FINAL REPORT

AVIATION INFRASTRUCTURE GAP ANALYSIS IN AFRICA (2023)

AND 25-YEAR FORECAST FOR AIR TRAFFIC DEMAND

EXECUTIVE SUMMARY

In January 2018, the African Union (AU) launched the Single African Air Transport Market (SAATM) initiative with the goal of developing a seamless African airspace architecture that ensures safe, efficient, harmonised, and interoperable air navigation services across the continent. As part of this initiative, the AU, in collaboration with the African Civil Aviation Commission (AFCAC) and the International Civil Aviation Organization (ICAO), and with support from the major Airspace Users (AFRAA & IATA members), various stakeholders and African member states, conducted a comprehensive aviation infrastructure gap analysis. This analysis aimed to identify deficiencies in airport and air navigation infrastructure and services, and aircraft fleet and equipage, with traffic projections spanning the next 25 years. The ultimate objective is to create a clear roadmap for achieving a seamless airspace and air navigation systems architecture, capable of handling the anticipated increase in traffic once SAATM is fully operational. The anticipated roadmap will address challenges related to aviation safety, airspace capacity, harmonised procedures, regulations and the efficiency of air transport operations. Achieving seamless operations of air navigation systems requires investment in and implementation of harmonized, interoperable and integrated air navigation infrastructure, supported by modern technologies aligned with the ICAO Global Air Navigation Plan Technology Roadmaps. These encompass air navigations systems i.e., air traffic management, communications, navigation, surveillance, aeronautical information management etc., and requisite (required) aircraft avionics equipage.

The 2018 IWAF/3 Declaration and Framework for development of an Aviation Infrastructure for Africa called upon African States and the aviation stakeholders, among others, to develop aviation infrastructure programmes and plans at national/regional levels based on a robust business case analysis, commensurate with the level of predicted traffic growth, and consistent with the ICAO Global Plans. The 2023 Aviation Infrastructure for Africa Gap Analysis conducted by the AUC, AFCAC, ICAO and other partners through the TWG, was done based on collaborative and cooperative approach, with success in the data collected. Compared to 2019 data collection on aviation infrastructure gap analysis, the data collection was a success. Forty-two (42) States submitted the data captured in this Report. The data provide is considered a reasonable sample across the continent that meet the objectives of the gap analysis.

The study also determined the passenger traffic forecasts for the short, medium and long- term, as well as the forecast of aircraft movement for the period 2025-2050. Factors influencing growth include growing African economy and population. African population growth is expected to reach 2 billion by 2050, resulting in an increase demand in traffic. An econometric model was used to forecast passengers and a market share approach for cargo. The forecasts revealed a projected passenger traffic of 223 million, 273 million and 469 million for 2025, 2030 and 2050 respectively, from a 2024 base of 160 million. Aircraft movements were derived from the forecasted passengers, seat, and load factor. The study revealed that passengers are expected to triple by 2050 and air traffic numbers are also expected to double by 2050

The survey collected large volume of data with detailed information. For section A- Part 1, 115 submissions were received from 41 States and 98 airports and for section A Part 2, 68 submissions from 34 States and 56 airports. Data collected for ANS were categorized as follows: (a) Air Traffic Management (ATM); (b) Communications, Navigation and Surveillance (CNS); (c) Aeronautical Information Management (AIM); and (d) Aeronautical Meteorology (MET). For section B-Part1 100 submission were received from 40 States and 72 airports and Part 2 – 74 submissions from 40 States and 71 airports. Section C on aircraft fleet and equipage, received 213 submissions from 111 air operators. The gap analysis focused on key high level infrastructure related items. It was essential to define appropriate parameters to define the gaps.

The data collected were analysed following several steps including: data cleaning and preparation, consolidation, aggregation and ensuring the integrity of data. The TWG further developed and adopted criteria to undertake the gap analysis. The gaps were identified by benchmarking and prioritisation. The outcome of the gap analysis was categorized and presented as gaps under (a) Aerodrome and Ground Aids (AGA), (b) Air Traffic Management (ATM); (c) Communication, Navigation and Surveillance (CNS); (d) Meteorology (MET) Gaps and (e) Aircraft fleet and equipage.

Eleven major gaps were identified for AGA, including lack of Airport Master Plan and Airport Certification as the most major gaps. Twelve major gaps were identified for ATM/SAR/AIS/PANSOPS including: lack of PBN

implementation at the regional (Enroute, Terminal and Approach) and lack of implementation of improved operation through enhanced Enroute. In the area of aeronautical Communications, Navigation and Surveillance systems for Air Traffic Management (CNS/ATM), the identified gaps were reclassified based on the Aviation System Block Upgrade (ASBU) and the Africa Indian Ocean (AFI) Planning and Implementation Regional Group (APIRG) Frameworks. Two other significant issues were recommended to be considered in the gap analysis – (a) Flight Testing of Navigational Aids and (b) Interruption of GNSS Signals. The major gaps identified were (a) COMI-B0/7 ATS Message Handling System (AMHS); (b) COMI-B1/1 Ground-Ground Aeronautical Telecommunication Network/Internet Protocol Suite (ATN/IPS); (c) FICE B0/1 Automated basic Inter-facility Data exchange (AIDC) (d) ASUR-B0/3 - Cooperative Surveillance Radar Downlink of Aircraft Parameters (SSR-DAPS). For MET nine major gaps were identified. Nine major gaps were identified for aircraft fleet and equipage, i.e. RVSM, TCAS, ETOPS (EDTOPS), RSP 180, PBCS OPERATIONS, RCP 240, CPDLC, 1 HF and VHF.

The Aviation Infrastructure for Africa Gap Analysis project is an important step towards the identification and development of bankable projects, programs, and plans at national/regional levels. The outcomes of the Aviation Infrastructure Gap Analysis should feed into the AFI ANS Master Strategy for Seamless Sky (25years) using the consolidated list of costed bankable projects that will be identified and developed in the next phase. These projects will form the basis of the implementation plan for the ANS Master Strategy and roadmap in the short term, medium term, and long term.

This plan is aimed at enhancing safety, capacity efficiency and sustainability in the provision of Air Navigation Services through harmonization of operations and procedures, implementation of Performance Based Navigation (PBN) in the terminal area and en-route, assignment and allocation of common secondary surveillance radar (SSR) codes and investment in interoperable and integrated CNS/ATM systems.

This report will be presented at the next meeting of the AUC STC TTIIE tentatively scheduled for December 2024, and thereafter, the development of bankable projects, the continental seamless airspace and air navigation infrastructure master plan.

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LIST OF ACRONYMS

ACC	Area Control Center
ACDM	Airport-Collaborative Decision Making
ACI	Airport Council International
ADS-B	Automatic Dependent Surveillance-Broadcast
AfDB	African Development Bank
AFI	Africa- Indian Ocean
AFRAA	African Airlines Association
AGA	Aerodromes and Grounds Aids
AMAN	Arrival Management System
ANS	Air Navigation Services
ANSP	Air Navigation Service Provider
APIRG	AFI Planning and Implementation Group
ASBU	Aviation System Block Upgrade
ASDE	Airport Surface Detection Equipment
ASECNA	L'Agence pour la sécurité de la navigation aérienne en Afrique et à Madagascar
ATC	Air Traffic Control
ATCT	Air traffic Control Tower
ATFM	Air traffic Flow Management
ATFCM	Air Traffic Flow and Capacity Management
ATFMU	Air Traffic Flow Management Unit
ATM	Air Traffic Management
ATNS	Air Traffic and Navigation Services
AU	African Union
AUC	African Union Commission
AUDA	African Union Development Agency
BAGAIA	Banjul Accord Group Accident Investigation Agency
BAGASOO	Banjul Accord Group Aviation Safety Oversight Organization
BOT	Build-Operate-Transfer
CANSO	Civil Air Navigation Services Organisation
CASSOA	Civil Aviation Safety and Security Oversight Agency
CDM	Collaborative Decision Making
CNS	Communications, Navigation and Surveillance
COMESA	Common Market for Eastern and Southern Africa
DMAN	Departure Management System
FAA	Federal Aviation Administration
FIR	Flight Information Region
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ISO	International Organization for Standardization

IWAF	ICAO World Aviation Forum
MET	Meteorology
NAS	National Airspace
NEPAD	New Partnership for Africa's Development
PBN	Performance-Based Navigation
RASG	Regional Aviation Safety Group
RFFS	Rescue and Fire Fighting Services
RNAV	Area Navigation
RNP	Required Navigation Performance
SAATM	Single African Air Transport Market
SASO	SADC Aviation Safety Organization
SDGs	Sustainable Development Goals
SME	Subject Matter Expert
SSR	Secondary Surveillance Radar
SWIM	System Wide Information Management
TA	Technical Assistance
TCM	Terminal Capacity Model
TFM	Traffic flow management
TRACON	Terminal Radar Approach Control Facilities
TWG	Technical Working Group
VHF	Very High Frequency

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CHAPTER 1: INTRODUCTION

1.1 Background

1.1.1. The African aviation market holds the greatest growth potential among global regions due to its large and increasing population. Despite this, the continent has not yet experienced consistent and significant air traffic growth. The aviation industry is constrained by lack of air transport liberalisation and inadequate aviation infrastructure. African states and aviation stakeholders face challenges in securing funds and financing for modernizing and expanding infrastructure. Additionally, the industry is hindered in the short term by a shortage of adequately trained aviation professionals.

1.1.2. Uncertainty about the continuation of air services negatively impacts inward investment in the tourism and travel industry, as well as opportunities for inbound tourism, making the potential loss of service even more costly. In this context, enhancing the use of aviation as a development tool aligns with ICAO's aspirational goal of eliminating constraints related to market access, infrastructure, capacity, technology, and financial resources for aviation development. It also supports the achievement of the African Union (AU) Agenda 2063 and the United Nations 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs).

1.2 Objectives of the Aviation Infrastructure for Africa Gap Analysis

The overall objective of the aviation infrastructure gap analysis was to identify the existing gaps in aerodromes and, air navigation infrastructure and aircraft equipage on the African continent in order to develop bankable projects that will address the gaps. The gap analysis was expected to serve as key input in the development of regional and national aviation infrastructure programmes that will support the establishment of a Seamless Airspace Architecture for Africa, taking into consideration the 25- Year Traffic forecast.

1.3 Scope of the Aviation Infrastructure for Africa Gap Analysis

The Infrastructure Gap Analysis Project covered the entire African continent and was conducted for 12 months from June 2023 until June 2024, including the 25-year forecasts of air traffic demand. To achieve the desired goal of project, the scope of work covered:

a) International Aerodromes;
b) Air Navigation Services;
c) Aircraft fleet Type and Equipage; and
d) 25 years forecast of air traffic demand.

1.4 Aviation Infrastructure Gap Analysis 2019

1.4.1 Reference is made to decisions of APIRG/22 and RASGAFI/5 Joint Sessions and outcomes of the 22nd meeting of the AFI Plan Steering Committee (Kampala, Uganda, 15 May 2019), including the 2019 Aviation Infrastructure for Africa Gap Analysis which was conducted by the AFI Plan Secretariat in response to ICAO Council Decision (C-DEC 24/7) on the implementation of the IWAF/3 Declaration and Framework for a Plan of Action for Development of Aviation Infrastructure in Africa.

1.4.2 In 2019, ICAO conducted and concluded an aviation infrastructure gap analysis as a follow-up to the above-referred IWAF/3 Declaration and Framework for a Plan of Action for Development of Aviation Infrastructure in Africa (November 2017). Only 26 African member States responded to the infrastructure questionnaires circulated by ICAO and hence the results were not representative of all African Member States. In addition, the outcomes were only validated for five years beginning 2019.

1.4.3 While considering the findings of the survey conducted in 2019, it must be noted that the impact of the COVID-19 Pandemic had a profound effect on the aviation industry since 2020, which could impact negatively on the base information to be used for future feasibility studies. The impact of the Pandemic had a profound

effect on the aviation industry in that ANSPs, Airports, Airlines and MET Offices on the African Continent, were all affected.

1.4.4 The gap analysis was conducted by ICAO regional offices through a detailed State survey, and complemented with information from the ICAO with the following outcomes:

1.4.4.1 International Airports

a) 70% of international Airports not certified;
b) 35% of international Airports with inadequate pavement strength;
c) 42% of international Airports with insufficient emergency plans/perimeter;
d) 20% of international Airports with inadequate (Rescue and Fire Fighting Services (RFFS) capacity;
e) 18% of international Airports without adequate passenger/cargo terminal capacity
f) 18% of international Airports with insufficient apron capacities;
g) 17% of international Airports with deficient electrical power systems;
h) 15% of international Airports without adequate airfield lighting systems;
i) 9% of international Airports facing runway/taxiway dimension problems; and
j) 8% of international Airports without adequate screening and Machine-Readable Travel Documents (MRTD) equipment.

1.4.4.2 Air Navigation Services

a) 35% of international Airports without PBN;
b) 95% of States have no ATM Master plan;
c) 95% of AFTN networks implemented;
d) 15% ATS Message Handling Systems (AMHS) implemented;
e) 5% ATS Inter-Facility Data Communications (AIDC) implemented;
f) 50% Controller-Pilot Data Communications (CPDLC) coverage;
g) 0% implementation of VHF Data Link;
h) 97% Ground aids/GNSS navigation systems implemented;
i) 3% augmented GNSS (SBAS) implemented;
j) 64%SSR-S,57%ADS-C,16%ABS-B,3%MLAT implemented;
k) 78%e-AIP, 70% e-TODD, 80% AIS/AIM Plans implementation;
l) Availability rate of OPMETs increased to 97% over time; and
m) Implementation of Volcanic Ash contingency procedures is at a very low stage of about 36%.

1.4.4.3 Airlines

a) Low connectivity - 27% of services among African States;
b) Direct traffic from SAATM States is mainly to Europe and intra-Africa, while traffic from SAATM to other regions is carried mainly through connecting flights;
c) In terms of international frequencies, 76% of the intra-Africa market served by African carriers;
d) In terms of origin-destination passengers, for 14 African States, over 50% of international passengers are carried by African carriers;
e) Airlines of all African States had an average load factor of 70.8% in 2017 (lower than the world average of 82%); and
f) 27 African States are party to Cape Town Convention.

1.4.5 Given the devastating impact of COVID 19, the relevant lockdowns which had been put into place and the economic impact of these actions on the status of the aviation industry, there was need for the 2023 Aviation Infrastructure Gap Analysis as a basis for the continental master plan for the seamless airspace to be established.

1.5 Role of Air Transport

1.5. 1 Connecting Africa through air transport is pivotal for facilitating the seamless movement of goods, people, and services across the continent. The air transport sector is not only a significant generator of direct and indirect employment opportunities but also a vital incubator for developing critical skills within the African workforce. Moreover, it has a positive ripple effect on auxiliary sectors, most notably tourism, by enhancing accessibility and attractiveness and a logistic engine for operationalisation of the AfCFTA.

1.5.2 Air transport services play an essential role in bolstering Africa's connectivity with the global economy. In this context, the liberalization of the African air transport market has emerged as a cornerstone for regional integration. By reducing barriers and encouraging competition, air transport liberalization fosters economic growth, enhances efficiency, and promotes sustainable development. This strategic initiative aligns with the broader goals of the African Union's Agenda 2063, which envisions an integrated, prosperous, and peaceful Africa, driven by its own citizens and representing a dynamic force in the global arena.

1.6 Road to African Liberalization

1.6.1 African Member States agreed to liberalize the intra-African air transport services when on 7 October 1988 the Yamoussoukro Declaration was adopted. In 2000, the AU Assembly adopted the Yamoussoukro Decision (YD) relating to the implementation of the Yamoussoukro Declaration made by the Ministers. The YD provides:

a) the full liberalization of intra-African air transport services in terms of market access, the free exercise of third, fourth and fifth freedom traffic rights for scheduled and freight air services by eligible airlines; and
b) the full liberalization of frequencies, tariffs, and capacity.

1.6.2 The framework for Air transport liberalization in Africa which is the Yamoussoukro Decision has evolved towards the establishment of a Single African Air Transport Market (SAATM) under the leadership of the African Union with AFCAC as the designated Executing Agency. A prioritized Action Plan was established for the implementation of SAATM, and AFCAC has developed measurable performance indicators to evaluate the implementation of SAATM. There is a need to strengthen the advocacy and promotion efforts to subscribe to and build the necessary capacity for the implementation of SAATM by Member States, as well as ensure market access through the granting of traffic rights, unrestricted free exercise of third, fourth and fifth freedom traffic rights.

1.6.3 As of February 2024, thirty-seven AU States had declared their solemn commitment to SAATM namely: Benin, Burkina Faso, Botswana, Cabo Verde, Cameroon, Central African Republic, Congo, Côte d'Ivoire, Chad, Democratic Republic of Congo, Egypt, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Mali, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Eswatini, Togo, Zambia, Zimbabwe and São Tomé and Príncipe, and Angola. Africa is a heterogeneous landscape, with disparity in national incomes. Whilst it is desirable for all AU member States to commit to SAATM, it is a truism that not all these States will be able and willing to fully open their air transport markets at the same time[1].

1.7 Outcomes of the Third ICAO World Aviation Forum (IWAF/3)

The Third ICAO World Aviation Forum (IWAF/3) that was hosted in November 2017 by the Government of the

[1] *Eighteen States are still to declare their solemn commitment to SAATM are: Algeria, Burundi, Comoros, Djibouti, Eritrea, Libya, Madagascar, Malawi, Mauritania, Mauritius, Sahrawi, Seychelles, Somalia, South Sudan, Sudan, Tanzania, Tunisia, and Uganda.*

Federal Republic of Nigeria in cooperation with the African Union Commission (AUC), African Development Bank (AfDB) and New Partnership for Africa's Development (NEPAD) Planning and Coordination Agency (now the African Union Development Agency (AUDA-NEPAD), brought together Ministers, high-level decision-makers, financial institutions and international organizations responsible for transport and infrastructure, finance, economy, tourism and sustainable development to explore the benefits of the aviation sector to the social, economic development and prosperity. Furthermore, the forum aimed to facilitate funding and mobilization of financing required to accelerate the implementation of international civil aviation global standards and policies, as well as the ICAO Global Plans for aviation. The Forum tackled existing and future financing challenges facing quality aviation infrastructure and capacity development, especially in Africa.

1.8 Declaration and Framework for a Plan of Action for the Development of Aviation Infrastructure in Africa

1.8.1 The Concluding Communiqué of the IWAF/3 included a Declaration and Framework for a Plan of Action for Development of Aviation Infrastructure in Africa, which was adopted within the framework of the Lomé Plan of Action (2017 –2019) of the AU adopted at the First Ordinary Session of the AU Specialized Technical Committee (STC) on Transport, Transcontinental and Interregional Infrastructure, Energy and Tourism, in Lomé, Togo on 17 March 2017 and endorsed at the Thirty-First Ordinary Session of the AU Executive Council through Decision EX.CL/Dec. 970 (XXXI). The Declaration called upon African States and African Regional Economic Communities (RECs) to take a set of specific actions, in cooperation and coordination with the AUC, NPCA, AfDB, UNECA, AFCAC, the African Airlines Association (AFRAA) and international partners.

1.8.2 With the launching of the Single African Air Transport Market and in consistency with the Declaration a prioritized action plan in which gap analysis for aviation infrastructure continued to feature, was adopted through the AU, AFCAC and AfDB to support its realization.

1.9 AUC, AFCAC, and ICAO Follow Up Work

1.9.1 The ICAO Council at its 213th and 214th Sessions considered, among other things, the calls of the Declaration and decided that ICAO's activities and actions indicated in the Declaration and Framework for a Plan of Action for Development of Aviation Infrastructure in Africa be implemented under existing arrangements, especially under the ICAO Comprehensive Regional Implementation Plan for Aviation Safety in Africa (AFI Plan) as a specific identifiable programme with timelines.

1.9.2 The AFI Plan Steering Committee at its 21st meeting held in Niamey, Niger on 17th July 2018 decided that the AFI Plan Secretariat should prepare an appropriate programme with timelines to implement the required actions including conducting a gap analysis indicated under the ICAO Council Decision on the Implementation of the Declaration and Framework for a Plan of Action for Development of Aviation Infrastructure in Africa.

1.9.3 During the 13th Air Navigation Conference (AN-Conf/13) held in Montréal, Canada, from 9th to 19th October 2018, African States under AFCAC, presented WP/220 on the Implementation of a plan of action for development of aviation infrastructure in Africa. The Conference supported the initiative and requested ICAO to support the implementation of an action plan under the Comprehensive Regional Implementation for Aviation Safety in Africa (AFI Plan).

1.9.4 Activity 1 and Activity 5 of Pillar 4, Aviation infrastructure Improvement under the JPAP/SAATM request the AUC in collaboration with AFCAC and ICAO to undertake Gap Analysis on Airspace Infrastructure Needs in the Continent undergoing development.

