ADAPTING EDUCATIONAL APPROACHES FOR SUSTAINABLE AIR TRANSPORT

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Abstract

The air transport industry, a vital catalyst for global connectivity and economic progress, is actively adapting to economic and technological trends, also considering the sustainability impact. This commitment reflects its significant role in shaping a resilient and eco-conscious future for global transportation systems.

This research is conducted within the Erasmus+ project "Creative Digital Teaching and Learning for Green Air Transport and Logistics (AVIONIC)", with partners from Finland, France, Romania, and Spain and having the continuous support from representatives in higher education, training, air transport, international and national authorities. The project's activities include: the identification of digital and green skills in air transport, sharing knowledge on innovative teaching and learning methods, developing new curricula and educational materials based on research findings on new jobs and qualifications, and creating new digital tools for interactive teaching and learning.

Through a comprehensive analysis of various documents and reports incorporating insights from prior research as well as our own investigations using questionnaires distributed to airport directors, air transport employees and educators, we have uncovered significant shifts and gaps in skills development in the industry. Recognizing the imperative to align with air transport labour market needs, our study has identified emerging occupations necessitating new or updated qualifications, driven by the digitalization and sustainable development in air transport.

Consequently, this paper advocates for the adaptation and reorientation of the entire educational process to effectively respond to these evolving trends. This necessitates a proactive approach involving a change in training requirements, course redesign and the incorporation of innovative teaching methods, integrating digital solutions for a comprehensive educational transformation.

Keywords: Air transport, Skills shortages, Emerging occupations, Reskilling, Course redesign.

1 INTRODUCTION

The air transport industry, a pivotal global engine of connectivity and economic growth, remains at the forefront of technological advancements and evolving trends. Every day, 128,000 flights take off, carrying 12.5 million passengers and $18 billion of world trade [1]. Recognizing its indispensable role, stakeholders are increasingly focused on fostering sustainability within the industry, striving to balance growth with environmental responsibility. The ongoing commitment to innovation and sustainability in air transport underscores its profound impact on shaping a resilient and eco-conscious future for global transportation systems. However, this industry is not immune to the challenges and complexities of our rapidly evolving world. In recent years, the air transport sector had to deal with various challenges, ranging from the need for *increased efficiency, safety issues to environmental concerns*. Nevertheless, remarkable advances have emerged, driven by technological innovation, and determined quest for sustainability.

Throughout the world, passenger traffic experienced a dramatic decline due to the unprecedented impact of the Covid-19 pandemic. This resulted in an overall reduction of 50% in available airline seats, a decrease of 2,703 million passengers (-60%), and an estimated loss of approximately USD 372 billion in gross passenger operating revenues for airlines [2]. While there has been a gradual recovery in the air transport system in recent years, with 3.2 million passengers traveling by airlines last year, this figure remains significantly lower than the 4.5 million passengers transported in 2019 [2]. The air cargo industry has rebounded to pre-pandemic levels, reaching a monthly transportation volume of 20 billion cargo-tone-kilometers by January 2023 [3].

The air transport industry has set a range of long-term objectives, as shown in Fig.1., but its progress has been gradual in recent years due to the issues related to safety. With notable advances in digitalization and sustainability, the aviation sector is anticipated to shift its emphasis towards these focal points, marking a substantial development for the industry on numerous fronts. However, the current educational landscape falls short in adequately equipping professionals for these transformative changes.

