework for analysis.

Problem Identification: The specific issue or challenge that the regulatory change aims to address is defined. This involves clarifying the scope of the problem and understanding its implications for the aviation sector.
Objective Definition: The Agency's overarching aims are specified in Article 2 of Regulation (EC) No 216/2008. This proposal aligns with those aims by addressing concerns detailed in Section 2. The proposal's distinct objective is to tackle the identified issues and their underlying causes.
Option Development: Various regulatory options are explored to address the identified problem. The potential impacts of each option are evaluated to determine which one provides the most favourable balance of benefits and costs. Whenever feasible, alternatives that do not involve creating new rules should be explored.
Impact Analysis: This is the core of the process. Different potential impacts are thoroughly assessed, such as economic effects, safety improvements, administrative burdens, and societal consequences. Quantitative and qualitative methods may be used to analyse these impacts.
Option comparison: At this stage the options are compared, and a final assessment is made stating the main reasons for choosing the preferred option recommended.

Methodology and data requirements, applicable particularly to a comprehensive RIA, play an important role in evaluating the effects of potential regulatory changes. If a full RIA is undertaken, the methodology used (such as Stakeholder Relationship Management (SRM), Cost - Benefit Analysis, or Multi Criteria Analysis) must be expounded upon, including the rationale behind estimations and underlying assumptions. It is essential to identify the data sources utilised and explain their relevance. Data requirements encompass necessary information, whether publicly accessible or collected through specific methods. The ensuing impact analysis entails a thorough evaluation of the repercussions associated with each considered option across various sectors within the civil aviation community. These sectors include manufacturers, operators, maintenance, crew, organisations, training institutions, consumers, aircraft owners, etc. If certain groups will be differentially affected, such as small businesses or specific regional entities, this discrepancy should be acknowledged for further evaluation. Pertinent sectors affected directly by the proposed measures should be considered.

Within this analysis, safety impacts are paramount. All potential safety ramifications linked to the options should be recognised and, when feasible, quantified. This involves identifying hazards and categorising risks by considering the likelihood of occurrence and the severity of consequences. If safety implications are negligible, this should be explicitly stated. Similarly, social impacts, whether advantageous or adverse, need to be identified. These encompass aspects like employment, working conditions, personnel mobility, and health.

Additionally, full RIA process beside impact on safety includes analysis of social impacts, economic impacts, environmental impacts, proportionality issues, impact on regulatory coordination and harmonisation.

Benefits:

The EASA RIA process aims to enhance the quality of regulations by considering their broader effects on the aviation sector and society. It promotes transparency, stakeholder involvement, and evidence-based decision-making, ultimately leading to more effective and balanced regulations.
It is a European framework that will be well known to regulators and NAAs responsible for development and amending national regulations, and as such would constitute a suitable basis for the IA approach in this research study.

Challenges:

Complexity of the assessment and multitude of inputs required.

Conclusion

This methodology is complex, and impact assessed is much wider than required when measuring the impact of security measures on safety. The elements of the framework could be used; however, this requires more in-depth analysis of IA and methodologies that allow for RIA completion including SRM, Cost - Benefit Analysis, or Multi Criteria Analysis also known as Multi Criteria Decision Making (MCDM).

Aviation Security Regulation – ICAO

The ICAO Security Manual, Doc 8973, offers guidance on operational and economic IA in the security domain. This encompasses a template designed for decision-making bodies, facilitating a desktop assessment.

ICAO guidance material is designed to equip states with the necessary tools for assessing the operational and economic impacts of introducing new or modified security measures into their aviation systems. An impact assessment involves evaluating both positive and negative effects on existing aviation systems and relevant stakeholders, encompassing aspects such as aircraft and airport operations, passenger and cargo security, safety, and facilitation. States are advised to conduct impact assessments whenever new or modified security measures are being designed, preferably before implementation, to identify effects on daily operations, costs, staff performance, and desired outcomes. The assessments should be proportionate to the nature of the evaluation. While comprehensive impact assessments considering changes over time are ideal, a more concise assessment may be suitable in cases requiring rapid action against urgent threats. In extreme urgency, states may choose to implement urgent security measures first before a formal impact assessment. Additionally, states should consider conducting impact assessments when reducing security measures.

Integral components of this approach include stakeholder engagement and consultation, as well as comprehending the relationship between impact and risk assessment. While risk assessment is viewed as an essential initial step in decision-making for the implementation or modification of security measures, impact assessment functions as a complementary tool, enriching the comprehensive understanding of risks.

Regarding a specific methodology, ICAO offers guidance on essential steps and recommends following a transparent approach, providing suitable guidance. However, it does not insist on a particular methodology, granting States the flexibility to choose the approach they deem most appropriate. It is acknowledged that measuring impact may pose challenges, given that the nature of collected data is often qualitative rather than quantitative.

Benefits:

Establishing a transparent impact assessment approach and involving stakeholders actively contributes to a more sustainable global security system. This approach ensures a balance between security and facilitation, allowing the security system to be better equipped for risk-based and outcome-focused security measures. This approach thoroughly takes into account a range of factors, covering international communication and cooperation, cost, operations, facilitation, technology, and health and safety.

Challenges:

While this approach takes into account the impact on aviation safety concerning procedures, operations, and coordination with safety authorities, it does not offer a specific explanation or definition of how the assessment of safety impact would be conducted.

Conclusion

This approach constitutes a valuable tool for States, particularly when introducing new security measures or modifying existing ones. However, it is essential to acknowledge that, inherently, the assessment leans towards the security domain rather than safety. It serves as a valuable initial reference point that states that impact on safety should be part of the assessment. It does not provide specific and structured methodology to assess this specific impact.

Aviation Security Regulation – UK

Impact assessment in the Aviation Security space in the UK are used where requested by the Appropriate Authority to provide additional information for a policy change, and specifically they are often used to assess financial impact. Where used, they will generally be separate and in addition to a risk assessment. Not all policy changes will have a separate impact assessment – with minor changes this can be built into the risk assessment. Separate impact assessments generally are used where a lot of impact data requires analysis, there is a significant economic impact, or a number of options are to be compared.
This summary focuses on the elements of the impact assessment, whether as a standalone document or integrated into a wider risk assessment.

The areas for consideration in an impact assessment are listed below. These should be methodically worked through and completed. Where a section is not used, it should be made clear why it does not apply.
The impact assessment should be undertaken at the same time or after a risk assessment to ensure the residual risk information is available.

Introduction/setting out the problem requiring change: This section clearly set out the introduction to the change considered and the problem that is addresses. In some cases, an impact assessment may look at the impact of not making a change.

Policy objectives and intended outcomes: This section should set out what the intended policy change is trying to achieve.

Alternatives to regulation/intervention considered: This section looks at the alternatives considered – including other ways to regulate/non-regulatory options such as guidance. This section should also look at the option of 'doing nothing'.

Context: Any relevant context should be added here – the outcomes of the risk assessment, regulatory criteria etc., anything that could be relevant is to the impact assessment.

Links to other relevant documents/part – e.g., for data this would be annexes, or a reference to the separate risk assessment where applicable: References to other relevant documentation should be included, or where possible they should be added as an Annex. Whether this can be done may depend on the length and format of the information as well as their security classification.

Economic (financial) assessment: This section should set out the direct cost impact of the change and ideally, primary data should have been collected from stakeholders to complete this section. It should set out the economic impact over a minimum of 5 years and looks at one off cost as well a recurrent costs.

Non monetised cost assessment (resource and time): This section should look at non-monetised costs such as time and resource – that could be aspects such as the time it takes to integrate the new requirements or additional time spent by staff undertaken an existing or new task.

Cost and benefit analysis: A comparison should be undertaken to review the benefits of the change against the cost, based on the information set out in the wider impact assessment.

Overarching impact for UK/state – international regulations/reputational etc.: There may be impacts that are not on domestic stakeholders directly but on the wider UK/state. These could include alignment/compliance to international standards, reputational impact etc. and these should also be included.

Generally, any primary data/evidence used would be attached in annexes to allow the data which fed the impact assessment to be available for review.

Benefits:

It provides an in-depth opportunity to review the impact and can serve as a record e.g., if years later an assessment is requested on the actual impact, the original IA can be used for comparison purposes.

It provides an assessment of the impact based on evidence and therefore should reflect the actual impact as close as possible.

It can generate stakeholder buy in to the policy change.

The process may uncover additional aspects to consider that would otherwise have been more difficult to identify.

Although the full process is time intensive, for urgent changes the basics can be undertaken very quickly.

Challenges:

It is time consuming to draft and can run into significant length which can make briefing senior management difficult and often requires an executive summary.

For it to be the most effective, it requires primary evidence from stakeholders, and this brings with it several challenges: ensuring evidence is representative; time consumption of this stage; backlash/concern by stakeholders based on drafting stage of regulation, rather than fully considered approach.

Stakeholder input requires there to be a relationship to be in place between Regulator/NAA and industry stakeholders that supports this type of approach, and this may therefore not be available to all states.

The process is not completely objective or without unconscious bias – mistakes are possible.

Conclusion

UK CAA model follows the principles of regulatory impact assessment for government policies (the template of which is attached in Annex B).

Adapting this methodology to assess the impact of security measures on safety seems possible, although not all areas may be as applicable in the same way. Using the combined method with an element of risk included would provide a better overall picture.

6.5 Impact Assessment in Cyber Security

Impact assessment plays a fundamental role in the cybersecurity domain by helping organisations understand the potential consequences of cyber incidents, breaches, or security measures. It involves evaluating the potential effects of various cybersecurity scenarios on an organisation's information systems, data, operations, reputation, and overall security posture. Impact assessment helps identify and prioritise potential risks in the cybersecurity landscape. It involves analysing the potential impact of different cyber threats, vulnerabilities, and attacks on critical assets and operations. By assessing the potential consequences, organisations can prioritise their efforts and resources to address the most critical risks. In this context, impact assessment serves as a foundational element within a comprehensive risk assessment and risk management framework. However, the primary focus of this assessment is not merely the influence of the cyber security system on other interconnected systems, but rather the pivotal concern lies in evaluating the potential consequences of a cyber breach itself. The National Institute of Standards and Technology (NIST) defines security impact analysis as "*the analysis conducted by an organisational official to determine the extent to which changes to the information system have affected the security state of the system*[13]*"*.

NIST 800-37 Rev 2 is a publication by NIST that provides guidelines and recommendations for the Risk Management Framework (RMF) for information systems and organisations. The purpose of the publication is to assist organisations in effectively managing risks to their information systems. It outlines a structured and systematic approach to managing security risks associated with the operation and use of information systems.

NIST 800-37 Rv. 2 provides a seven-step process for implementing the RMF, and have been defined by NIST as:

Prepare: The purpose of this step is to carry out essential activities at the organisation, mission and business process, and information system levels of the organisation to help prepare the organisation to manage its security and privacy risks using the Risk Management Framework.

Categorise: The purpose of this step is to inform organisational risk management processes and tasks by determining the adverse impact to organisational operations and assets, individuals, other organisations, and the broader community with respect to the loss of confidentiality, integrity, and availability of organisational systems and the information processed, stored, and transmitted by those systems.

Select: The purpose of this step is to select, tailor, and document the controls necessary to protect the information system and organization commensurate with risk to organisational operations and assets, individuals, other organisations, and the Nation.

Implement: The purpose of this step is to implement the controls in the security and privacy plans for the system and for the organisation and to document in a baseline configuration, the specific details of the control implementation.

Assess: The purpose of this step is to determine if the controls selected for implementation are implemented correctly, operating as intended, and producing the desired outcome with respect to meeting the security and privacy requirements for the system and the organisation.

Authorise: The purpose of this step is to provide organisational accountability by requiring a senior management official to determine if the security and privacy risk (including supply chain risk) to organisational operations and assets, individuals, other organisations, or the Nation based on the operation of a system or the use of common controls, is acceptable.

Monitor: The purpose of this step is to maintain an ongoing situational awareness about the security and privacy posture of the information system and the organisation in support of risk management decisions.

[13] NIST SP800-128

Benefits and potential challenges: NIST 800-37 Rev 2 provide a structured approach to identifying, assessing, and managing the risks associated with an organisations' information systems. It is designed to enable informed decision making related to the implementation of security measures (controls) and helps with the ongoing protection information systems. This framework integrates impact assessment and risk assessment and emphasises continuous monitoring as a part of its risk management approach. This involves ongoing assessment of risks and impacts, allowing organisations to adapt and respond to changing circumstances.

However, the framework is complex, especially for those with limited resources when it comes to cyber risk management expertise. Implementation of such a framework may require significant time, effort and financial investment.

Conclusion

NIST 800-37 is a complex framework and specific to information systems, therefore it could be challenging to adapt it to measure the security impact on safety, without compromising the intent of the framework. However, there are number of risk assessment methodologies in cyber security that could possibly be tailored to meet this requirement, for example, ISO27001:2022.

But in its simplest form, a cyber risk assessment methodology centres around the following key steps:

Establish the scope: Identify the scope of the risk assessment (i.e., the assets to be protected)
Identify the risks: potential risks to the confidentiality, integrity, and availability of assets. This includes both internal and external risks, such as unauthorised access (physical or logical) data breaches, natural disasters, or human errors.
Analyse the risk: Assess the risk in terms of impact and probability. This analysis helps prioritise risks based in their significance and their treatment plans.
Evaluate the risk: Analyse the risk against the tolerance levels (risk appetite) to determine which risks are acceptable and which require treatment.
Treat risks: Assign treatment plans to the risks that sit outside the risk's appetite. This may include among others, the implementation of controls, transferring the risk (through insurance), or accepting the residual risk.
Monitor and review: Ongoing monitoring of risks and treatment plans to evaluate the effectiveness and to identify and new risks or changes in the risk landscape.

This framework prioritises comprehensive risk management, seamlessly incorporating impact assessment into its processes. The integration of impact assessment and risk assessment in this domain shall be further investigated in task 4 of this research project.

6.6 Impact Assessment in Aircraft Design

Design Aspects

During the initial design phase and development of an aircraft and its systems, there is a requirement to conduct an analysis in accordance with CS XX.1309 to ensure that no catastrophic failures can occur from a single occurrence, and incidents that occur from multiple failures are extremely improbable (occurrence rate of less than 1 in 1,000,000,000 flying hours (1 in 10^{-9})). The analysed failures are classed as Catastrophic, Hazardous, Major, Minor and No Safety Effect, each with an increasing permitted probability of occurrence. Associated with this any software embedded in a system must be assured to a Design Assurance Level from A to E. Where A is commensurate with a Catastrophic failure, B is Hazardous and so on.

Any security breaches should not therefore be permitted to be a single point in causing Catastrophic or Hazardous failure conditions. In assessing the security aspects, the system architecture will therefore need to be designed accordingly.

An example of this would be where an aircraft has two digital networks that are interconnected. An aircraft network which has control functions and a passenger network connecting to the internet via Satcom antennas installed on the fuselage of the aircraft. In this scenario the aircraft network should be protected from the passenger network via combinations of firewalls and partitioned software parts (e.g., Level A and Level D or E).

To enable the certification of these relatively new network systems the JAA/EASA and FAA introduced Special Conditions to address these aspects. A special condition is basically an additional set of requirements published by the authority to address new and novel issues where the existing Certification Specifications (e.g., CS 25) did not adequately address these potential aspects.

Moving forward EASA has amended CS 25 at Amendment 25 to introduce a new requirement CS25.1319 which addresses Equipment, systems, and network information protection.

This requirement states: *"(a) Aeroplane equipment, systems, and networks, considered separately and in relation to other systems, must be protected from intentional unauthorised electronic interactions (IUEIs) that may result in adverse effects on the safety of the aeroplane. Protection must be ensured by showing that the security risks have been identified, assessed, and mitigated as necessary.*
(b) When required by paragraph (a), the applicant must make procedures and Instructions for Continued Airworthiness (ICA) available that ensure that the security protections of the aeroplane's equipment, systems and networks are maintained."

As a result of the of assessing security issues and requirements the complexity of the systems architecture may increase.