1.9.5 In this framework, the AUC first elaborated in collaboration with the AFCAC draft Terms of Reference (ToR) to carry out the feasibility study on the Gap Analysis of the Aviation Infrastructure in Africa. The AUC also requested the financial support of the World Bank, which agreed to fund the cost of undertaking the Continental Study on the Gap Analysis of the Aviation Infrastructure in Africa.

1.10 ICAO and United Nations 2030 Agenda Sustainable Development Goals (SDGs)

1.10.1 ICAO Assembly Resolution A39-25 urges Member States to enhance their air transport systems by effectively implementing SARPs and policies while at the same time including and elevating the priority of the aviation sector into their national development plans supported by robust air transport sector strategic plans and civil aviation master plans, thereby leading to the attainment of the United Nations Sustainable Development Goals (UN SDGs).

1.10.2 The Thirteenth ICAO Air Navigation Conference (October 2018) specifically recommended that States:

a) establish a defined connection between their air navigation and safety plans, as well as other relevant national plans;

b) include clear references to the UN SDGs in their air navigation and safety plans, as well as in other relevant national plans, with the objective of showcasing the contribution of aviation to the UN SDGs and national economies;

c) engage with States to promote the importance of aviation development, taking into consideration environmental and socio-economic aspects, and to include aviation within their relevant national plans, and, as necessary, national budgeting, which might be vital to unlocking funding for aviation needs; and

d) develop guidance for States to include aviation within their relevant national plans taking into consideration global and regional planning.

1.10.3 The Third ICAO World Aviation Forum (IWAF/3) held in Abuja, Nigeria in November 2017 adopted a Communique and the Declaration and Framework for a Plan of Action for Development of Aviation Infrastructure in Africa which will be implemented with the African Union Programme for Infrastructure Development in Africa (PIDA) and included in its priority projects for the period 2020- 2030, in cooperation with AfDB, AUC and African Union Development Agency (AUDA-NEPAD). Amongst others, the 2017 Abuja Ministerial Declaration and Framework for a Plan of Action for Development of Aviation Infrastructure in Africa highlighted the need for the conduct of an aviation infrastructure gap analysis for African States and a study on capacity building.

1.10.4 The GANP which was developed in collaboration with and for the benefit of all stakeholders, is a key contributor to the achievement of ICAO's Strategic Objectives and has an important role to play in supporting the United Nations 2030 Agenda for Sustainable Development. A key goal that relates to the GANP is Sustainable Development Goal (SDG) 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

1.11 Global and Regional Requirements

1.11.1 The Gap Analysis was conducted against relevant global and regional requirements as contained in the following reference documents and frameworks:

a) The Global Aviation Safety Plan (GASP, ICAO Doc 1004);
b) The Global Air Navigation Plan (GANP, ICAO Doc 9750);
c) The Global Aviation Security Plan (GASeP, ICAO Doc 10118)
d) The AFI Air Navigation Plan (ANP, ICAO Doc 7474);

e) The Revised Abuja Safety Targets (as revised in 2024);
f) The Windhoek Declaration and Targets for Security and Facilitation (adopted in 2015);
g) The Planning, Implementation and Monitoring mechanisms through Regional Groups established by ICAO, including:
   i. the AFI Planning and Implementation Regional Group (APIRG);
   ii. the AFI Regional Aviation Safety Group (RASG-AFI);
   iii. the AFI Comprehensive Regional Implementation Plan for aviation Safety in Africa (AFI Plan); and
   iv. the AFI Comprehensive Regional Implementation Plan for Security in Africa (AFI SECFAL

Plan).

1.11.2 The overall purpose of the Global Plans is to guide the harmonized development of regional and State planning, supported by regional activities coordinated by the established regional groups. The Global Plans seek to assist States and regions in their respective policies, planning and implementation by:

a) establishing the global priorities and Global Plan objectives;
b) providing a planning framework, timelines, and guidance material; and
c) presenting implementation strategies and a global aviation roadmap to address the procedures and methods to achieve the Global Plan objectives and set specific priorities at both State and regional levels as well as the role of industry partners.

1.12. African Union and the Agenda 2063

1.12.1 The African Union (AU) launched in January 2018 the Single African Air Transport Market (SAATM) initiative, which is one among twelve flagship projects of the AU Agenda 2063. The AU assembly decision (Assembly/AU/Decl.1(XXIV): Declaration on the Establishment of a Single African Air Transport Market) urged the AUC in collaboration with the African Aviation Stakeholders to develop by 2023 a seamless African Airspace Architecture that would provide safe, efficient interoperable air navigation services throughout the continent. As part of this initiative, the AUC in collaboration with AFCAC and ICAO with the support of Member States, IATA, AFRAA, ATNS, ASECNA, ACI Africa, AfDB, BAGAIA, BAGASOO, SatNav JPO, CASSOA, SASO, Roberts FIR, Southern Africa Airlines Association and others undertook a continental aviation infrastructure gap analysis with the objective of establishing the gaps existing in the airports and Air Navigation Infrastructure and services with a traffic projection of 25 years. The seamless African Airspace architecture will also complement two other AU agenda 2063 projects, i.e. the African Continental Free Trade Area (AfCTA) and the freemen of persons and goods.

1.12.2 The ultimate goal will be to develop a clear roadmap for achieving a seamless airspace and Air Navigation Systems Architecture to cope with the expected increase in traffic once the SAATM is fully operationalized, while addressing associated challenges in terms of aviation safety, airspace capacity and effectiveness of air transport operations in a seamless environment as well as ensuring that States grant each other air transport market access. Seamlessness of the Air Navigation systems operations should be achieved through investment and implementation of interoperable and integrated air navigation infrastructure supported by modern technologies consistent with the ICAO Global Air Navigation Plan Technology Roadmaps for air traffic management, communications, navigation, surveillance, information management and avionics.

CHAPTER 2: METHODOLOGY

2.1 Technical Working Group

2.1.1 A Technical Working Group (TWG) as indicated in Appendix B, to this report, was established to develop a Strategy and Work Plan to carry out the continental Aviation Infrastructure Gap Analysis together with the 25-year forecasts of air traffic demand. The membership of the TWG was drawn from Member States Experts, AUC, AFCAC, ICAO, IATA, AFRAA, ATNS, CANSO Africa, ASECNA, ACI Africa, AfDB, BAGAIA, BAGASOO, COMESA, SatNav JPO, CASSOA, SASO, Roberts FIR, Southern Africa Airlines Association, and other stakeholders.

2.1.2 The mandate of the Technical Working Group was to:

a) Complete the data collection, validate the data collected and validate the results of the gap analysis.
b) Review the Global and Regional Air Navigation Planning and Implementation Framework and Gap Analysis Initiatives in Africa, including ICAO Aviation Infrastructure Gap Analysis for Africa (2019) and AUC Gap Analysis for Air Navigation Services in Africa (2023).
c) Review and adopt the Draft Terms of Reference (ToR) and Draft Rules of Procedures of the Technical Working Group (TWG).
d) Consider aspects related to Seamless Airspace and ANS architecture in Africa.
e) Develop proposals for a coordinated Strategy and draft Work Plan to undertake the continental Gap Analysis as well as Seamless Airspace and ANS architecture.

2.1.2 The project Technical Working Group developed various documents for the successful implementation of the Project as follows:

a) Project document
b) Responsibility Matrix
c) Work Packages
d) Project Roadmap and Gantt Chart
e) Roster of Regional Support Teams for the 5 AU Regions-Southern, Northern, Eastern, Western and Central.

2.1.3 The Project Document consisted of twelve (12) Work Packages. The work plan, WP-02 called for the development of a Coordination Strategy and Responsibility Matrix for the implementation of the Aviation Infrastructure Gap Analysis Project.

2.1.4 The Coordination Strategy and Responsibility Matrix for the implementation of the Aviation Infrastructure Gap Analysis in Africa covered the guidelines and various strategies that were adopted such as Monitoring and Evaluation, and the Responsibilities for the various entities involved in the Project.

2.1.5 The main goal of the TWG was to ensure successful data collection. Experience from ICAO and IATA provided useful lessons on the collection of similar data. It was necessary for the project plans to allow more time in the collection of data, sensitize States and State experts on the data requirement and data collection process, ensure the scope of the study is aligned to the ICAO 2019 study, adequate planning and preparation for activities, ensure the active collaboration of all the key stakeholders, and ensured continuous monitoring and updates on progress regarding the data collection.

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2.1.6 The TWG strategized to gather information from publicly available documents, including but not limited to reports, maps, and meeting minutes from ICAO, the IATA, CANSO, ACI, AFRAA, major airlines based in the region and operating in the region. The data gathering was done using approved data collection instruments and platforms.

2.1.7 The different work packages required subject matter expertise and specific skill sets. The Responsible Entity for each work package had to identify the subject matter Experts required. Focal Points and/or resource persons within the State or organization were identified to support the project, especially on data gathering.

2.1.8 The TWG had regular virtual follow up to monitor the progress of the Project. The Focal Persons were responsible for giving feedback on the progress as required.

2.1.9 The success of the project was achieved through the participation of all the Stakeholders. The responsibility matrix indicated the role of the various stakeholders in the project. Where an entity was responsible for a particular work package and needed to consult other entities, the Responsible Agency ensured allowed for such consultations, using the most effective communication means.

2.1.10 Communication within the project was accomplished through writing, via emails/online, virtual by teleconference, by videoconference, WhatsApp groups, or in-person meetings. AFCAC was responsible for coordinating the communication between members of TGW. Where two or more entities were responsible for the delivery of a particular work package, the Lead Agency or Responsible Entity would plan the appropriate means of communication to deliver the work packages, including meetings. Following the completion of any work packages, the deliverables were communicated to AFCAC. AFCAC would thereafter inform the TWG. For efficiency, AFCAC used sub-expert groups to review certain deliverables before they were presented to the TWG.

2.2 Funding the project, Budget, and mobilisation of resources

2.2.1 AUC, with the support of the World Bank was responsible for mobilizing and providing the Project funding for hosting the in-person meetings of the TWG. All entities were responsible for facilitating and funding the work packages assigned to them.

2.3 1st TWG Meeting for the Aviation Infrastructure Gap Analysis for Africa

2.3.1 AFCAC, AUC and ICAO jointly coordinated and convened the 1st Technical Working Group (TWG) meeting from 27th to 30th June 2023 in Casablanca, Morocco to launch the 2023 Aviation Infrastructure Gap Analysis in Africa. The overall objective of the workshop was to mobilize all concerned stakeholders to provide from the onset their technical expertise through the Technical Working Group. The workshop outcomes included:

a) Project Document;
b) TWG Rules of Procedures;
c) Matrix of Roles and Responsibility and Coordination Strategy; and
d) Work Plan and Gantt chart for the conduct of the Africa-wide Aviation Infrastructure Gap Analysis.

2.3.2 In order to achieve the objectives of the Project, a total of 8 virtual follow-up meetings of the TWG were convened between November 2023 and April 2024. In addition, the TWG determined that there was a need for an awareness and sensitization session for Member States and all stakeholders.

2.4 1st Follow up TWG Virtual Meeting

The 1st Follow up TWG Virtual Meeting was held on 6th October 2023 and attended by members of the TWG as a follow-up on the action plan for the Aviation Infrastructure Gap Analysis Project. The TWG considered the following:

a) Reviewed WP001 and the work plan adopted in Morocco;
b) Adopted WP002 – Draft coordination strategy including a responsibility matrix for the implementation of the project.
c) Reviewed WP003 – the designed assessment questionnaire and relevant tools.
d) WP004 – Review and approval of the gathering tools and questionnaire
e) Planning for WP005 – Sensitization and awareness of States about the data gathering method and tools.

2.5 Member States and Stakeholders awareness and sensitization session

The awareness and Sensitization Session for Member States and stakeholders was held virtually on 2nd November 2023. Nominated Experts from member States/Organizations attended the sensitization and awareness virtual session on the questionnaires and Data Gathering Tools to support the achievement of the successful outcome of the project. Participants included technical personnel from CAAs and industry (Airlines, Airports, ANSPs, etc.) responsible for Aviation Safety as well as Air Navigation Capacity and Efficiency related matters.

2.6 2nd Follow up TWG Virtual Meeting

The 2nd Follow up TWG Virtual Meeting was held on 6th October 2023. The meeting considered the following:

a) Feedback and Adoption/Approval of Questionnaire by TWG;
b) Presentation of Revised Gantt chart by AUC/AFCAC;
c) Presentation of Regional Data Gathering Monitoring Teams by AFCAC; and
d) Way Forward and Next Steps.

2.7 3rd Follow up TWG Virtual Meeting

The 3rd Follow up TWG Virtual Meeting was held on 14th December 2023. The TWG considered the following:

a) Updates from the Southern Region;
b) Updates from the Eastern Region;
c) Updates from the Central Region;
d) Updates from the Western Region;
e) Updates from the Northern Region;
f) Updates from the Airlines;
g) Updates from the ICAO Data Collection Centre; and
h) Way Forward and Next Steps.

2.8 4th Follow up TWG Virtual Meeting

The 4th TWG Follow up Virtual meeting was held on 9th January 2024 and covered the following Agenda:

a) Updates from the Southern Region;
b) Updates from the Eastern Region;
c) Updates from the Central Region;
d) Updates from the Western Region;
e) Updates from the Northern Region;
f) Updates from the IATA and AFRAA on their member Airlines;
g) Updates from the ICAO Data Collection Centre; and
h) Way Forward and Next Steps.

2.9 5th Follow up TWG Virtual Meeting

The 5th TWG Follow up Virtual meeting was held on 9th January 2024 and considered the following:

1) Initial report on data collection by ICAO Data Collection Centre;
2) Report from IATA/AFRAA on member airlines data collection;
3) Updates from the Southern Region;
4) Updates from the Eastern Region;
5) Updates from the Central Region;
6) Updates from the Western Region;

7) Updates from the Northern Region; and
8) Way Forward and Next Steps – Extended data collection deadline from 19th January to 23rd February 2024.

2.10 6th Follow up TWG Virtual Meeting

The 6th TWG Follow up Virtual meeting was held on 16th February 2024 and covered the following Agenda:

a) Updates from the ICAO Data Collection Centre;
b) Updates from the Airlines;
c) Updates from the Southern Region;
d) Updates from the Eastern Region;
e) Updates from the Central Region;
f) Updates from the Western Region;
g) Updates from the Northern Region; and
h) Way Forward and Next Steps- Conclusion on the data collection process.

2.11 7th Follow up TWG Virtual Meeting

The 7th TWG Follow up Virtual meeting was held on 7th March 2024 and covered the following areas:

a) Updates on Member States Data Collection;
b) Updates on Airlines Data Collection; and
c) Way Forward and Next Steps – Clean-up of data and quality check.

2.12 8th Follow up TWG Virtual Meeting[2]

The 8th TWG Follow up Virtual meeting was held on 19th April 2024 to consider the following areas:

a) Updates on Data Consolidation and Aggregation;
b) Updates on Data Clean-up and Analysis;
c) Updates on 25-year Traffic Forecast; and
d) Way forward and Next Steps (including Proposed 2nd Physical TWG Meeting date and venue).

2.13 2nd TWG Meeting for the Aviation Infrastructure Gap Analysis for Africa

2.13.1 After nine months of work and implementation of the project work plan, the African Union Commission in collaboration with AFCAC and ICAO organized the second TWG workshop from the 25-28 June 2024, at the AUC Head Quarters, Addis Ababa, Ethiopia. The second TWG Workshop considered the following agenda items:

a) Project Background and Implementation Progress
b) Data Collection Report
c) 25 Years Traffic Forecast for Air Traffic Demand
d) Data Analysis Report
e) Draft Outcomes and Report
f) Seamless airspace and ANS architecture
g) Bankable projects to address Aviation Infrastructure gaps; and
h) Draft Roadmap for development of seamless airspace and ANS Architecture

2.13.2 The workshop brought together 55 participants representing various organizations and States as members of the Technical Working Group (TWG), including: AU Member States, regional and international organizations

[2] *Reports of the various follow-up meeting are achieved at the project secretariat.*

- AUC, AFCAC, AFRAA, UNECA, ICAO (WACAF & ESAF), Member States experts, RECs (COMESA), IATA Africa, ACI Africa, ANSP (ATNS, ASECNA, Roberts FIR), CANSO-Africa and RSOOs (BAGAIA, BAGASOO, SASO), AfDB and World Bank.

2.13.3 The 2nd TWG meeting offered an opportunity to share information, and experiences and assist in formulating the objectives, scope, and methodology of the regional and national aviation infrastructure programmes as well as the development of a civil aviation master plan for Africa. It also served as a platform to increase familiarization with the requirements of Global and Regional plans in relation to quality aviation infrastructure, explore data collection aspects and the methodology for detailed gap analysis, and share information on the development of Aviation Master Plans.

2.13.4 During the sharing of experiences on similar Aviation Infrastructure Gap Analysis exercises conducted in different regions by TWG experts, the following key issues were highlighted:

a) Development and implementation of national and regional civil aviation master plans is key to addressing gaps in infrastructure and as such, it was recommended that States should promote the importance of aviation development, noting that aviation contributes significantly to national, regional and global economy;
b) The scope of aviation infrastructure projects is very large and thus, a long timeframe from planning to completion should be observed, usually with multiple adjustments to the original plan along the way;
c) Civil aviation master plans should be linked to ICAO's Global and Regional plans, as well as the national development framework;
d) Identified aviation infrastructure gaps, as well as their causes, should be quantified, remedy identified and included in the civil aviation master plans; and
e) Given the limited availability of resources and funds, bankable projects in line with identified infrastructure gaps and development banks' requirements should be developed to meet the continent's needs, and ensure sustainability in closing the gaps.

2.14 Regional Support Teams

The members of the Project Technical Working Group (TWG) were assigned to the 5 AU Geographical Regions to provide the necessary support and guidance through the NCMC or nominated focal person in Member States responsible for the coordination of the data collection exercise. In addition, the ICAO Regional Offices accredited to respective States provided additional guidance and support, as necessary. The Regional Support Teams are indicated in Appendix A.

2.15 Tools and Techniques

2.15.1 The user (each State) was required to complete as many questionnaires as existing international airports. The online data gathering tools developed by ICAO, configured using Microsoft form, consisted of five questionnaires distributed through 10 links in English and French:

a) Two for section A (international aerodromes – (Part I and Part II);

b) Two for section B – Air Navigation Services (Part I and Part II); and

c) for Section C (Aircraft Feet and Equipage) in English/French.

2.15.2 Section A Part 1 had 195 questions and could be completed in 85 minutes if the respondent had all the required data available. Part 2 had 32 questions and could take 17 minutes to complete.

2.15.3 Section B Part 1 had145 questions requiring at least 53 minutes to complete while Part 2 of the questionnaire had 199 questions requiring at least 22 minutes to complete. Section B: Air Navigations Services also had two parts and four links. Data for Sections A and B were collected by Member States and submitted to ICAO.

2.15.4 Section C had 26 questions designed by IATA and 25 questions by ICAO. This Section could take 10

minutes to complete per fleet. Section C: Aircraft fleet and equipage – has just one part with two links (1 in English and 1 in French). The Airlines were required to complete as many questionnaires as the existing type of fleet operated by the Air Operators.

2.15.5 The online questionnaires were accessible in both English and French through the following links:

a) EN - 2023 - SAATM - Section A - Part I - International Aerodromes - V1.0 - https://forms.office.com/r/2A3MBu2750

b) EN - 2023 - SAATM - Section A - Part II - International Aerodromes - V1.0 - https://forms.office.com/r/2qGJCkeKqu

c) EN - 2023 - SAATM - Section B - Part I - Air Navigation Services - V1.0 - https://forms.office.com/r/pbMfNB44uR

d) EN - 2023 - SAATM - Section B - Part II - Air Navigation Services - V1.0 - https://forms.office.com/r/LNPTdZ9Udn

e) EN - 2023 - SAATM - Section C - Aircraft Fleet and Equipage V1.0 - https://forms.office.com/r/wbPz1JL6yD

f) FR - 2023 - MUTAA - Section A - Partie I - Aérodromes Internationaux - V1.0 - https://forms.office.com/r/hsqyX8knKT

g) FR - 2023 - MUTAA - Section A - Partie II - Aérodromes internationaux- V1.0 - https://forms.office.com/r/uR67hXp8YE

h) FR - 2023 - MUTAA- Section B - Partie I - Services de la navigation aérienne - V1.0 - https://forms.office.com/r/Xed3dHyUnt

i)FR - 2023 - MUTAA - Section B - Partie II - Services de la navigation aérienne - V1.0 - https://forms.office.com/r/LakGRJVBb1

j)FR - 2023 - MUTAA - Section C - Flotte d'avions et équipements V1.0 - https://forms.office.com/r/Kha7aNSZwm

2.15.6 *Statistical Software:* Used tools like R, Python, SPSS, or SAS for statistical analysis.

2.15.7 *Geographic Information Systems (GIS):* Utilized GIS software for spatial analysis and mapping.

