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Secrétariat Général



المملكة المغربية
وزارة النقل واللوجستيك
الكتابة العامة

MENA ARCM/4-Workshop

“Data Collection and Analysis (DCA) to Prevent Civil Aviation Accidents”

**Legal framework, main challenges
and obstacles**

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Introduction

Importance of **Aviation Safety**;

Significance of preventing serious incidents and accidents in the aviation industry;

Impact of accidents on human lives and reputation of airlines ;

Legal and financial consequences of accidents ;

Role and the importance of **DCA** in aviation safety in **preventing** accidents ;

Aviation industry's **commitment** to safety ;

Key Regulatory Bodies: (FAA, EASA, ICAO, National CAAs) ;

Role of ICAO in establishing international aviation safety standards.





OUTLINE

“Data Collection and Analysis to Prevent Civil Aviation Accidents” *Legal framework, main challenges and obstacles*

- I. Sources, collection Methods and analysis techniques**
- II. Legal Framework;**
- III. Main challenges;**
- IV. Obstacles;**
- V. Ways to enhance aviation safety and way forward**





I – Sources, collection Methods and analysis techniques



1. Sources, Methods and techniques

1.1. Primary sources

- ❖ **Flight Data (FDR/CVR):** flight parameters (Altitude, airspeed, heading, cockpit voice recordings, and other critical data during the entire flight) ;
- ❖ **Air Traffic Control (ATC) Data:** ATC systems log and store communication between pilots and controllers, including instructions, clearances, and any deviations from standard procedures ;
- ❖ **Maintenance Records:** (History of inspections, repairs, and modifications performed on an aircraft);
- ❖ **Pilot Training and Performance Data:** (Performance evaluations, Training manuals and syllabi) ;
- ❖ **Incident and Accident Reports** (Previous incidents and accidents, Reporting systems) collect and analyze this data for safety enhancement efforts;
- ❖ **Airline Safety Programs:** Safety Management Systems (SMS), Data on safety reports, risk assessments, and safety-related audits.





1. Sources, Methods and techniques

1.2. Other sources

- ❖ **Regulatory authority records;**
- ❖ **Manufacturer and Operator Data :** (Manuals, Service Bulletins, airworthiness Directives, other technical data and Operator’s manuals and SOPs);
- ❖ **Pilot and Crew Statements:** (Testimony- actions, decision-making processes, and any human factors) ;
- ❖ **Meteorological Data:** (Airports, Weather forecasts, records and briefing material; and weather stations) ;
- ❖ **Accident Databases:** Aviation authorities (facilitate trend analysis and identification of safety issues) ;
- ❖ **Simulation and Flight Data Analysis:** (capture of detailed parameters).





1. Sources, Methods and techniques

1.2. Other sources (follow-up)

- ❖ **Physical examination** of the equipment used during the safety event ;
- ❖ **Documentation** spanning a broad spectrum of the operation :
 - Personal records/logbooks ;
 - Certificates and licenses ;
 - In-house personnel and training records and work schedules;
 - Flight planning documents;
 - Aeronautical information publications.
- ❖ **Interviews** conducted with individuals directly or indirectly involved in the safety event.
- ❖ **Direct observation of actions** performed by operating or maintenance personnel in their work environment.
- ❖ **Specialist advice.**



1. Sources, Methods and techniques

1.3. Main methods of data collection

- ❖ **Accident Reporting Systems:** (Aviation Safety Reporting System (**ASRS**) and the Global Aviation Information Network (**GAIN**));
- ❖ **Flight Data Monitoring (FDM):** (Flight data parameters from an aircraft's onboard recording systems: flight operations, aircraft performance, and incident patterns);
- ❖ **Safety Management Systems (SMS) ;**
- ❖ **Air Traffic Control (ATC) Reporting ;**
- ❖ **Surveillance Systems:** Radar systems, Automatic Dependent Surveillance-Broadcast (ADS-B), and other surveillance technologies (Real-time data transmission from aircraft to ground stations)





1. Sources, Methods and techniques

1.4. Data Analysis Techniques

- ❖ **Statistical analysis:** Identifying patterns and trends ;
- ❖ **Machine learning and Artificial Intelligence algorithms ;**
- ❖ **Predictive modeling and risk assessment ;**
- ❖ **Root cause analysis:** to identify the underlying causes of accidents;
- ❖ **Human factors analysis:** Evaluate the impact of human errors.