Operational Aspects

As a result of the system architecture and protections introduced, these may affect the operational data such as

- Aircraft Flight Manual (AFM)
- The OEMS Master Minimum Equipment List (MMEL)
- The Operators Minimum Equipment List (MEL)
- Flight Crew Training Data
- Maintenance Certifying Staff Data

The amendments to these, where applicable will have a positive effect for the ongoing operations with respect to security matters. The MMEL from design perspective and MEL from an Ops/AW perspective should be reviewed to ensure that there are no items that can be allowed to be inoperative that could compromise aircraft security.

Maintenance Aspects

The requirements of CS25.1529, 1729 and now 1319 require instructions for continued airworthiness to be produced to ensure the systems, wiring and protections are maintained to the certified standard. These instructions include:

- Scheduled Tasks
- Wiring Diagrams, and Wiring Practices
- Equipment Removal Instructions
- Installation Instructions
- Software and Database Loading Instructions (if applicable)

- Troubleshooting Instructions
- Test instructions
- Electrical Load Information

These will have a positive effect on the aircraft system security.

It has been identified that there is an interdependency between Safety and Security, and this is applicable to many areas including aircraft design. To address specific security concerns, certification requirements have already been amended to include additional requirements (Reference Part 21 - 21.A.91 and GM 21.A.91).
The main purpose of introducing a security measure is to prevent intentional unauthorised electronic interactions (IUEIs), and as such, at strategic level the impact of those measures remains positive.

Security measures may have a direct impact on the aircraft design (initial design or later modifications) and, may introduce additional safety risks that may contribute to the development of unsafe conditions (negative impact). However, it is also identified that security measures and related requirements may also contribute to the achievement of safety objectives (positive impact).

The Certification Specifications (CS) require a level of safety to be established for equipment, systems, and installations (CS 25 Subpart F – equipment). For Large Aeroplanes, CS25 is applicable and is used for certification of new products and for modifications to existing products.

- CS 25.1301 covers Function and Installation.
- CS 25.1302 covers Installed systems and equipment for use by the flight crew.
- CS 25.1309 covers equipment, systems, and installations.
- Other requirements may be addressed by other CSs depending on the nature of the installation.
- CS 25.1309 is applicable to any equipment or systems installed in the aeroplane.

Appendix 1 of CS 25.1309 provides several methods for assessing causes, severity and probability of failure conditions and are used to support experienced engineering and operational judgment.
This approach of assessment provides key safety elements of the equipment / systems under review.
A similar approach could also be used to identify key security elements of the equipment / systems, which would allow for a comparison of the safety / security aspects and the interdependencies.

To understand the impact of a security measure on the aircraft design there is a need to understand what the key safety and security elements of the equipment / system are affected. Based on a CS. XX1309 assessment process it would be possible to identify both Safety and Security elements. Areas to be considered as part of the assessment could be Safety Targets / Failure Rates, Installation features, Reliability, Operability and Maintainability.

The review could include the following key elements of the design which could impact on safety:

Installation – Design Review
- Complexity
- Salient design features related to safety

Reliability
- Failure Rates (Based on XX.1309 assessment)
- Software Design Assurance Level(s) - DALs

Operability
- Operational Suitability Data (OSD)
- Master Minimum Equipment List (MMEL)
- Aircraft Flight Manual (AFM)
- Human Machine Interface (HMI), Human Factors (HF), etc.

Maintainability
- Aircraft Maintenance Manual (AMM)

- Component Maintenance Manual (CMM), Human Factors (HF)
- Electrical wiring interconnection system (EWIS)
- Critical Design Configuration Control Limitation (CDCCL) etc.

Any other key aspects identified based on Design Review

- Accessible Data buses
- Wi-Fi connectivity

Each of the areas of assessment would be used to identify a positive or negative change indicator. Example of the review process to identify the positive or negative impacts of the security requirements on the safety aspects of the aircraft design is provided in the table below.

Indicator	Security vs Safety Negative, Positive, No Change	Potential Impact of Security change on Safety levels
Installation – Design Review		
• Complexity	Negative Impact (Medium)	Increased complexity
• Salient Features of the design related to safety	No Change	
Reliability		
• Failure Rates	Negative Impact (Small)	Increase in failure rates
• Software Design Assurance Level(s) - DALs		
Operability		
• OSD (Operational Suitability Data)	Positive Impact	Additional training
• MMEL (Master Minimum Equipment List) • CDL (Configuration Deviation List)	Positive impact	
• AFM (Aircraft Flight Manual)	Positive impact	
• Human Machine Interface (HMI)	Negative Impact (Large)	Additional displays
Human Factors (HF)	No Change	
Maintainability		
• Aircraft Maintenance Manual, Component Maintenance Manual	Negative Impact (Medium)	Increased rate of inspection (AMM)
• Human Factors (HF)	No Change	
• Electrical Wiring Interconnection System (EWIS)	No Change	
• Critical Design Configuration Control Limitation (CDCCL)	No Change	
Any other key aspects identified based on Design Review	Not Applicable	N/A
• Accessible Data buses • Wi-Fi connectivity	Not Applicable	N/A

Table 1. Example of safety - security impact assessment (aircraft design)

A negative impact may need to be further categorised as either being Large, Medium, or Small. Definitions of Large, Medium, or Small for a "Negative Impact" would need to be provided for each of the assessment areas.

The assessment would provide an indication as to whether the security measure is having a positive or negative affect at system / installation.

If security aspects of the design are identified as having a negative impact in several areas, then those would be reviewed to understand the relationship between the safety classification of the system / installation and the impact of addressing the security aspects.

Benefits and potential challenges:

The benefits from this type of CS XX.1309 assessment is that it provides a standardised approach that is already used in the aircraft design and is well understood by industry and the regulator.

The safety - security assessment will provide a means of identifying key elements of the design that are impacted and to what extent. This could then be used to determine whether the improved security is justified based on any potential changes to the safety levels.

Using the key elements (suggestions provided in Table 1) a level of assessment can be made of the overall affect the security elements of the design has had on the safety elements of the design.

This approach can be developed for both complex and for lower complexity systems and installations.

The challenges will be to review and produce the information on the affected system / installation to be able to populate the assessment table. This will require comprehensive assessment of the system / installation and identifying all the applicable elements that need to be considered. This will also require some subjective analysis to determine the extent (i.e., Large, Medium, or Small) to which the security change is impacting on the system / installation.

Conclusion

The Safety / Security assessment process as proposed in Table 1 will provide an indication as to where the Security change(s) is impacting on the key design elements of the System / Installation and how significant this will be with respect any potential negative effects on the overall safety requirements.

This will also need to consider the requirement for the systems and equipment to be protected from security risk, which requires the system to meet a certain Security Assurance Level (SAL) and as defined in CS XX.1309.

The implementation of a Security design change may impact on the overall Safety Objectives (both Positive and Negative) of the System / Installation. However, the Safety Objectives for the System must be maintained to an acceptable level to meet the CS XX.1309 requirements.

6.7 Impact Assessment in Military Aviation

The exploration of Impact Assessment within military aviation reveals that the fundamental nature of risk and impact differs markedly from the civil aviation context. Risk tolerance and acceptance experience significant shifts between wartime and peacetime scenarios, thereby altering the very essence of conducted impact assessments. The choice of integrating military security protective measures (such as chaff and flare dispensers against missile threats or armoured seats against light calibre bullets) is primarily driven by two factors: cost and aircraft performance. During wartime, there is no target level of safety due to the high security risk, making peacetime safety objectives less relevant. The main goal is to achieve performance objectives within a budget.

Conversely, in peacetime, military aircraft must approach safety levels as close to civil equivalents as possible in terms of performance and weight. Examples of security measures for military aircraft include:

- Armoured plates, seats
- Ejection seats
- Chaff and flare dispensers
- RADAR
- Crashworthy seats
- Cable cutters
- Automatic ground collision avoidance systems
- Survival equipment

The military features integrated for security reasons must adhere to the target level of safety during peacetime. These equipment pieces are regarded as standard aircraft components.

This methodology aligns security measures with peacetime safety objectives. The benefit is the seamless integration of security equipment. The challenge is the added costs to certify high safety standards.

Impact Assessment methods of military systems (systems, system of systems and organisations including logistics)

Defence organisations must consistently evaluate, in collaboration with the armed forces' leadership, the suitability of military systems in specific strategic and tactical scenarios. This continuous assessment can be viewed as an impact assessment approach operating within an ever-evolving context of threats.

That impact assessment can be divided in 2 categories:

- The assessment of the current systems in a current strategic context (known threats)
- The assessment of current system in a near future strategic context (new estimated threats)

The assessment of the impact of a military system in a current environment is performed:

- In reality during trainings or major exercises. The outcomes of each exercise are analysed in depth in order to evaluate the readiness and the effectiveness of the system.
- In a simulated environment and when possible, realistic war exercises.

The assessment of the impact of a military system in a future strategic context is done by simulation.

Benefits and potential challenges:

Exercises are costly and require available assets and the participation of a number of personnel. It is not compatible with a civil continuous activity. Simulations are cost-effective but require realistic data for meaningful conclusions.

Conclusion

In conclusion, integrating security measures into military aircraft considers factors like cost and performance. Peacetime and wartime safety objectives differ. For impact assessment, methodologies vary based on context, involving real exercises and simulations. Adaptation for civil aviation impact assessment would need tailored approaches.

6.8 Summary

Various industries employ a range of methodologies to assess impact, with the chosen approach heavily dependent on the specific nature of the impact under examination. There is no one-size-fits-all methodology, as methods are typically customised to meet the unique requirements of a particular project or sector. Government-led strategies, such as regulatory impact assessment, represent standardised approaches that extend beyond aviation and are utilised in various sectors.

Certain sectors, such as the military or emergency services, depend on live exercises and scenario-based assessments, which are deemed unsuitable for this research. Meanwhile, other sectors, like civil nuclear or the chemical industry, employ different approaches depending on what impact is being measured. Multi-criteria assessment or life-cycle assessment are amongst common methods.

Assessments seldom rely solely on a singular defined methodology; instead, prevailing approaches often integrate both qualitative and quantitative assessments. Quantitative assessments are less common when there is an abundance of qualitative information to analyse. Moreover, reducing qualitative information to a single numerical value may oversimplify the complexity of the problem and establish a rigid framework that fails to account for the diversity of inputs.

Usually, the impact assessment process follows a structured framework with specific steps. It's not unusual to permit the use of various methodologies within specific framework to accommodate the unique context and characteristics of the impact being evaluated. For example, regulatory impact assessment defines necessary steps, however it allows to employ the most suitable methodology to be utilised. Stakeholder engagement is often a key aspect of the assessment, alongside the collection and analysis of qualitative data and development of criteria and indicators. Assigning numerical values to qualitative information is more straightforward in certain contexts, such as environmental assessments, where data is presented numerically. However, this task becomes more challenging when the data doesn't readily translate into numerical values.

Impact assessments may intertwine stakeholder management with cost-benefit analysis. In situations where decisions need to be made and the optimal choice must be selected based on provided information, multi-criteria decision-making (multi-criteria analysis) emerges as a common tool. The forthcoming chapter details the most frequently utilised methodologies that offer valuable insights into assessing the impact of security measures on safety.

7. Impact Assessment Methodologies

While the preceding chapter provided a comprehensive overview of impact assessment across various sectors, the focus of this chapter is to investigate specific methodologies commonly employed in impact assessment. The objective is to explore these methodologies, identify common steps for effective Impact Assessment, examine approaches to quantify qualitative information, and ascertain whether any existing methodologies are suitable for evaluating the impact of security measures on safety. Additionally, the chapter aims to evaluate whether creating a new, specific methodology based on identified best practices is the optimal solution and endeavors to recommend the necessary steps for development. This process aims to facilitate an informed decision-making process in tailoring a methodology for assessing the impact of security measures on safety.

At this stage, the team is exclusively exploring impact assessment methods, distinct from risk assessment and management methods, which will be the subject of independent investigation in task 4 of this research project. As highlighted in chapter 6 of this document, impact assessment and risk management are often closely linked, mutually reinforcing concepts. While impact assessment may be necessary to identify hazards and risks for suitable assessment and mitigation, there are cases where impact assessment is integrated into the risk assessment process. The approach varies depending on the context and sector.

This specific task aims to identify the methodology for assessing security measures' impact on safety and determining whether the impact is positive, neutral, or negative. The actual assessment with the use of developed methodology will be conducted in task 2.3 of this research, and the integration of the developed methodology into the broader context of risk management will be addressed in task 4.

7.1 Stakeholder Relationship Management (SRM)

Stakeholder Relationship Management (SRM) is a systematic approach used to evaluate the effects of stakeholder interactions and relationships on an organisation's goals, operations, and outcomes. This methodology focuses on understanding the impact that various stakeholders, such as customers, employees, partners, regulators, and the public, have on an organisation, as well as how the organisation's actions affect these stakeholders. While commonly applied in various sectors, notably in project management, its relevance also extends to the aviation industry.

The key components of the SRM include:

Stakeholder Identification: This step involves identifying and categorising the different stakeholders who are directly or indirectly impacted by the organisation's activities. It is important to have a comprehensive understanding of who these stakeholders are and their potential influence on the organisation.

Stakeholder Analysis: Once stakeholders are identified, a deeper analysis is conducted to understand their needs, expectations, interests, and concerns. This helps in determining the potential positive and negative impacts they could have on the organisation's decisions and operations.

Impact Assessment: This is the core of the methodology. It involves evaluating the potential impacts that stakeholder relationships can have on the organisation's strategies, projects, processes, and reputation. These impacts can be both quantitative (e.g., financial effects, changes in market share) and qualitative (e.g., brand perception, employee morale).

Risk Assessment: Assess the risks associated with stakeholder relationships. This includes identifying potential conflicts, misunderstandings, or resistance that could hinder the organisation's objectives.

Mitigation and Enhancement Strategies: Based on the impact and risk assessment, strategies are developed to manage and enhance stakeholder relationships. These strategies could involve improving communication, addressing concerns, aligning goals, and creating win-win situations.

Implementation and Monitoring: Once strategies are defined, they are implemented, and their effects are monitored over time. Regularly evaluating the impact of these strategies helps in adjusting them as needed and maintaining positive stakeholder relationships.

Engagement Plans: Develop plans for engaging with stakeholders effectively. These plans outline how the organization will communicate, involve, and collaborate with stakeholders throughout various projects and initiatives.

Continuous Improvement: SRM IAM is an iterative process. Regularly reviewing and updating the methodology ensures that it remains aligned with the changing needs and expectations of stakeholders and the organization itself.

The main goal of SRM is to foster positive stakeholder relationships that contribute to the organisation's success while minimising negative impacts. It emphasises a proactive approach to managing stakeholder interactions and aims to create a harmonious and mutually beneficial environment for all parties involved.

In the aviation industry, stakeholders play a pivotal role, particularly within the realms of safety and security. Stakeholders include industry stakeholders but also government officials, national security services, police and more. These two domains are inherently interconnected, yet breaking down the silos that often separate them demands effective collaboration among all stakeholders engaged in aviation activities. As identified in Task 1.1 and 1.2 of this research, security measures have impact on safety areas, furthermore there are a number of job roles that hold safety and security functions. The successful navigation of this intricate relationship requires the wholehearted cooperation of all entities involved. This encompasses a broad spectrum of stakeholders, including regulatory bodies, airport authorities, air carriers and operators, aircraft manufacturers, air traffic control, security agencies, maintenance organisations, and those operating outside airport's perimeter. By identifying and involving all relevant stakeholders, a comprehensive understanding of how security measures reverberate through the safety domain can be established, ensuring a holistic approach that safeguards the industry's integrity and the well-being of all its constituents.

To successfully measure the impact of security measures on safety, the impact of given measure on all relevant stakeholders has to be identified. It is recommended that proposed methodology include identification of stakeholders, predominantly those operating within safety areas identified in Task 1.1.