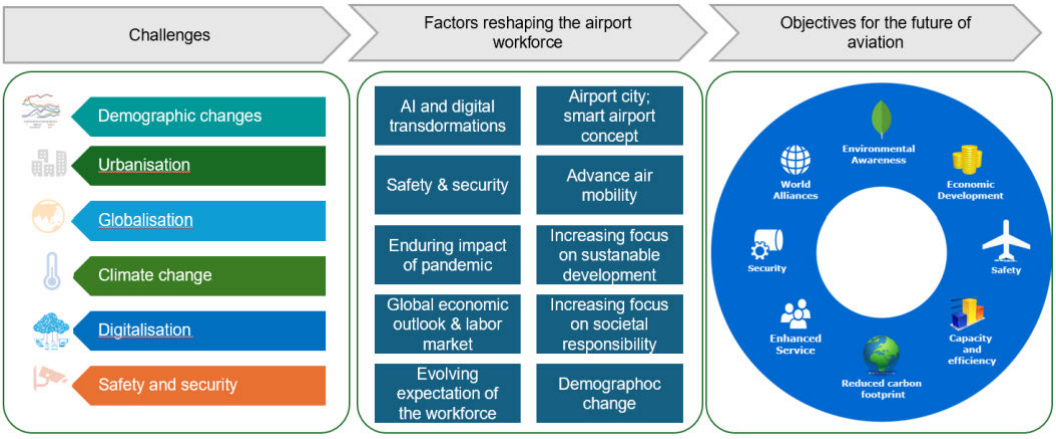

Figure 1.Challenges and perspectives for air transport industry

One of the defining trends shaping the air transport landscape is the accelerated pace of **digitalization.** The integration of cutting-edge technologies, such as *artificial intelligence, data analytics and automation* are reshaping operational processes, enhancing safety measures, and optimizing overall efficiency. These digital advancements not only improve the passenger experience but also offer airlines and aviation authorities unprecedented insights into operational dynamics.

An increasingly significant challenge facing the air transport industry is the growing concern for climate change, **sustainability, and emissions** in the air transport industry [4]. As sustainability becomes a central imperative, the air transport sector is embracing measures to address environmental impacts. The aviation industry is proactively seeking eco-friendly solutions. Initiatives for *sustainable aviation fuels (SAF), energy-efficient aircraft, and carbon offset programs* are gaining momentum, reflecting a commitment to reducing the environmental footprint of air travel.

As part of the Green Deal transformational initiative, the European Commission (EC) has introduced a series of proposals aimed at aligning the EU's climate, energy, transport, and taxation policies with the objective of reducing net greenhouse gas emissions by at least 55% by 2030, in comparison to 1990 levels [5]. As climate news intensifies with increasingly alarming forecasts indicating greater impacts in the near future, leaders within the aviation industry have taken a very important step by committing to achieving net-zero CO2 emissions by 2050. Achieving net zero by 2050 will require a combination of several factors and constant and strong involvement of all stakeholders. A potential scenario from IATA is that 65% of this will be obtained through sustainable aviation fuels (SAF), 19% from offsets and carbon capture, 13% due to new technologies electric and hydrogen related and 3% as a result of infrastructure and operational efficiencies [6]. One of the greatest efforts the world will have to overcome is the progression from using fossil fuels to alternative energy such as solar energy, mainly because almost 75% of global CO2 emissions come from the use of fossil energy. The global SAF market size is projected to grow from USD 1.1 billion in 2023 to USD 16.8 billion by 2030 [7].

Societal responsibility in air transport encompasses a broad spectrum of ethical considerations and obligations that the industry bears toward society at large. As a driver of global connectivity and economic growth, the air transport sector must navigate its operations with awareness of environmental impact, community well-being, and ethical practices. This involves addressing issues such *as reducing carbon emissions, noise pollution and the overall ecological footprint of air travel,* promoting sustainable practices, ensuring passenger safety and comfort, supporting local communities, philanthropic initiatives and volunteer work [8]. Achieving societal responsibility in air transport requires a holistic approach that aligns business objectives with social and environmental stewardship, ultimately contributing to a more sustainable and inclusive aviation landscape.

Moreover, as the air transport sector navigates the complexities of the future, it is confronted **with the emergence of new occupations** that mirror transformative industry changes, driven by the technological advancements on equipment, services, and infrastructure and by concerns about ecological and environmental protection. This evolving landscape necessitates a **proactive response** from industry professionals and from education and training providers, demanding a continuous commitment to **upskilling and adaptation** to these contemporary demands. The need for upskilling in many fields and, in particular, in air transport is supported also by documents and reports from EC, International Civil Aviation Organization (ICAO) and European Aviation Safety Agency (EASA).

2 METHODOLOGY

In this study, we employed a multi-faceted approach to comprehensively analyze the challenges and opportunities within the air transport industry and propose effective educational solutions. The methodology encompassed several key components.

This research was conducted within the framework of the Erasmus+ *project Creative Digital Teaching and Learning for Green Air Transport and Logistics (AVIONIC)* [9]. Collaboration with partners from Finland, France, Romania and Spain, along with support from representatives in higher education, training, air transport, and international/national authorities, ensured a holistic approach to addressing industry needs.