2.15.8 *Data Visualization Tools:* Employed tools like Tableau, Power BI, or Excel for creating visual representations of the data.

2.15.9 *Project Management Tools:* Used software like Microsoft Project to manage tasks and timelines throughout the Project.

CHAPTER 3: DATA COLLECTION

3.1 Awareness and sensitization session

3.1.1 Following the awareness and sensitization session, AFCAC distributed the Data Collection Package to all the Member States on the 27th of November 2023. The package included:

a) Guidelines for data gathering using the online Questionnaire;

b) The Links to access the online questionnaires; and

c) Regional Support Teams for Aviation Infrastructure Gap Analysis Data Collection.

3.1.2 The users required internet access and a Microsoft 365 (office) license as a prerequisite to use the Microsoft Form of the questionnaires. However, if these conditions were not fulfilled, the user could resort to the paper version of the questionnaire in English or French.

3.1.3 Structural limitations – the paper questionnaire contained 630 questions whilst each Form allowed up to 200 questions. Unlike a paper questionnaire, the lines could not be added to the online questionnaire and just one person had to fill the questionnaire. There was need for internal coordination among users to collect the data. The original link could be shared among several users.

3.1.4 IATA and AFRAA sent questionnaires for Section C to their member airlines while the Civil Aviation Authorities in Member States distributed the relevant questionnaire to non-IATA and non-AFRAA registered airlines.

3.1.5 Given that IATA has conducted globally such surveys to its member airlines, the TWG agreed that IATA would use existing questions for the purposes of data collection. After data collection, both IATA and AFRAA de-identified the names of the airlines from the data collected and submitted the collected data to ICAO for aggregation.

3.1.6 Respondent were provided with an opportunity to raise any questions or concerns relating to the exercise through the focal persons. The questionnaire used dropdown menus as well as open-ended questions with space to provide more detailed responses. It was possible for the user to stop filling the questionnaire at any time and resume the process later on. It was also possible to edit the responses already entered.

3.1.7 ICAO provided a User Manual on the Procedure to answer the questionnaire including instructions on:

a) Prerequisites;

b) Distribution with names of the various files in English and French;

c) Opening and filling the questionnaire. Questions with asterisk (*) were compulsory and must be completed;

d) Reviewing and/or resuming the filling of the questionnaire and (v) Creating an account in Microsoft.

3.2 Data Collection Strategy and Process

3.2.1 The Continental Aviation Infrastructure in Africa covering Airports, Air Navigation Services and Air Operators with respect to fleet capacity was conducted jointly by AUC, AFCAC, ICAO, in collaboration with Member States, IATA, AFRAA, ATNS, RSOOs, Regional Economic Communities, Air Navigation Service Providers and other key stakeholders. The data obtained from the survey were supplemented by additional information and Secondary data from various stakeholders.

3.2.2 The survey strategy and process flow that were applied are summarized by the Gantt Chart in **Figure 3.1** below:

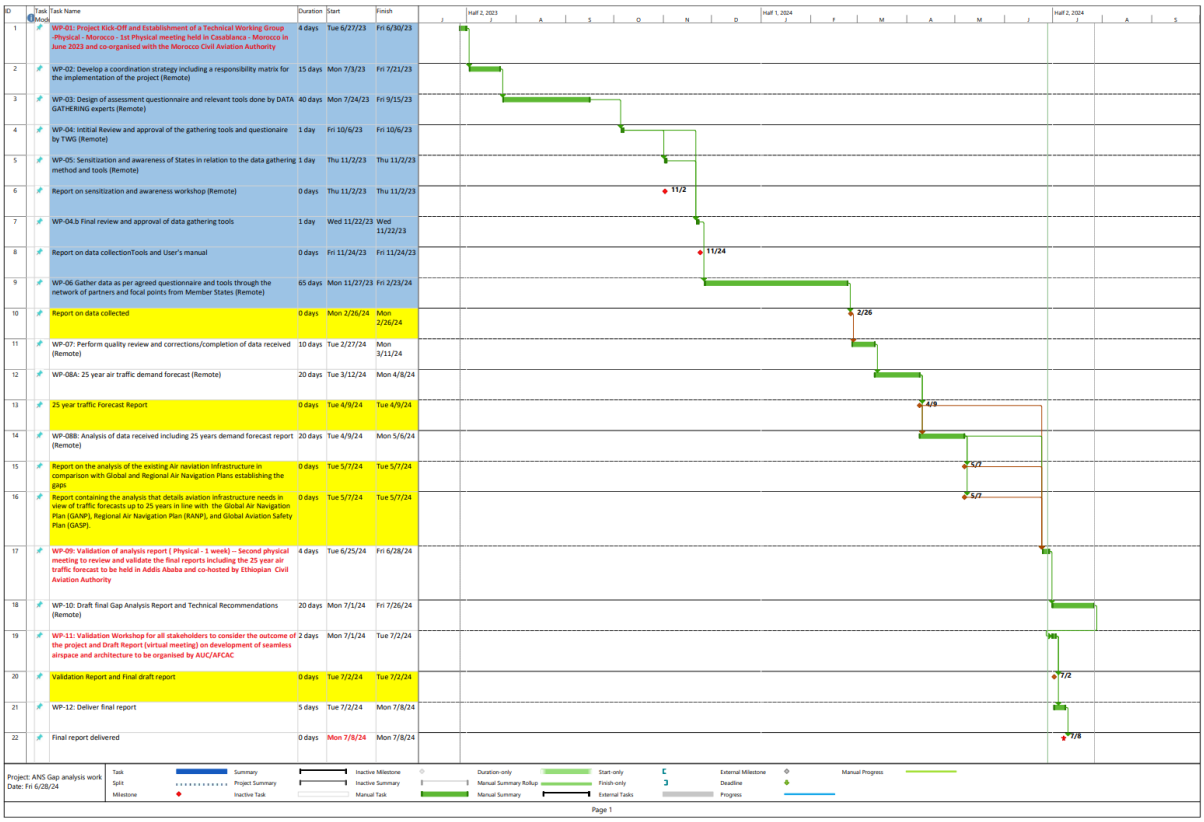

Figure 3. 1: Survey Process Flow - Gantt Chart

3.2.3 The survey questionnaire was sent to all African States, out of which 41 States (77%) responded. The 41 States were monitored through a weekly reporting dashboard as shown below:

41 State i.e. 77% responded

Flow of collected data for the SAATM

Data collection on Aviation Infrastructure Gap Analysis in Africa / Weekly reporting dashboard

	Online + paper questionnaires received		Section A International aerodromes		Section B Air Navigation Services		Section C Aircraft and Equipage	
	Week #		Part I	Part II	Part I	Part II	ICAO + AFRAA	IATA
Kick-off	# 01	01/12/2023	0	0	0	0	0	?
	# 02	08/12/2023	0	0	0	0	0	?
	# 03	15/12/2023	4 / 1 State	3 / 1 State	3 / 3 Entities	2 / 2 Entities	0	?
	# 04	22/12/2023	6 / 3 States	4 / 2 States	3 / 3 Entities	2 / 2 Entities	0	?
	# 05	29/12/2023	6 / 3 States	4 / 2 States	3 / 3 Entities	2 / 2 Entities	3	?
	# 06	05/01/2024	8 / 5 States	6 / 3 States	10 / 5 Entities	5 / 3 Entities	4	?
	# 07	12/01/2024	17 / 10 States	14 / 9 States	24 / 13 Entities	10 / 8 Entities	10	?
Deadline # 01	# 08	19/01/2024	48 / 22 States	40 / 21 States	50 / 24 Entities	33 / 20 Entities	26	?
	# 09	26/01/2024	53 / 31 States	44 /27 States	51 / 29 Entities	39 / 25 Entities	35	?
	# 10	02/02/2024	57 / 31 States	48 /27 States	53 / 31 Entities	42 / 26 Entities	37	?
	# 11	09/02/2024	61 / 33 States	49 / 27 States	61 / 32 Entities	49 / 29 Entities	42	?
	# 12	16/02/2024	64 / 34 States	49 / 27 States	68 / 35 Entities	51 / 30 Entities	47	?
Deadline # 02	# 13	23/02/2024	108 / 39 States	65 / 34 States	95 / 38 Entities	67 / 66 Entities	47	?
	Until end of April		115 / 41 States	68 /34 States	100 / 40 Entities	74 / 40 Entities	56	55

NB : Responses may come from CAA, providers or operators — Last update : 04/30/2024

Figure 3. 2: Monitoring the flow of data submission

Figure 3. 3: Major airport location within Member States

3.3 Aviation Infrastructure Gap Analysis Data

The collected data is accessible on Link to dashboard on data to allow stakeholders visualize the data in an interactive format.

CHAPTER 4: 25 YEAR FORECAST FOR AIR TRAFFIC DEMAND

4.1 Introduction

Aviation is the fastest mode of transportation, allowing people and cargo to reach their destinations more quickly and efficiently than any other method. It also significantly contributes to tourism and economic growth, particularly in developing countries. In recent years, excluding the impact of COVID-19, the AFI region has seen growth in air travel, likely due to improved intra and inter-Africa connectivity and other socio-economic factors. Air traffic forecasting is essential for planning and deploying air navigation infrastructure, as well as for capacity and resource management.

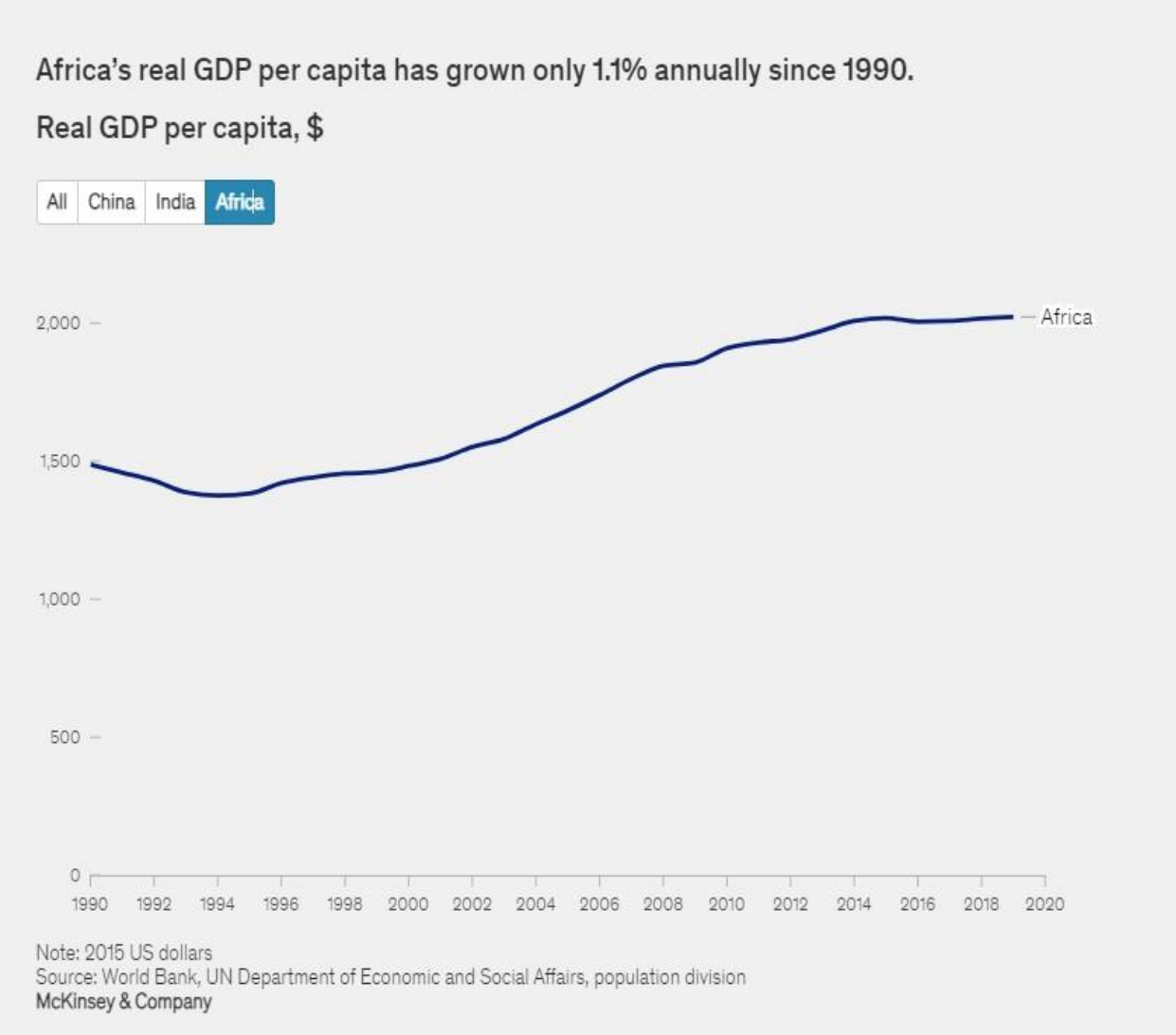

Figure 4. 1: Africa Real GDP per Capita, (1990-2020)

4.2 Regional Trends

4.2.1 Economic Trends

4.2.1.1 The expected overall, real gross domestic product (GDP) growth for the continent is on average 3.8% and 4.2% in 2024 and 2025, respectively. This is higher than the projected global averages of 2.9% and 3.2%. The continent is set to remain the second-fastest-growing region after Asia. According to McKinsey, Africa is home to the world's youngest and fastest-growing population, burgeoning cities, and bold innovations in everything from fintech to clean energy. With its population expected to nearly double to 2.5 billion people by 2050, the continent presents myriad opportunities for robust, inclusive growth that harness its rich natural resources and abundant human potential to increase prosperity not only in Africabut around the world.

4.2.1.2 From 2000 to 2010, real GDP grew at an average rate of 5.1 percent annually from an annual average of only 2.5 percent in the previous decade. Growth slowed to 3.3 percent per year between 2010 and 2019.

4.2.2 Passenger and Air Traffic Trends

4.2.2.1 Air travel in Africa is on a robust pre-pandemic recovery passenger traffic which mirrors a global trend, with some regions exceeding pre-pandemic levels. The African region passenger trend was going upward before the pandemic, and this is also shown by the resilience of the recovery within the region. It is anticipated that air travel in the region will surpass pre-pandemic levels in the current year (2024).

4.2.2.2 According to ACI, Cairo International Airport recovered and surpass pre-pandemic levels by 2022 and it is the only one in the top ten passenger numbers. The top ten airports in terms of total passengers represented 50% of overall passenger traffic in Africa in 2022. The passenger traffic in Africa is quite dependent on the international passenger traffic. When analysing the air traffic by sub-region, the Northern region dominated the passenger traffic with a share of 45% in 2022, which is normal with 4 airports in the region in the top ten ranking. The Southern region followed with a 21% share, strongly driven by airports in South Africa. The Eastern and Western sub-regions had a similar share at around 16% whereas the Central sub-region had a share of 1%.

AIRPORTS COUNCIL INTERNATIONAL

TOP 10 AFRICAN AIRPORTS IN TERMS OF PASSENGER TRAFFIC 2022

2022 RANK	2021 RANK	2019 RANK	AIRPORTS	COUNTRY	PAX 2022	% change vs 2021	% change vs 2019
1	1	2	Cairo International Airport	Egypt	20 009 336	76.3%	5.4%
2	2	1	OR Tambo International Airport	South Africa	14 789 508	80.3%	-31.4%
3	6	4	Cape Town International Airport	South Africa	7 875 425	65.5%	-28.3%
4	9	5	Mohammed V Airport	Morocco	7 559 854	82.6%	-27.7%
5	5	8	Hurghada International Airport	Egypt	7 164 088	46.0%	-4.5%
6	7	3	Addis Ababa Bole International Airport	Ethiopia	6 656 516	45.2%	-44.5%
7	10	6	Jomo Kenyatta International Airport	Kenya	6 556 569	65.0%	-21.0%
8	3	9	Murtala Muhammed Airport	Nigeria	6 526 034	14.6%	-10.2%
9	13	7	Alger Houari Boumédiene Airport	Algeria	6 317 793	190.7%	-19.4%
10	4	14	Nnamdi Azikiwe International Airport	Nigeria	5 985 596	13.4%	10.7%

Figure 4. 2: Africa's Top 10 Airports in terms of Passenger Traffic 2022

4.2.2.3 The graph below shows the analysis of the region from 2019 before the pandemic to 2023. During the five years OR Tambo International airport leads with air traffic movements. Egypt leads with passenger traffic followed by South Africa. South Africa and Kenya are also led with cargo followed by Egypt and Ethiopia. Ethiopia is led with air traffic movements followed by Algeria. International passengers which are playing a crucial role in the growth of the aviation industry and economy represents 64% of total passengers.

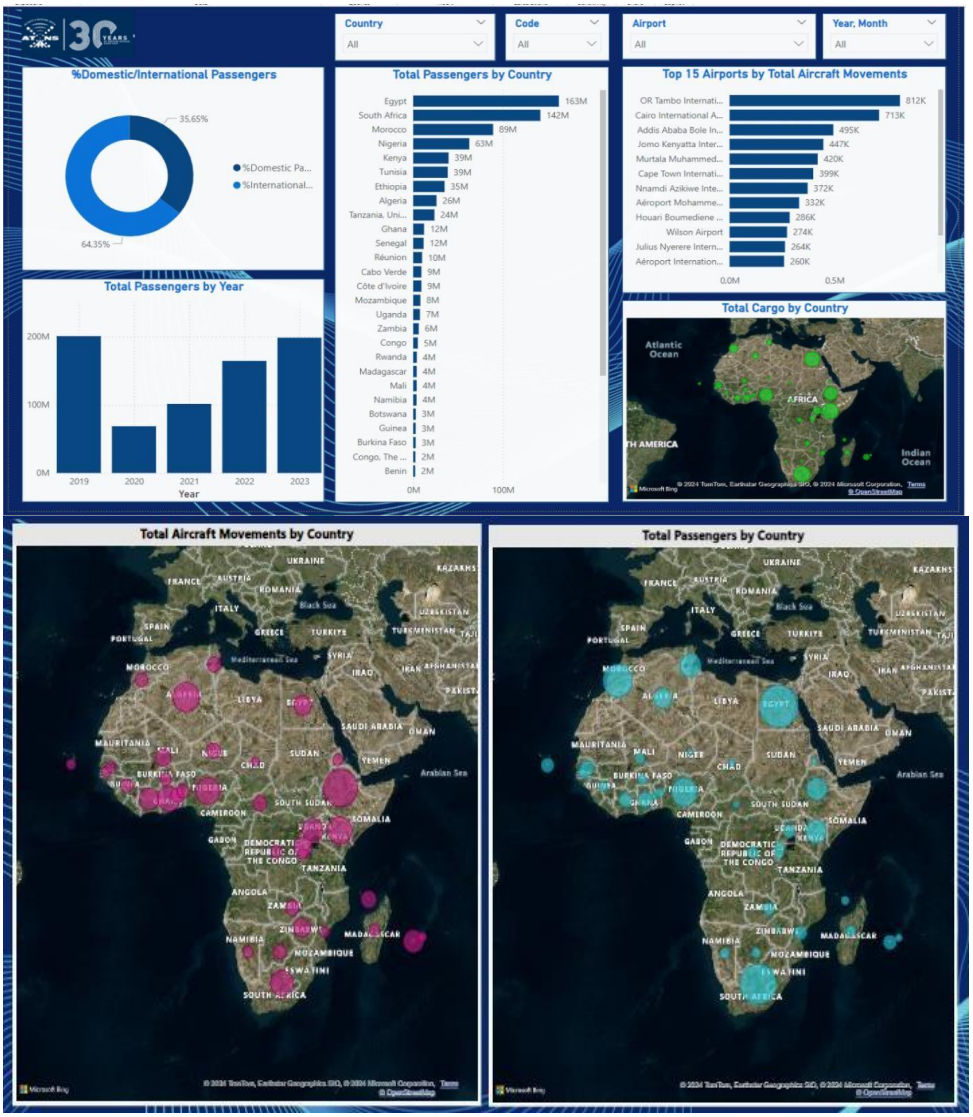

Figure 4. 3: Analysis of the region from 2019 to 2023

4.3 Forecast Methodology

4.3.1 Investigated historical air travel activities to look into the trends for different segments like passengers, cargo, and air traffic movements. The demand for air travel was primarily determined by income levels, demographics, and the price of air travel.

4.3.2 The forecast was categorized into the following:

a) Short-term forecasts (2025-2030);
b) Medium-term forecasts (2025-2035); and
c) Long-term forecasts (2025-2050).

4.4 Forecast Approach

4.4.1 The adopted forecasting approach is generally used in air traffic forecasting of relating historic

traffic demand to the trends of indicators driving traffic demand, specifically social economic indicators. The historic relationship between air traffic and socio-economic drivers was statistically assessed using multiple regression analysis, through an iterative process to establish the validityof relationships. These relationships are supported by economic theory. Various combinations of social economic variables were tested, and the most suitable regression model was adopted.