7.2 Cost – Benefit Analysis (CBA)

Cost-Benefit Analysis (CBA) in aviation is a systematic method used to evaluate the potential advantages and disadvantages of a proposed aviation project, regulation, policy, or investment. It involves assessing the anticipated costs associated with implementing a certain initiative against the expected benefits it would generate. The primary goal of CBA is to provide decision-makers with quantitative insights into whether a particular aviation project is economically justified and whether its benefits outweigh the costs incurred.
In the aviation context, CBA considers a wide range of factors, including financial costs such as infrastructure development, equipment acquisition, operational expenses, and training. On the benefits side, it takes into account various aspects such as increased operational efficiency, enhanced safety, improved passenger experience, environmental impacts, revenue generation, and potential savings in the long run. By assigning monetary values to these costs and benefits, decision-makers can make informed judgments about whether the proposed aviation endeavour is worth pursuing.

For instance, when evaluating the introduction of new technology, like advanced avionics systems or more fuel-efficient engines, CBA would involve calculating the expenses associated with implementation, training, and maintenance, and then contrasting these costs with the projected fuel savings, reduced emissions, and improved performance.

CBA provides a structured framework to ensure that aviation investments align with overall organisational goals and regulatory requirements. However, it is important to note that assigning accurate monetary values to certain qualitative factors, like passenger satisfaction or improved safety, can be challenging. Despite this complexity, CBA remains an essential tool in aviation decision-making, helping to optimise resource allocation, prioritise projects, and guide policies that enhance the industry's overall efficiency, safety, and sustainability.

In the context of a comprehensive EASA Regulatory Impact Assessment (RIA), Cost-Benefit Analysis (CBA) can be incorporated, accompanied by a clear explanation of the reasons behind estimations and the underlying assumptions. It is important to pinpoint the sources of data utilised and explain their relevance.

CBA is also utilised as an element of UK CAA Regulatory Impact Assessment for Aviation Security which should be undertaken at the same time or after a risk assessment to ensure the residual risk information is available.

7.3 Multi Criteria Analysis (MCA) / Multi Criteria Decision Making (MCDM)

Multi-Criteria Decision Making (MCDM) is a decision-making technique used to evaluate various options or alternatives based on multiple criteria or factors. It provides a structured approach for comparing choices in situations where there are multiple dimensions to consider. MCDM involves developing of assessment criteria, assigning weights to different criteria based on their importance and then scoring each option against these criteria. The scores are combined to generate an overall value for each option, aiding in the identification of the most favourable alternative. MCDM is particularly valuable when dealing with complex decisions that involve conflicting objectives or varying stakeholder perspectives. It promotes transparency by providing a systematic way to assess and prioritise options while taking into account the diverse range of factors that impact the decision-making process[14].

MCA and MCDM are often used interchangeably, however MCA is the broader umbrella term that encompasses the entire process of analysing multiple criteria, while MCDM specifically emphasises the decision-making aspect within this broader framework. MCA is a broader term that encompasses various techniques and methods used to assess and analyse multiple criteria when evaluating alternatives or making decisions. It involves considering multiple criteria or factors, assigning weights to them based on their importance, and then systematically evaluating and comparing alternatives based on these criteria. MCA does not necessarily prescribe a specific decision-making method but rather refers to the overall process of analysing multiple criteria, whilst MCDM is a specific subset of MCA that refers to the process of making decisions in the presence of multiple criteria.

This methodology is commonly applied when selecting the best option when different criteria must be considered and is widely used in different sectors. Different scoring and weighting methodologies are applied depending on the nature of the problem.

The purpose of Task 1.3 of this project is not to choose between different security measures but to analyse the extent of the impact of security measures on safety. This methodology would not therefore be suitable in its entirety however it provides useful tool to assess the impact, without choosing the most appropriate option.

Essential elements in this analysis are:

Formulating the problem and develop understanding of the decision context. To effectively apply MCA, it's essential to have a clear understanding of the overarching objectives guiding the decision. To define these objectives and criteria, it's necessary to identify both the decision-makers (for establishing objectives) and individuals who may be impacted by the decision.

Determining the options to be assessed involves compiling a list of all potential alternatives for evaluation. Given that MCA is a decision-making tool designed to identify the optimal choice, this phase entails identifying and listing all viable options that will undergo the evaluation process.

Identifying criteria and sub-criteria is the next essential step of MCA. This is also referred to as identification of categories and criteria for each category. The criteria and sub-criteria serve as the performance measures for assessing the options. A significant portion of the value added by a formal MCA process comes from the establishment of a well-founded set of criteria against which the options are to be evaluated. When formulating appropriate criteria, the initial step involves an understanding of the stated problem followed by responses to the following question: "*What would distinguish between a good choice and a bad one in this decision*

[14] Department for Communities and Local Government: London (2009), Multi-criteria analysis: a manual, Communities and Local Government at: [Multi-criteria_Analysis.pdf (lse.ac.uk)]

problem?[15]" Grouping criteria into sets can be beneficial, especially when they pertain to distinct components of the overall objective. This approach proves particularly advantageous when the decision structure involves a relatively substantial number of criteria, typically eight or more.

Assessing performance levels to each criterion is the next step of MCA process. This may be done with or without scoring and weighting. This assessment without scoring and weighting may include assessment against performance matrix and may be based on either qualitative information (descriptions) or quantitative values (price, numerical values, numerical scales, for example 1 to 100). Scoring involves assigning numerical values to each alternative for every criterion being assessed. These values represent the performance or achievement of each alternative in relation to a specific criterion. The scoring process requires a systematic assessment or measurement for each alternative against each criterion. Weighting is the process of assigning relative importance or priority to each criterion in the decision-making process. Since not all criteria are of equal importance, weighting allows decision-makers to emphasise certain criteria over others based on their significance in achieving the overall objectives. Typically, weights are expressed as percentages or ratios, and their sum equals 100%. The higher the weight assigned to a criterion, the more influence it has on the final decision. After scoring each alternative for each criterion, the scores are multiplied by the corresponding weights assigned to the criteria. This results in a weighted score for each alternative for each criterion. The weighted scores are then summed across all criteria to obtain a total score for each alternative. This final total score reflects the overall performance of each alternative, considering both the scores achieved on individual criteria and the relative importance of those criteria.

For example, in EIA, Multi Criteria Analysis is typically used with different scoring methodologies implemented under MCA. Ron Janessen in *On the Use of Multi-Criteria Analysis in Environmental Impact Assessment in The Netherlands*[16] provides an overview of different methodologies used in the Netherlands to conduct EIA. The mentioned overview describes that frequently a combination of quantitative and qualitative scores are applied. Qualitative scores typically use a plus-and-minus (---/+++) scale, which often represents an underlying classification of quantitative scores. This scale doesn't function as a true ordinal scale because the plus and minus signs reflect impact size rather than order. Analysed studies include a legend explaining the meaning of plus and minus scores, with most studies linking these to quantitative ranges or providing verbal descriptions. However, in some cases, the usage of the (---/+++) scale is less precise, potentially causing readers to expect "+++" always represents the best score and thus undervalue "++" on a (0/++) scale. The most common method to analyse the impact is weighted summation, which represents one of the easiest to apply scoring methodology.

In summary, MCA offers a clear and structured process for impact assessment, with many of the outlined steps being valuable for evaluating the impact of security measures on safety. However, the study's objective is to gain insights into the specific impact of security measures on safety, identifying both positive and negative impact. Importantly, the research team is not tasked with making decisions based on optimal performance or determining the appropriateness of specific security measures. Consequently, this methodology may not be the most suitable in its entirety but may be adapted to suit specific needs of this project. Specific steps that are part of this methodology are easily adaptable to the requirements of this project.

7.4 Input – Process – Output (IPO) and Change Management

Impact assessment is widely used across different domains. OECD defines impact assessment as a process aimed "*to understand to what extent and how a policy intervention corrects the problem it was intended to address. Impact assessment focuses on the effects of the intervention, whereas evaluation is likely to cover a wider range of issues such as the appropriateness of the intervention design, the cost and efficiency of the*

[15] Janssen R., (2001), On the Use of Multi-Criteria Analysis in Environmental Impact Assessment in The Netherlands, JOURNALOFMULTI-CRITERIADECISIONANALYSIS J.Multi-Crit.Decis.Anal.10:101–109
[16] Ibid

intervention, its unintended effects and how to use the experience from this intervention to improve the design of future interventions[17]."

In this context "intervention" could be understood as "change" and "policy intervention" as a "regulatory change". As such it will fall into the merits of "change management" process. This process is widely recognised in aviation domain and described in ICAO Safety Management Manual Doc 9859.

Doc 9859 defines change management as "*A formal process to manage changes within an organisation in a systematic manner, so that changes which may impact identified hazards and risk mitigation strategies are accounted for, before the implementation of such changes*."

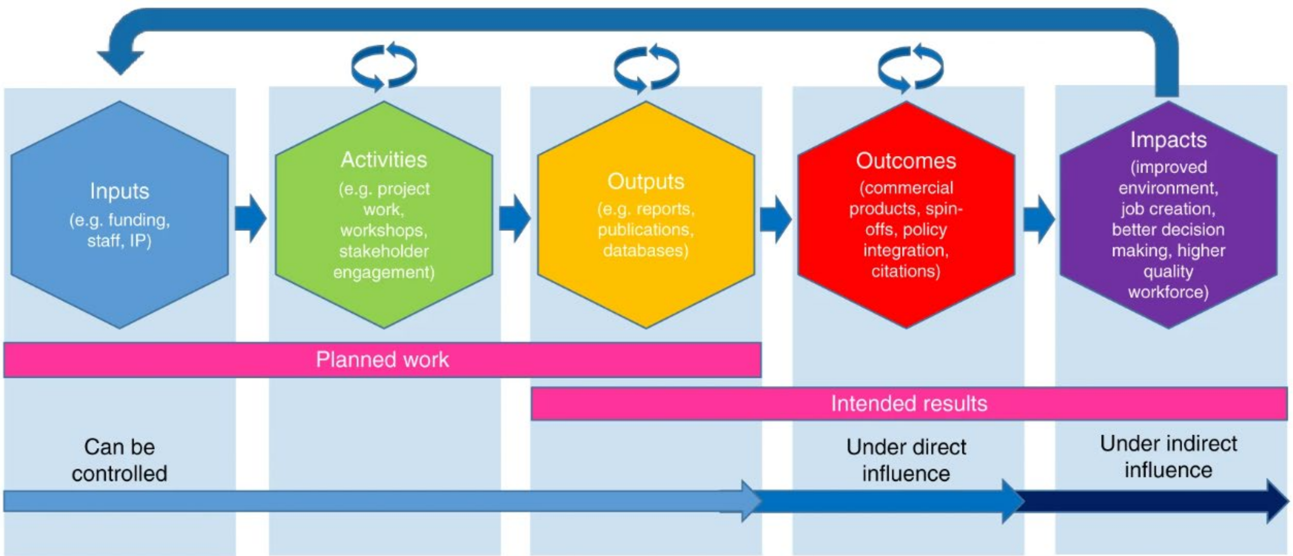
Change management is widely described, and different models have been identified. A project can be defined as "a unique set of coordinated activities, with definite starting and finishing points, undertaken by an individual or organisation to meet specific objectives within defined schedule, cost and performance parameters". A. Lester in his book *Project Management, Planning and Control* states "*Project management is essentially management of change*[18]*".*

Introduction of new or altered security measures, as well as removing security measures will constitute such a change and in this sense, it will be a project that needs to be managed.

Projects are evaluated depending on their success. In the article "Implementation of Input-Process-Output Model for Measuring Information System Project Success"[19] different perspectives of success of the project have been described.

The above-mentioned study developed an alternative model of the project success measurement based on input-process-output (IPO) model.

IPO model is illustrated below:



[17] OECD, [What-is-impact-assessment-OECDImpact.pdf]

[18] Lester A., (2014) Project Management, Planning and Control

[19] A'ang Subiyakto, Abd. Rahman Ahlan, *Indonesian Journal of Electrical Engineering*, Vol.12, No.7, July 2014, pp. 5603 - 5612

Figure 3 The Research Impact Pathway[20]

In the context of security measures all these elements could be defined as follows:

Input - security resources, security regulation
Activities – implementation of security measures based on identified resources and regulations
Output – immediate results of the implementation
Outcomes – security benefits of the outputs
Impact – effect these above have on safety

Closer look into last stages of this process is central for deliberations in the context of this project. Moving from Outcomes into Impact stage shifts the optic which now becomes less security and more or entirely safety centric. Therefore, certain level of situational awareness related to this process is necessary at the beginning to establish basic level of alignment. This step is explained here in the context of this particular methodology.
Aiming at identification of the impact of security measures on safety the safety component is placed in the centre of the process.

Security condition (e.g., new or modified measures) will constitute from this moment an input or change trigger as described in the ICAO Safety Management Manual section 9.5.5 Management of Change (SMM, Doc 9859). List of factors resulting in the change is indicative and for example letter e) of 9.5.5.1 - "*external regulatory changes, economic changes and emerging risks* ", encompasses security conditions.
Understanding of this, is foundational for considerations to the input-process-output (IPO) model presented. The diagram below illustrates how IPO and Change Management model could be used to structure relationship between security and safety risk assessment.

It must be noted that this wider context of risk assessment and management will be further explored in task 4 of this research project.

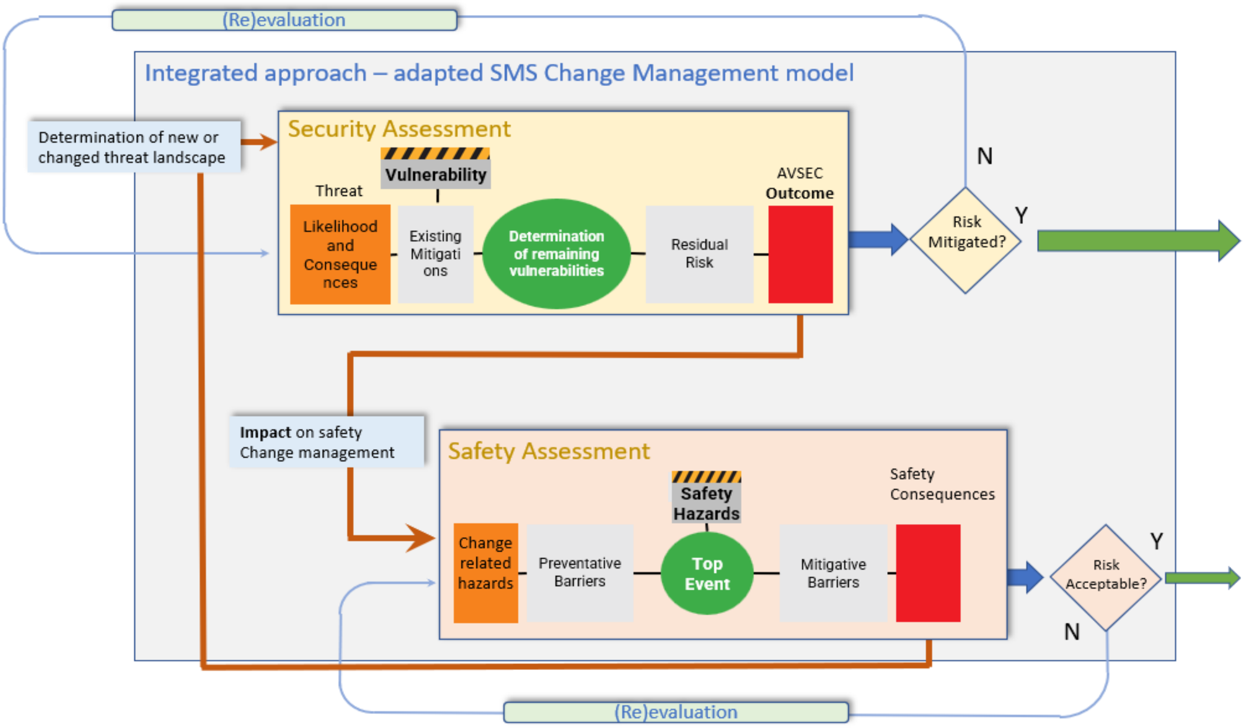


Figure 4 - Integrated approach model to security and safety assessment

[20] Fryirs, K.A., Brierley, G.J. & Dixon, T. *Engaging with research impact assessment for an environmental science case study. Nat Commun* **10**, 4542 (2019). https://doi.org/10.1038/s41467-019-12020-z

Once the desire to evaluate impact is established, and as a next step the change management process should allow to identify concrete safety areas/domains/topics affected by security measure concerned. ICAO SMM states in this context "*In addition, new hazards and related safety risks may be inadvertently introduced into an operation when change occurs. Hazards should be identified and related safety risks assessed and controlled*"[21].

