INTERNATIONAL CIVIL AVIATION ORGANIZATION

Fourth Meeting of the APIRG Infrastructure and Information Management Sub-Group (IIM/SG4)

(Virtual, 31August -03 September 2021)

Agenda Item 5: Implementation of ASBU Modules

WP5.1D - AFI Research, Development and Innovation (RDI) in Aviation

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SUMMARY

This working paper provides the digital technologies opportunities and challenges; calls attention to Air Traffic Management (ATM) community in terms of the ICAO Global ATM Operational Concept (Doc 9854)[1] to embrace digital technologies, early consultations and engagements to develop strategic approach in ATM research, development and innovation (RDI) to assist with Implementation of ASBU Modules and other AFI Operational requirements.

Action:
As recommended in Par. 4

REFERENCE(S):
1. 40th Assembly Session - Resolution 26/2 (Doc 10136, A40-EX)
2. 13th Air Navigation Commission (ANC) Report, Doc 10115

Related ICAO Strategic Objective(s): Safety; Air Navigation Capacity and Efficiency; Security & Facilitation; Economic Development of Air Transport; and Environmental.

INTRODUCTION

1.1 Innovation is critical for the sustainability and survival of Aviation Industry in the future. Innovative and creative thinking are elemental for solving various problems that the industry might face either currently or in the future as well as assisting States to be agile and efficient in their daily operations.

1.2 The digital technologies and innovative methods have brought a sense of excitement to Aviation, including new opportunities for a digital transformation of the Air Traffic Management (ATM). The Aviation industry needs to adapt; as there's no longer the time for a slow adaptation to respond to operational demand.

1.3 The opportunities of digital technologies like Artificial Intelligence (AI), Machine learning, Blockchain, etc. have the potential to accelerate the ATM enhancement goals of improving efficiency, safety; and reliability of service.

1.4 These goals can be achieved through collaboration of researchers, academia, industry, regulator and other stakeholders.

1.5 Numerous civil aviation processes have already been replaced by digital processes, such as electronic strips, electronic aeronautical information management (AIM) databases. It should be noted that this digitisation started as novel idea but now it is widely adopted within the Aviation industry.

[1] ATM Community: The aggregate of organizations, agencies or entities that may participate, collaborate and cooprate in the planning, development, use, regulation and maintenance of the ATM system (ICAO Doc 9854, Appendix A refers).

1.6 Digitalisation is an enabler for enhancing and developing new services to improve efficiency, safety levels, capacity and economic efficiency in Aviation. However, to realise these enablers collaboration and funding is essential.

1.7 Various operational improvements have been identified through the GANP (BBB and ASBU); with key projects and activities so that we are not left behind. However, some of the identified areas of improvements might not address the AFI operational requirements and require different Innovative solutions; the continent might not have the required subject matter experts or skills within the areas of these projects and activities to ensure the successful delivery of these projects and activities; and required funding to deploy the emerging technologies.

1.8 This working paper provides the digital technologies opportunities and challenges; calls attention to Air Traffic Management (ATM) community to embrace digital technologies, early consultations and engagements to develop strategic approach in ATM research, development and innovation (RDI) to assist with Implementation of ASBU Modules and other AFI Operational requirements.

DISCUSSION

The ICAO 40th Assembly Session - Resolution 26/2 (Doc 10136, A40-EX) on Innovation in aviation concluded that:

2.1.1 Whereas Article 44 of the Convention on International Civil Aviation states that among the aims and objectives of ICAO are development of the principles and techniques of international air navigation and fostering of the planning and development of international air transport so as to meet the needs of the people of the world for safe, regular and economical air transport;

2.1.2 Whereas Article 37 of the Convention stipulates that ICAO shall adopt and amend from time to time, as may be necessary, international standards and recommended practices and procedures dealing with […] and such other matters concerned with the safety, regularity, and efficiency of air navigation as may from time to time appear appropriate;

2.1.3 Whereas several ICAO Conferences have recognized the real and potential benefits and challenges that innovation can bring to the safety, efficiency, security, facilitation and to the economic and environmental sustainability of air transport and that Member States should be provided the opportunity to realize these benefits in a manner that leaves no country behind;

2.1.4 Recognizing that ICAO provisions apply to all civil airspace users, and the absence of normative activity at the global level may hamper the realization of innovative technological solutions and prevent the materialization of their benefits in aviation; and to that end ICAO can benefit from continued interaction with industry to identify the latest technological developments their timely integration;

2.1.5 Recognizing that the nature and pace of innovations require regulators at the national, regional and global level avail themselves of new methodologies that facilitate the timely evaluation and assessment of technological developments;

2.1.6 The Assembly: Urges all Member States that have experience in facilitating the introduction of innovation in civil aviation, and that have evolved their regulatory methods to better evaluate and assess the application of such innovations, to share their experience with other States through ICAO.