4.4.2 The econometric model is critical in forecasting the annual passenger numbers which later are converted to air traffic movements, by making assumptions on theseats per ATM, load factor and passengers per ATM. The cargo movements use a market share approach. It should be known that even where models weredeveloped, the forecasts incorporate a significant element of judgement.

4.4.3 Grouping of the major routes to, from and within the African region was done. The major route groups relate to the following region-pairs:

a) Intra Africa;
b) Africa – Europe;
c) Africa – Middle East;
d) Africa – Asia;
e) Africa – North America; and
f) Africa – South America.

4.4.4. The econometric model for all the major routes was combined and not separated according to their routes. The data obtained was consolidated and not divided according to the routes, this resulted in the following formula for the model:

Ln (Pax) = 0.68Ln (Africa GDP) + 0.54Ln (Real GDP / Capita Europe) + 1.09Ln (RealGDP / Capita Asia) + 0.09Ln (Real GDP / Capita N. America) - 0.20Ln (Real GDP / Capita S. America) – 0.11Ln (Real GDP / Capita Middle East) $R^2 = 0.99$

4.5 25-Years Traffic Forecast

4.4.5 The above socio-economic relationship was tested and shows a better relationship with the historic passenger numbers. The passenger air traffic to, from and within the region for the period 2024-2050 is expected to increase at an average annual rateof 4.32%[3]. The short, medium, and long-term forecasts will be shown in the table below.

Table 4. 1: The 25-Year passenger forecast

Year	2024	2030	2035	2050
Passengers	160m	222m	273m	469m
Average annual growth rate %		5.56%	4.97%	4.21%

[3] The passenger traffic average growth rate is within the range reported by ICAO long term traffic forecast 2018-2050. ICAO REPORT ON THE UPDATED LONG-TERM TRAFFIC FORECASTS WITH POST-COVID-19 PANDEMIC SCENARIOS. https://www.icao.int/Meetings/a41/Documents/WP/wp_014_en.pdf

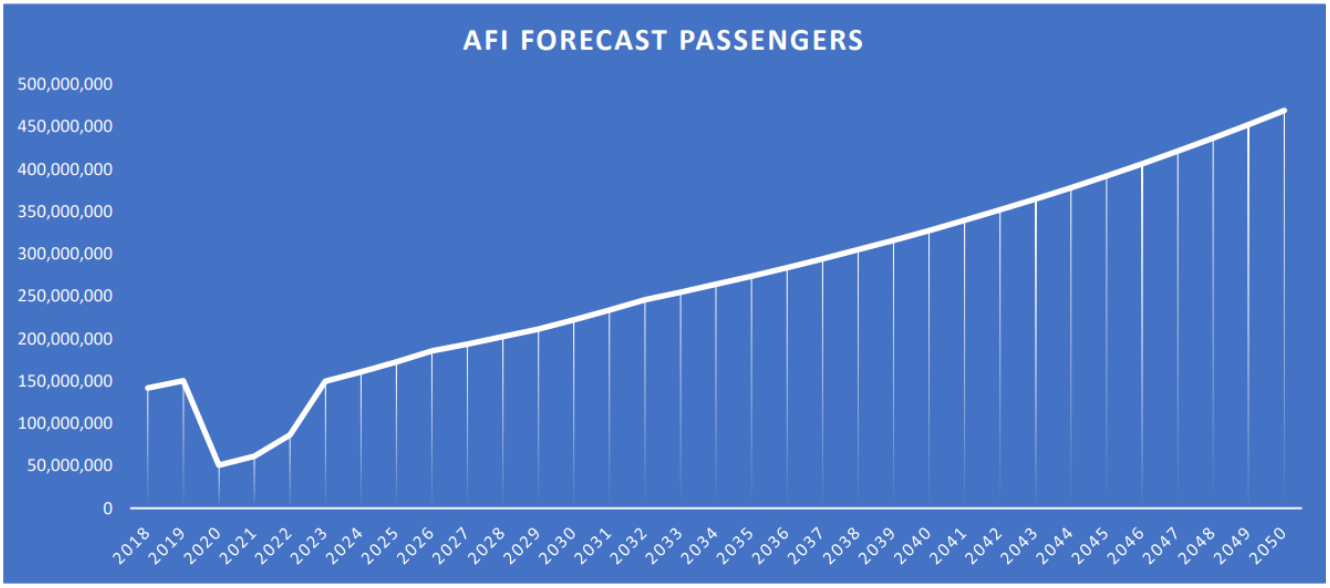

Figure 4.4: The Passenger Air Traffic Forecast to, from and within the AFI region for the period 2018-2050

4.4.6 Having established the passenger traffic growth rate for short, medium and long-term, the forecast of aircraft movement growth rates for the period 2025-2050, were developed using a stepwise design (top-down approach) and assumptions related to the future evolution of load factors and average aircraft seats over the same period. The table below shows the future trends in the load factors and average aircraft seats.

Table 4. 2: future trends in the load factors and average aircraft seats

	2024	**2030**	**2035**	**2050**
Seats	165	174	182	208
Load factor	63	66	69	76

Assumptions were made on seats and load factor. Similarly, a top-down approach was used.
4.4.7 The table below shows air traffic movements and average annual growth rate. The short-term forecast is represented by 2030, medium-term forecast is represented by 2035 and lastly long-term forecast is represented by 2050.

Table 4. 3: Air traffic movements and average annual growth rate

Year	**2024**	**2030**	**2035**	**2050**
Pax ATM	1.55m	1.92m	2.18m	2.95m
Cargo ATM	216k	296k	360k	590k
Total ATM	1.77m	2.22m	2.54m	3.54m
Average annual GR % (Pax ATM)		3.68%	3.14%	2.50%

Average annual GR % (CargoATM)		5.34%	4.73%	3.93%
Average annual GR % (Total ATM)		3.89%	3.35%	2.71%

4.5 Busiest Airports in Africa

4.5.1 To have a quick glance on what is currently happening within the region we assess the busiest airports based on the number of scheduled passenger flights and exclude freighters or chartered flights.

1. OR Tambo International Airport with a daily average of **251** flights
2. Cairo International Airport with a daily average of **243** flights
3. Addis Ababa Bole International Airport with a daily average of **194** flights
4. Jomo Kenyatta International Airport with a daily average of **123** flights
5. Mohammed V International Airport with a daily average of **104** flights
6. Cape Town International Airport with a daily average of **103** flights
7. Murtala Muhammed International Airport with a daily average of **101** flights
8. Houari Boumediene Airport with a daily average of 100 flights
9. Tunis-Carthage International Airport with a daily average of **83** flights
10. Nnamdi Azikiwe International Airport with a daily average of **79** flights
11. Marrakech Menara Airport with a daily average of **79** flights
12. Dar Es Salaam International Airport with a daily average of **75** flights
13. Zanzibar International Airport with a daily average of **70** flights
14. Kotoka International Airport with a daily average of **57** flights
15. King Shaka International Airport with a daily average of **53** flights

4.6 Conclusions on 25-Year Forecast for Air Traffic Demand

4.6.1 Factors influencing the traffic growth include growing African economy, population growth expected to reach **2 billion by 2050**, resulting in an increase demand in traffic.

4.6.2 In terms of methodology, an econometric model was used to forecast passengers and market share approach for cargo.

4.6.3 Aircraft movement was derived from the forecasted passengers, seat, and load factor.

4.6.4 Forecast revealed that passengers are expected to **triple by 2050** and Air traffic numbers are also expected to double by 2050.

CHAPTER 5: GAP ANALYSIS DATA PROCESSING

5.1 Key High Level Priority Infrastructure Items

The Gap analysis was conducted based on responses to the questionnaires which were received from **41** Member States. These responses were of varying degrees of detail. To the extent possible, additional data and information from the ICAO database and other available sources was utilized in the case of non-respondent African States to fill-in other missing details. Due to the large volume of data and detailed information covered by the survey, it was considered necessary, in analysing the gaps, to identify and focus on key high level infrastructure related items and determine the appropriate parameters to define the gaps.

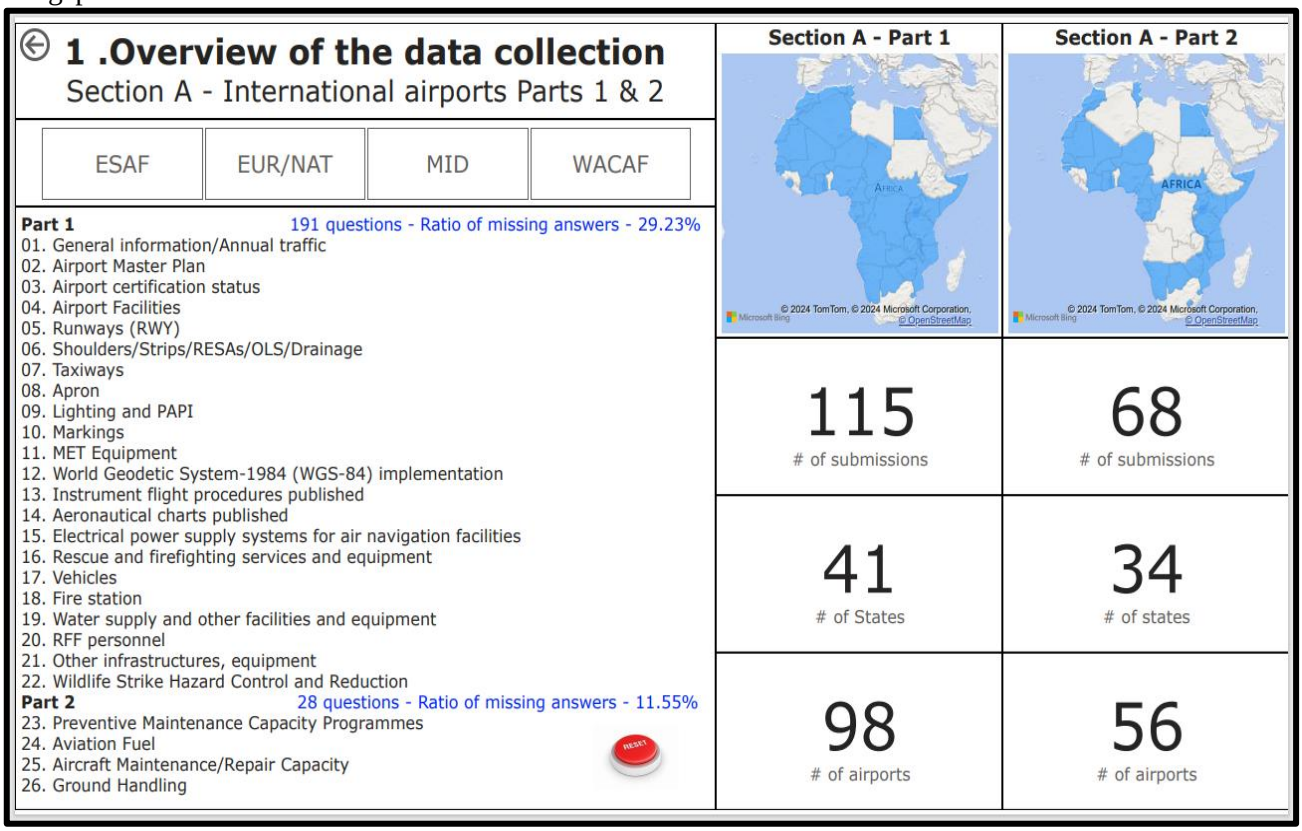

Figure 5. 1: Overview of the data collection-Section A-International Airports

5.1.1 International Airports (AGA)

The Data collected for International Aerodromes

5.1.1.1 Certification (certified VS not certified) – Yes or No

5.1.1.2 Runway/Taxiway (RWY /TWY) Capacity:

a) RWY /TWY Dimensions - (length/width versus annual number of movements of each type of aircrafts using the runway) – Adequate or Non adequate;
b) Pavement Strength - (Pavement Classification Number (PCN) versus annual number of movements of each type of aircraft using the runway) - Adequate or Non adequate; and
c) RWY/TWY numbers - (Aerodrome traffic density versus Actual runways/taxiways layout) - Adequate or Non adequate.

5.1.1.3 Apron Capacity - (Aerodrome traffic density versus Actual number of parking positions) - Adequate

or Non adequate.

5.1.1.4 Passenger Terminal Capacity - (Annual passengers' traffic (taking into account peak hours) versus Terminal design capacity) – Passengers Terminal occupancy rate.

5.1.1.5 CRG Terminal Capacity - (Annual cargo traffic (taking into account peak hours) VS Terminal design capacity) – Cargo Terminal occupancy rate.

5.1.1.6 Aerodrome RFFS - (Actual aerodrome RFFS category versus annual number of movements of each type of aircraft using the aerodrome) - Adequate or Non adequate.

5.1.1.7 Machine readable travel documents (MRTD) - (Annual passenger traffic (taking into account peak hours), versus number of available equipment) - Percentage lack of equipment.

5.1.1.8 Passenger/Personnel/Bag Screening Equipment - (Annual passenger traffic (taking into account peak hours), number of access gates for workers, versus number of available equipment) – Percentage lack of equipment.

5.1.1.9 Cargo Screening Equipment – (Annual cargo traffic (taking into account peak hours) versus number of available equipment) – Percentage lack of equipment.

5.1.1.10 Perimeter fences & emergency operational centre (EOC) and Mobile command post - (exist or not) - Yes or No.

5.1.1.11 Electrical power supply systems - (Approach category of the runway versus existing electrical power system) - Adequate or Non adequate.

5.1.1.12 Airfield Lighting / Visual Aids for navigation - (Approach category of the runway versus existing runway lighting system) - Adequate or Non-adequate.

5.1.2 Air Navigation Services (ANS)

Data collected for ANS was categorized as follows:

a) Air Traffic Management (ATM) ;
b) Communications, Navigation and Surveillance (CNS) ;
c) Aeronautical Information Management (AIM); and
d) Aeronautical Meteorology (MET).

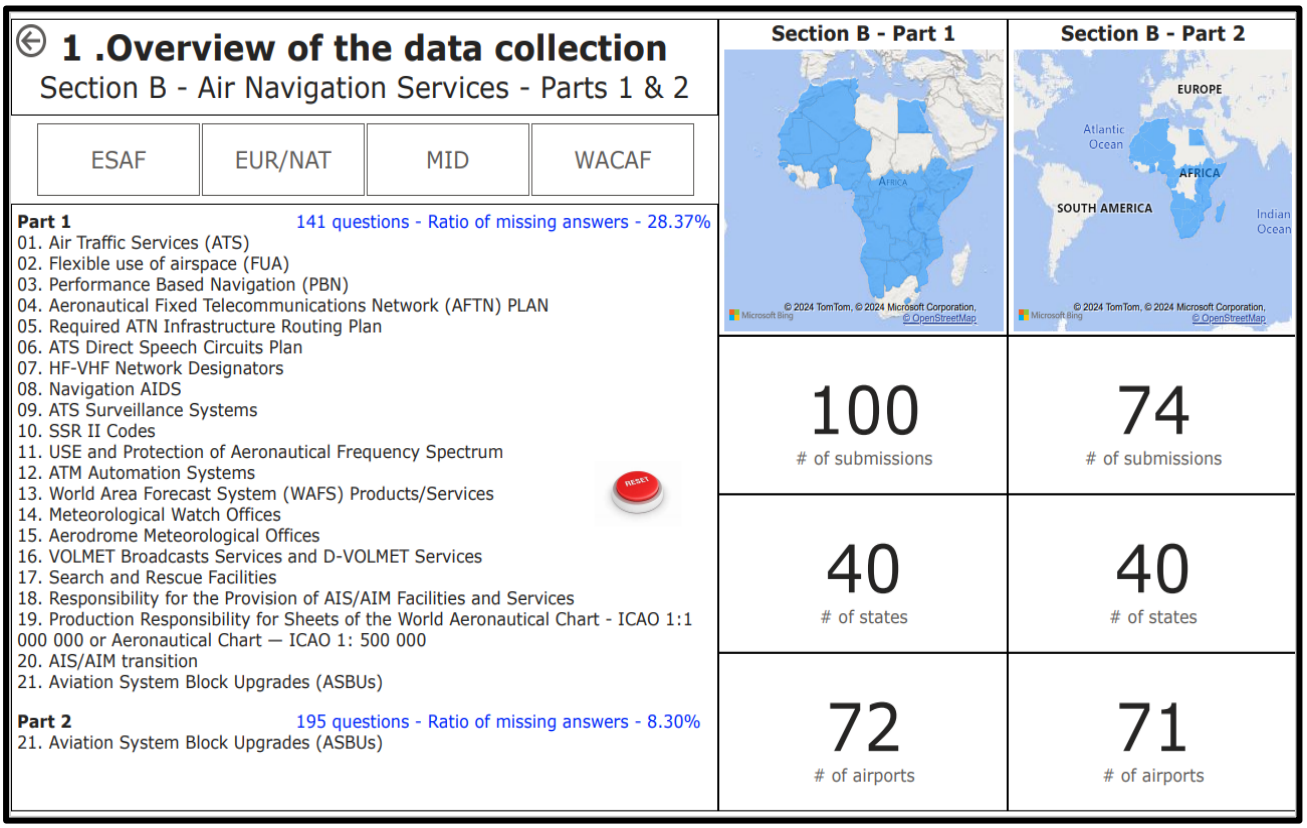

Figure 5. 2: Overview of the data collection- Section B-ANS

5.1.2.1 Air Traffic Management (ATM)

a) Air traffic services (ATS) Units Capacity: # of aircraft per hour per Declared Capacity;
b) ATM Master Plan: % of qualified number of required ATCOs; % of Class A-D Airspace implemented in accordance with APIRG strategy;
c) PBN Plan: % of Robust National PBN Plan; % of PBN Airspace; # PBN Routes implemented;
d) Standard instrument departure procedures /Standard arrival procedures (SIDs/STARs): % of instrument runways with PBN SIDS/STARS; and
e) Continuous climb operations (CCO)/Continuous descent operations (CDO): % of instrument runways with PBN CCO/CDO.

5.1.2.2 Communications, Navigation and Surveillance (CNS)

a) Aeronautical fixed telecommunication network (AFTN), ATS Message Handling System (AMHS), Air traffic services Direct speech (ATS/DS), ATS Inter-Facility Data Communication (AIDC), Voice over Inter Protocol (VoIP), Operational meteorological (OPMET) data: # % Required and regionally planned circuits (with regard to the AFI Regional Air Navigation Plan -AFI ANP) but not yet implemented;
b) Very High Frequency (VHF) & High Frequency (HF) communications, Controller-Pilot Data Link Communications (CPDLC), VHF and HF Data Link (VDL &HF DL) communications: # % Required and regionally planned route coverage (with regard to the AFI Regional Air Navigation Plan -AFI ANP) but not yet implemented; and
c) Navigation and Surveillance: # % Required and regionally planned Stations (with regard to the AFI Regional Air Navigation Plan -AFI ANP) but not yet implemented.

5.1.2.3 Aeronautical Information Management (AIM)

Aeronautical Information Exchange Model (AIXM) Based e-AIP, AIS/AIM Transition, Electronic Terrain, and Obstacle Data (e-TOD): # % Required and regionally planned Actions plans (with regard to the AFI Regional Air Navigation Plan -AFI ANP) but not yet implemented developed/implemented.

5.1.2.4 Aeronautical Meteorology (MET)

a) Availability of operational meteorological (OPMET) data; and
b) Volcanic Ash Contingency Plans.

5.1.3 Airlines

The aviation industry in Africa is a mix of large national carriers, smaller regional airlines, and emerging low-cost carriers. The industry is characterized by both challenges and opportunities, influenced by economic, regulatory, and infrastructural factors.