Identification of impacted areas would typically be assigned to safety subject-matter experts and based on their experience intertwined with exchanges with security counterparts. The discussion should be exploratory in nature and avoid biased visions and opinions.

As a reference, or a starting point to this discussion, conclusions of Task 1.1 listing areas of interdependencies could be used. Equally, consideration can be made to the safety Key Risk Areas according to European Risk Classification Scheme (ERCS) (Regulation (EU) 2020/2034) which should be kept in mind as a reference.
These areas include:

- Airborne collision - a collision between aircraft while both aircraft are airborne; or between aircraft and other airborne objects (excluding birds and wildlife),
- Aircraft upset - an undesired aircraft state characterised by unintentional divergences from parameters normally experienced during operations, which might ultimately lead to an uncontrolled impact with terrain,
- Collision on runway - a collision between an aircraft and another object (other aircraft, vehicles, etc.) or person that occurs on a runway of an aerodrome or other predesignated landing area. It does not include collisions with birds or wildlife,
- Excursion - an occurrence when an aircraft leaves the runway or movement area of an aerodrome or landing surface of any other predesignated landing area, without getting airborne. It includes high-impact vertical landings for rotorcraft or vertical take-off and landing aircraft and balloons or airships,
- Fire, smoke and pressurisation - an occurrence involving cases of fire, smoke, fumes or pressurisation situations that may become incompatible with human life. This includes occurrences involving fire, smoke or fumes affecting any part of an aircraft, in flight or on the ground, which is not the result of impact or malicious acts,
- Ground damage - damage to aircraft induced by operation of aircraft on ground on any other ground area than a runway or predesignated landing area, as well as damage during maintenance,
- Obstacle collision in flight - collision between an airborne aircraft and obstacles rising from the surface of the earth. Obstacles include tall buildings, trees, power cables, telegraph wires and antennae as well as tethered objects,
- Terrain collision - an occurrence where an airborne aircraft collides with terrain, without indication that the flight crew was unable to control the aircraft. It includes instances when the flight crew is affected by visual illusions or degraded visual environment,
- Other injuries - an occurrence where fatal or non-fatal injuries have been inflicted, which cannot be attributed to any other key risk area.

The measurement of the impact comes with certain challenges, depending on the approach. The change management process guidance as suggested by ICAO refers to Action Plan. The guidance in section 9.5.5.7 states to *"develop an action plan; this should define what is to be done, by whom and by when. There should be a clear plan describing how the change will be implemented and who will be responsible for which actions, and the sequencing and scheduling of each task".* Action Plans are without the doubt very good and structured way to handle changes individually. It's however difficult to aggregate different action plans into data sets.

[21] Section 9.5.5.2, ICAO Doc 9859 Safety Management Manual, 2017, 4th Edition

In the attempt to measure the impact (prior to development of individual Action Plans) we identified the Pre-Post Analysis described below which could be used.

		Likert scale				
		1	2	3	4	5
Safety Domain	Catastrophic	X				
	Hazardous	X	X			
	Major		X			
	Minor			X	X	X

Table 2. Example of IPO Pre-Post analysis application

The Pre-Post Analysis methodology is used to evaluate the impact of an intervention by comparing the outcomes before and after the intervention.

The process flow for the Pre-Post Analysis could look as follows:

Define the problem or desired outcome: Clearly articulate the problem trying to be address or the outcome to be achieved. This could be done through a problem statement, needs assessment, or another research.
Identify the target population: Identify the group of individuals or communities that the intervention will target.
Define the outcome measures: Identify the outcomes that is intended to be measured. These could be behavioural, attitudinal, or situational changes that one hopes to achieve.
Collect baseline data, if applicable: Collect data on the outcome measures before the intervention. This will provide a baseline against which to compare the post-intervention data.
Implement the intervention: Description of the situation after the measure was implemented.
Collect post-intervention data: Collect data on the outcome measures after the intervention has been implemented.
Analyse the data: Compare the baseline data with the post-intervention data to determine if there has been a change in the outcome measures.
Interpret the results: Interpret the results of the analysis and determine if the intervention had an impact on the outcome measures.
Draw conclusions and make recommendations: Based on the results of the analysis, draw conclusions about the impact of the intervention and make recommendations for future interventions or improvements.

Translating the impact to a scale is yet another challenge. Typically for such type of measurements tools like Likert scale (e.g., 1-5) are used. Over here the lower the assessment is on the scale the more negative impact has been identified (e.g., 1-Strongly Negative, 2- Negative, 3- Neutral, 4-Positive, 5-Strongly Positive). The scale could be reduced to 3-step or expanded to 7 step scale if needed and noting the impact on granularity of analysis.

In safety domain meanwhile the impact measured as an effect on safety could be:

- Catastrophic
- Hazardous
- Major
- Minor

With the first two leading to an accident, and the third to an incident. What is interesting to note as a difference, is that safety domain does not foresee positive impact. It is understandable given the origins of the impact (failures, hazards) it attempts to measure.

Merging the two approaches produces this table below:

Likert scale						
		1	2	3	4	5
Safety Domain	Catastrophic	X				
	Hazardous	X	X			
	Major		X			
	Minor			X	X	X

Table 3. Example 2 of IPO Pre-Post analysis application

Benefits: IPO methodology is a structured approach and as such comes with certain advantages:

- Helps to clarify and understand different components of a process
- Categorisation of elements into inputs, processes and outputs facilitates comprehension of these and their interactions
- Increased optimisation of efforts
- Can help to mitigate unintended consequences
- Methodological approach that is supported by documentation

Challenges: The largest potential challenges related to IPO process would include:

- Potential oversimplification
- Inadequate representation
- Lack of Context

In the context of security measures, the largest challenge is related to the collection of exact baseline data (for "old" measures or "proactively" implemented measures) and/or post-intervention data. In the absence of sufficient data for quantitative approach an attempt to describe what the pre-situation was (including the rationale for the introduction of a new policy/measure) and/or what the post-situation will be, could be undertaken using qualitative approach.

The example of application of IPO within the change management process.

Step	**Description**
Define the problem or desired outcome	Detection of Dangerous Goods (DG) in Hold Baggage after the introduction of Hold Baggage Screening EDS in automatic mode.
Identify the target population	Screeners (responsible for detection of prohibited items), Airlines (responsible for prevention of DG transport).
Define the outcome measures	(Security) – increase in IED detection, reducing the workload on screeners.
Collect baseline data	Quantitative approach – given cooperations of airports or security providers could: analysis of hold baggage throughput dependant on number of screening personnel (as the desired outcome measure is also reducing workload of screeners). Qualitative description (based for example on structured interviews) of the state where DG detection could have been potentially "better" as all images were reviewed by screeners with the previous method of conventional x-ray.
Implement the intervention	Description of the situation after the implementation. (Security) – automation helps in detection and facilitates utilisation of resources.

	(Safety) – As not all images are reviewed by screener (some are only analysed by the machine in the automatic mode), some DG may not be detected if the x-ray machine is not configured to alarm on them.
Collect post-intervention data	Qualitative description, as it is difficult to have data about DGs that have not been detected (unless there was a DG related incident/accident).
Analyse the data	Same as above
Interpret the results	Measure impact again Key Risk Area "Fire, smoke and pressurisation" (meaning potential accidents related to DGs) and based on 1-5 scale intertwined with safety domain scale.
Draw conclusions and make recommendations	Formulate recommendations to feed the decision making within the change management process.

Table 4. The example of application of IPO within the change management process

7.5 Summary

Impact assessment is a versatile tool employed across various environments to evaluate the potential effects of certain actions, policies, or projects. A number of methodologies can be tailored to the specific characteristics and requirements of each environment, providing valuable insights for decision-making, risk management, and sustainable development.

Certain methodologies outlined in the document exhibit a closer alignment between impact assessment and risk assessment. The intricate aspects of integrated risk assessment and management will be explored more extensively in Task 4 of this research study. It becomes evident that several common elements are shared among diverse approaches and methodologies, which include:

- Scope and problem identification
- Identification of affected stakeholders
- Data collection and analysis
- Development of criteria or indicators to assess the impact
- Identification of proposed solutions and the selection of the best option

In the context of this research and the objectives of this task, these frameworks have a broader scope than merely assessing the impact of one domain on another. Both qualitative and quantitative analyses are often combined to comprehensively evaluate the impact and in general terms methodologies include between 5 to 7 steps to evaluate the impact. Some of the proposed methodologies rely heavily on engaging stakeholders.

In conclusion, the purpose of this task is to develop an easy-to-use tool that will enable both regulators and entities to assess the impact of security measures on safety. The amalgamation of various methodologies will provide a necessary framework for evaluating the impact of security measures on safety. Specifically, Stakeholder Relationship Management, Multi-Criteria Analysis and Input – Process – Output methodologies can achieve positive results. The elements of such impact assessment may include essential initial steps:

- Problem identification (security measure to be assessed or introduced)
- Identification which aviation stakeholders will be affected – this will correspond with identified areas of safety – security interdependency (Task 1.1)
- Identification which job roles within safety – security interdependency will be affected by this security measure (Task 1.2)
- Establishment of criteria to rate the impact – impact indicators
- Selection of applicable indicators and description of rationale by stakeholders or SME's
- Assessment of the outcome and follow-up action leading to either acceptance or reconsideration of given security measure.

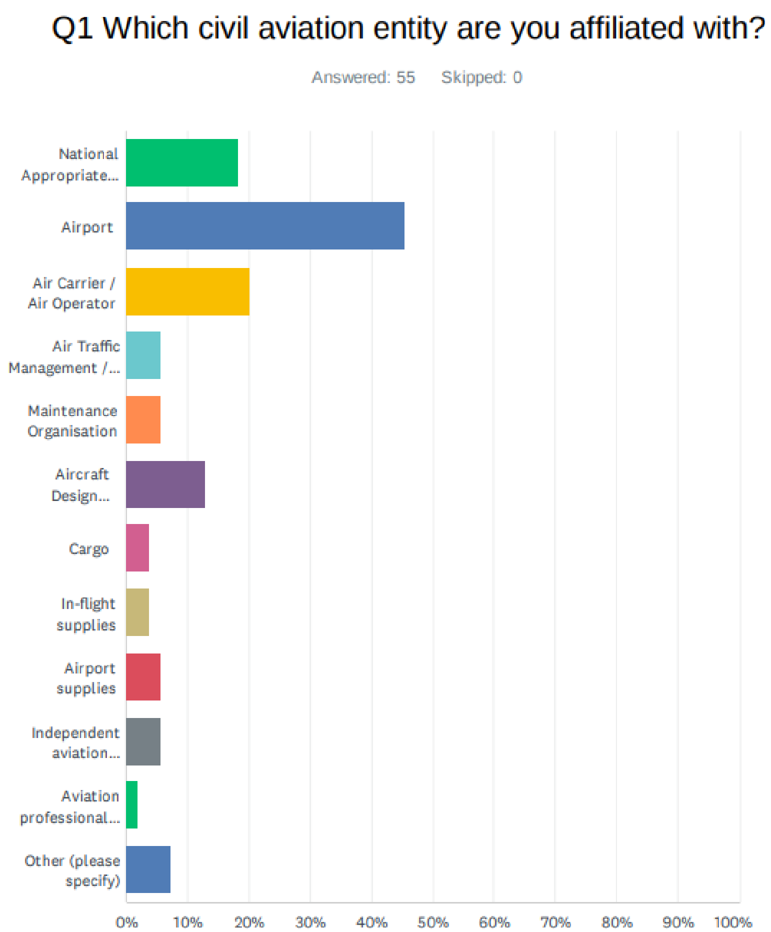
8. Assessing impact of security measures on safety – stakeholder engagement

8.1 Stakeholder survey

To ensure the completeness of this research and verify what actions are being currently undertaken in the industry and regulatory bodies to measure the impact of security measures on safety, a survey was issued to the aviation stakeholders. The aim of this survey was to engage with those who are dealing with the safety-security interdependency on a daily basis and to investigate if the impact of security measures on safety is currently being undertaken. In other words, is the impact of security measures being currently analysed as part of security impact assessment and risk management. Additionally, if impact of security measures on safety is considered and undertaken, this survey aimed to identify what methodologies are currently implemented by entities.

Attendees of the Introduction Webinar held on July 5, 2023, were surveyed to establish an initial understanding of the current methodologies employed in assessing the impact of security measures on safety. Among the 150 stakeholders contacted, 55 provided responses to the survey.

First question aimed to identify which aviation entities the respondents are affiliated with. Out of 55 respondents 25 represented Airport Operators, 10 represented NAA's, and 7 Aircraft Design organisations. More specific picture of the respondents can be seen in the following charts.

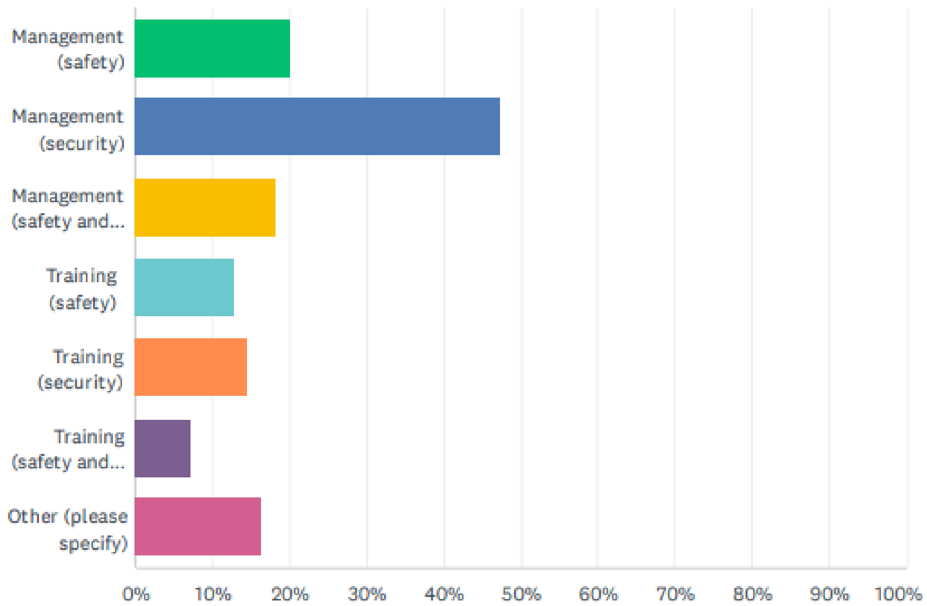


ANSWER CHOICES	RESPONSES	
National Appropriate Authority (NAA) / Civil Aviation Authority	18.18%	10
Airport	45.45%	25
Air Carrier / Air Operator	20.00%	11
Air Traffic Management / Air Traffic Services	5.45%	3
Maintenance Organisation	5.45%	3
Aircraft Design Organisation	12.73%	7
Cargo	3.64%	2
In-flight supplies	3.64%	2
Airport supplies	5.45%	3
Independent aviation training organisation	5.45%	3
Aviation professional association	1.82%	1
Other (please specify)	7.27%	4
Total Respondents: 55		

The second question sought to determine whether stakeholders were affiliated with the safety or security domain. Approximately 18% of respondents indicated that they oversee both safety and security, while 47% were associated solely with the security environment, and 20% exclusively with safety. Drawing a conclusion from these findings, it is evident that a significant portion of participants holds roles that intersect both safety and security domains, underscoring the interconnected nature of these aspects within the surveyed group.