1. Sources, Methods and techniques

1.5. Benefits of Data Analysis

- ❖ **Early detection of potential risks ;**
- ❖ **Real-time monitoring and alert systems;**
- ❖ **Evidence-based decision-making ;**
- ❖ **Continuous improvement of safety standards**





II - Legal Framework

2. Legal Framework

Objective:

Understand the **legal framework** of DCA in aviation safety

- ❖ **Legal requirements and regulations** (FDR and CVRs);
- ❖ **Legal obligations : Mandatory Reporting** (Airlines, pilots, other aviation stakeholders);
- ❖ **Legal requirements for implementing an effective SMS** (including DCA);
- ❖ **Legal considerations and regulations : Data Protection and Privacy:** (protection and privacy of individuals' data in aviation safety);
- ❖ **Role of national laws and regulations in DCA for aviation safety**





2.1. International legal framework / Annex 13

While Annex 13 does not specifically address data collection and analysis, it outlines the general principles and processes for gathering and analysis of all relevant evidences.

Chapter 4 - Notification

- **A list of addresses (AIG authorities)** (*Doc 9756 Part I / ICAO/AIG web site*),
- **Forwarding to relevant parties** (most suitable/quickest),
- **Format and content** (even if information are incomplete),
- **Language** (ICAO working languages /the Recipients).





2.1. International legal framework / Annex 13

Chapter 8. ACCIDENT PREVENTION MEASURES

OBJECTIVE :

Promote accident prevention by analysis of accident and incident data and by a prompt exchange of information

- ❖ ***Safety recommendations** 6.8 (any preventive action);*
- ❖ ***Incident reporting systems** (8.1 to 8.3): Mandatory/voluntary incident reporting systems (Doc 9422);*
- ❖ ***Database systems** (8.4 to 8.5): analysis / data exchange;*
- ❖ ***Analysis of data — Preventive actions** (8.6 to 8.8):
preventive actions required. identifies safety Matters; safety recommendations safety studies ;*
- ❖ ***Exchange of safety information** (8.9): Safety information sharing networks through **Cooperation and Collaboration.***





2.1. International legal framework / Annex 13

ATTACHMENT B.

Immediate **notification** and **reporting checklist**

- ❖ **International occurrences:** *accidents and serious incidents occurring in the territory of a Contracting State to aircraft registered in another Contracting State;*
- ❖ **Domestic occurrences:** *accidents and serious incidents occurring in the territory of the State of Registry;*
- ❖ **Other occurrences:** *accidents and serious incidents occurring in the territory of a non-Contracting State, or outside the territory of any State.*





2.2. National legal framework/ Law 40.13:

Article 250 : Mandatory notification

Paragraph 1: « Any accident or serious civil aviation incident occurring on Moroccan territory or in its airspace must be notified immediately by the pilot in command, by the quickest means, to the permanent organization or, failing this, to the authority in charge of civil aviation. »

Paragraph 2: « This obligation also applies, in the absence of the pilot in command, to any crew member, to the airport authority of the aerodrome nearest to the site of the accident or serious incident, and to the local administrative authority. »

Paragraph 3: « The permanent organization sends notification of the accident or serious incident to all States and organizations concerned in accordance with the Chicago Convention ... »

Paragraph 4: « In the event of an aircraft accident or serious incident involving a Moroccan aircraft outside Moroccan territory, and without prejudice to notifications made by any other person, organization or State in accordance with the aforementioned Chicago Convention, the pilot-in-command, or a crew member if either is able to do so, or the owner, operator or charterer, must notify the said accident or serious incident without delay and by the quickest possible means to the permanent organization and to the authority in charge of civil aviation. the owner, the operator or the charterer, must notify the said accident or serious incident without delay and by the quickest possible means to the permanent organization and to the civil aviation authority. »

Law 40.13: Article 266 : Voluntary notification

« Anyone who spontaneously and immediately reports a civil aviation incident to the permanent body referred to in article 240.... may not be subject to any disciplinary or administrative sanction, except in cases where the person concerned has himself, through his action or inaction, contributed to the occurrence of the incident. »