5.1.3.1 Aircraft fleet and equipage

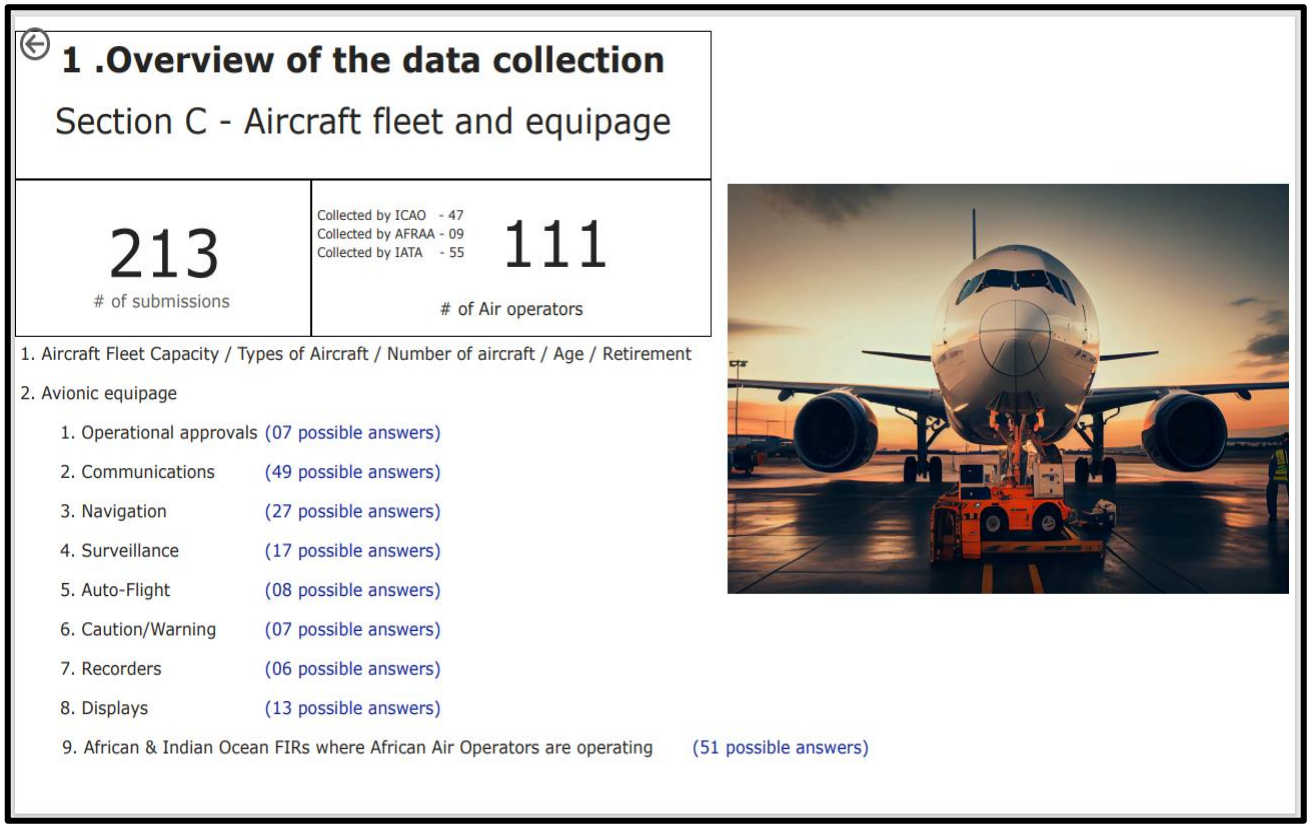

Figure 5. 3: Overview of the data collection- Section C-Aircraft Fleet and Equipage

5.1.3.2 Market share of the State/African Airlines

a) Available Seat Kilometers (ASK) by the State Airline as a percentage of the total capacity available to the State market;
b) Share of passengers carried by the State airlines as a percentage of the total; and
c) Share of passengers carried by the African airlines as a percentage of the total.

5.1.3.3 Connectivity

a) Number of International Destinations /States Served by Airlines certificated by the State;
b) Number of African Destinations/States Served by the Airlines certificated by the State;
c) Total Number of weekly international schedule Services by local and foreign airlines Summer/Winter;
d) Total Number of weekly international schedule Services by local airlines;
e) Total Number of weekly international schedule Services by African airlines; and
f) Total Number of weekly international schedule Services by other airlines.

5.1.3.4 Capacity Utilization of Airlines

Load factor of an Airline - Load factor of an Airline (Available Seat Kilometres/Revenue per Passenger Kilometres (ASK/RPK).

5.1.3.5 Aircraft ownership

Percentage of leased aircraft from the total fleet.

CHAPTER 6: GAP ANALYSIS RESULTS

6.1 Outcome of Data Collection

At the completion of data gathering, based on the Project Roadmap and in line with the responsibility matrix, it was necessary to analyse the data submitted by the Member States and airlines. This involved several systematic steps summarized below.

6.1.1 Data Cleaning and Preparation

a) *Data Validation:* Ensured that the data collected was complete, accurate, and consistent.
b) *Data Cleaning:* Identified and corrected errors or inconsistencies in the data. This included handling missing values, outliers, and duplicates.
c) *Data Formatting:* Standardized data formats, units of measurement, and coding schemes to ensure consistency.

6.1.2 Data Integration

a) *Data Consolidation:* Combined data from different sources, such as surveys, historical records, and sensor data, into a single dataset.
b) *Data Transformation:* Converted data into a suitable format for analysis, which included normalization, aggregation, or creating derived variables.

6.1.3 Descriptive Analysis

a) *Statistical Summary:* Calculated summary statistics such as mean, median and frequency distributions to understand the basic characteristics of the data.
b) *Data Visualization:* Use graphs, charts, and maps to visually explore patterns and relationships in the data. Common visualizations included bar charts, histograms, scatter plots, and geographic maps.

6.1.4 Diagnostic Analysis

a) *Trend Analysis:* Examined historical data to identify trends and patterns over time. This helped in understanding how aviation infrastructure needs have evolved.
b) *Correlation Analysis:* Investigated relationships between different variables to identify factors that might influence infrastructure gaps, such as passenger volume, flight frequency, or economic indicators.

6.1.5 Predictive Analysis

a) *Model Development:* Developed statistical or machine learning models to predict future infrastructure needs based on current and historical data. Common models include regression analysis, time series analysis, and decision trees.
b) *Scenario Analysis:* Simulated different scenarios to assess potential future demands and infrastructure requirements. This helped in planning for various possible futures.

6.1.6 Gap Identification

a) *Benchmarking:* Compared current infrastructure against industry standards, best practices, or benchmarks from similar regions or airports.
b) *Needs Assessment:* Identified specific areas where current infrastructure does not meet current or projected demands. This included capacity constraints, service deficiencies, or outdated facilities.

6.1.7 Prioritization

a) *Impact Analysis:* Evaluated the potential impact of identified gaps on airport operations, passenger experience, safety, and economic factors.

b) *Cost-Benefit Analysis:* Assessed the costs and benefits of addressing each gap to prioritize actions. This included estimating the financial investment required and the potential return on investment.

6.1.8 Reporting and Recommendations

a) *Report Preparation:* Compiled the analysis results into a comprehensive report. This includes an executive summary, methodology, findings, visualizations, and recommendations among other crucial aspects.
b) *Stakeholder engagement:* The outcomes of the Project including the findings and recommendations will be presented to stakeholders, including civil aviation authorities, airport authorities, air navigation services providers, government agencies, and industry partners using clear and concise language, supported by visual aids. The Report will be validated prior to submission to Member States and AU Policy Organs for adoption.

6.2 Aviation Infrastructure Data Analysis

6.2.1 The 2nd TWG considered the outcomes of the data collection exercise, cleaning and preparation, consolidation and aggregation including the quality check. The final gap analysis was based on the following criteria that was developed and adopted by the TWG as shown in Table 6.1.

Table 6. 1: Criteria for Gap Analysis

Name	Type	Value	Evaluation | Information
ID	Information	Text	The ID of the question in the questionnaire relative to the gap
Title	Information	Text	A short title for the gap subject
Area	Information	Text	In what technical area resides the gap?
Gap	Information	%	What is the value of the gap (in percentage)?
Objective	Information	Safety/Efficiency/Capacity/Environment/Economic	What is the primary objective for closing the gap?
Geography	Information	Continental/Regional/National/Sub-national	At what level would the gap ideally be addressed?
PPP	Information	Yes/No	Could closing the gap be done under a private-public partnership?
Description	Information	Text	A general comment of the identified gap
Feasibility	Evaluation	Low/Medium/High	What would be the effectiveness of a potential project to close the gap
Complexity	Evaluation	Low/Medium/High	How complex or complicated is it to close the gap knowing the root causes related?
Politicality	Evaluation	Low/Medium/High	In how far is closing the gap a political rather than technical decision?
Safety Risk	Evaluation	Low/Medium/High	In how far this gap constitutes a risk for aviation safety?
Impact	Evaluation	Low/Medium/High	How many States are impacted by the gap?
Criticality	Evaluation	Low/Medium/High	How critical is closing the gap in relation to current and future traffic growth?

6.2.2 The outcomes of the gap analysis were categorized and presented as Aerodrome and Ground Aids (AGA) Gaps in Table 6.2 Air Traffic Management (ATM) Gaps in Tables 6.3, 6.4 and 6.5, Communication, Navigation and Surveillance (CNS) Gaps in Table 6.6, Meteorology (MET) Gaps in Table 6.7 and Aircraft fleet and equipage in Table 6.8 respectively.

Table **6.** 2: **Aerodrome and Ground Aids Gaps**

Category	ID	Title	Area	Gap	Objective	Geography	PPP	Description	Feasibility	Complexity	Politicality	Safety Risk	Impact	Criticality	Remarks 1
AGA 1	AGA 01	Airport Masterplan	AGA	75%	Capacity, Efficiency, Economic, Environment, Business continuity	Continental	Yes	Prerequisite requirement for all certified and public aerodromes to have for long term development	High	Medium	Low	High	High	High	Priority Project No. 1
AGA 1	AGA 02	Airport Certification	AGA	45%	Safety, Economic	Continental	No	Requirement for all International aerodromes	High	High	Low	High	Medium	High	Priority Project No. 2
AGA 1	AGA 03	Runway End Safety Area (RESA)	AGA	50%	Safety	Regional, National	No	Requirement for all International aerodromes	Medium	Medium	Low	High	High	High	Priority Project No. 4
AGA 1	AGA 04	Obstacle Limitation Surfaces (OLS)	AGA	50%	Safety	National	Yes	Requirement for all International aerodromes	Medium	Medium	Medium	High	High	High	Priority Project No. 6
AGA 1	AGA 05	Airport Drainage system	AGA	31%	Safety	National	Yes	Requirement for all International aerodromes	High	Medium	Low	High	Low	High	Priority Project No. 4
AGA 1	AGA 06	WGS-84 Survey	AGA	75%	Safety, Capacity	Continental, Regional	Yes	Requirement for all International aerodromes	High	High	Low	High	High	High	Priority Project No. 6
AGA 1	AGA 07	Wildlife Strike Hazard Control	AGA	75%	Safety, Environment	National	Yes	Requirement for all International aerodromes	High	Medium	Low	High	High	High	Priority Project No. 5
AGA 1	AGA 08	Preventive maintenance Capacity programmes	AGA	70%	Safety, Efficiency, Economic	Regional, National	Yes	Requirement for all International aerodromes	High	High	Low	High	High	High	Priority Project No. 4
AGA 1	AGA 09	Runway Pavements surface conditions/ Shoulder condition	AGA	50%	Safety, Efficiency, Economic	Regional	Yes	Requirement for all International aerodromes	High	High	Low	High	High	High	Priority Project No. 4
AGA 1	AGA 10	RFF Services and Equipment	AGA	75%	Safety, Efficiency, Economic, Capacity, Environment	Continental	Yes	Requirement for all International aerodromes	High	High	Low	High	High	High	Priority Project No. 3
AGA 1	AGA 11	A-CDM B01/02	AGA	90%	Safety, Efficiency, Economic, Capacity, Environment	Continental	No	Requirement for all International aerodromes	High	Medium	Low	High	High	Medium	Priority Project No. 7

6.3 Aerodrome and Ground Aids Gaps

6.3.1 Based on the AGA analysis in consultations with other regional bodies/entities, RSOO's, etc. it is concluded that the Airport Master Plan and Airport Certification Projects are to be considered as the key Bankable Projects. In addition, the team reviewed the rest of the outstanding 8 Gaps which have also been prioritized based on the reflection of outstanding activities within the States. However, if the first two priorities are given the needed attention, they will cater for the remaining 8 Gaps identified. Considering the need to rate and choose additional projects, the remaining 8 gaps have been further prioritized as shown in the matrix. Based on the Airport capacity, Safety, Sustainability, and long-term traffic forecasts provided by ATNS, SAATM, AfCFTA etc., there is need to improve on the Airports Infrastructure to further accommodate future airport capacity development and expansion.

6.3.2 The ACDM analysis report was also reviewed which also revealed a continental gap. The analysis indicate that Africa is way behind in the implementation of the ACDM ASBU Block 1 and Block 2 elements. If the forecasted traffic is anything to go by, there is an urgent need to ensure that the collaboration among airport stake holders is implemented to avoid any inconveniences and safety occurrences that may be experienced as a result of not implementing ACDM in Africa Airports. There is therefore a need for Capacity Building across the Continent on ACDM elements including development and implementation of harmonized procedures for effective ACDM.

Table 6. 3: ATM/SAR/AIS/ PANSOPS Gaps

Category	ID	Title	Area	Gap	Objective	Geography	PPP	Description	Feasibility	Complexity	Politicality	Safety Risk	Impact	Criticality	Remarks 1
ATM	B2-21	Improved Arrival and departure operations (APTA)	PANSOPS	70.00%	Safety and Efficiency	Continental	Yes	lack of implementation	High	Medium	Low	High	High	High	
ATM	B2-21	improved operation through enhanced enroute (FRTO)	ATM	76%	Efficiency	Regional	No	lack of implementation	High	High	Medium	High	High	High	
ATM	B2-21	Flight and Flow Information for a Collaborative Environment (Ff-Ice)	ATM	83%	Safety, Efficiency, Environment, Capacity, Economic	Continental	Yes	Lack of implementation	High	low	Low	High	High	High	
ATM	B1-20	AIS/AIM Transition and DAIM	AIM	78%	Efficiency and Safety	Regional	Yes	Lack of implementation of the transition from AIS to AIM	High	Low	Low	High	High	High	
ATM	B2-21	Network Operations (NOPS)	ATM	100.00%	Safety and Capacity	Regional	no	lack of implementation	High	High	Medium	High	Medium	Medium	
ATM	B1-21	Safety Net (SNET)	ATM	52.00%	Safety	Continental	No	lack of implementation	High	Low	Low	High	High	High	
ATM	B1-09	Trajectory Based Operations (TBO)	ATM	73.00%	Safety and Efficiency	Continental	No	lack of regional coordination	Medium	Medium	low	High	Medium	Medium	
ATM	B2-21	Global Aeronautical Distress and Safety System (GADSS)	SAR	34%	Safety	Regional	No	Lack of implementation Global Aeronautical Distress and Safety System (GADSS) to enhance search and rescue	Low	High	High	High	High	High	
ATM	B2-21	Improved access to optimum flight levels in oceanic and remote airspace (OPFL)	ATM	100%	Safety	National	No	Lack of implementation of Improved access to optimum flight levels in oceanic and remote airspace	Medium	Medium	Low	High	High	High	
ATM	B2-21	Cooperative separation (CSEP)	ATM	70%	Safety, Efficiency, Environment, Capacity, Economic	National	Yes	lack of implementation	High	High	Low	High	High	High	

Category	ID	Title	Area	Gap	Objective	Geography	PPP	Description	Feasibility	Complexity	Politicality	Safety Risk	Impact	Criticality	Remarks 1
ATM	B2-21	Surface Movement Guidance Control (SURF)	ATM	90.00%	Safety, Efficiency, Environment, Capacity, Economic	National	Yes	lack of implementation	Low	High	Low	Medium	High	High	

6.4 ATM/SAR/AIS/PANSOPS Gaps

6.4.1 The following is a summary of the gaps identified in ATM/SAR/AIS/PANSOPS in the order of priority.

Table 6. 4: Categorization of ATM/SAR/AIS/PANSOPS Gaps

NO.	GAP	Description	RECOMMENDATION
1.	Improved Arrival and departure operations (APTA). Average percentage of the GAP is **70%**	Lack of PBN implementation at the regional (Enroute, Terminal and Approach)	(a) Establish Regional PBN implementation Project Covering the enroute, Terminal and Approaches) including infrastructure (CNS) and training. **Note:** All the Block Zero elements should be implemented. **Benefits:** The project will enhance Safety, efficiency, Capacity, environment
2.	Improved operation through enhanced en-route trajectories (FRTO). Average percentage of the GAP is **76.05%**	Lack of implementation of improved operation through enhanced enroute	(a) Establish a regional concept/committee for FUA and airspace management and issue Route Availability Document (RAD) and implement ATFM measures. **Note:** All the Block Zero elements should be implemented. **Benefits:** The project will enhance Safety, efficiency, Capacity, environment.
3.	Flight and Flow Information for A Collaborative Environment (FF-ICE) Average percentage of the GAP is **83%**	Lack of Implementation of Flight and Flow Information for A Collaborative Environment	(a) Establish Systemic sharing Data between acters and ensuring that they have access to the most accurate Data Available. **Note:** All the Block Zero elements should be implemented. **Benefits:** The project will enhance Safety, and efficiency
4.	Transition from AIS to AIM/DAIM/SWIM Project. Average percentage of the GAP is **77.91%**	Lack of implementation of the Transition from AIS to AIM phase 1, phase 2 and Phase 3.	(a) Establish a regional Project to assist in the implementation of the transition from AIS to AIM with the aim of ensuring completion of the all Phases.

NO.	GAP	Description	RECOMMENDATION
			(b) DAIM and SWIM should be considered as part of the Transition Project. **Benefits:** The project will enhance efficiency and quality assurance of information management
5.	Network Operations (NOPS) the implementation of the Element has not start hence percentage GAP is at **100%**	Lack of implementation of Network operations to improve ATFM both basic and advanced	(a) Establishment of the project for NOPS is desirable based on the Regional Air Navigation Plan. The implementation is expected to be done at regional level. (b) This is one of the ASBU modules that, because of their strong business and/or safety case, are recommended for implementation everywhere. (c) NOPS is desirable at the regional level to achieve the centralized the regional planning and management. **Note:** upper Airspace and **A**ll the Block Zero elements should be implemented. **Benefits:** The project will enhance Safety, and support a good Business Case
6.	Safety Nets (SNET) Average percentage of the GAP is **51.06%**	Lack of implementation of the safety Nets	(a) Establishment of the project for SNETs is not essential but desirable. The implementation is expected at regional level. (b) This is one of the ASBU modules that, because of their strong business and/or safety case, are recommended for implementation everywhere. **Note:** All the Block Zero elements should be implemented. **Benefits:** The project will enhance Safety and support a good Business Case.
7.	GADNSS Average percentage of the GAP is 84**%**	Lack of effective Tracking of Aircraft in distress with the objective of saving lives and	(a) Establishment of the project is specific depending on the state requirement efficiency. The

NO.	GAP	Description	RECOMMENDATION
		providing SAR service in the Region	implementation is expected at National level. (b) This is one of the ASBU modules recommended for implementation to address a particular operational environment in specific geographical regions. **Benefits:** The project will enhance Safety.
8.	Trajectory-based operations (TBO) The Gap is **73%**	Lack of implementation at the Region	(a) The establishment of the project is specific depending on the state requirement efficiency. The implementation is expected at the regional level. (b) This is one of the ASBU modules recommended for implementation to address a particular operational environment in specific geographical regions. (c) TBO is desirable at the regional level to achieve the centralized the regional planning and management. **Benefits:** The project will enhance Safety and efficiency..
9.	Improved access to optimum flight levels in oceanic and remote airspace (OPFL) 100%	Lack of implementation of Improved access to optimum flight levels in oceanic and remote airspace	(a) Establishment of the project is specific depending on the state requirement efficiency. The implementation is expected at National level. (b) This is one of the ASBU modules recommended for implementation to address a particular operational environment in specific geographical regions. **Benefits:** The project will enhance Safety, and efficiency
10.	Cooperative Separation (CSEP) 70.25%	Lack of implementation	(a) Establishment of the project is specific depending on the state requirement efficiency. The implementation is expected at National level. (b) This is one of the ASBU modules recommended for

NO.	GAP	Description	RECOMMENDATION
			implementation to address a particular operational environment in specific geographical regions. **Benefits:** The project will enhance Safety, capacity environment and efficiency
11.	Surface Movement Guidance Control (SURF) 90%	Lack of implementation Surface Movement Guidance Control	(a) Establishment of the project is Optional depending on the state requirement efficiency. The implementation is expected at National level. (b) This is one of the ASBU modules recommended for implementation to address a particular operational environment in specific geographical regions **Benefits:** The project will enhance Safety, capacity environment and efficiency.
12.	Improved traffic flow through runway sequencing (RSEQ) 59%	Lack of implementation of Improved traffic flow through runway sequencing.	(a) Establishment of the project is Optional depending on the state requirement efficiency. The implementation is expected at National level. (b) This is one of the ASBU modules recommended for implementation to address a particular operational environment in specific geographical regions. **Benefits:** The project will enhance Safety, capacity environment and efficiency.

6.2.2 The regional seamless upper airspace is an essential component to be considered before the implementation of the block zero at the continental, regional or national level. The summary indicated above was determined based on the following ASBU Modules as outlined in the Regional ANP Vol. III.