Q2 To which specific area does your role and responsibility relate to?

Answered: 55 Skipped: 0



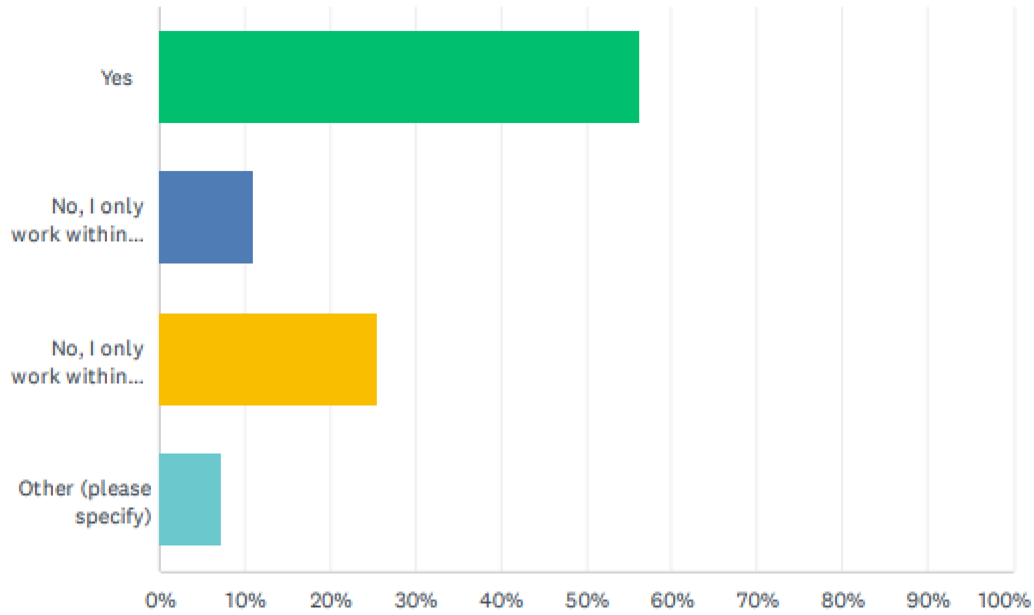
ANSWER CHOICES	RESPONSES	
Management (safety)	20.00%	11
Management (security)	47.27%	26
Management (safety and security)	18.18%	10
Training (safety)	12.73%	7
Training (security)	14.55%	8
Training (safety and security)	7.27%	4
Other (please specify)	16.36%	9
Total Respondents: 55		

Diverse roles within the surveyed group encompassed strategic and policy-making positions, project management, compliance monitoring, ground operations, air traffic management, maintenance and engineering, cargo and supplies, aviation professional organisations, operations, and the design of flight control systems, including roles in cybersecurity.

The investigation sought to determine the extent to which roles within the surveyed group require expertise in both aviation safety and security regulations or procedures. The findings suggest a notable prevalence of positions where an understanding of aviation safety and security is deemed essential. This underscores the significance of integrating knowledge from both domains within diverse professional capacities in the aviation sector.

Q3 Does your role require knowledge of both safety and security regulations or procedures?

Answered: 55   Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	56.36%	31
No, I only work within safety domain	10.91%	6
No, I only work within security domain	25.45%	14
Other (please specify)	7.27%	4
TOTAL		55

A supplementary overarching query was included to validate the interdependencies between safety and security. This open-ended question aimed to corroborate the insights outlined in the Task 1.1 report, that was focused on regulatory interdependencies. Notably, four out of 55 respondents opted not to respond to this particular inquiry.

Q4 What most common safety and security interdependencies you observe in your area of work?

Answered: 51 Skipped: 4

The survey feedback underscores the intricate relationship between safety and security measures in aviation, underscoring their shared objective of safeguarding air passenger well-being and averting potential harm. Various aspects of this intersection were highlighted by respondents, revealing a complex landscape where both safety and security considerations are paramount.

The management of unruly passengers emerged as a focal point, emphasising the need to identify and address potential disruptions before and during flights. This aligns with the overarching goal of ensuring a secure and disturbance-free air travel experience.

The identification and management of dangerous goods, especially lithium batteries, showcased the delicate balance required to mitigate safety risks while addressing potential security threats associated with certain items.

The measures surrounding unmanned aircraft systems (UAS) incidents provided a noteworthy example of the dual nature of safety and security considerations. Mandatory registration, remote identification, and criminal sanctions illustrate a collaborative approach to managing the evolving landscape of aviation risks posed by UAS.

Conflicts arising in tasks like aircraft protection and cabin baggage management highlight the challenges of balancing safety missions with access protection responsibilities.
The shortage of experienced ground handling staff post-COVID emerged as a shared concern impacting both safety and security operations, emphasising the need for strategic personnel management and training.

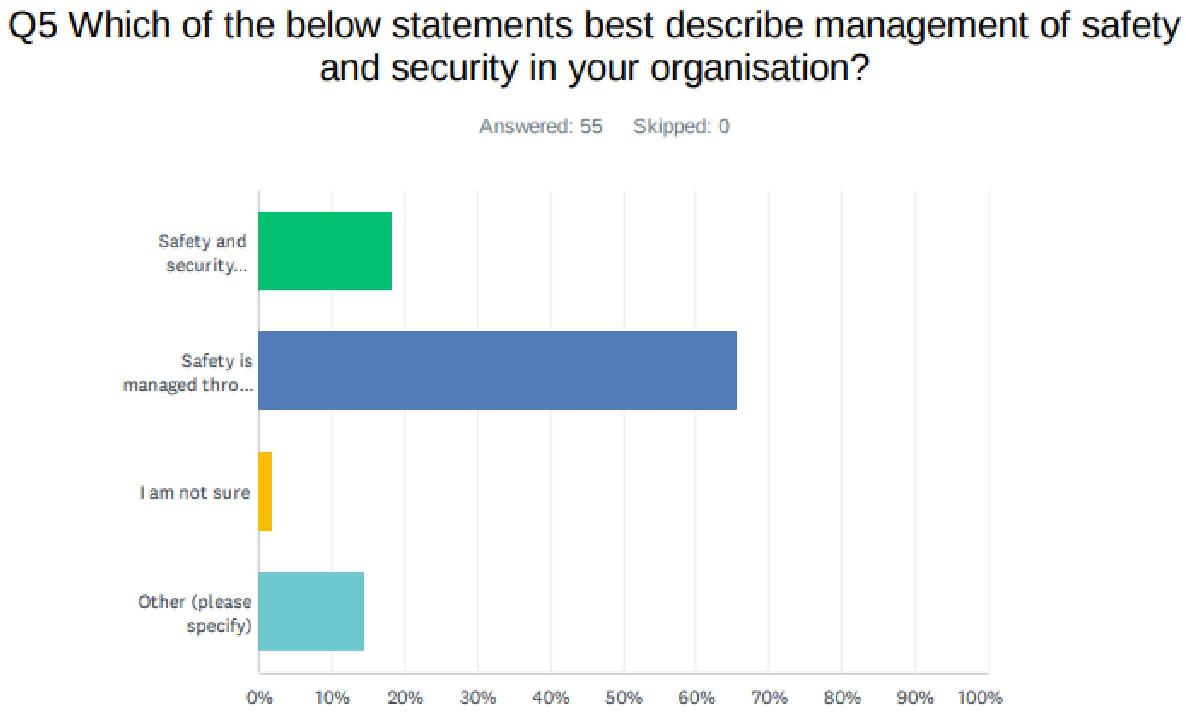
Respondents also provided insights into the positive benefits of both safety and security approaches. Security measures, despite potential limitations, were acknowledged as fundamental pillars for safety. For instance, security checkpoints were recognised for allowing only reliable and trained workers into operational areas, contributing to overall safety.

Further feedback delved into specific areas of expertise and challenges. The use of software packages for design, production, and maintenance organisations highlighted the integral role of technology in both safety and security domains. The intersection of safety and security requirements in a network of diverse actors with different certification standards underscored the need for a harmonised approach to address specific project needs.

Challenges in cross risks, cyber-attack prevention, and the identification of security requirements through safety analyses showcased the intricacies of managing risks that span both safety and security domains. The importance of integrating security considerations into legacy system design and the potential impact on flight control systems highlighted the critical need for a holistic approach.

In summary, the survey responses provide a rich and detailed understanding of the interdependencies between safety and security in aviation. The feedback emphasises the need for a unified and integrated approach, acknowledging the multifaceted challenges and benefits that arise from addressing both safety and security concerns in tandem.

The survey sought to ascertain the extent to which safety and security management are integrated within the industry. Among the 55 respondents, 10 indicated that safety and security management is fully integrated, while the majority confirmed the separate management of safety and security. Notably, entities such as airports, Aircraft Design Organisations, air carriers, airport supplies organisations, and independent training organisations were identified among those fully integrating safety and security management.

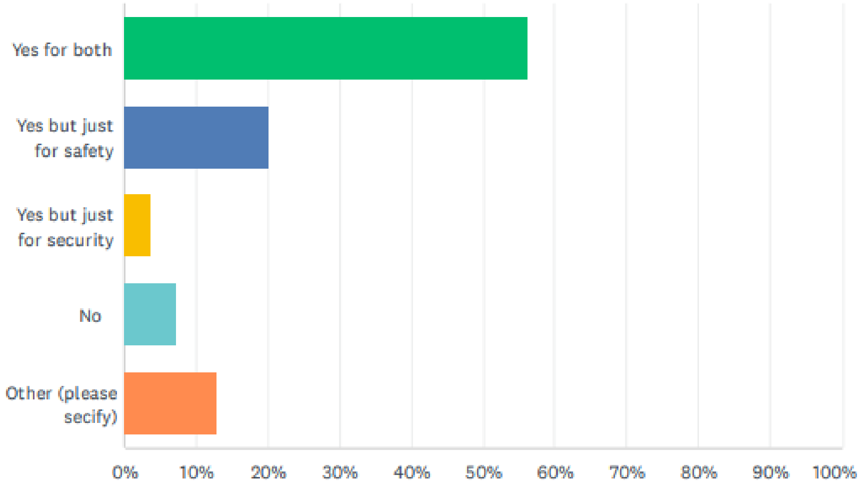


ANSWER CHOICES	RESPONSES	
Safety and security management is fully integrated in my organisation	18.18%	10
Safety is managed through SMS (Safety Management System), security is managed separately	65.45%	36
I am not sure	1.82%	1
Other (please specify)	14.55%	8
TOTAL		55

Recognising that certain entities are already incorporating the management of safety and security, this survey sought to determine whether impact assessments are presently conducted when introducing new safety or security measures.

Q6 Does your organisation undertake Impact Assessments when implementing or amending safety and security measures?

Answered: 55 Skipped: 0



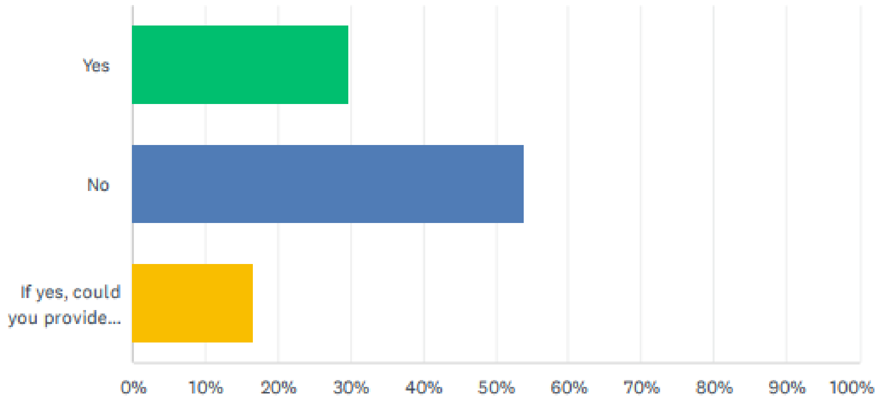
ANSWER CHOICES	RESPONSES	
Yes for both	56.36%	31
Yes but just for safety	20.00%	11
Yes but just for security	3.64%	2
No	7.27%	4
Other (please secify)	12.73%	7
TOTAL		55

The survey findings indicate that a significant portion of the 55 respondents actively conducts impact assessments when introducing both safety and security measures. Furthermore, one entity is currently in the process of implementing impact assessments in both areas. Regarding regulators, it was acknowledged that impact assessments are typically completed with the introduction of major regulatory changes, often involving different departments. Among the entities undertaking impact assessments in both safety and security, there were airports, maintenance organisations, National Aviation Authorities (NAAs), Aircraft Design Organisations, air carriers, Air Traffic Management/Air Traffic Services (ATM/ATS), and airport supplies.

Subsequently, the next question aimed to enhance our understanding of whether the impact of introduced security measures on safety is taken into account. Out of the 55 respondents, 29 indicated that it is not considered, while 16 stated that security is indeed a part of their overall consideration.

Q7 If your organisation does currently undertake Impact Assessments when implementing or amending security measures, is the Impact Assessment on safety part of your consideration?

Answered: 54 Skipped: 1



ANSWER CHOICES	RESPONSES	
Yes	29.63%	16
No	53.70%	29
If yes, could you provide details?	16.67%	9
TOTAL		54

The supplementary feedback provided by respondents offers further insights into the approach taken to analyse the impact of security measures on safety within the aviation sector. Formalised impact assessment related to impact of security measures on safety appears lacking, except in cases where it concerns passenger safety linked to security equipment certification. Certification processes for new security equipment involve ensuring compliance with public health requirements, such as X-ray safety standards, to prevent any harm to passengers. Notably, specific security measures are studied by both safety and security teams.

In the domain of Unmanned Aircraft Systems (UAS), the impact assessment primarily focuses on safety, but interdependencies with security are considered, particularly through mandatory coordination with security authorities when security issues are at stake. Examples include decisions on the use of jamming devices to neutralise UAS in violation of restricted/forbidden airspace, where safety analyses were performed to assess their impact on aviation and navigation systems, leading to the establishment of specific procedures.

The survey feedback also emphasises that impact analyses of new security measures play an important role in defining affected areas of operational activities and safety aspects, providing the framework for necessary change management. This includes considerations for processes, human resources, technologies, financial costs, and other pertinent factors. Moreover, the safety aspects of these changes undergo review by a panel of safety experts, incorporating risk assessments to ensure a comprehensive understanding of potential impacts.

In summary, the responses reflect a multifaceted approach to analysing the impact of security measures on safety, encompassing certification processes, coordination with security authorities, and thorough impact analyses. The integration of safety considerations into the decision-making processes surrounding security measures exemplifies a proactive stance towards holistic risk assessment in the aviation industry.

The subsequent open – ended question aimed to ascertain how entities determine the risk to safety when a new security measure is proposed or implemented.

Q8 What methods are used by your organisation to determine and mitigate the level of risk to safety if a new security measure is proposed?

Answered: 50 Skipped: 5

Entities investigating potential safety risks when introducing security measures primarily rely on standard safety risk assessments or risk management procedures. Hazard identification is another common approach, with several entities indicating that they gather information on potential risks through relevant department meetings where the overall impact is assessed. The answers provided encompass various methods employed to assess the risks associated with the introduction of new security measures. These include:

- EUROCAE Guidance - ED-206 - Guidance on Security Event Management
- Engagement between safety and security experts
- Safety Risk Management and Risk Assessment
- Safety management system in accordance with ICAO Doc 9859
- Hazard log – safety management
- Flight safety assessment
- Safety assessment for aircraft design organisations
- Management of change process
- Safety Case and Safety Action Group
- Regular dev. process following DO-178C
- In-house developed system based on Bowtie methodology and European Risk Classification Scheme
- HIRA - Hazard Identification & Risk Assessment
- The process to determine and mitigate risk to safety from new security measures is currently being implemented
- No risk to safety is considered when security measures are introduced

Q9 Do you have additional comments or suggestions in relation to the impact of security measures on safety?

