MORE ELECTRIC AIRCRAFT TECHNOLOGY INTRODUCTION IN SOUTHERN AFRICA: A CASE STUDY OF ZAMBIA

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ABSTRACT
Zambia, like many other southern African countries has the majority of the locally registered aircraft operating without the More Electric Aircraft (MEA) technology incorporated for various reasons. Consequently, these countries miss out on the benefits of MEA technology. This paper highlights challenges faced by the Zambian aviation sector in its quest to introduce the MEA technology. In addition, the paper makes recommendations that address the identified challenges. The gathered information could help to find solutions to the challenges in the direction of reducing environmental pollution, promotion of local aviation industry's growth, safety and reducing aircraft maintenance costs. The research is conducted through a literature review and interviews with members of staff of selected aviation operators, approved aircraft maintenance organisations (AMOs), aviation training school, the Civil Aviation Authority, and Zambia Airports Corporation Limited. In addition, the working environment of the mentioned institutions were also considered to ascertain their readiness to support the MEA technology. It was discovered that most of the challenges involved aviation training institutions, aircraft operators and the AMOs. It is therefore recommended that the aviation training institutions be adequately equipped with training aids and materials to embark on capacity building of members of staff. Further, the AMOs should also be equipped with MEA technology diagnostic equipment. In addition, the aircraft operators should also invest in a holistic MEA human resource training.
Keywords: more electric aircraft, environmental pollution, safety, and growth.

1 INTRODUCTION

The Zambian aviation sector's fleet of aircraft is comparatively small in size and has a largely conventional aircraft architecture, which has more mechanical subsystems compared to electrically operated subsystems (more electric subsystems) [1]. The More Electric Aircraft (MEA) architecture is achieved by replacing mechanical, hydraulic, or pneumatic subsystems with electrical alternatives [2]. The conventional aircraft architecture has higher non-propulsive power consumption, more prone to failure, and has a complicated circuit which results in expensive repairs and component replacement compared to MEA architecture. In addition, the subsystem's energy and fuel consumption are also comparatively high. The key drivers in the shift from conventional aircraft to MEA are improved efficiency, weight, and volume, hence reduced fuel burn and improved environmental impact. Therefore, the MEA concept is an enabler for the future greener aviation. Research has shown that the transportation sector consumes about 66% of crude oil supply worldwide and produces about 25% of carbon dioxide emissions. Therefore, the contribution to the energy budget and emissions (CO_2) by the transport sector is predicted to increase to 80% by 2050 if nothing is done to address this global environmental concern. The transport industry contributes about 20% of the global total emissions and ; the aviation sector should not be ignored in the match, to reduce the total emission contribution by the transport industry. This can be achieved through the introduction of energy efficient technologies which have reduced environmental impact [3].

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This paper presents the challenges faced by the Zambian aviation sector in its quest to accommodate the needs of aircraft with MEA architecture. To achieve this the main objective of the paper is to present the country's readiness to effectively manage MEA aircraft from the point of view of the aircraft operators, Approved Aircraft Maintenance Organisations (AMO), the Zambia Civil Aviation Authority (CAA), Zambia Airports Corporation Limited (ZACL) and Zambia Air Services Training Institution (ZASTI). The introduction of MEA technology will benefit the country through operational cost reduction resulting from aircraft system weight reduction, ease of maintenance, increased engine efficiency, reduced engine use on ground, controllability, reconfigurability, and use of advanced diagnostics and prognostics maintenance techniques [3].The paper presents the gap which may help relevant and concerned stakeholders take the necessary measures to fill it up and ensure that the country contributes to the global cause of reducing greenhouse gas emissions.

The research was conducted using survey method. This was found to be appropriate because the focus population was in one area, i.e., the Kenneth Kaunda International Airport. In this paper Section 1 is the introduction while Section 2 covers the methods used to arrive at the results and discussions presented in Section 3. Section 4 concludes by giving a brief summary of the paper.

2 METHODOLOGY

The case study research method was used where an empirical inquiry that investigates contemporary phenomena within its real life was done. A comparison between conventional and non-conventional aircraft (MEA) in terms of infrastructure requirements for airport handling, maintenance and regulation was conducted. The research strategy was chosen because it was found to provide reliable data with less complication in line with research needs [4].

2.1 Data collection

A conducted tour, staff interview and literature review regarding readiness to manage and operate the MEA aircraft technology was done. At the training institution the training aids, learning materials and facilities and staff qualifications were considered, while a visit at the AMO focused on spares availability, workshop facilities, diagnostic equipment, staff competences. For the CAA, the main concern was about what has been put in place to regulate component certification, training schools, airport services providers and approved aircraft maintenance organisations. The airport services provider focus was on air navigation, ground handling, airport facilities and infrastructure that support introduction of MEA technology. The combined results of the conducted tour, staff interview, and literature review resulted in the percentage scores of Tables 1 to 4. A record of what was lacking in the Zambian aviation sector's quest to introduce MEA was done in line with the aviation training, maintenance, civil aircraft regulation and airport handling [4].