Table 6. 5: Relationship between the gaps and ASBU Modules

	ASBU module		Applicability
1.	FICE, DAIM; ACAS, FRTO, APTA	**Essential (E):** These are the ASBU modules that provide substantial contribution towards global interoperability, safety, or regularity.	All States

2.	ACDM, NOPS, ASUR, SNET, AMET, TBO, GADNSS	**Desirable (D):** These are the ASBU modules that, because of their strong business and/or safety case, are recommended for implementation almost everywhere.	All States
3.	OPFL, CSEP, WAKE	**Specific (S):** These are the ASBU modules that are recommended for implementation to address a particular operational environment in specific countries of the AFI region (for example South Africa).	Specific States
4.	SURF and RSEQ	**Optional (O):** These are the ASBU modules that address operational requirements in specific countries of AFI region and provide additional benefits that may not be common everywhere.	Specific States

Table 6. 6: CNS ***Gaps***

Category	ID	Title	Area	Gap	Objective	Geography	PPP	Description	Feasibility	Complexity	Politicality	Safety Risk	Impact	Criticality	Remarks
CNS	2 -49/50-SEC B	ADS-B	Surveillance	77.46%	safety, efficiency, capacity, economic	Regional	yes	Lack of implementation of the module may result in limited surveillance coverage within the airspace, resulting in a lack of separation where their traditional surveillance systems do not exist.	High	Medium	Low	Medium	Low	Medium	
CNS	2 -51/52-SEC B	MLAT	Surveillance	94.40%	safety, efficiency, capacity	National	No	If not implemented, there will be no provision of surveillance data in the vicinity of approach areas but does not have a significant effect on the provision of air navigation services	Medium	High	Low	Low	Low	Low	Complexity of the network design
CNS	2 -53/54-SEC B	ASUR-B0/3 - Cooperative Surveillance Radar Downlink of Aircraft Parameters (SSR-DAPS	Surveillance	74.30%	safety, efficiency, capacity, economic	National	No	If not implemented, there will be no provision of surveillance data to the ATS which may result in lack of controller awareness and increased controller workload	High	Low	Low	High	Low	High	
CNS	2 -55/56-SEC B	COMI-B0/1- Aircraft Communication Addressing and Reporting System (ACARS)	Communications	87.32%	safety, efficiency	Continental	No	The Aircraft Communications Addressing and Reporting System (ACARS) is a digital datalink system for the transmission of messages between aircraft and ground stations via VHF or satellites.	High	High	Low	High	High	Medium	many procedures involved more beneficial to busy airports
CNS	2 -57/58-SEC B	COMI-B0/2 - Aeronautical Telecommunication Network/Open System Interconnection (ATN/OSI	Communications	83.70%	safety, efficiency	Continental	No	Non implementation may result in errors and reduced safety	High	Medium	Low	Medium	Low	Low	

Category	ID	Title	Area	Gap	Objective	Geography	PPP	Description	Feasibility	Complexity	Politicality	Safety Risk	Impact	Criticality	Remarks
CNS	2 -59/60-SEC B	COMI-B0/3 - VHF Data Link (VDL) Mode 0/A	Communications	94.37%	safety, efficiency, capacity	National	No	VDL Mode 0/A is a data communications subnetwork that supports transmission of data link messages. Non implementation may result in reduced efficiency	High	Medium	Low	low	Low	Low	
CNS	2 -61/62-SEC B	COMI-B0/4 VHF Data Link (VDL) Mode 2 Basic	Communications	94.37%	safety, efficiency, capacity	National	No	VDL Mode 2 is narrow-band transceiver operating in the VHF aviation protected spectrum band, which will transmit data to support data communications between the aircraft and ground. It consists of a set of air-ground protocols that increase the data rate to 31.5 kbits.	Medium	High	medium	High	High	Medium	
CNS	2 -63/64-SEC B	COMI-B0/5 Satellite communications (SATCOM) Class C Data	Communications	90.40%	safety, efficiency, capacity	Regional	No	Satellite-based, narrow-band communication provided by multiple service providers that can be used for safety and routing communications.	High	Low	Low	Medium	medium	Low	
CNS	2 -65/66-SEC B	COMI-B0/6 High Frequency Data Link (HFDL)	Communications	90.40%	safety, efficiency, capacity	National	No	To communicate in areas where SATCOM and VHF are not available.	low	Low	Low	low	Low	Low	
CNS	2 -67/68-SEC B	COMI-B0/7 ATS Message Handling System (AMHS)	Communications	64.79%	safety, efficiency	Continental	No	Lack of implementation will result in the unavailability of safety information to flights which will result in reduced safety	High	Medium	Low	High	High	High	
CNS	2 -69/70-SEC B	COMI-B1/1 Ground-Ground Aeronautical Telecommunication Network/Internet Protocol Suite (ATN/IPS)	Communications	77.40%	safety, efficiency, economic	Continental	No	To provide for a more modern, more efficient, cost-effective, and robust data communications network infrastructure.	High	Medium	Low	High	medium	High	

Category	ID	Title	Area	Gap	Objective	Geography	PPP	Description	Feasibility	Complexity	Politicality	Safety Risk	Impact	Criticality	Remarks
CNS	2 -71/72-SEC B	COMI-B1/2 VHF Data Link (VDL) Mode 2 Multi-Frequency	Communications	97.20%	safety, efficiency, capacity	National	No	VDL Mode 2 is a narrow-band transceiver operating in the VHF aviation protected spectrum band, which will transmit data to support data communications between the aircraft and ground. It consists of a set of air-ground protocols that increase the data rate to 31.5 kbits.	High	Low	Low	High	Low	Medium	
CNS	2 -73/74-SEC B	COMI-B1/3 SATCOM Class B Voice and Data	Communications	98.60%	safety	Continental	no	SATCOM System is a broadband, IP based communication system that provides voice and high-speed data communications between the aircraft and the air traffic controller. This evolution will support enhanced civil-military cooperation and coordination functions, if interoperability and military information security aspects are considered.	High	Medium	Low	Medium	Low	Medium	
CNS	2 -75/76-SEC B	COMI-B1/4 Aeronautical Mobile Airport Communication System (AeroMACS) Ground-Ground	Communications	95.80%	safety, efficiency, environment, capacity	National	No	AeroMACS is a broadband wireless communications system. It can provide network connectivity on the airport surface for fixed wireless communications and can be used only for the safety-critical and regularity of flight. The fixed assests supported by AeroMACS include multilateration sensors, weather sensors, surface radar and fixed navigation aids.	High	Low	Low	High	medium	Medium	
CNS	2 -77/78-SEC B	COMS B0/1 CPDLC (FANS 1/A & ATN B1) for domestic and procedural airspace	Communications	83.10%	safety, efficiency, capacity	Regional	No	CPDLC is a complement to voice communications and provides the controller and the pilot with the ability to communicate through the exchange of data link messages.	High	Medium	Low	High	medium	High	

Category	ID	Title	Area	Gap	Objective	Geography	PPP	Description	Feasibility	Complexity	Politicality	Safety Risk	Impact	Criticality	Remarks
CNS	2 -79/80-SEC B	COMS B0/2 ADS-C (FANS 1/A) for procedural airspace	Surveillance	78.80%	safety, efficiency	Regional	No	The ADS-C capability provides automatically, without pilot intervention, an ATS unit with information concerning the aircraft position and projected profile for the flight at time intervals, events or on demand dictated by the ground needs.	High	Low	Low	High	medium	Medium	
CNS	2 -81/82-SEC B	COMS-B1/1 PBCS approved CPDLC (FANS 1/A+) for domestic and procedural airspace	Surveillance	90.10%	safety, efficiency, capacity	Regional	No	Controller Pilot Data Link Communications (CPDLC), in conjunction with Automatic Dependent Surveillance – Contract (ADS-C), currently enables the use of Future Air Navigation System 1/A+ (FANS 1/A+) over oceanic The CPDLC function allows for uplink allows clearances, downlink reporting and clearance requests between the aircraft and the controlling ATC center airspace	Medium	High	Low	Medium	medium	Medium	
CNS	2 -81/82-SEC B	COMS B1/2 PBCS approved ADS-C (FANS 1/A+) for procedural airspace	Surveillance	94.30%	safety, efficiency, capacity	Regional	No	Performance Based Communications and Surveillance (PBCS) is the combination of the criteria of Performance Based Communication (PBC) and Performance Based Surveillance (PBS)	low	High	Low	low	Low	Low	
CNS	2 -81/82-SEC B	COMS B1/3 SATVOICE (incl. routine communications) for procedural airspace	Surveillance	90.10%	safety, efficiency	Regional	No	Because of frequency congestion and ionospheric/solar conditions in oceanic and remote flight operations, aircraft operators may use SATVOICE equipment as one of their two long-range communication systems (LRCS)	low	low	Low	Medium	Low	low	
CNS	2 -81/82-SEC B	FICE B0/1 Automated basic inter-facility data exchange (AIDC)	Surveillance	82.57%	safety, efficiency, capacity	Continental	No	To improve the efficiency of coordination and transfer of control between ATS units.	High	Medium	Low	High	High	High	

Category	ID	Title	Area	Gap	Objective	Geography	PPP	Description	Feasibility	Complexity	Politicality	Safety Risk	Impact	Criticality	Remarks
CNS	2 -81/82-SEC B	ACAS B1/1 ACAS Improvements	Surveillance	84.34%	safety, efficiency	Continental	No	TCAS systems selectively interrogate nearby aircraft to determine their position and velocity (using Mode C/S replies); this information is passed through “threat logic” to determine proximate traffic, issue traffic alerts, and issue collision avoidance “resolution advisories” to flight crews. Resolution advisories provide flight crews with vertical guidance (climb, descend, remain level, do not descend/climb) as appropriate to avoid collisions.	High	low	Low	High	High	High	
CNS	2 137/138 SEC B	NAVS-B0/1 Ground Based Augmentation Systems (GBAS)	Navigation	95.78%	Safety, Efficiency, capacity	National	No	improve accuracy, integrity and availability through a local airport based differential satellite navigation and monitoring system.	high	High	medium	Low	Low	Low	One GBAS can be used for many runways
CNS	2 139/140 SEC B	NAVS-B0/2 Satellite Based Augmentation Systems (SBAS)	Navigation	97.18%	Safety, Efficiency, capacity, environment	Regional	Yes	improvements of the availability, accuracy and integrity of satellite navigation through a wide area differential satellite navigation position and integrity monitoring system.	High	High	High	Low	Low	low	
CNS	2 141/142 SEC B	NAVS-B0/3 Aircraft Based Augmentation Systems (ABAS)	Navigation	83.10%	Safety, Efficiency, Capacity, Environment	Continental	No	Support non-precision (LNAV) and vertically guided (LNAV/VNAV) approaches with BaroVNAV and other terminal and enroute navigations.	High	High	High	Medium	Medium	Medium	

Category	ID	Title	Area	Gap	Objective	Geography	PPP	Description	Feasibility	Complexity	Politicality	Safety Risk	Impact	Criticality	Remarks
CNS	2 143/144 SEC B	NAVS-B0/4 Navigation Minimal Operating Networks (Nav. MON)	Navigation	95.77%	Safety, Efficiency, Economic	Regional	Yes	adjust conventional navaids networks through the increased deployment of satellite-based navigation systems and procedures to ensure the necessary levels of resilience for navigation. To provide a minimum level of capabilities to accommodate State aircraft operations where there is a mismatch in terms of aircraft equipage. To make a more efficient use of the frequency spectrum	Medium	medium	medium	low	Low	Low	

6.5 CNS Gaps

6.5.1 The summary shown in Table 6.4 presents the evaluation and reclassification of the gaps in aeronautical Communications, Navigation and Surveillance systems for Air Traffic Management (CNS/ATM) based on the Aviation System Block Upgrade (ASBU) and the Africa Indian Ocean (AFI) Planning and Implementation Regional Group (APIRG) Frameworks.

6.5.2 The focus was on aviation systems with continental and regional implications highlighting key areas of concern and their respective gap percentages, feasibility, complexity, impact, and criticality.

6.5.3 Generally, the implementation of CNS/ATM by States following the ASBU and APIRG Framework is low. The analyses underscore the need for improvements in aeronautical Communication, Navigation and Surveillance systems to enhance overall safety and efficiency across continental airspace. Although there are dependencies between some of the service realizations, they have not necessarily been considered in the classifications done.

6.5.4 Based on the criteria for Criticality, Geography and feasibility the following aspects have been deduced:

COMI-B0/7 ATS Message Handling System (AMHS)

a) COMI-B0/7 ATS Message Handling System (AMHS)

i. ***Overview:*** The ATS Message Handling System (AMHS) is a critical component of the aviation communication infrastructure, designed to facilitate the exchange of aviation safety-related messages. This system enhances flight information coordination between Air Navigation Service Providers (ANSPs) and relevant military units, ensuring seamless and secure communication.

ii. ***Objective:*** Provide communication to enable the exchange of aviation safety-related messages, thereby improving flight information coordination.

iii. ***Justification:*** Per the survey, 64.79% implementation Gap; Criticality: High and Geography: Continental; and Feasibility: High. Although it is mandatory at the regional and continental levels, implementation is low. Additionally, States that have implemented the systems are using them for AFTN message routing without gleaning the full benefit of the AMHS.

iv. ***Implications:*** Non-implementation of AMHS may result in the unavailability of safety information crucial for flight operations. This lack of information can significantly reduce safety, as timely and accurate communication is essential for managing flight operations and responding to any potential issues.

b) COMI-B1/1 Ground-Ground Aeronautical Telecommunication Network/Internet Protocol Suite (ATN/IPS)

i. ***Overview:*** The Ground-Ground Aeronautical Telecommunication Network/Internet Protocol Suite (ATN/IPS) is an advanced communication system designed to provide a more modern, efficient, cost-effective, and robust data communications network infrastructure for air traffic services (ATS). It supports enhanced civil-military cooperation and coordination functions, ensuring secure and reliable communication across national and international airspace. The ATN/IPS system supports a wide range of communication functions essential for modern air traffic management, including the coordination between civil and military airspace users.

ii. ***Objective:*** Provide a more efficient, cost-effective, and robust data communications network infrastructure for air traffic services.

iii. ***Justification:*** Per the survey, 77.40% implementation Gap; Criticality: Medium and Geography: Continental; and Feasibility: High.

iv. *Implications:* Non-implementation of ATN/IPS may result in communication errors and reduced safety, as the system is designed to enhance the reliability and efficiency of data link applications used in air traffic management. This could compromise the coordination and control of flights, particularly in complex and high-density airspace. Its implementation is critical for maintaining seamless and secure communication, thereby enhancing the overall safety and efficiency of air traffic services.

c) FICE B0/1 Automated basic Inter-facility Data exchange (AIDC)

i. *Overview:* The Automated Basic Inter Facility Data Exchange (AIDC) system, identified as FICE B0/1, is a fundamental component in the modernization of air traffic management. It aims to automate the coordination and transfer of control between Air Traffic Service (ATS) units, thereby improving efficiency and reducing the likelihood of human error in the transfer process. The AIDC is a crucial step towards automating and standardizing the exchange of flight information between ATS units.

ii. *Objective:* Improve the efficiency of coordination and transfer of control between ATS units.

iii. *Justification:* Per the survey, 82.57% implementation Gap; Criticality: Medium; Geography: Continental; and Feasibility: High.

iv. *Implications:* Non-implementation of the AIDC system may result in inefficient coordination and increased potential for errors during the transfer of control between neighbouring ATS units. This could compromise the safety and smooth operation of air traffic management, particularly in busy and complex airspace environments. By ensuring that all relevant flight information is accurately and timely transferred, the system enhances the safety and efficiency of air traffic operations. Addressing the gap in its implementation will lead to more efficient and safer operations, reducing the risk of errors and improving the overall performance of ATS units.

d) ASUR-B0/3 - Cooperative Surveillance Radar Downlink of Aircraft Parameters (SSR-DAPS)

i. *Overview:* The Cooperative Surveillance Radar Downlink of Aircraft Parameters (SSR-DAPS) is an essential surveillance system designed to enhance air traffic control by providing additional information to support Air Traffic Services (ATS). This system aims to improve controller awareness and reduce controller workload by downlinking aircraft parameters directly to ground stations.

ii. *Objective:* Enhance controller awareness and reduce controller workload by providing additional information.

iii. *Justification:* Per the survey, 74.30% implementation Gap; Criticality: High; Geography: National; and Feasibility: High.

iv. *Implications:* If not implemented, there will be no provision of surveillance data to ATS, potentially leading to a lack of controller awareness and increased workload. This system is vital for maintaining real-time situational awareness in air traffic control, which is crucial for the safe and efficient management of airspace.

e) Additional Identified Gaps

Two other significant issues warrant attention, even though they were not part of the gaps identified in the survey conducted. These issues are critical for the enhancement of aviation safety and operational efficiency on the African continent. They are:

i. **Flight Testing of Navigational Aids**:

a. ***Overview:*** Flight testing of navigational aids is a critical safety assurance program as mandated in Annex 10, Volume 1. This requirement stipulates that Member States periodically flight test installed navigational aids in use within their airspaces and aerodromes and publish the results to support safe air navigation.

b. ***Issue:*** The Universal Safety Oversight Audit Programme (USOAP) reports have highlighted that several Member States are unable to comply with this requirement. The primary reasons include the excessive cost of procuring services from a Flight Inspection Organization (FIO) and the availability of flight calibration aircraft necessary to meet the rigorous testing requirements specified in ICAO Doc 7910.

c. ***Implications:*** Non-compliance with flight testing requirements poses significant safety concerns in Africa. Without regular and accurate flight testing, the reliability and performance of navigational aids may be compromised, potentially leading to unsafe flight operations.

ii. **Interruption of GNSS Signals**:

a. ***Overview:*** The Global Navigation Satellite System (GNSS) is a critical enabler for Performance-Based Navigation (PBN), providing precise navigation and guidance for all flight phases, from en-route to precision approach. GNSS offers accurate position and timing information, essential for several systems crucial to flight safety.

b. ***Issue:*** There has been an alarming increase in jamming and spoofing activities targeting GNSS signals globally, with recent occurrences reported in various countries in Africa.

c. ***Implications:*** Disruption of GNSS signals can severely impact the safety and efficiency of flight operations. As aviation shifts from conventional navigation systems to satellite-based navigation (GNSS), ensuring the integrity and availability of these signals is paramount. The recent rise in GNSS jamming and spoofing activities necessitates urgent attention to safeguard navigation systems and maintain operational safety.

6.5.5 This summary provides a comprehensive assessment of various aviation systems, highlighting significant gaps in their implementation across aeronautical Communication, Navigation and Surveillance domains. This analysis underscores the critical need for advancements and modernization to enhance the overall safety, efficiency, and reliability of air traffic management.

6.5.6 Addressing the gaps using the recommended systems will significantly improve the safety, efficiency, and reliability of air traffic management, ensuring harmonization of aviation operations, which can meet the growing demands and complexities of modern airspace environments on the continent.

Table 6. 7: Meteorology (MET) Gaps

Category	ID	Title	Area	Gap	Objective	Geography	PPP	Description	Feasibility	Complexity	Politicality	Safety Risk	Impact	Criticality	Remarks 1
MET	AMET-B0	MET Products	MET	50%	Safety	Continental	No	Observation, forecast and warning products development and delivery	Medium	Low	Low	High	High	High	
MET	AMET-B1	MET Information	MET	65%	Safety	Continental	No	Information and dissemination	Medium	Medium	Low	High	High	High	
MET	VOLMET	VOLMET broadcast	MET	75%	Safety	Continental	No	Dissemination of volcanic ash real-time information	High	Low	Low	Low	High	Medium	

6.6 Meteorology (MET) Gaps

6.6.1 Analysing gaps in aviation infrastructure, particularly in aeronautical meteorology as shown in Table 6.4, involved assessing the current state of weather services and equipment used in aviation and identifying areas that need improvement. It covered MET Products MET Information and VOLMET broadcast.