Answered: 31 Skipped: 24

The concluding question in this survey aimed to provide an open platform for additional thoughts and reflections on the impact of security measures on safety. Further insights cover the following topics:

Integrated Approach to Safety and Security:

- Two responding entities are currently in process of integrating safety and security management and alignment of SMS and SeMS is in progress. They also indicated that this project is seen as a significant initiative.
- Often, security does not consider safety, and safety analysis is overlooked when implementing security measures.
- In many companies, security is not treated with the same respect as safety, despite its direct impact on safety operations. There is a need for an integrated regulatory framework involving both.
- The relationship between safety and security is such that a weakness in security increases risk, leading to a decrease in safety. Thus, safety and security are directly proportional but inversely proportional to risk. Close cooperation between these fields is mandatory, and relevant changes in legal and regulatory requirements should be communicated to both safety and security parties in an organisation.

- Security information and regulations need to be made available for safety, and any new regulation should be evaluated for contradictions with safety.
- The alignment and impact assessment should be conducted on a regulatory level when drafting implementing regulations. The decision about the importance of risk mitigation measures and their priority, including the impact assessment of existing safety and/or security measures, must be with legislative bodies. Especially for security, where a risk assessment is only possible if intelligence units are involved in decision-making.
- Consideration for both legacy and new designs is essential, using the Model-Based System Engineering approach and evaluating both software and hardware aspects.

Related to the Project:

- The topic can add value to many organisations and the entire industry.

Training:

- Training on the human factor and cybersecurity should cover both security and safety.

Concerns:

- Concerns exist about the impact of safety measures that could interfere significantly with security operations, such as a potential mandatory requirement to detect dangerous goods in hold baggage.

Security vs other aviation domains:

- Due to the risk of loss of life, litigation, and compensation, Environment, Health and Safety (EHS) teams and structures outweigh those tasked with ensuring security management systems and compliance. Both, however, apply the same methodology to risk management.

Insider Threat vs Safety:

- Curiosity arises about insider threats and safety. Currently, staff cannot access security documentation without clearance, yet they can perform all other normal operations. If an individual intentionally places a prohibited article, it falls under the domain of security. Conversely, if someone willingly neglects, for instance, to correctly repair the aircraft, it pertains to safety considerations. The impact on safety when background checks delay releasing personnel to work is also a consideration.

8.2 Additional stakeholder engagement

The broader context and the proposed methodology were introduced during the consortium informative workshop held on November 28th, 2023, and the exploratory workshop on December 7th, 2023. In order to enhance engagement and elicit feedback, a pre-workshop material explaining the methodology and offering a platform for comments was distributed to all individuals who consented to consultation and participated in the initial informative workshop. Subsequently, the same material was shared with all participants of the exploratory workshop. The feedback received has been incorporated into proposed methodology.

Use of proposed methodology by stakeholders already undertaking impact assessment:

Already existing methodologies address the requirements outlined in the Aerodrome Operator (EU139/2014) and ATM service provider (EU373/2017) regulations, particularly for entities certified for both activities. According to EU139/2014 ADR.OR.B.040 Changes and EU373/2017 ATM/ANS.OR.A.040 Changes, airports are mandated to conduct safety assessments when implementing changes affecting the certificate, certification basis, or safety-critical aerodrome equipment. Airport operators routinely conduct assessments related to health, environment, and various risks, utilising specific methodologies or generic ones based on ISO standards principles.

While recognising the merit of developing the proposed methodology, it was recommend positioning this methodology as an alternative to be employed when no existing system is in place. The methodology should explicitly identify and acknowledge recognised methodologies already in use by airports. It should also emphasise that, prior to adopting this specific methodology, authorities should consult with airports about their existing approaches to impact/safety assessment, advocating for reliance on established methodologies to maintain consistency. This approach ensures that staff tasked with similar activities are not burdened by the use of different methodologies, thereby mitigating potential human factor impacts such as confusion. This approach is critical to preserving the overall safety objectives that this project aims to enhance. It considered imperative that airports regard the proposed methodology as supplementary in any case.

Avoiding 'checklist blindness':

Creating an extensively structured framework reliant on checklists has the potential to undermine the efficacy of an assessment if it fails to accommodate factors lying beyond the scope of the predetermined checklist. The rigidity of such a framework may inadvertently neglect elements or variables that are not explicitly covered by the checklist.

In constructing a comprehensive evaluation system, it must be recognised that certain aspects of a scenario or environment may elude the constraints of a predefined checklist. This limitation becomes particularly apparent when confronted with nuanced or evolving situations that demand flexibility and adaptability in the assessment process.

Therefore, it is important to strike a balance between the benefits of a structured checklist and the necessity for a dynamic approach that allows for the consideration of unforeseen elements. An ideal assessment framework should possess the agility to incorporate additional items or variables that may emerge during the evaluation, ensuring a more holistic and responsive analysis.

In essence, while checklists serve as valuable tools for maintaining consistency and guiding assessments, they should be viewed as complementary rather than exhaustive instruments. A successful assessment framework acknowledges the inherent limitations of checklists and integrates mechanisms to capture and address unforeseen elements, thereby enhancing its overall effectiveness.

9. Proposed interim methodology

This task aims to develop an Impact Assessment methodology that serves the dual purpose of allowing regulators and regulated entities to evaluate the effects of security measures on safety and establish appropriate mitigating actions to counteract potential adverse consequences of such measures. To prevent potential misunderstandings and differentiate from security RIA, this is referred to as Safety Impact Assessment. This assessment aims to fully understand impact of security measures on safety (potential safety hazards developed as result of safety – security interaction) and serves as a foundation for fostering coordination and communication between two domains. Beyond understanding safety hazards in play when security measure is introduced or changed, this SIA aims to establish a well-organised framework for facilitating communication, engaging stakeholders, and cultivating a shared understanding among safety and security experts.

The proposed methodology emerged from a comprehensive analysis of the initial section of this report. Theoretical research allowed to delineate best practice and to identify the most common steps necessary for conducting an effective impact assessment. In general, impact assessments formulate specific evaluation criteria tailored to the subject and objectives of the assessment. Recognising this, the following methodology incorporates typical steps for impact assessments, with a particular emphasis on the development of specific safety criteria and indicators that will allow to identify safety hazards (negative impact) and define where security measures could potentially contribute to reducing safety risks (positive impact).

This interim methodology will be initially deployed within the scope of this project, specifically for assessing the impact of security measures on safety and identifying potential safety hazards arising from security measures (part of task 2.3 of this project). By implementing this methodology during the research phase, the research team will be able to uncover additional challenges and areas requiring refinement. Once validated for its fitness for purpose, the final methodology will be disseminated to regulators and operators as guidance.

Security measures are typically initiated within the security domain, as depicted in Figure 2, illustrating the Security vs Safety impact of security measures. The proposal for a new security measure may arise from evolving security threats or changes in the threat landscape. Additionally, other regulatory modifications may prompt the proposition of security measures. Consequently, the impact assessment may be undertaken for new security measures, existing security measures, or proposed changes to security measures.

The initiation of this process lies within the security domain, requiring those advocating for the change or introduction of security measures to take responsibility for commencing the Safety Impact Assessment process. This entails defining the objective of the safety assessment and outlining the initial context and threat landscape. It is recognised that security experts may lack the relevant safety expertise required for a comprehensive assessment. Thus, suitable safety stakeholders/experts shall be identified and actively participate in this assessment. This assessment should embody a collaborative effort that begins in the security domain and concludes in the safety domain, ensuring the active involvement of those directly responsible for safety outcomes.

Below process map outlines essential steps of Safety Impact Assessment of security measures.

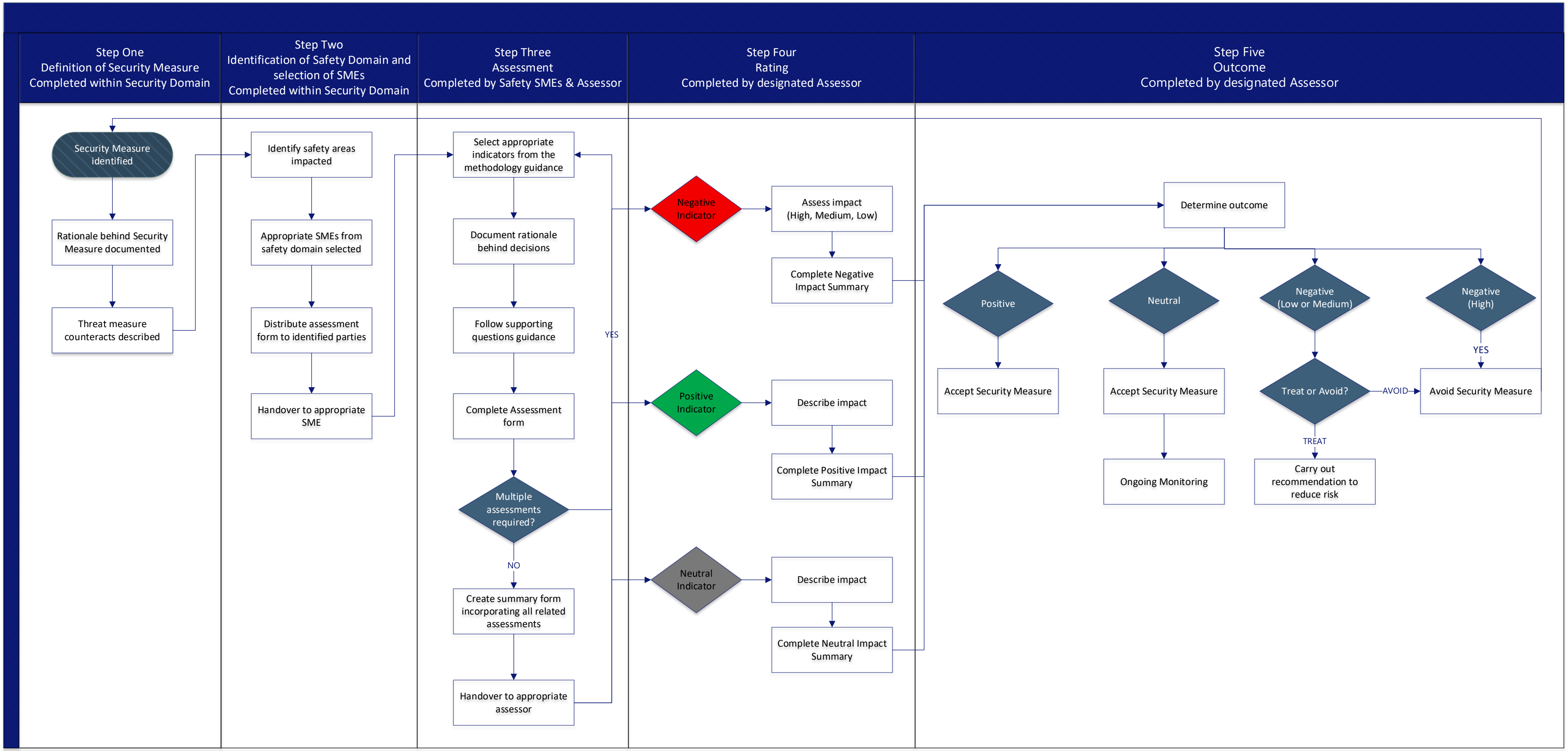


Figure 5. Safety Impact Assessment methodology – process map.

9.1 Methodology

Step 1. Security measure to be assessed

Objective: Identification of the security measure that will be assessed.

Essential elements:

- Clear definition of the security measure is essential to enable an understanding of its applicability and potential impact on safety domains.

Additional elements to consider:

- Indicating rationale for the introduction of the security measure, including reasons for a change to the existing measures, will allow to understand the security objective intended to be achieved which can be used in case any changes are required as the outcome of the implemented impact assessment process.
- The reasons and details of some security measures may not be provided in detail in a public or non-restricted document.
- This step is applicable for evaluating both existing security measures, new security measures to be implemented and proposed changes to the existing measures.

Step 2. Identification of safety domain and selection of safety experts

Objective: Identification of the safety domains potentially affected by the security measure under assessment. This step will enable the (i) identification of the safety areas (ii) and the selection of relevant stakeholders or subject matter experts that will be involved in the SIA process.

Essential elements:

- Select which safety domains may be affected by the security measure under assessment.

Safety areas impacted by security measures	Check the correct box
Aircraft	☐
• Design	☐
• Maintenance	☐
• Staff recruitment and training (e.g., maintenance)	☐
Unmanned Aircraft Systems	☐
• UAS Design	☐
• Maintenance	☐
• UAS Operations	☐
• U-Space (UTM)	☐
Air operations	☐
• Flight preparation (ground procedures)[22]	☐
• In-flight operations	☐
• Emergency response and contingency planning	☐
• Staff recruitment and training	☐
• Staff performance	☐
Ground operations/handling	☐
• Ground supervision	☐
• Flight dispatch and load control	☐
• Passenger handling	☐
• Freight and mail handling	☐
• Apron handling of aircraft	☐
• Baggage handling	☐
• Handling of dangerous goods	☐
• Fuel and oil handling	☐
• Aircraft services	☐
• Loading of catering	☐
• Staff recruitment and training	☐
• Staff performance	☐
• Emergency response and contingency planning	☐
Airport / Aerodrome	☐
• Passenger services and terminal operations	☐
• Airport security services	☐
• Aerodrome infrastructure and design	☐
• Aerodrome safety-related equipment	☐

[22] Flight preparation includes ground handling operations and horizontal verification should be undertaken.

• Staff recruitment and training	☐
• Staff performance	☐
• Emergency response and contingency planning	☐
Air Traffic Management / Air Traffic Services / Air Traffic Control	☐
• Operations	☐
• ATN ground equipment and infrastructure	☐
• Emergency response and contingency planning	☐
• Staff recruitment and training	☐
• Staff performance	☐
Other	☐
• Please specify (open category)	

Table 5. Step 2 of the SIA methodology

Additional elements to consider:

- The areas selected in the above table will allow the identification of relevant SME's or stakeholders that will participate in this assessment. The safety areas above correspond to the EU safety regulatory framework. It is recommended to develop a list of SME's or stakeholders that are most suited to contribute to this impact assessment with consideration to the specific safety areas were selected in the above table.

Step 3. Assessment

Objective: The objective of step 3 is the (a) selection of safety indicators applicable to the security measure under assessment and (b) description of rationale for the selection of indicators.

Step 3 (a) Selection of safety indicators

Objective: Selection of safety indicators applicable to the security measures under assessment.

Essential elements:

- Proposed or existing security measure shall be assessed against the below criteria by stakeholders/SME's with a relevant expertise in the safety area potentially impacted by the security measure under assessment.
- The table below includes a set of indicators which should be analysed by the safety assessor with objective to identify relevant elements that confirm the impact on safety.
- Assessment of a specific security measure should begin by reviewing and selecting (if applicable) negative indicators followed by the review of positive indicators.
- When no negative or positive indicators have been selected neutral indicators should be reviewed to confirm neutral impact.

Negative safety indicators for security measures	Check relevant boxes
Forces safety non-compliance, contradicting safety rules	☐
Decreases implementation of safety rules by making compliance more difficult	☐
Decreases safety awareness	☐
Develops latent conditions whereby safety can be compromised	☐
Creates actual decrease of safety standards	☐
Decreases efficiency of systems and equipment (aircraft, air traffic, aerodrome)	☐
Causes deterioration of system and/or equipment (aircraft, air traffic, aerodrome)	☐
Increases maintenance requirements (aircraft, air traffic, aerodrome)	☐
Negative impact on staff performance in terms of human factors causing decline in safety performance	☐
Decreases operational efficiency	☐
Increases operational complexity	☐
Increases complexity of required training (safety or security)	☐
Decreases efficiency of emergency operations/ procedures	☐
Decreases efficiency of standard operating procedures	☐
Introduces additional challenges in safety management	☐
Introduces additional challenges in management of emergency situations	☐
Introduces safety hazard	☐
Reduces or impacts on safety data collection	☐

Table 6. Negative impact indicators.