2.1.1 Data analysis

The collected data was analysed using the narrative data analysis method. This exposed what needed to be put in place for smooth operation of the more electric aircraft. The gaps noticed were tabulated in percentages according to the capacity of each institution to meet the needs of MEA technology in order to address the observed gap [5].

3 RESULTS AND DISCUSSION

The results of the comparison of requirements in terms of training, regulation, maintenance, and airport handling are shown in Tables 1 to 4 followed by discussion.

3.1 Training

For successive operation of MEA technology on aircraft there is need for human resource training that meets the requirements of MEA in terms of academic staff, facilities and training aids. The state of aviation training at ZASITI is shown in Table 1.

Table 1: MEA Training requirements.

S/No.	Details	State
01	Academic staff	At 35%
02	Training aids	At 0%
03	Training facilities	At 85%
04	Training materials	At 5%

3.2 Regulation

The CAA is mandated to regulate and enforce aviation regulations in training, and other civil institutions in the aviation sector. This is done using the Zambia Civil Aviation Regulations Requirements (ZCARs) and Annex 13 to the Convention of the International Civil Aviation Organisation (ICAO). Table 2 shows the capacity of the CAA to regulate aircraft with MEA technology.

Table 2: MEA Regulation requirements.

S/No.	Details	State
01	Component certification human resource	At 90%
02	Training aids	At 25%
03	Airport facilities	At 80%
04	Ground	At 40%
05	Maintenance Organisations	At 65%

3.3 Aircraft maintenance

The active locally registered fleet of commercial civil aircraft is very small with the biggest private operator having seven aircraft and the total number of operators that include airlines and chartered companies not exceeding 10. The smaller aircraft in the Piper and Cessna family, such as that operated by charter services, has a passenger capacity of six although the majority carry four, whilst the biggest locally registered aircraft, the B737-500, has a passenger capacity of 132. The average age of the aircraft is between 27.1 to 30 years. The fuel consumption for the Cessna 206 and the B737-500 are 2,400 kg/hour and 15 gallons per hour [6].

The results of the status of approved AMOs in meeting the needs of the introduction of the MEA aircraft are presented in Table 3.

Table 3: MEA AMO requirements.

S/No.	Details	State
01	Spares	At 0%
02	Component maintenance	At 0%
03	Workshop facility	At 5%
04	Tools/equipment	At 10%

3.4 Airport handling

Among the 10 active airports contributing to the 186,791 annual passenger traffic, the largest number of passengers is contributed by the three main air ports, namely the Kenneth Kaunda International Airport (KKIA), Simon Kapwepwe International Airport (SMKIA) and Harry Mwaanga Nkumbula International airport (HMNKIA). The mentioned three international airports are the only ones equipped with aircraft ground handling equipment such as the ground power unit used for charging more electric aircraft that use these airports. It should be noted that the Zambian AMO lacks capacity to troubleshoot nor rectify snags on aircraft with more electrical systems [7]. Table 4 shows the state of the airport handling facilities in terms of meeting the needs of the introduction of MEA.

Table 4: MEA airport handling status.

S/No.	Details	State
01	Air navigation	At 100%
02	Ground handling	At 100%
03	Airport facilities	At 85%
04	Infrastructure	At 85%

3.5 Discussion

Lack of trained instructors, as well as training aids and materials in MEA technology is an impediment to the production of aviation students with MEA qualifications. This gap can be addressed through instructor training, and the acquisition of both training aids and materials. Dependence on foreign AMOs for repairs and spares supply, besides being costly, is a disadvantage that increases the lead time to repair. Export of maintenance works makes maintenance very expensive. The delay slows down aviation business where time is of paramount importance. To resolve the issue, there is need to create incentives that will attract investment in setting up AMOs and aircraft spares as well as diagnostic equipment manufacturing plants. There is a need to employ qualified staff in MEA technology in regulatory, maintenance and training institutions in order to address human resource challenges.

The small size of the aviation industry in the country entails that there would be insignificant power saving from the main hydropower grid which accounts for more than 90% of the power generation in the country. Developing countries such as Zambia need to be cautious when transitioning from conventional to non-conventional aircraft. The switch to non-conventional aircraft technology should be phased due to cost implications, and observed gaps in trained engineers and technicians and facilities. Although, bridging this gap may take one to two decades, the country may start by phasing the introduction of standards and regulations requiring aviation sector players to incorporate set technology within a given time period failure to which they would not be allowed to operate.

4 CONLUSION

The paper has presented the state of the Zambian civil aviation sector's readiness to embrace MEA technology highlighting the gap that each key institution is expected to address. It was found that, whereas some considerable progress was made by the airport services institution, more has to be done by the other institutions which were still lagging behind. The solution to address the noticed gap was presented. The study population was based on institutions at Kenneth Kaunda International Airport and the surrounding aviation maintenance institutions and air operators. Nevertheless, the paper has stated the existing gap for the Zambian aviation sector to fully support the introduction of the MEA in the country.

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