For data collection, we started with an extensive analysis of various documents and reports from relevant sources such as the EC, ICAO and EASA which provided valuable context and insights into industry trends and challenges. Additionally, we distributed questionnaires to stakeholders within the air transport industry, including airport directors, air transport employees, and educators. These questionnaires were designed to gather insights into skills shortages, emerging occupations, and educational needs. Additionally, we conducted consultations and discussions with stakeholders from the air transport industry in Spain and Finland, engaging with airport directors and European human resources representatives in Bucharest and Bologna, and collaborating with specialists in digital learning and gamification in France.

For data analysis, the quantitative data collected through questionnaires were analyzed to identify patterns and trends related to skills shortages and emerging occupations in the air transport sector.

The development of **new or updated qualifications** was guided by the European Qualifications Framework (EQF) and aligned with the Sectorial Qualification Framework for Air Transport (SQFAT) Methodology [10] , developed within the KAAT Project [11]. This ensured that the proposed qualifications met international standards and addressed industry-specific competencies.

A key part of this methodology is the curriculum development process. Learning outcomes are being revised to reflect the identified skills shortages and emerging occupations, with a focus on interdisciplinary knowledge areas relevant to the evolving needs of the air transport industry. Study programs and curricula will be adapted to incorporate innovative teaching methods and digital solutions, enhancing the relevance and effectiveness of educational offerings.

Rigorous validation processes were implemented to ensure the quality and relevance of research findings and educational materials, fostering confidence in the proposed solutions. By using this robust methodology, we aimed to provide actionable insights and recommendations to support the ongoing evolution of the air transport industry and enhance the educational landscape to meet its evolving needs.

3 RESULTS

3.1 Skills shortages and reskilling needs in the air transport sector

Based on our own investigation and analyses from other sources, we have identified significant skills shortages and gaps within the air transport sector, highlighting the necessity for reskilling or upskilling the workforce. These shortages pose a critical challenge to the industry's efficiency and adaptability in the face of rapid technological advancements and evolving market demands.

In our survey with airport directors, one topic of discussion was their perspectives on the current structure of skilled labor within their companies and any existing shortages. Furthermore, they highlighted potential emerging positions within their organizations and forecasted skill requirements for the future. The directors were asked to identify the areas within their organizations where they perceived skill shortages among their workforce. Subsequently, they were prompted to identify the least prominent skills within their organization, aiding in the identification of associated requirements. Various areas were described, including **adaptation to technological advancements, environmental awareness** and **innovative management methodologies**, among others.

High-skill non-manual occupations are in high demand by all companies in most of the areas shown in Fig. 2. However, there are areas where these types of positions are not required, such as "Societal responsibility and business ethics", where highly qualified personnel may not be imperative. Moreover, the remaining skilled non-manual occupations and skilled manual occupations show a similar across all areas, only regarding new management approaches having a lower score (12%).

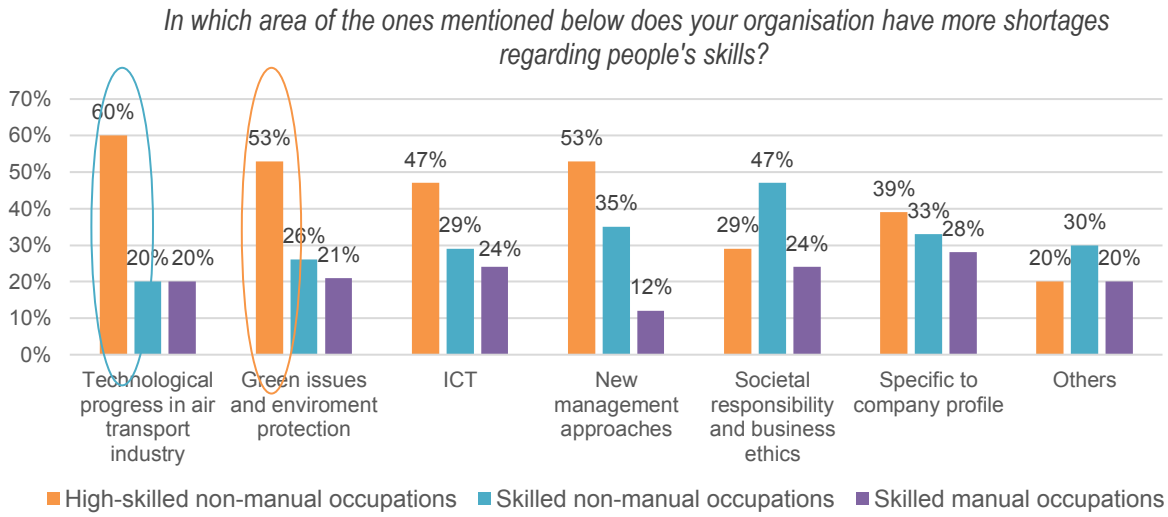

Figure 2. The perceptions of top management from air transport sector about skills shortages in their organization (Source: own survey)[12]