Positive safety indicators for security measures	Check relevant boxes
Facilitate compliance with safety rules	☐
Increases implementation of safety rules	☐
Increases safety awareness	☐
Offers opportunity for safety improvement or leads to actual safety improvement	☐
Increases efficiency of systems and equipment (aircraft, air traffic, aerodrome)	☐
Reduces aircraft maintenance requirements	☐
Improves staff performance in terms of human factors	☐
Increases operational efficiency	☐
Reduces maintenance requirements (aircraft, air traffic, aerodrome)	☐
Reduces operational complexity	☐
Reduces complexity of required safety training	☐
Increases efficiency of emergency operations/ procedures (aircraft, air traffic, aerodrome)	☐
Increases efficiency of standard operating procedures (aircraft, air traffic, aerodrome)	☐
Provides additional safety benefits	☐
Improves safety management	☐
Allow for reduction of safety hazard	☐
Enables increased data collection	☐
Improves emergency management	☐
Decreases the possibility of conflicting safety – security priorities	☐

Table 7. Positive safety indicators

Neutral safety indicators for security measures	Check relevant boxes
Does not affect compliance with safety procedures (implementation of safety rules)	☐
Does not affect safety awareness	☐
Does not contribute to tangible safety enhancements nor diminishes safety	☐
Does not affect efficiency of systems and equipment (aircraft, air traffic, aerodrome)	☐
Does not affect maintenance requirements (aircraft, air traffic, aerodrome)	☐
Does not affect staff performance in terms of human factors	☐
Does not affect operational efficiency	☐
Does not affect operational complexity	☐
Does not affect complexity of required training (safety, security)	☐
Does not affect efficiency of emergency operations/ procedures (aircraft, air traffic, aerodrome)	☐
Does not affect efficiency of standard operating procedures (aircraft, air traffic, aerodrome)	☐
Does not offer additional safety benefits	☐
Has no impact on safety management	☐
Does not affect emergency management	☐
Has no impact on data collection	☐
Does not introduce conflicting safety – security priorities	☐
Does not reduce or increase safety hazard	☐

Table 8. Neutral safety indicators

Step 3 (b) Description of rationale

Objective: Description of rationale for the selection of indicators.

Essential elements:

- Once relevant indicators are selected based on the stakeholder's knowledge of operational environment, the second part of this step is to explain the rationale. This will provide qualitative information that will be assessed once all stakeholders completed their assessments. Essentially, this entails responding to the fundamental question: "Why was this indicator selected?" To enhance structure, a set of accompanying questions are provided for each rationale box as guidance.

Additional elements to consider:

- The rationale section should offer a comprehensive overview of the reasoning behind the selection of relevant indicators. Addressing the following questions can guide the identification of pertinent information to be included in this section.

  Supporting questions for negative indicators:

  - Are there any available data sources, such as incident reports, pertaining to the specific issue being assessed?
  - What potential safety issues are anticipated in the event of implementing the proposed security measures?
  - Are there any known conflicting safety requirements associated with the assessed security measure?
  - Are there any identified duplications of regulatory requirements that might lead to divergent requirements in the future?
  - For existing security measures, what mitigating measures or training is currently implemented or required to reduce any negative effects on safety?
  - In the case of new security measures, what mitigating measures or training is anticipated or deemed necessary to prevent negative impacts on safety?
  - Is the staff trained to handle potential issues arising from conflicting priorities?

  Supporting questions for positive indicators:

  - What potential benefits are expected upon the implementation of the proposed new security measures?
  - Does this security measure support any known safety requirements?
  - Are there any available data sources pertaining to the specific issue being assessed?

Upon completion of step 3 actions, the assessment should be returned to the assessor. All provided answers will be compiled into a comprehensive report, facilitating the scoring of the overall impact.

Step 4. Impact rating

Objective: Assessment of the negative impact on safety based on the information collected.

Essential elements:

- The following criteria will allow the assessment of the severity of the impact. Where negative indicators have been selected, and a rationale has been provided for their selection, it should now be assessed against the following negative criteria.

HIGH NEGATIVE IMPACT:

Description	
Severe consequences – may lead to an aircraft accident or serious incident within the meaning of Regulation (EU) No 996/2010	☐
Direct impact on the aircraft / aircraft operation (flight crew, ATM, aerodrome), aircraft critical systems and equipment	☐
There is a documented history of accidents resulting from this security measure	☐
Robust evidence of negative impact (for existing security measures) in form of occurrence reports and root cause analysis	☐
High number of mitigating measures is required in form of procedures, training and (if applicable) equipment to counter negative impact on safety	☐

MEDIUM NEGATIVE IMPACT:

May lead to an incident (other than serious) within the meaning of Regulation (EU) No 996/2010	☐
Training is required to ensure safety not compromised	☐
Some mitigating measures are required to counter the impact on safety	☐
Some evidence of impact supported by occurrence reports	☐
Impact on operating procedures	☐

"Incident means an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation"[23]

LOW NEGATIVE IMPACT:

Does not lead to an accident or an incident however is contrary to safety requirements	☐
Negative impact was identified but there is no evidence	☐
Additional training is not required to counter negative impact	☐
No actual or anticipated safety measures required to counter the impact	☐
Minor consequences on safety	☐
Security measure creates latent conditions where safety issue may develop	☐

[23] Ibid

Additional elements to consider:

- In general, the impact will be greater if:
  - The specific impact indicators are supported by historical events (for example, in case of Germanwings accident in relation to flight deck door),
  - The impact is direct on the aircraft, aircraft critical systems and aircraft parts, or activities directly supporting aircraft operation,
  - If it is evidenced through occurrence reports and root cause identification (relevant to negative impact),
  - Significant number of mitigating measures is implemented to decrease safety risk (relevant to negative impact),
  - Significant training is required to ensure staff preparedness to deal with potential hazards.
- The impact is less severe if:
  - There is no historical evidence to support given statement/indicator,
  - The impact is not directly affecting aircraft safety, but for example may affect operating procedures,
  - There is very limited evidence of the impact in form of reports,
  - Low number of mitigating measures are required to decrease safety risk,
  - Training is not required to counter possible negative consequences.
- Positive or neutral impact does not require scoring. Safety regulations and standards do not assess or track positive impact and there are no regulatory sources that would allow identification of the level of positive impact on safety. The whole concept of aviation safety aims for continuous improvement of safety leading to no fatalities related to aircraft operation.

POSITIVE IMPACT:

Description of the nature of positive impact

NEUTRAL IMPACT:

Description of the nature of interdependency with neutral impact

Step 5. The outcome

Objective: To (a) determine the overall outcome of the safety impact assessment and (b) decide on the appropriate risk management options where adverse safety impacts have been identified.

Step 5 (a) Determination of the overall outcome

Objective: To determine the overall outcome of the safety impact assessment.

Essential elements:

- Determination of the overall impact which may be:
  - Positive
  - Neutral
  - Low negative impact
  - Medium negative impact
  - High negative impact

Step 5 (b) Risk management option to be followed

Objective: To decide on the appropriate risk management options.

Essential elements:

- Once the impact has been determined, the subsequent steps need to be carefully considered, and appropriate actions to be taken accordingly. Commonly recognised methodologies for risk treatment can be utilised to decide on the follow-up action required. Determined risk can be treated by avoidance, acceptance, transfer or treatment.[24] In case of negative impact of security measures on safety two of these outcomes are suitable to be adopted to this methodology – impact avoidance or treatment.
- Where positive impact is identified, no further action is required, however the positive impact should be described (if not already done in step 4).
- Where the impact is neutral, no further action is required, however a description of interdependency should be provided (if not already done in step 4).
- Low and medium negative impact will have to be treated. This means establishing countermeasures in either safety or security domain to modify, mitigate or reduce the safety impact. This will include a list of safety recommendations for the proper implementation of this security measure. Treatment or avoidance.
- Where the impact of proposed security measures is high negative, security measure shall be reviewed. This level of impact should be avoided, and alternative options should be proposed. Impact assessment will be undertaken again on alternative security measure. Avoidance.
- When the impact of existing and well-established security measures is determined to be highly negative, any safety and security countermeasures identified should be listed and analysed. If required, additional recommendations should be proposed. Any risks stemming from these measures should be identified and treated accordingly.

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[24] National Cyber Security Centre, Risk management, Cyber security risk management framework at: Risk management - NCSC.GOV.UK

Ultimately, if a security measure results in introduction of a hazard into safety domain, this needs to be recognised and resolved with either adjustment to the particular security measure or by suitable safety countermeasures.

Additional elements to consider:

- In the case of safety and in particular in relation to safety impact, the organisation cannot take decisions that may have an impact on safety based on their organisational risk appetite. Risks can therefore only be accepted in the case that there is no impact on aviation safety.
- Unlike business risks, aviation safety risks cannot be transferred for example through insurance as accountability always remains in the responsible organisation.
- It is also recommended to monitor safety – security interdependencies with neutral impact as any changes in the operational context, safety or security measures, may change the nature of impact which could become either positive or negative.

9.2 Moving forward

The next step of this research is to apply proposed methodology in Task 2.3, where the security measures outlined in Task 1.1 will undergo assessment using this structured approach. The resultant output will be a comprehensive report that delineates the impact of these security measures on safety.

The scope of assessing the impact of security measures on safety is expansive and intricate, encompassing diverse safety domains ranging from UAS and ATM to aerodrome and air operations. Through the subsequent stages of this project, the methodology's steps and indicators, including criticality levels, will be rigorously tested. It must be acknowledged that minor adjustments to this process may be necessary as the research unfolds.

Upon the release of Report 2.3, guidance for operators and regulators elucidating this methodology will be disseminated. Throughout the research phase, additional feedback from stakeholders will be actively solicited and incorporated into the final guidance, ensuring a comprehensive and refined approach.

The forthcoming stages of this research will involve a review of all security measures cataloged in Task 1.1, followed by the execution of steps 1 and 2 of the defined methodology. The articulation of assessment objectives in step 1 will serve as the foundation for curating the list of security measures to be assessed in Task 2.3. It is worth noting that some of the interdependencies highlighted in Task 1.1 may necessitate assessment in subsequent tasks (Task 3 or 4).

9.3 Examples

These examples are designed to present the methodology only. The full assessment of all identified security measures within the areas of safety – security interdependency will be conducted in task 2.3 of this project.

Example 1

Step 1 Security measure to be assessed

Assessment of 'Features of interior (aircraft) design' (reduction of panels and hatches accessible to passengers). Regulatory reference: ICAO Annex 8 – Airworthiness of aircraft; Chapter 11 – Security; 11.4 Interior design.

Rationale for introduction: It was identified that the interior design of an airplane shall incorporate features that will make it more difficult to hide dangerous objects in the airplane or make it easier to find them if they have been brought onboard. Interior design with many panes and hatches which are accessible to passengers does facilitate easy concealment of weapons, explosives or other dangerous objects on board aircraft.

Description of the threat that this measure is counteracting: IED/ prohibited article concealed in passenger cabin.

Step 2 Identification of safety domain and selection of safety experts

- Select which safety domains may be affected by the security measure under assessment.

Safety areas impacted by security measures	Check the correct box
Aircraft	☒
• Design	☒
• Maintenance	☐
• Staff recruitment and training (e.g., maintenance)	☐
Unmanned Aircraft Systems	☐
• UAS Design	☐
• Maintenance	☐
• UAS Operations	☐
• U-Space (UTM)	☐
Air operations	☒
• Flight preparation (ground procedures)	☒
• In-flight operations	☐
• Emergency response and contingency planning	☐
• Staff recruitment and training	☐
• Staff performance	☒
Ground operations/handling	☐
• Ground supervision	☐
• Flight dispatch and load control	☐
• Passenger handling	☐
• Freight and mail handling	☐

• Apron handling of aircraft	☐
• Baggage handling	☐
• Handling of dangerous goods	☐
• Fuel and oil handling	☐
• Aircraft services	☐
• Loading of catering	☐
• Staff recruitment and training	☐
• Staff performance	☐
• Emergency response and contingency planning	☐
Airport / Aerodrome	☐
• Passenger services and terminal operations	☐
• Airport security services	☐
• Emergency response and contingency planning	☐
• Aerodrome infrastructure	☐
• Staff recruitment and training	☐
• Staff performance	☐
Air Traffic Management / Air Traffic Services / Air Traffic Control	☐
• Operations	☐
• Ground equipment and infrastructure	☐
• Emergency response and contingency planning	☐
• Staff recruitment and training	☐
• Staff performance	☐
Other	☐
• Please specify (open category)	

Who is directly affected by this measure? Aircraft design engineers, cabin crew or other staff conducting security search.

Stakeholder 1: Aircraft design organisation (DOA) - aircraft design engineer
Stakeholder 2: Air carrier/operator - safety manager

Step 3 Assessment

Step 3 (a) Selection of safety indicators

<u>Stakeholder 1 Aircraft design organisation (DOA), aircraft design engineer:</u>

Negative indicators for security measure	Check relevant boxes
In contradiction to safety needs or requirements	☒

Step 3 (b) Description of rationale

The FAA Advisory Circular on Interior Design to Facilitate Searches, issued on October 24, 2008, emphasises the challenge in aircraft design where conflicting needs arise. Balancing the safety considerations for passengers and crew, such as ensuring accessibility of life jackets and maintaining out-of-sight storage in lavatories for supplies, becomes essential. These requirements, while necessary for safety and functionality, can potentially conflict with the goal of minimising spaces that could be exploited for hiding prohibited articles. Achieving a delicate balance between meeting safety regulations and optimising the space for efficient and thorough security searches within aircraft interiors may be challenging.

There are no data sources or incident reports specific to this issue. No duplications of safety requirements in this area.

Safety requirement of accessible life jackets is conflicting with security requirement of reducing the number of stowage areas accessible to passengers.

Stakeholder 2: Air carrier/operator, safety manager

Step 3 (a) Selection of safety indicators

Positive safety indicators for security measures	Check relevant boxes
Improves staff performance in terms of human factors	☒
Increases operational efficiency	☒
Reduces operational complexity	☒

Step 3 (b) Description of rationale

This feature of interior design prevents easy concealment of prohibited articles on-board the aircraft and ensures aircraft security search or checks (if required) are facilitated. This reduces complexity of security search procedures which in general terms reduces workload on staff responsible for security search. Staff able to focus on other safety related responsibilities. Less likelihood of conflicting priorities when other safety related duties are being carried out, for example safety equipment checks. This results in less complex operational procedures if security check or search is required, also leading to reduced workload. Less time required for completing the security search increasing the operational efficiency.

The implementation of less complex security procedures helps to avoid conflicting priorities with other safety-related duties, such as safety equipment checks and flight preparation.

Step 4 Impact rating

HIGH NEGATIVE IMPACT

Description	
Severe consequences – may lead to an aircraft accident or serious incident within the meaning of Regulation (EU) No 996/2010	☐
Direct impact on the aircraft / aircraft operation (flight crew, ATM, aerodrome), aircraft critical systems and equipment	☐
There is a documented history of accidents resulting from this	☐
Robust evidence of negative impact (for existing security measures) in form of occurrence reports and root cause analysis	☐
High number of mitigating measures is required in form of procedures, training and (if applicable) equipment to counter negative impact on safety	☐

MEDIUM NEGATIVE IMPACT

May lead to an incident (other than serious) within the meaning of Regulation (EU) No 996/2010	☐
Training is required to ensure safety not compromised	☐
Some mitigating measures are required to counter the impact on safety	☐
Some evidence of impact supported by occurrence reports	☐
Impact on operating procedures	☐

"Incident means an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation"[25]

LOW NEGATIVE IMPACT

Does not lead to an accident or an incident however is contrary to safety requirements	☒
Negative impact was identified but there is no evidence	☐
Additional training is not required to counter negative impact	☒
No actual or anticipated safety measures required to counter the impact	☐
Minor consequences on safety	☐
Security measure creates latent conditions where safety issue may develop	☒

POSITIVE IMPACT:

Description of the nature of positive impact
This security measure has a positive impact on safety in operational areas for the air carriers. It reduces complexity of operational procedures, improves performance and increases efficiency of operations. This requirement of aircraft design allows for quicker and less complex security search procedures which have an impact on other safety related duties of staff when the aircraft is on the ground, for example safety equipment checks and preparing the aircraft for the flight. Typically, this will be related to cabin crew duties on the ground. Staff face fewer conflicting priorities and can focus on safety related duties when a number of panels and hatches accessible to passengers is lower. When security search is performed by external entity (cleaning or security staff) the process is less complex necessitating less time to complete.