2.2. National legal framework/Technical Instruction :

Article 18 : Obligation to report accidents and incidents

« All aircraft owners, operators, pilots and air navigation service providers **must notify**, *without delay*, the Bureau d'Enquêtes et d'Analyses d'Accidents d'Aviation of any of the civil aviation incidents listed below, using the "**Notice of Incident**" form, by the quickest means available, telephone, fax, e-mail or the Aeronautical Fixed Telecommunications Service Network (AFTSN), in particular :

E-mail : beamaroc@aviationcivile.gov.ma /
Duty : +212 660 181 870
Fax : +212 537 773 015 »

Article 19 : Civil aviation events to be notified to BEAM

Notification of events concerning flight operations (aircraft operations, emergency situations, crew incapacity, meteorology, etc.), aircraft technical components (structure, propulsion and APU systems), air navigation services, etc.

Article 20 : Notification of events not listed

«When deemed useful for the improvement of civil aviation safety, any other event not mentioned in the list **must also be reported.**»



III. Main challenges

3. Main challenges

3.1. Technological challenges.

Data Quality, Availability, Accessibility, Integration and Interoperability : the **integrity, accuracy and reliability** of collected data, the need for standardization and consistency across different **sources and formats** - the importance of accessibility to relevant stakeholders ;

Data Volume and Complexity : requires robust infrastructure, advanced analytics tools, and efficient data processing techniques.



3.2. Environmental and personal challenges

Multifactorial nature of accidents: Aviation accidents typically involve a combination of **human, mechanical, environmental, and organizational factors**. Analyzing such multidimensional data and identifying causal relationships among various factors **can be complex** ;

Data Interpretation: Interpreting and making sense of the collected data can be challenging. Identifying relevant trends, patterns, and correlations within vast amounts of data requires **specialized knowledge, expertise, and domain understanding** ;

Bias and subjectivity: Analyzing accident data requires objectivity and unbiased analysis. However, inherent biases, subjective interpretations, and personal judgments can inadvertently influence the analysis process, potentially leading to inaccurate conclusions and recommendations.



3.3. Regulatory requirements and legal challenges

Legal and Regulatory Compliance: Data collection protocols may impose specific protocols, mandating what data should be collected, how it should be collected, and who can access it. These protocols ensure consistency and accuracy but can **be challenging to implement across different aviation stakeholders** ;

Data sharing and collaboration: legal considerations, intellectual property concerns, and liability issues can **hinder the smooth sharing of data**, impeding the comprehensive analysis required for accident prevention ;

Legal consequences of data analysis: Analysis of aviation accident data can sometimes lead to identifying **potential negligence or non-compliance** with safety regulations. This may result in **legal consequences** for the involved parties. The fear of trial may discourage some organizations from openly sharing data or participating in collaborative efforts, limiting the effectiveness of accident prevention initiatives ;

Compliance with reporting requirements: Failure to comply with these requirements can lead to **penalties and legal consequences**.



3.4. Privacy, confidentiality and Security challenges

The need to **balance** privacy, legal and security concerns with data collection and analysis efforts **while respecting legal and ethical challenges.**

Confidentiality and Reputation: Airlines may be **hesitant** to share certain accident data due to **concerns about reputation, liability, or potential legal consequences.** The fear of negative publicity or damage to their brand can deter them from engaging in open sharing of all relevant information ;

Data Sensitivity: Accident data often contains **sensitive information** about individuals, such as passengers and crew members. This includes **personal** identities, **medical** conditions, and even **potential security vulnerabilities.** Balancing the need for transparency with protecting the privacy of those involved is a challenging task ;

Trust and Cooperation: Airlines, regulators, and investigators must work together to **establish a mutual understanding of data privacy concerns** and the steps taken to address them (clear protocols and agreements regarding the handling, storage, and sharing of accident data).

3.5. Privacy and Security challenges

Public Perception: Balancing the need for transparency in preventing future accidents while respecting the privacy of those affected can be challenging. Disclosing accident data may sometimes raise concerns among the public or victims' families regarding privacy and respect for the victims ;

Anonymization: Ensure that any Personally Identifiable Information (PII) is removed or anonymized to protect their privacy; However, this anonymization process can be challenging while still retaining valuable data in the analysis ;

Security Measures: With the increasing digitalization of data, ensuring the security and integrity of aviation accident data becomes crucial. Safeguarding this sensitive information from unauthorized access, breaches, and cyber threats while maintaining confidentiality is a constant challenge.