Analyzing the survey results, it is evident that there is a pronounced deficiency in skills related to new management approaches, with 53% of respondents indicating shortages in high-skilled non-manual occupations, underscoring the industry's need for innovative leadership strategies. Similarly, the data reveals substantial gaps in skills pertaining to technological progress, with 60% of respondents identifying shortages in high-skilled non-manual occupations, reflecting the industry's struggle to keep pace with rapid technological advancements. Furthermore, the significant shortage of skills in green issues and environmental protection, reported by 53% of respondents in high-skilled non-manual occupations, underscores the pressing need for sustainability initiatives within the air transport sector. The relatively lower percentages of shortages in skilled manual occupations across all areas suggest a greater demand for specialized expertise in non-manual roles. These findings emphasize the importance of targeted reskilling or upskilling programs to address these skill gaps and ensure the industry's long-term viability and competitiveness.

The findings both from other research and from our own survey underscore the necessity for proactive measures to address these skill gaps through targeted reskilling or upskilling initiatives. Moreover, the identification of specific areas within organizations where skill shortages are most pronounced provides valuable insights for strategic workforce planning and resource allocation. Overall, the research underscores the imperative for stakeholders in the air transport sector **to prioritize investments in human capital development** to ensure long-term sustainability and competitiveness.

3.2 New occupations generated by digitalization and sustainable development in air transport

Back in 2019, the Organisation for Economic Cooperation and Development (OECD) issued a forward-looking prediction. It projected that within 15 to 20 years, new automation technologies would potentially eliminate 14% of the world's jobs and significantly alter another 32% [13]. These projections were significant, affecting over 1 billion people globally, and did not even consider the emergence of ChatGPT and the latest wave of generative AI that has recently surged into the market. If the OECD estimates prove accurate, the coming decades may necessitate the complete reskilling of millions of workers creating a fundamental and complex societal challenge. This will require workers not only to acquire new skills but also to effectively apply them in transitioning to different occupations.

Through desk research, we have identified several occupations within the air transport industry that are likely to undergo changes or even disappear. This section serves as a compilation and summary of the identified occupations from our research.

Table 1. Interdisciplinary occupations for future air transport industry [12]

Categories of occupations	Groups	Occupations
Aviation and ICT	Big Data applied in aviation	Big Data Architect, Data Scientist, Data Analyst, Chief Data Officer, Data Protection Officer
	Cybersecurity	Auditor, Crisis Management Specialist, Expert intrusion tests, Head of the Information Systems Security, Secure communication supervisor
	Data Storytelling	Data Storyteller, Data Scientist, Business Analyst, Web Analyst
	Data Science	Chief Data Officer, Data Steward, Data Analyst, Data Scientist, Data-Miner, Developers and integrators of blockchain and virtual technology, AI engineer
	Piloting	Remote pilot
	New management approaches	Expert in flight procedure design, managers for ACDM and APOC implementation
Aviation, ICT and Marketing	Search Engine Optimization (SEO)	SEO Manager, SEO Consultant, Content Manager, Traffic Manager
	E-CRM (Electronic Customer Relation Management)	CRM Responsible, Consultant, CRM Manager, Project Manager, Data Analyst
	E-reputation	E-reputation Manager, E-reputation Consultant, Advisor / Watchman in e-reputation, Community Manager, Content Manager
	User eXperience (UX) / User Interface (UI) design	Service Designer, UX Manager, UI Designer, UX Designer, Ergonomist Designer
Aviation and sustainable development	Sustainable aviation research	Sustainable experts. Green energy researchers, Climate Change Reversal Specialist, Green Fuels Researcher
	Circular economy management	Alternative energy engineer, circular economy manager
	Electrical engineers	Battery technician, Energy and maintenance engineers, electrical GSE engineers, Energy and maintenance engineer: thermal, solar; electric aircraft technician, engineer for maintenance hydrogen systems
	Sustainable aviation experts	Sustainable airport engineer, Airport environmental system manager, Sustainability consultant, green lead airport operation manager, environment al risk manager, Sustainable Aviation Policy, Air Quality Analyst, Solar flight specialists, Director for sustainable aviation
	Biofuels	Chemistry engineer, Biology experts
Aviation, ICT and sustainable development	Airport operations optimization	Air traffic manager, chief operations officer, Sustainable Airport Planner. Consumer energy analysts, Optimization researcher or expert
	Alternative vehicle developer	Project Manager, Data Analyst, Designers of autonomous vehicles Safety officers for unmanned systems, Pilots for UAV
	Management of vertiports	Vertiport operation officer, CEO vertiports, Advanced ATC officers
	Maintenance of new IT equipment based on green energy	Technicians/ engineers for green energy equipment