NEUTRAL IMPACT:

Description of the nature of interdependency with neutral impact
N/A

Step 5 The outcome

Step 5 (a) Determination of the overall outcome

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[25] Ibid

Low negative impact – the assessment indicates this security conflict with safety requirements of accessibility of life jackets to all passengers. There is low negative impact on safety and does not lead to an accident or an incident.
Life jackets must be accessible to all passengers; this requires maintaining relevant stowage in the aircraft cabin. Current aircraft design already include solutions in form of sealed pouches under the passenger seat or placing life jackets in the overhead panels.

Step 5 (b) Risk management option to be followed

Risk treatment options: This is well established security related requirement originating from safety domain. Historically, aircraft design organisations had to balance security requirements of reducing the number of panels and hatches available to passengers with the safety requirement of availability of life jackets for all passenger during the flight. Since this was originally proposed, a number of changes to aircraft design were introduced, for example storage of the life-jackets in the overhead panels which reduces the likelihood of passenger tampering with the storage without drawing attention of crew and other passengers. Other solution introduced by manufacturers were sealed, transparent life jacket compartments underneath the passenger seat which allow better visibility if prohibited articles were inserted in the life-jacket compartments.

Additional countermeasure includes security searches and checks required by the Implementing Regulation EU2015/1998 and Implementing Decision (C)2015/8005. Specific procedures for aircraft searches and checks developed by the operators and air carriers may be less complex if the above design requirements are followed or more complex if the aircraft design allow for more storage areas that are accessible to passengers.

Considering all the above, there are no additional recommendations for specific operational countermeasures in this case. Aircraft design shall allow for appropriate stowage for passenger life jackets, so they remain accessible to all passengers during the flight.

Example 2

Step 1 Security measure to be assessed

Assessment of security requirements related to carriage of potentially disruptive passengers as required by EC300/2008, Annex I, 4.3 and Implementing Regulation EU 2015/1998, 4.3.

Potentially disruptive passenger is defined by the regulation EC300/2008 as *a passenger who is either a deportee, a person deemed to be inadmissible for immigration reasons or a person in lawful custody.* These passengers encompass individuals such as those under arrest, in lawful custody, deemed inadmissible, facing deportation, or undergo judicial or administrative proceedings.

In safety domain these passengers are referred to as special category of passengers this terminology is also referred to in ICAO international security standards ICAO Annex 17 and Doc 8973.

Rationale for introduction: Due to potential security risk, these passengers must undergo additional administrative procedures before being allowed to board an aircraft. According to the Chicago Convention, each Member State is tasked with establishing operational guidelines for transporting such passengers. These guidelines should be documented in the National Civil Aviation Security Program and further detailed in the security programs of aircraft operators.

This security requirement aims to minimise the risk of unruly / disruptive behaviour resulting from deportation, refused entry or reasons for which the passenger is in custody. "*The behaviour of such a passenger in-flight* *could potentially impact the implementation of crew procedures, their management of flight, increasing their workload in the face of potentially dangerous behaviour, jeopardising their own safety, or that of other passengers[26]".*

Step 2 Identification of safety domain and selection of safety experts

- Select which safety domains may be affected by the security measure under assessment.

Safety areas impacted by security measures	Check the correct box
Aircraft	☐
• Design	☐
• Maintenance	☐
• Staff recruitment and training (e.g., maintenance)	☐
Unmanned Aircraft Systems	☐
• UAS Design	☐
• Maintenance	☐
• UAS Operations	☐
• U-Space (UTM)	☐
Air operations	☒
• Flight preparation (ground procedures)	☒
• In-flight operations	☒
• Emergency response and contingency planning	☒
• Staff recruitment and training	☐
• Staff performance	☒
Ground operations/handling	☐
• Ground supervision	☐
• Flight dispatch and load control	☐
• Passenger handling	☐
• Freight and mail handling	☐
• Apron handling of aircraft	☐
• Baggage handling	☐
• Handling of dangerous goods	☐
• Fuel and oil handling	☐
• Aircraft services	☐
• Loading of catering	☐
• Staff recruitment and training	☐
• Staff performance	☐
• Emergency response and contingency planning	☐
Airport / Aerodrome	☐
• Passenger services and terminal operations	☐
• Airport security services	☐
• Emergency response and contingency planning	☐
• Aerodrome infrastructure	☐

[26] EASA (2023) *Impact of Security Measures on Safety – Identification of the main security threats and scenarios having an impact on aircraft safety.*

• Staff recruitment and training	☐
• Staff performance	☐
Air Traffic Management / Air Traffic Services / Air Traffic Control	☐
• Operations	☐
• Ground equipment and infrastructure	☐
• Emergency response and contingency planning	☐
• Staff recruitment and training	☐
• Staff performance	☐
Other	☐
• Please specify (open category)	

Security requirements related to special category of passengers affect the safety area of air operations specifically related to air carriers.

The requirement of notification of the air carrier remains with the competent authority however this requirement will have an impact on the air carrier and air carrier staff especially those operating specific flights – cabin crew, flight crew.

Who would be most suited to contribute to this assessment? Those with knowledge of operational duties of air carrier staff. Those managing flight crew and cabin crew.

Stakeholder 1: Air carrier/operator - safety manager

Step 3 Assessment

Step 3 (a) Selection of safety indicators

Stakeholder 1 Air carrier/operator - safety manager:

Positive safety indicators for security measures	Check relevant boxes
Facilitate compliance with safety rules	☒
Increases safety awareness	☒
Improves staff performance in terms of human factors	☒
Increases operational efficiency	☒
Increases efficiency of emergency operations/ procedures (aircraft, air traffic, aerodrome)	☒

Step 3 (b) Description of rationale

Receiving early information about potentially disruptive passengers carried on board the aircraft is essential for the flight crew and cabin crew. There are specific safety requirements for special category passengers (which include departees, passengers in custody and inadmissible passengers) under EASA Air Operations regulation CAT.OP.MPA.155(c). These passengers may not occupy seats with direct access to emergency exits, furthermore air carriers may allocate specific seats as per operator procedures. Special Category Passengers are not a suitable Able Body Passengers (selected to help crew with evacuation in emergency situations). Early notification about carriage of potentially disruptive passengers allows the crew to ensure appropriate seating requirements are followed and last-minute changes of seating arrangements may be avoided which facilitates compliance with safety rules, increases safety awareness in terms of required briefings and increases operational efficiency.

This security requirement duplicates safety requirements contained in CAT.OP.MPA.155(d) which states that *"The commander shall be notified in advance when SCPs are to be carried on board"*. This duplication, however, supports safety requirements and provides more details regarding "notification" provided to the commander of the aircraft. Whilst safety domain requires notification in advance, security related requirements specify what such notification should include which includes identity, gender, reason for transportation, names of escorting officers, risk assessment carried out by appropriate authority, seating arrangements and nature of travel documents.

In terms of human factors and crew resource management, this security measure contributes to anticipation and preparation for potential threats related to unruly passenger, in line with Threat and Error Management (TEM) principles. TEM "*is the practice of thinking ahead in order to predict and avoid errors and operational threats and manage any that occur*[27]". Notification of carriage of potentially disruptive passengers allows the flight crew and cabin crew to anticipate potential issues and be prepared if they actually occur, discuss available options and perform better in case of escalation. This anticipation leads to quicker and better decisions in normal and emergency situations.

Step 4 Impact rating

HIGH NEGATIVE IMPACT

Description	
Severe consequences – may lead to an aircraft accident or serious incident within the meaning of Regulation (EU) No 996/2010	☐
Direct impact on the aircraft / aircraft operation (flight crew, ATM, aerodrome), aircraft critical systems and equipment	☐
There is a documented history of accidents resulting from this	☐
Robust evidence of negative impact (for existing security measures) in form of occurrence reports and root cause analysis	☐
High number of mitigating measures is required in form of procedures, training and (if applicable) equipment to counter negative impact on safety	☐

MEDIUM NEGATIVE IMPACT

May lead to an incident (other than serious) within the meaning of Regulation (EU) No 996/2010	☐
Training is required to ensure safety not compromised	☐
Some mitigating measures are required to counter the impact on safety	☐
Some evidence of impact supported by occurrence reports	☐
Impact on operating procedures	☐

[27] Civil Aviation Authority (2023), *Flight-crew human factors handbook,* CAP 737, Second Edition February 2023 at: CAP 737: Flight Crew Human Factors Handbook | Civil Aviation Authority (caa.co.uk)

"Incident means an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation"[28]

LOW NEGATIVE IMPACT

Does not lead to an accident or an incident however is contrary to safety requirements	☐
Negative impact was identified but there is no evidence	☐
Additional training is not required to counter negative impact	☐
No actual or anticipated safety measures required to counter the impact	☐
Minor consequences on safety	☐
Security measure creates latent conditions where safety issue may develop	☐

POSITIVE IMPACT:

Description of the nature of positive impact
There is a regulatory overlap with positive impact where the security measure supports and enables better adherence to safety rules. This security measure has a positive impact on safety in operational areas for the air carriers. Particularly it impacts operational procedures related to seating arrangements of special category of passengers and staff performance in relation to human factors. With early notification to the commander of the aircraft, all crew can maintain better safety awareness for normal and emergency situations. This requirement also contributes to better application of Threat and Error Management where possible issues are anticipated and crew are better prepared shall the situation occur.

NEUTRAL IMPACT:

Description of the nature of interdependency with neutral impact
N/A

Step 5 The outcome

Step 5 (a) Determination of the overall outcome

Positive impact on safety in areas of air operations (on the ground, in-flight, normal and emergency operations, staff performance.

Step 5 (b) Risk management option to be followed

Positive impact – no further action.

Considering all the above, there are no additional recommendations for this security measure.

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[28] Ibid

10. Conclusion

Impact assessment in the aviation sector refers to the systematic evaluation and analysis of the potential consequences that various events, decisions, or changes can have impact on safety, operations, finances, reputation, and other aspects within the aviation industry. It is a process that helps aviation organisations, regulatory bodies, and stakeholders understand the potential effects of their actions or external factors.

The aim of this study was to analyse current methodologies and develop suitable impact assessment methodology to assess the impact of security measures on safety considering it will be utilised for both existing and newly proposed security measures.

Comprehensive research was undertaken to gain insights into impact assessment methodologies employed across diverse domains, both within and outside of aviation. The initial section of this report is dedicated to conducting an in-depth analysis of impact assessment theory and its practical application in operational contexts, spanning not only the aviation sector but also other industries.

Security measures can potentially have both direct and indirect impacts on safety. The proposed impact assessment methodology seeks to pinpoint the potential repercussions of implementing these measures on safety aspects. This process aims to provide a transparent understanding of the domains that might be affected. By doing so, it empowers both regulatory bodies and the entities under their oversight to develop appropriate mitigation strategies in the event that any adverse impacts are identified. Impact assessment is essential to:

- Anticipate consequences
- Minimise negative effects
- Allocate resources efficiently
- Enhance safety
- Plan for contingencies
- Adhere to regulations
- Consider stakeholder interests
- Evaluate long-term effects
- Evaluate financial impact

Many of the approaches and methodologies analysed in this document utilise a type of risk assessment methodology to evaluate the impact. The specific complexities of integrated risk assessment and management will be explored further in Task 4 of this research study. It is apparent that there are common elements shared by various approaches and methodologies, including:

- Scope and problem identification
- Identification of affected stakeholders
- Data collection and analysis
- Identification of proposed solutions and the selection of the best option
- Review and ongoing data analysis

Within the scope of this research and the task's objectives, it's important to note that analysed frameworks extend beyond simply assessing the influence of one domain on another. They often encompass a combination of qualitative and quantitative analyses to provide a comprehensive evaluation of impact. Additionally, some of the proposed methodologies place a significant emphasis on involving stakeholders in the assessment process.

In conclusion, the aim of this task is to develop a user-friendly tool that facilitates the assessment of how security measures impact safety for both regulators and entities. The integration of various methodologies forms the essential framework for evaluating this impact, with Stakeholder Relationship Management and Input-Process-Output methodologies showing promise in achieving positive outcomes.

The second part of this study introduces a proposed methodology tailored to assess the impact of security measures on safety. In summary, this methodology incorporates qualitative elements along with active engagement with stakeholders or SME's. Stakeholder / SME engagement is considered essential to foster collaboration within the civil aviation community and ensure that impact assessments are not conducted in isolation but rather draw from all available information.

In summary the steps of proposed impact assessment include:

Step 1. Security measure to be assessed. Clearly defining the security measure to be assessed, description of rationale for its introduction and definition of security threat it is counteracting.

Step 2. Identification of safety domain and selection of safety experts. Identifying the safety domains affected by the security measure under assessment and safety experts/stakeholders that will be involved in the assessment process.

Step 3. Assessment. Next stage is to assign specific criteria that will enable to rate the impact (step 3 a) and provide rationale for selection (step 3 b). This will be based on a variety of available data and information for example, occurrence reports but also general knowledge relevant to the specific field, issues that are anticipated in case of proposed new security measures. Description of known conflicting safety requirements, any known duplications of regulatory requirements that may lead to divergent requirements in the future, in case of existing measures, implemented mitigating measures or training that is required to reduce the negative effect or in case of new measures, anticipated mitigating measures or required training to prevent negative impact.

Step 4. Impact rating. Evaluation of the negative impact to determine whether it could result in an accident, or a serious incident.

Step 5. The outcome. Analysis of all the answers and determination of the overall impact and decision on appropriate risk management options. Acceptance, treatment or rejection of assessed security measure. When treatment is required issuance of recommendations for reduction of impact.

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Annex A Impact Assessment Survey

The objective this research study was to understand the nature and extent of the interdependencies between safety and security in civil aviation in order to assess the impact of security measures on safety. One of the main tasks of this project was to develop a comprehensive knowledge base in relation to Impact Assessment practices with a view to recommending an Impact Assessment Framework to industry and regulators. This framework will aid the evaluation of potential impacts (both positive and negative) of security measures on the overall safety performance of aviation systems, personnel and operations.

The primary objective of this survey was to evaluate whether civil aviation organisations and entities are presently conducting assessments on the impact of security measures on safety. If such assessments are being conducted and if yes, what methodologies are currently being implemented to undertake such assessment.

1. Which civil aviation entity are you affiliated with?

- National Appropriate Authority (NAA) / Civil Aviation Authority
- Airport
- Air Carrier / Air Operator
- Air Traffic Management / Air Traffic Control
- Maintenance organisation
- Aircraft design organisation
- Cargo
- In-flight supplies
- Airport supplies
- Independent aviation training organisation
- Aviation professional association
- Other
- If 'other' please specify:

2. To which specific area does your role and responsibility relate to?

- Management (safety)
- Management (security)
- Management (safety and security)
- Training (safety)
- Training (security)
- Training (safety and security)
- Other
- If 'other' please specify:

3. Does your role require knowledge of both aviation safety and security regulations or procedures?

- Yes
- No, I only work withing safety domain
- No, I only work within security domain
- Additional comments:

4. **What most common safety and security interdependencies you observe in your area of work?**

5. **Which of the below statements best describes management of safety and security in your organisation?**

- Safety and security management is fully integrated in my organisation
- Safety is managed through Safety Management System, security is managed separately
- I am not sure

6. **Does your organisation undertake Impact Assessments when implementing or amending safety and security measures?**

- Yes for both
- Yes but just for safety
- Yes but just for security
- No
- Additional comments:

7. **If your organisation does currently undertake impact assessments when implementing or amending security measures, is the impact assessment on safety part of your consideration?**

- Yes
- No
- If yes, could you provide details?

8. **What methods are used by your organisation to determine and mitigate the level of risk to safety if a new security measure is proposed?**

9. **Do you have additional comments or suggestions in relation to the impact of security measures on safety?**

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