IV. Obstacles

4. Main obstacles

4.1. Obstacles related to data

- ❖ Data Fragmentation (Spread across multiple sources, making it challenging to collect and consolidate: Different entities, such as airlines, regulators, and manufacturers, maintain separate databases- Lack of standardized data formats and protocols further complicates the integration of information ;
- ❖ Volume and Velocity of Data (Enormous and increases rapidly, Real-time data collection from various sources, Analyzing vast amounts of data in a timely manner requires advanced tools and techniques to identify patterns and potential risks) ;
- ❖ Separate data Silos and lack of Collaboration (Restricts the comprehensive analysis of data across the industry).



4.2. Obstacles related to reporting and privacy

Reporting inconsistencies: A variety of reporting systems ;

Underreporting or incomplete Voluntary reporting ;

Cultural and language barriers: Global aviation involves diverse cultures and languages. Language barriers may affect the accuracy of accident reports, translation, and data comprehension ;

Data quality and accuracy: Errors, omissions, or subjective judgments in accident reports may lead to flawed analysis and ineffective prevention measures ;

❖ Privacy and Confidentiality.

4.3. Obstacles / Lack of timely and complete data

Inaccurate risk assessment: difficult to accurately assess the risks associated with various aspects of aviation operations and to prioritize preventive actions effectively ;

Inadequate identification of recurring patterns: Without access to timely and complete data, it becomes harder to recognize the patterns that may indicate systemic issues.

Delayed identification of emerging risks: Early detection of new or evolving safety concerns is critical for taking proactive measures to prevent similar accidents in the future ;

Compromised safety research and development: The lack of complete and timely data can hinder in-depth safety research initiatives and therefore the trends analysis (contributing factors, effective preventive measures).



V. Ways to enhance aviation safety and way forward



5.1. Ways to enhance aviation safety

1. Identifying Safety Trends: Aviation authorities and airlines can identify potential safety risks and address them proactively (B737 MAX) ;

2. Predictive Maintenance: This proactive approach minimizes the chances of in-flight system failures and reduces the risk of accidents caused by technical malfunctions (monitoring and analyzing various parameters) ;

3. Risk Assessment: enables proactive risk mitigation and accident prevention (airspace usage, weather patterns, and flight operations...); operators can identify high-risk areas and adjust flight routes, schedules, or procedures accordingly ;

4. Pilot Training and Performance Monitoring: track and monitor pilot performance, identifying areas for improvement or additional training to address specific weaknesses and behavioral ;

5. Post-Incident Investigations: identify root causes and contributing factors and reconstruct events.





5.2. Way forward

- ❖ Increasing **automation** and **digitalization** in data collection ;
- ❖ Integration of emerging technologies like **Artificial Intelligence** and **Big Data**.



Conclusion

The effective collection and data analysis in aviation safety requires **collaboration** among aviation industry stakeholders. By leveraging insights obtained from data analysis, the industry can continuously enhance safety protocols and mitigative measures, ultimately saving lives and preventing accidents.

Addressing these challenges requires implementing **robust data governance practices**, establishing secure data sharing protocols, complying with applicable regulations, and ensuring responsible and ethical handling of the collected data. Striking the **right balance between data privacy and aviation accident prevention** is essential for maintaining public trust and improving aviation safety.

Overcoming those obstacles requires **collaborative** efforts between international aviation organizations, governments, airlines, and stakeholders through the establishment of a **standardized reporting protocols**, a **reporting culture** without fear of retaliations, **investing in data collection and analysis technologies**, and enhancing international cooperation to obtaining timely and complete data for effective accident prevention measures.

Overall, invest in **upcoming technological paradigm** such as **Artificial intelligence** will be the most important challenge for everybody especially for developing and emerging countries.



REFERENCES

Annex 13 - Aircraft accident and incident investigation;

ICAO Doc 9859 - Safety Management Manual, Fourth Edition - 2018;

ICAO Integrated Safety Management website ;

ICAO Doc 9456 'Manual of Aircraft Accident and Incident Investigation, “Part I Organization and Planning”, Second edition, 2015 ;

ICAO Doc 9456 “Manual of Aircraft Accident and Incident Investigation Part III – Investigation” ;

National Law 40.13 ;

Moroccan AIG Technical Instruction.



Q&A ?

Merci de votre attention



Thank you