The results of the survey indicate a transformative shift in occupations by 2030, with emerging roles such as energy and maintenance engineers specializing in thermal and solar technologies, electric engineers involved in alternative vehicle development, aviation data analysts, electric aircraft technicians, air traffic controllers (ATC), pilots, safety management system (SMS) specialists, and customer service desk personnel. Conversely, traditional roles such as cashiers, on-board co-pilots, security controllers, ground handling drivers, company counters for checking, and manual data input occupations are projected to diminish.

As can be seen in the tables from above, the anticipated creation of **new occupations** in the organization over the next 10 years includes roles such as *Big Data specialists, drone pilots, AI experts, cybersecurity specialists, sustainable aviation engineer, green fuels researcher, drone traffic manager, climate change specialist and environmental specialists.* These positions reflect the evolving landscape where expertise in data analytics, emerging technologies, and environmental sustainability is becoming increasingly vital for organizational success. In the coming decade, the organization envisions the emergence of new occupations, ranging from specialists in environment and sustainable aviation policy to engineers and planners dedicated to sustainable practices. The anticipated roles also encompass experts in climate change, consumer energy analysis, air quality, and education, highlighting a strategic commitment to environmental consciousness and technological advancements within the aviation sector.

All detailed research and results can be found on AVIONIC project website [9] [12] or procured form the corresponding author.

3.3 Innovative educational approaches for new or updated qualifications

One of the specific objectives of the AVIONIC project is to assess and enhance the learning outcomes (LOs) of 10 study programs encompassing over 60 courses, aligning them with the occupational demands identified in our previous research on occupations and qualifications within the air transport sector. New learning outcomes addressing the trends of digitalization and green practices within air transport will contribute to the overarching goal of enhancing the quality and relevance of knowledge and skills among future professionals.

The **new or updated qualifications** for the identified new occupations will be described based on *learning objectives in terms of knowledge, skills, and attitudes*, according to the guidelines set from the European Commission (EC) and European Parliament Recommendations for the European Qualifications Framework (EQF), as well as the stipulations of the European Aviation Safety Agency (EASA) and the International Civil Aviation Organization (ICAO).

Subsequent to the revision of these learning outcomes, **new curricula** will be developed. The adaptation of study programs will be in accordance with the emerging interdisciplinary nature of occupations, necessitating proficiency in aviation combined with IT, environmental studies, and economics. The primary aim is to align the strengths of the study programs and curricula with the specific requirements and professional objectives within the aviation industry, ultimately enhancing graduates' employability and professional competence.

The development of the new curricula is a collaborative effort involving knowledge co-creation among 3 higher education institutions (HEIs) and stakeholders from the aviation and environmental sectors across 4 countries. The revision process will emphasize the adoption of innovative delivery methods, including *modular learning with tailored curricula, personalized learning approaches, utilization of open educational resources, and virtual learning platforms.* This allows individuals to focus on specific areas of interest or skill gaps, ensuring that their learning experiences are relevant and impactful. Personalized learning approaches further enhance this by catering to the unique needs and learning styles of each student, maximizing engagement and retention. Open educational resources play a crucial role in democratizing access to knowledge and fostering collaboration within the industry, providing learners with diverse perspectives and resources to enrich their learning journey. Additionally, virtual learning platforms offer flexibility and accessibility, enabling students to engage in immersive and interactive learning experiences regardless of their location or schedule constraints. By leveraging these innovative approaches, air transport education and training can effectively equip future professionals with the diverse skill set and expertise needed to thrive in this dynamic industry.