2.2 There's been a notable rapid growth of the new entrants into the air navigation systems. The digital technologies and innovations in operations above FL 600, supersonic aircraft and commercial space flights, are creating new opportunities and challenges for the Aviation industry. This call for a fundamental change in how things are done and an increase in collaboration.

2.3 The future South African Air Navigation plans to consider concepts such as global aeronautical distress and safety systems (GADSS), big data, Internet of Things (IoT) and a global aviation internet network. It is crucial that the aviation industry take timeous action to monitor and evaluate these developments in a manner that does not leave AFI States behind.

2.4 These technologies are rapidly becoming available across the aviation sector and can lead to more efficient and streamlined aviation processes. There has been increased use of machine learning, artificial intelligence and blockchain in applications developed for aviation which have similar effects for other sectors like banking, health, agriculture, etc. The digital technologies promise to result in improved optimization, efficiency, capacity and more safety, adaptability, to all aviation stakeholders.

Machine Learning

2.4.1 Machine learning is a field of artificial intelligence that focuses on adaptive systems that continuously learns from human interaction and adapts to increase performance.

2.4.2 South Africa (ATNS) has been looking at the use of machine learning to automatically measure the workload of area controllers. A project was started in collaboration with an Original Equipment Manufacturer (OEM) where the eye-tracking technology is used to quantify the workload and use situational analysis to predict the controller actions.

2.4.3 The benefits of machine learning lie in the ability to automate mundane and repetitive tasks to free up the controllers to focus on more safety critical tasks. This will greatly decrease controller workload and potentially improve safety and efficiency of operations.

2.5 Artificial Intelligence (AI)

2.5.1 The ability to learn, improve and predict is the distinguishing factor of an AI system from a traditional software system. The AI system can produce new knowledge based on training and use to new situations. The aviation is faced with uncertainties, operational changes and skills shortage but the industry can exploit the use of AI address the current challenges and empower the industry with the ability of quick decision making and provision of procedures that simple algorithms may not provide.

2.5.2 South Africa (ATNS) has initiated a research project to develop AI-based application for the ATM community. The ATNS research team is developing an artificial intelligence solution that uses speech recognition technology that would effectively prevent Runway Incursions by alerting tower controllers of impending conflicts called ROAST (Runway Occupancy Alert System).

2.5.3 ATNS experiences approximately 6 Runway Incursions (RI) per year. The risk rating associated with these runway (RWY) incursions is usually high, falling into category A (i.e. a serious incident in which a collision was narrowly avoided) and B (i.e. an incident in which separation decreases and there is a significant potential for collision, which may result in a time critical corrective/ evasive response to avoid a collision) events. Runway incursions normally have a high-risk rating because of the small window of opportunity available to either the Air Traffic Controller (ATC) or Pilot for error correction. The 2nd runner up to the ATNS 2019 Innovation Ideas competition proposed a novel method of reducing runway incursions using Fourth Industrial Revolution (4IR) and ATC behaviour encouraging techniques.

2.6 Potential Benefits of Artificial Intelligence

2.6.1 Increased decision-making capabilities within complex and uncertain environments; predictions with less or no information. This will greatly assist with human error especially during traffic and airspace changes.

2.6.2 Applied to speech recognition to act as a safety net; foreseen as an essential tool that will be integral to future ATM operations.

2.7 Blockchain

2.7.1 Blockchain technology is a distributed ledger technology that is used to improve transactional security. A normal ledger is a log of transactions that can capture how transactions are completed, e.g. banking users would log into a banking app and transfer money from one account to another. Transactional logging would include when the user logged in, the balance when the user logged in, when the user transacted to transfer the money, how much money was transferred, how much money was left after transfer and update the account to which the money was transferred to.