Table 6.8: Aircraft Fleet and Equipage Gaps

ID	Title	Area	Gap	Gap Percer	Objective	Geography	PPP	Description	Feasibility	Complexi	Politica	Safety Ri	Impact	Critical	Remarks
1	RVSM	Navigation	38	18%	Capacity/Efficiency/Environment	Continental	No	Lack of RVSM will hampers access to RVSM airspace and as such restricted to flight to 290. Hence the adverse implication to efficiency and environment, and also increases cost of operations.	High	High	Low	High	High	High	Assuming the 213 Aircraft fleet are capable of flying above 290. Complexity - Aircraft capability and modification. Safety risk - LHD
2	TCAS	Navigation/Surveillance	96	45%	Safety	Continental	No	Lack of TCAS increase risk of collision.	High	High	Low	High	High	High	
3	ETOPS(EDTOPS)	Flight Operations	116	54%	Safety	Continental	No	Not all AOC require EDTOPS as OPS SPEC.	Low	Low	Low	Low	Low	Low	Not all AOC require EDTOPS as OPS SPEC.
4	RSP 180	Surveillance	121	57%	Capacity	Continental	No	PBCS Operations	Medium	Medium	Medium	Medium	Medium	Medium	
5	PBCS OPERATIONS	Flight Operations	124	58%	Capacity	Continental	No								
6	RCP 240	Communication	127	60%	Capacity	Continental	No								
7	CPDLC	Communication	CPDLC is only primary in a remote area.	N/A	Safety	Regional	No	CPDLC is only primary in a remote area.	High	Medium	low	Medium	Medium	Medium	CPDLC is only primary in a remote area.
8	1 HF	Communication	142	67%	Safety	Continental	No	Required as a back-up for	Medium	Medium	Medium	Medium	Medium	Medium	
9	VHF	Communication	48	23%	Safety	Continental	No	All Aircraft are equiped with VHF. However, 8.33KHz is only required in Europe.	High	Medium	Medium	Medium	Medium	Medium	Currently applicable in Europe. Applicable for traffic projections