Through *the internationalization of course content* and the involvement of educators from multiple countries, the project aims to foster *an international teaching and learning environment*. Methods and tools will be implemented to enable students to engage in cross-border collaboration, thus laying the groundwork for an international work environment specific to air transport.

By designing, refining, and implementing *interdisciplinary* study programs, learners will be empowered with competencies in digital technologies and sustainable development for the field of air transport. Taking into consideration the recommendations of the EC and the methodology developed in the KAAT project [11] regarding the Sectorial Qualification Framework for Air Transport (SQFAT) [10], we propose a process for improving study programs and curricula (Fig 3.), comprising the following activities:

- Establishing the list of study programs and courses chosen for improvement; divide them into categories, if necessary (in our case, we had 3 main categories);

- Developing a grid for the study program outlining the general competences of the study program or training, following the model of the grid in KAAT/SQFAT. This grid describes the general competences with descriptors, categorizing professional knowledge, skills, and transversal competences through attitudes and responsibility;
- Consulting with stakeholders regarding the grid and learning outcomes (LOs);
- Developing a specific grid for each discipline, considering the LOs outlined in the general grid of the program;
- Updating and refining the course syllabus, by incorporating the specific competences of the discipline, learning outcomes, and, if necessary, updating the content of proposed topics for the course and practical applications;
- Conducting a cross-check of syllabus and new curricula, through a peer review process;
- Designing the final version of curricula;
- Developing course materials aligned with to new LOs and syllabus, integrating new digital solutions into the course content to foster a more dynamic and interactive teaching and learning environment;
- Pilot implementation.

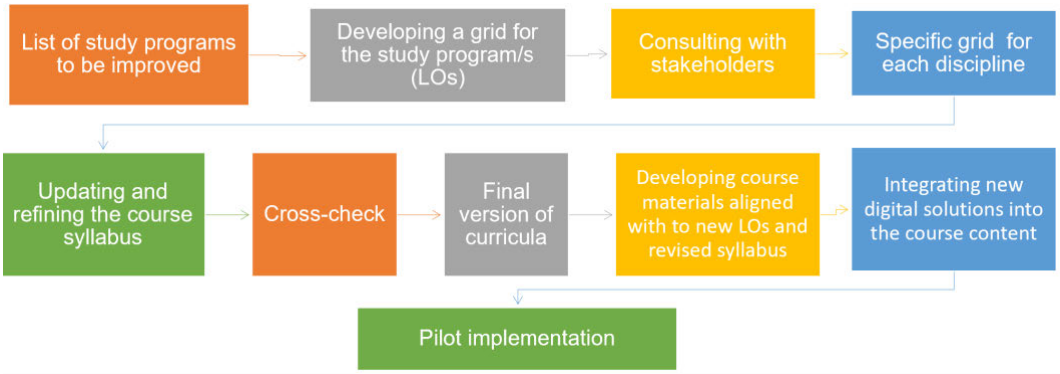

Figure 3. Process for improving a study program curricula

4 CONCLUSIONS

In conclusion, our research underscores the critical importance of *adapting educational approaches* to meet the evolving demands of the air transport industry, particularly in the context of sustainability and digitalization. Through a comprehensive analysis of industry trends, skills shortages, and emerging occupations, we have identified key areas for improvement and proposed actionable solutions.

Firstly, our findings highlight *the urgent need for reskilling and upskilling* initiatives to address skills shortages and align educational offerings with industry requirements. The integration of digital technologies and sustainable practices is reshaping operational processes and creating new job roles, necessitating a proactive approach to curriculum development and training programs.

Furthermore, our study emphasizes the importance of *collaboration among stakeholders*, including higher education institutions, industry representatives, and regulatory bodies. By fostering knowledge co-creation and leveraging collective expertise, we can ensure that educational initiatives are relevant, effective, and responsive to industry needs.

Importantly, our research aligns with European guidelines and frameworks, ensuring that proposed qualifications meet international standards and reflect industry-specific competencies. By adhering to these standards and embracing innovative teaching methods, we can enhance the quality and relevance of educational offerings in the air transport sector.

In summary, our study advocates for a holistic approach to **educational transformation**, encompassing *curriculum redesign, skills development, and collaborative partnerships*. By embracing these principles, we can empower professionals with the knowledge and skills needed to navigate the challenges and opportunities of a rapidly evolving industry landscape, ultimately advancing the goals of sustainability, safety and efficiency in air transport.

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