2.7.2 Transactional ledgers are susceptible to malicious editing. Blockchain replicates the ledger and stores it across the network of users and continuously synchronises and compares the ledgers. Any

malicious edits to the ledger are then easily traced and audited. ATNS, and other aviation stakeholders, are researching blockchain technology to keep a distributed ledger in the sharing of aeronautical information. GADSS, ATS Interfacility Data Communication (AIDC) and System Wide Information Management (SWIM) requires more sharing of operations information across aviation stakeholders. Blockchain is being researched as an information security technique.

2.7.3 In numerous cases, the digital technologies are improving aviation security, accessibility, safety and sustainability. However, it introduces the elements of information and communication technology (ICT) dependency.

2.7.4 It is not a straightforward transformation; largely due to lack of relevant competencies that understand and can apply the digital technologies in aviation. There's a need to conduct awareness of the capabilities and align with operational and regulatory requirements.

2.7.5 Embracing the digital technologies has allowed ATNS to improve its in-house R&D processes and the development of functional product called BONISA. This fosters collaborative working amongst Internal subject matter expects from different departments.

2.7.6 BONISA (derived from Bonaero Integrated Situational Awareness) is a programme that aims to research ATS display systems to improve situational awareness by providing useful information to the ATCs. The BONISA CID (Controller Information Display) is the first in-house developed and implemented project of the BONISA programme;

2.7.7 The BONISA software is wholly developed by ATNS and does not require any licencing. ATNS would only require procuring hardware for the deployment of the system. Technical support of the final product will be simpler, efficient and cost effective. This an opportunity for ATNS to develop a product that they can own and commercialise;

2.7.8 The initial field demonstration prototype of the BONISA CID has been developed. The BONISA CID is not just aimed at replacing the current Digital Airfield Information Display (DAID) system but to provide added useful functionality for the ATCs and utilise the latest technologies in line with 4IR and other international initiatives;

2.7.9 The BONISA CID prototype is developed using an ATNS R&D developed information exchange platform that support aeronautic and non-aeronautic information exchange and modelling. This platform will become a baseline for an ATNS System Wide Information Management (SWIM); and

2.7.10 The developed CID software is modular and may be deployed at most of the South African airports. A key exception is Cape Town International Airport, which uses a different Automated Weather Observing System (AWOS) from the other airports.

CONCLUSION

3.1 Due to the nature of innovations, it is crucial to continuously evolve and not be left behind.

3.2 The 40th Assembly Resolution 26/2: Urges all Member States that have experience in facilitating the introduction of innovation in civil aviation, and that have evolved their regulatory methods to better evaluate and assess the application of such innovations, to share their experience with other States through ICAO.

3.3 There is a need to align research amongst the AFI States aviation stakeholders to prepare for the future; share relevant experiences so that members are aware of the potential benefits. This will allow AFI to share with other Continents as per A40 Resolution 26/2.

3.4 A greater research collaboration is required within the ATM community because as the technology evolves, it becomes difficult to develop the technical depth to evaluate and facilitate the introduction of the technologies. Therefore, a practice to share the experience, expertise and best practice to support the introduction of new technologies; and co-develop rules.

3.5 Therefore, there's a need for APIRG, its auxiliary body and the ATM community subject matter experts to

consider the following in their respective areas:

3.5.1 Develop the AFI RDI Strategy and Framework; it is important to recognize the need for, and endorse the development of a framework which is not technology specific but can be used to evaluate innovations in a timely manner;

3.5.2 Monitor RDI in aviation;

3.5.3 Identify AFI strategic RDI programmes aligned with AFI State operational requirements;

3.5.4 Foster innovation and extend participation to other technological disruptors in other industries;

3.5.5 Facilitate the sharing of information and RDI by the AFI State aviation community;

3.5.6 Intellectual Property (IP) Management;

3.5.7 Translate ideas into commercialization and ensure commercialization is achieved;

3.5.8 Source RDI funding; and

3.5.9 Conduct cost benefit analysis of new RDI technologies.

ACTION BY THE MEETING

The meeting is invited to:

a) Recognize the potential of the digital technologies and possible applications to ATM community;

b) Work together through collaborative partnerships to achieve benefits for the aviation ecosystem;

c) Recommend incorporation of RDI activities in the work of APIRG; and

d) Support the proposed tasks listed in Par 3.5.

4.2 **Draft Decision 4/xx : Title of Decision**

Incorporation of Research, Development and Innovation (RDI) in APIRG work programme

That the work programmes of APIRG and its auxiliary bodies be amended to include activities related to Research, Development and Innovation (RDI), in order to assist AFI States in addressing the implementation of operational requirements and ASBU modules elements.

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