6.7 Aircraft Fleet and Equipage Summary

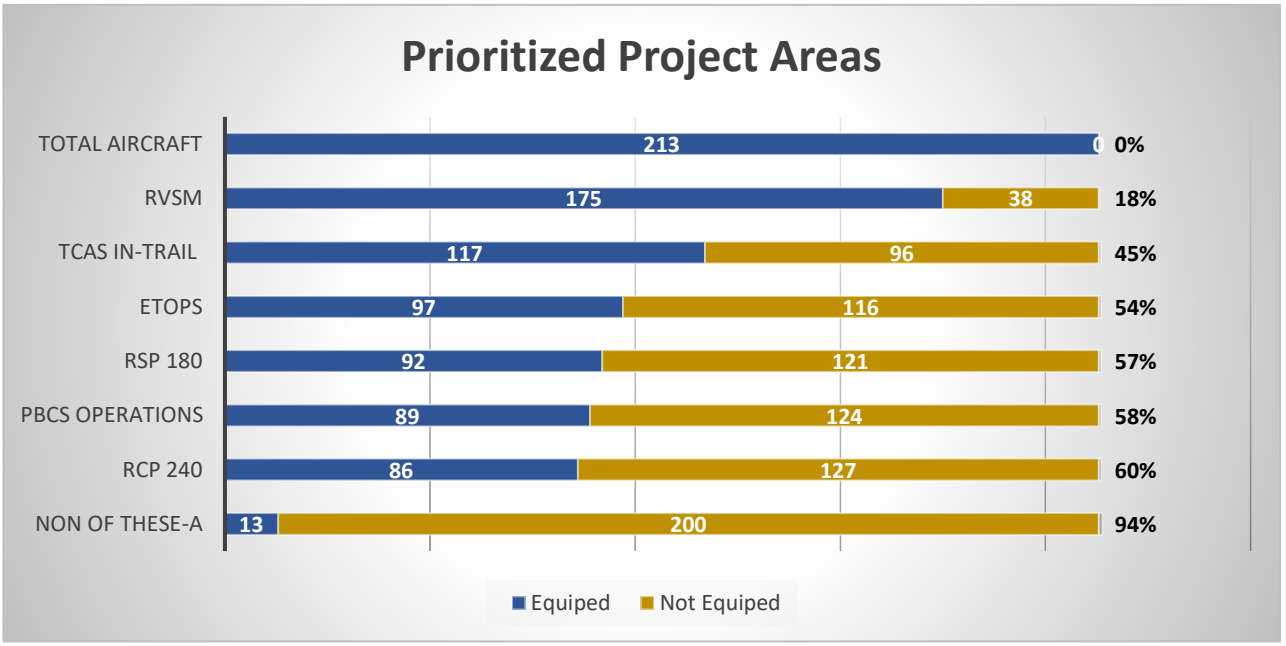

Figure 6. 1: Aircraft Fleet and Equipage Main Gaps

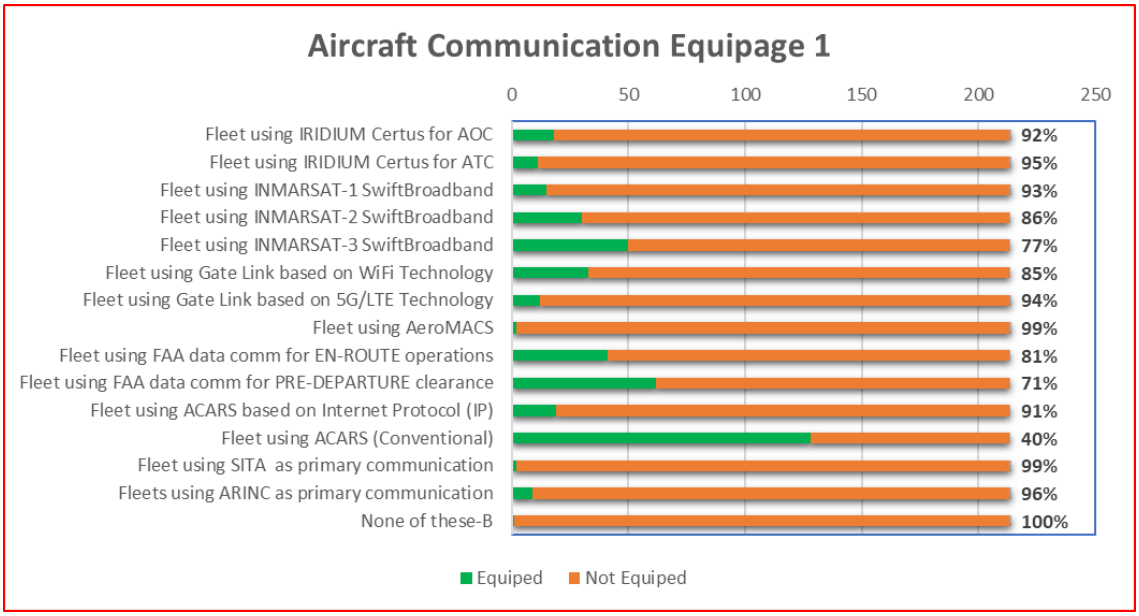

Figure 6. 2: Aircraft Communication Equipage 1 Gaps

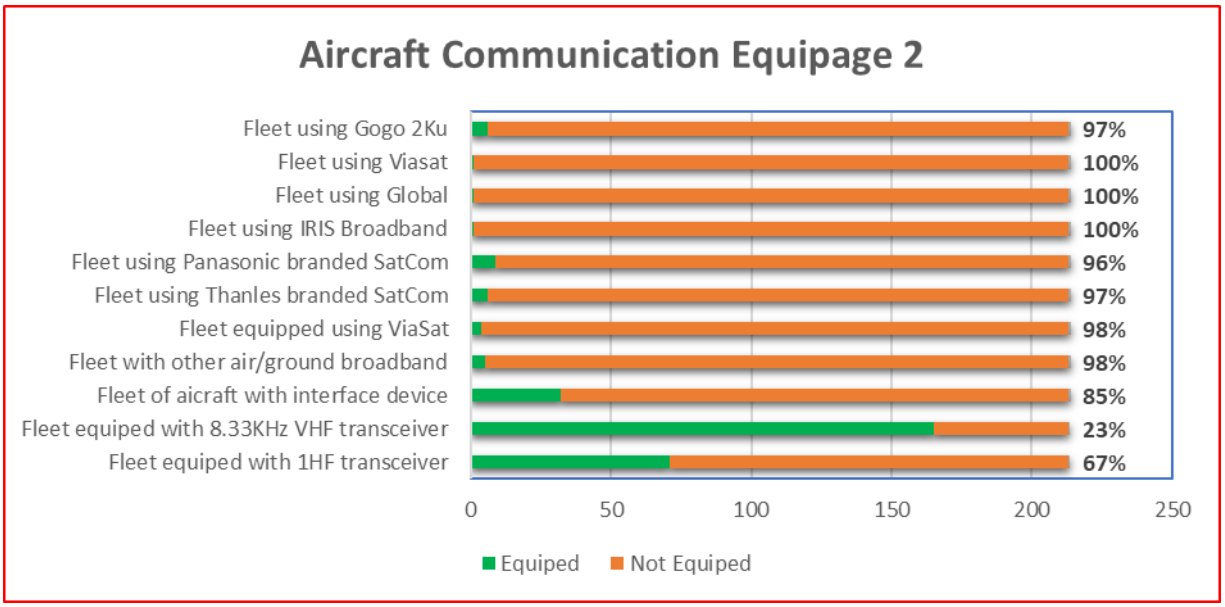

Figure 6. 3: Aircraft Communication Equipage 2 Gaps

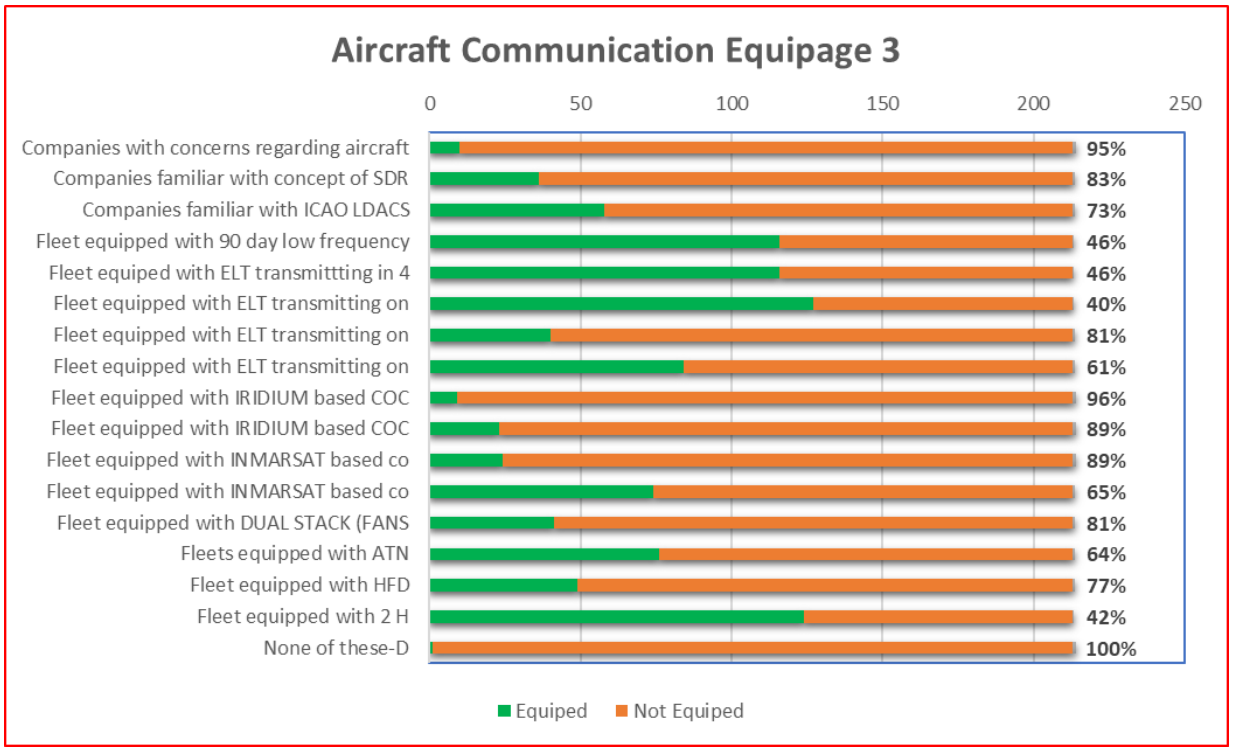

Figure 6. 4: Aircraft Communication Equipage 3 Gaps

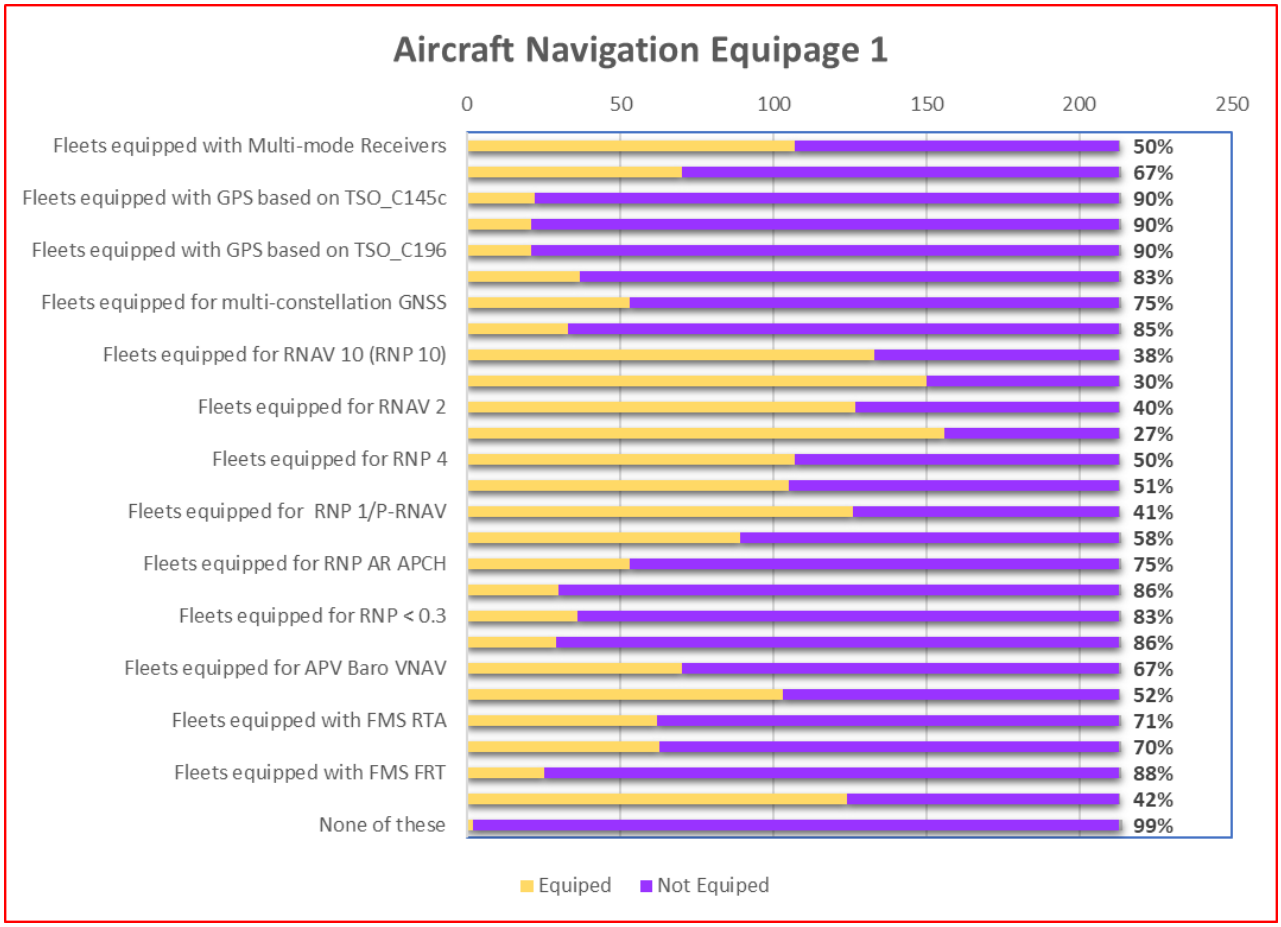

Figure 6. 5 Aircraft Navigation Equipage 1 Gaps

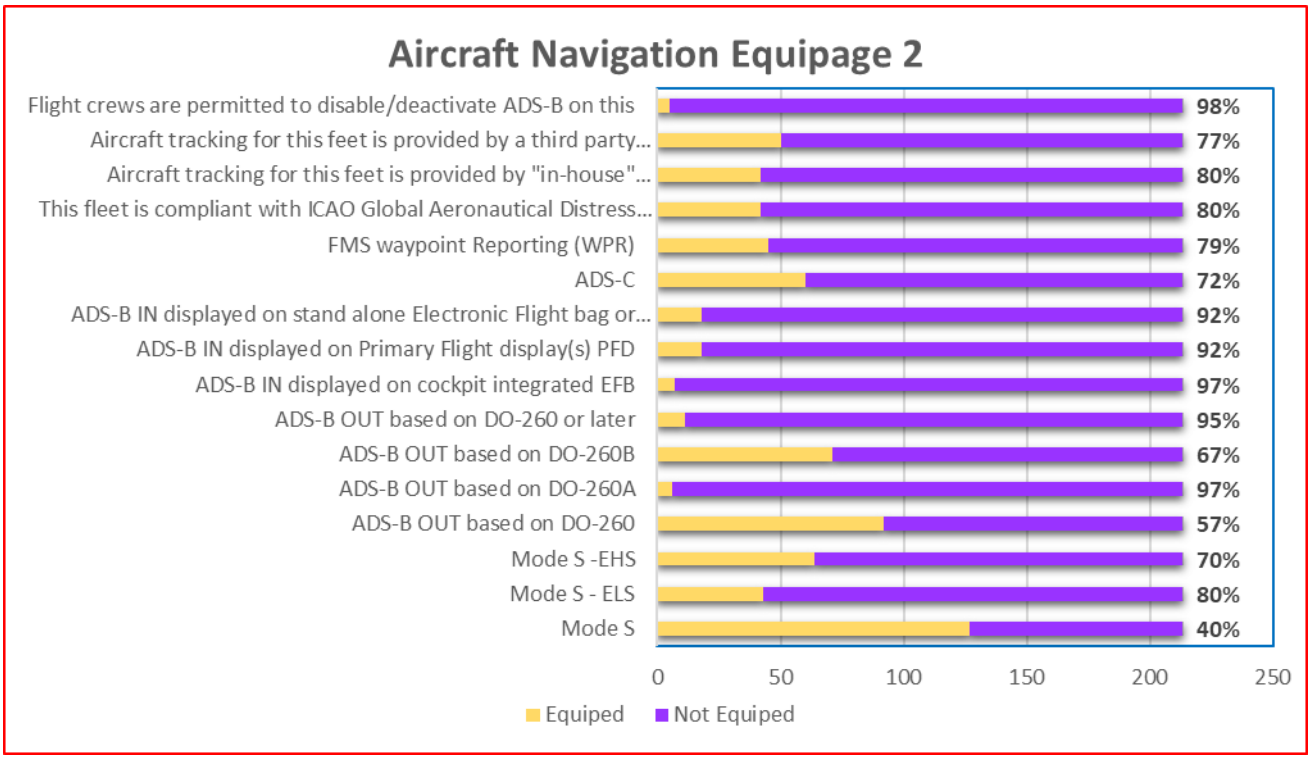

Figure 6. 6 Aircraft Navigation Equipage 2 Gaps

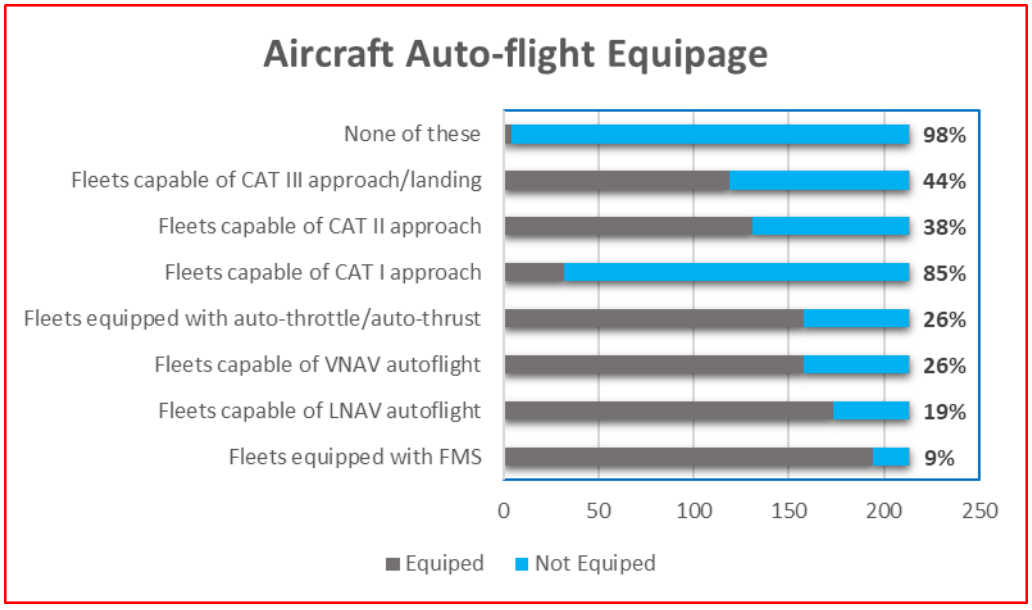

Figure 6. 7 Aircraft Auto-flight Equipage Gaps

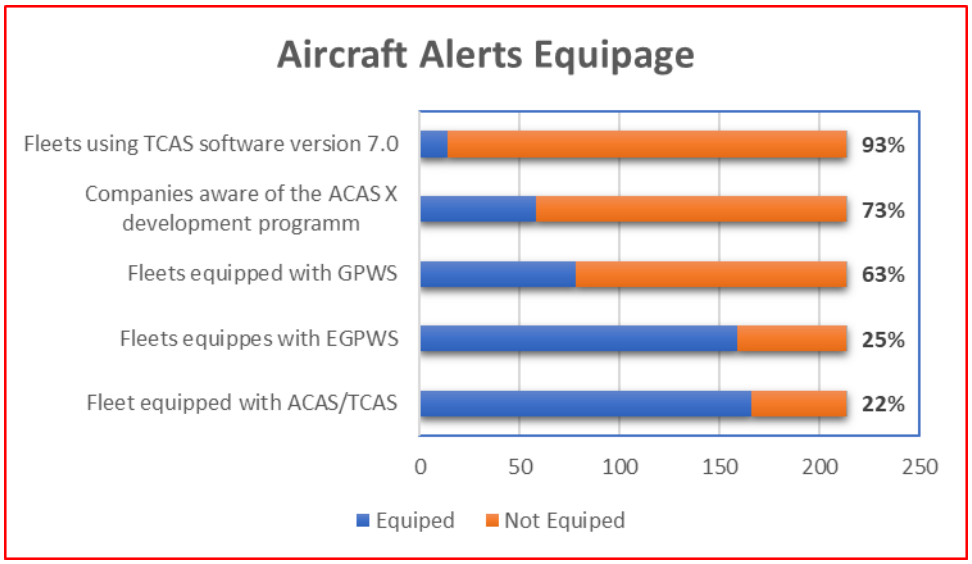

Figure 6. 8: Aircraft Alerts Equipage Gaps

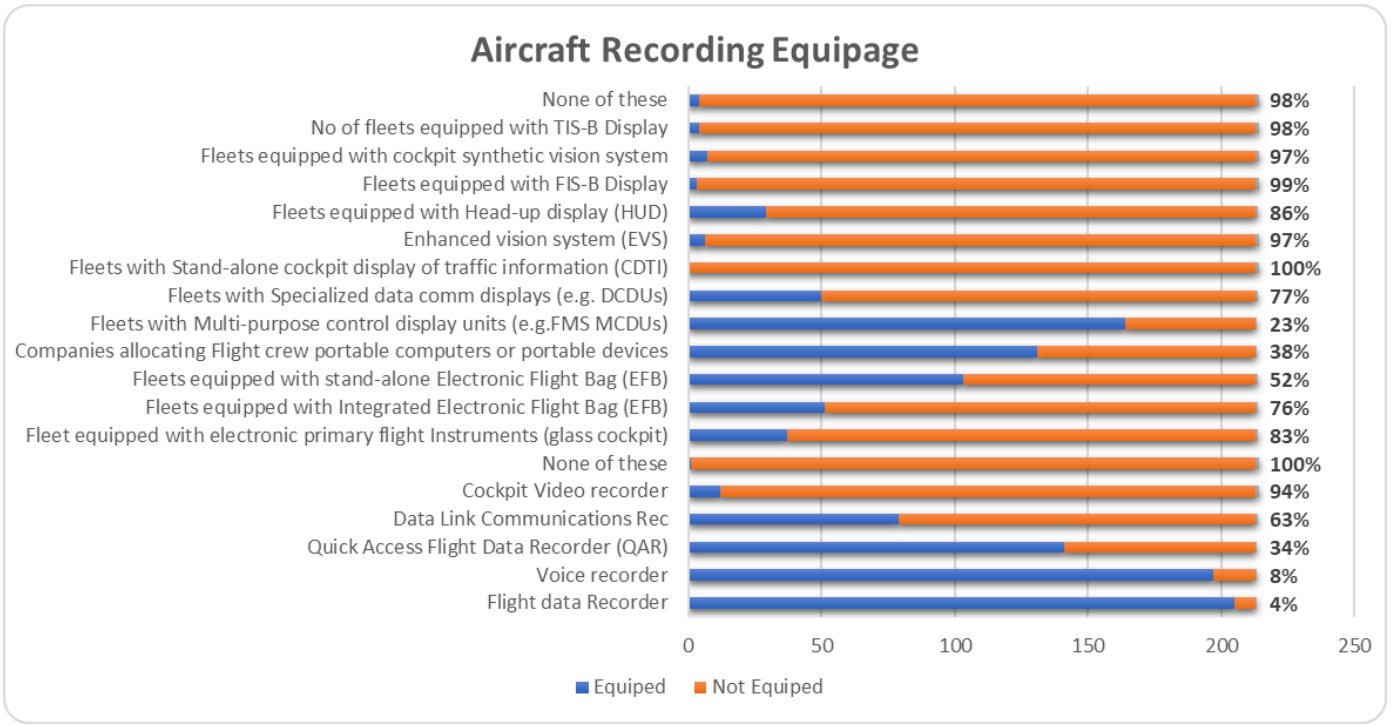

Figure 6. 9: Aircraft Recording Equipage Gaps

6.8 The Aviation Infrastructure Gap Analysis Dashboard

6.8.1 The dashboard is accessible on **Link to GapsProjectList Dashboard** and presents the outcomes of the Aviation Infrastructure Gap analysis. The data points include the following fields:

a) *ID:* Unique identifier for each infrastructure gap.

b) *Title:* A brief title for the gap.
c) *Area:* The specific area within aviation infrastructure (e.g., runways, terminals).
d) *Gap:* A description of the gap identified.
e) *Objective:* The objective of addressing this gap.
f) *Geography:* The geographical location of the gap.
g) *PPP (Public-Private Partnership):* Information on whether the project involves a PPP.
h) *Description:* Detailed description of the gap and the project.
i) *Feasibility:* Feasibility assessment score or description.
j) *Complexity:* Complexity level of addressing the gap.
k) *Politicality:* Political implications or considerations.
l) *Safety Risk:* Safety risk associated with the gap.
m) *Impact:* Potential impact of addressing or not addressing the gap.
n) *Criticality:* The criticality of the gap in terms of priority.

6.8.1.1 The displayed fields such as ID, Title, Area, Gap, Objective, and Description provides a means of highlighting critical gaps.

6.8.1.2. *Geographical Analysis:* This provides a visual representation of where the gaps are located whether at the national or regional level.

6.8.1.3 *Feasibility and Complexity:* This helps in understanding the practicality of addressing each gap.

6.8.1.4 *Politicality and Safety Risk*. This can help in identifying politically sensitive and high-risk gaps.

6.8.1.5 *Impact and Criticality:* This will help stakeholders prioritize the gaps based on their importance.

6.8.2 Filters allow users to filter the data dynamically. Users can click on a gap and view more detailed information. The Power BI dashboard effectively communicates the outcomes of the Aviation Infrastructure Gap analysis. This dashboard is meant to help stakeholders quickly understand the key areas that need attention and make informed decisions based on the data presented.

6.8.2 The TWG conducted an in-depth Gap Analysis and identified at least sixty (60) key deficiencies as gaps that need to be addressed. Weighted measures ranging from 0-12 were included on the dashboard for each of the gaps identified. The general presentation of the dashboard with the identified gaps and descriptive fields is illustrated below.

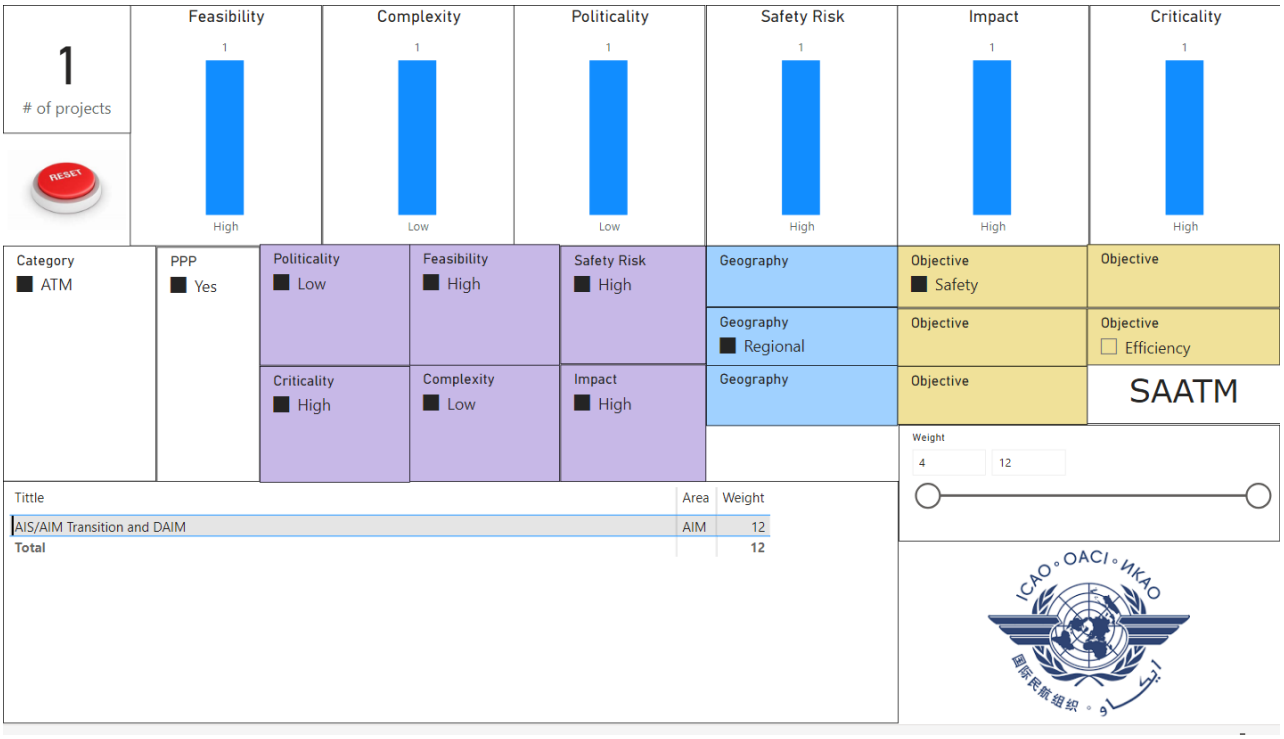

Figure 6. 10: Aviation Infrastructure Gaps

CHAPTER 7: OBSERVATIONS AND RECOMMENDATIONS

The following key outcomes and recommendations were derived from the Aviation Infrastructure Gap Analysis Project:

7.1 Observations

7.1.1 The collaboration and cooperation shown in the data gathering and data analysis process by all key stakeholders was greatly appreciated.

7.1.1 The outcomes of the data collection and analysis process was acceptable with regard to completeness and assurance that it captured information from as many States as possible.

7.1.2 Compared to 2019 data collection on aviation infrastructure gap analysis, the data collection was a success, and this was attributed to good planning, collaboration and coordination.

7.1.3 Forty-one (41) States submitted the data captured in this Report provide data. Data collected presented a reasonable sample to meet the objectives of the gap analysis.

7.1.4 Factor influencing the traffic growth in Africa include growing economy, population growth (expected to reach 2 billion by 2050) resulting in an increase demand in traffic.

7.1.5 Traffic flow management is important for the implementation of a seamless airspace and there is need for harmonization of regulations, operations procedures and equipment.

7.2 Recommendations

7.2.1 The outcomes of the Aviation Infrastructure Gap Analysis will be used to develop bankable Projects to address the identified gaps.

7.2.2 National ANS and CNS Roadmaps must be aligned with the regional roadmap on relevant areas relating to seamless services, Technology and information sharing need to comply with relevant standards, Systems and information need to be secure in line with agreed standards to ensure that the regional system does not get compromised.

7.2.3 Regional service level agreements should support regional service delivery on all operational and technical aspects, and the increase in traffic volumes must be managed through regional Air Traffic Flow Management to ensure optimal resource utilization.

7.2.4 Seamless airspace needs to start with the national airspace, and it should be interoperable with other neighbouring airspaces.

7.2.5 Development of seamless airspaces should be guided by the GANP and RANP.

7.2.6 The air navigation architecture should take into consideration new technologies and concepts such as new aircraft types, ASBU and others.

7.2.7 The formation of collaboration areas that promote R & D initiatives and customization of technologies is encouraged.

7.2.8 The project should take into consideration ongoing efforts to develop an ANS Master plan strategy.

7.2.9 The TWG was informed of the Free Route Airspace (FRA) Trials being undertaken under the UPR project. The project needs to learn from ASECNA's experience in operation of a seamless airspace and interoperability.

7.2.10 The outcomes of the Aviation Infrastructure Gap Analysis should feed into the AFI ANS Master Strategy for Seamless Sky (2 5years) using the consolidated list of costed bankable projects that will be identified and developed in the next phase. These projects will form the basis of the implementation plan for the ANS Master Strategy and roadmap in the short term, medium term, and long term.

CHAPTER 8: CONCLUSION

8.1 The IWAF/3 Declaration and Framework for development of an Aviation Infrastructure for Africa called upon African States and African Regional Economic Communities (RECs) to take specific actions, in cooperation and coordination with the AUC, NPCA, AfDB, UNECA, AFCAC, the African Airlines Association (AFRAA) and international partners to:

a) develop aviation infrastructure programmes and plans at national/regional levels based on a robust business case analysis, commensurate with the level of predicted traffic growth, and consistent with the ICAO Global Plans;
b) align and integrate national and/or regional aviation infrastructure programmes and plans with an appropriately balanced development of transport modes, including multi-modal and urban planning initiatives, and also link them with national and/or regional development plans and budgets;
c) include the aviation sector in the overall planning, development and implementation of continental infrastructure programs and projects under the integrated, corridor development and spatial development approach of infrastructure development for bankability, effectiveness, maximum development impacts, sustainability and for the industrialization of the continent;
d) ensure the inclusion of major aviation infrastructure projects in the PIDA Priority Action Plan (PAP) for 2020 – 2030 and forging-African economic cooperation and international assistance platforms such as the Tokyo International Conference on African Development (TICAD);
e) promote cooperation and compatible decision-making among transport authorities and other ministries in charge of related portfolios, including finance, economic planning, energy, environment, trade and tourism;
f) consolidate planning and development efforts for aviation, tourism and trade infrastructure, whenever possible, while harmonizing regulatory frameworks and balancing the benefits of these economic sectors;
g) determine strategic infrastructure targets that are consistent with the ICAO Global Plans by conducting gap-analyses between forecasted demand and current capacity and according to national and regional needs;
h) balance long-term uncertainty for infrastructure investment with the need to adjust to short- term priorities and funding constraints for successful project delivery;
i) establish project monitoring and evaluation frameworks using a data-driven approach;
j) build capacity of soft infrastructure, especially within the framework of the MoveAfrica initiative, as investment in quality aviation infrastructure development requires simultaneous enhancement in human capacity and is completely dependent on each other;
k) identify and develop skills required for the preparation of aviation-related PIDA-PAP projects through the establishment and implementation of capacity building strategies, taking advantage of the existing intra-African training capacity and the assistance of partners, such as TICAD; and
l) review national legislation and procedures to fulfil States' safety, security and economic oversight obligations and enhance their oversight capabilities and capacity of regional and sub- regional oversight mechanisms to effectively implement ICAO's Standards and Recommended Practices (SARPs).

8.2 The Aviation Infrastructure for Africa Gap Analysis conducted by the AUC, AFCAC, ICAO, the major airspace users and other partners through the TWG is an important step towards the identification and development of bankable projects, programs, and plans at national/regional levels based on a robust business case analysis, commensurate with the level of predicted traffic growth and consistent with the ICAO Global Plans.

8.3 This report will be considered by the next meeting of the Specialized Technical Committee of Ministers responsible for Energy and Transport. The 3rd Technical Working Group (TWG) meeting tentatively scheduled for the fourth quarter of 2024, for the development of bankable projects as well as the continental seamless airspace and air navigation infrastructure master plan. The projects to be developed will be considered under APIRG/ MIDIAN PIRG/ EUR-NAT PIRG and it will form a solid basis to engage ICAO partners, international/regional institutions and aviation stakeholders through mechanisms such as the ICAO No Country Left Behind Initiative, the PIDA Priority Action Plan (PAP) for 2020 – 2030, and other economic cooperation and international assistance platforms.

– END -

APPENDICES

APPENDIX A: SUPPORT TEAMS FOR THE 5 AFRICAN REGIONS

NORTHERN REGION	
1.	Mohamed SABBARI
2.	Tayseer Mohamed ABDEL KAREEM
3.	Bourribab Fatima Zohra
4.	Dr. Nermin Mohamed
5.	Zainab Khudhair
WESTERN REGION	
1.	Mahaman KANTA KANTA
2.	Cheikh Vedel MOHAMED
3.	Sylvain N'zebo Oi N'ZEBO
4.	Nebnoma Alexandre KABORE
5.	Samuel Kojo ZORMELO
6.	Tarr Raphael WONYABUE
7.	Sinaly Bagayoko
CENTRAL REGION	
1.	Nietche Disraely NGUIE
2.	Ousmane GUINDO
3.	Mvola Ndong TOUSSAINT
4.	Ali Mahamat MOUSSA
5.	Raymond Bell BISSE
6.	Pelengue MAGNOUREWA
7.	Gaoussou Konate
EASTERN REGION	
1.	David Ontweka ONDIEKI
2.	Protas OGANGA
3.	Gerald AGABA
4.	Odette UMUGANWA
5.	Yohannes Abera BELETE
6.	Sylvestre SIRINANZI
7.	Protus Seda
SOUTHERN REGION	
1.	Doreen Silavwe MWAANGA
2.	Nirison RAKOTOARIMANA
3.	Maxwanu NDIPOPIWA
4.	Knowledge Siboniso DLAMINI
5.	William James MFUNE
6.	Rashid KHAMIS
7.	Linda Annie MANONDO
8.	Ananias SICHONE
9.	Protus Seda

APPENDIX B : TWG MEMBERS

	NAME	ORGANIZATION
1	N'ZEBO Oi N'zebo Sylvain	CAA, Cote D'Ivoire
2	OGANGA Portas Odhiambo	CAA, Kenya
3	MANONDO Linda Loise Annie	CAA, Malawi
4	KABORE Nebnoma Alexandre	CAA, Burkina
5	AGYARE William Gyamerah	CAA, Ghana
6	CHEIKH Mohamed Vadel Chemssedine	CAA, Mauritania
7	MAHAMAN Kanta Kanta	CAA, Niger
8	ZORMELO Samuel Kojo	CAA, Ghana
9	DLAMINI Siboniso Knowledge	CAA, Eswatini
10	AGABA Gerald	CAA, Uganda
11	MOHAMED Ali Mohamed Ali	CAA, Egypt
	ANGO SHEHU Mohammad	CAA, Nigeria
13	MAXWANU Ndipopiwa Sarafina Helena	CAA, Namibia
14	DJIMHOMADJI KRADJI Parfait	ANAC, Chad
15	NGUIE Nietche Disraely	CAA, Congo
16	VUDZIJENA Lawrence Simbarashe	CAA, Zimbabwe
17	BISSE BELL Raymond	CAA, Cameroun
18	MWAANGA Doreen	CAA, Zambia
19	MFUNE William James	CAA, Zambia
20	SSENKOOTO Faraji	AFCAC
21	DANGA James	AFCAC
22	OJIAMBO Henry Okech	AFCAC
23	OKEMWA Motende Japhet	AFRAA
24	KONATE Gaoussou	AFRAA
25	GERSBACH Carel Hendrik Baumgratz	ATNS
26	MUNETSI Aaron Ronnie	AASA
27	DU-PONT Edgar Sipho	SASO
28	OCHE Victor-Elias Ekoza	BAGASSO
29	WANDA Alex	SATNAV AFRICA JPO
30	NDOH Njasawaka Ngoe	Consultant
31	NDEMA Nicholas	COMESA
32	WANE Ibrahima	ACI-AFRICA, DAKAR AIRPORT
33	OTIENO Protus Seda	IATA
34	SINARINZI Sylvestre	EAC CASSOA
35	GATETE Richard	EAC CASSOA
36	JALLOH Ibrahim Baba	ROBERTS FIR, LIBERIA
37	KHOSA Fannuel	ATNS
38	ERHUEH Charles Irikefe	BAGAIA
39	KHAMIS Rashid Said	CAA, Tanzania
40	MYEZA Thabani Cedric	CANSO
41	MASON Lyat Olabisi	CAA, Sierra Leone
42	EKOTO Romain Philippe Michel	AfDB
43	MANZI Nelson Leon	ASECNA

44	OMUYA Elisha Bwabi	ICAO
45	KEBEDE Eyob Estifanos	ICAO
46	MERENS Marco	ICAO
47	HERVE Forestier	ICAO
48	SALAMBANGA Francois-Xavier	ICAO
49	GOLAFALE Harold Success	ROBERTS FIR
50	MOHAMED LAMINE ABANI Moustapha	ASECNA
51	TEFERA Mekonnen	ECAA Consultant
52	ERIC Ntagengerwa	AUC-IED
53	ARJAN Mohamed	AUC-IED
54	FIORELLA Di Pede	AUC-IED