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Integrating Sustainability into Aviation Training: Perspectives from Industry Professionals

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Abstract
This paper is part of a broader research project aimed at identifying the most appropriate training materials, formats, and delivery methods for aviation sustainability content for future aviation professionals, starting from the early stages of their training. The current paper presents the data analysis and results of a short online survey targeting aviation professionals. Specifically, it provides preliminary data on sustainability perspectives from global aviation professionals. Through qualitative analysis, the creation of a baseline from a random sample of aviation professionals offers insight into their perspectives and how they could be influenced toward a more sustainable pathway. Additionally, the paper presents a Cramér's V statistical test to examine the association between aviation professions and responses on sustainability. The aim of this paper is to analyze current attitudes toward sustainability among aviation professionals and to explore how they can be better prepared and informed about emerging topics like sustainability.

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1. Introduction

Aviation professionals represent a critical group at the core of aviation operations and sustainability. They work in a highly regulated environment governed by laws that define operational conditions. The aviation industry is a complex matrix of aircraft systems, balanced delicately with economic and business development. Incorporating sustainability into aviation operations is no longer optional; it is a necessity, driven by the industry's growing commitment to meeting Net Zero Targets and Pathways. This change can only be achieved through the engagement and cooperation of all stakeholders, including pilots, maintenance personnel, air traffic controllers, and other aviation professionals. However, aviation personnel are often expected to engage in sustainability practices within their organizations without a full understanding of what these practices entail or how they are implemented (Maleviti, 2023a; Maleviti 2023b). For example, pilots may participate in calculating emissions for schemes such as the International Civil Aviation Organization (ICAO) CORSIA or the EU-ETS (Emissions Trading Scheme), or may contribute to carbon offsetting by using Sustainable Aviation Fuels (SAF). Yet, they may not always be fully informed or motivated to understand how these practices contribute to broader sustainability objectives. Similarly, professionals working as maintenance engineers on fuel-efficient aircraft engines or for companies with a strong sustainability presence may not be aware of the concept of sustainability or their company's related actions. These observations raise two crucial questions: how can aviation professionals be better prepared and more knowledgeable about emerging topics like sustainability, and what strategies can be implemented to foster their meaningful engagement? The study discussed in this paper aims to develop a training approach that will enable aviation professionals to understand and implement sustainability practices. The opinions and perspectives of aviation professionals on sustainability are presented here, with the goal of informing the development of training materials that foster a sustainability culture within the aviation industry.

2. Literature review

The concept of sustainable development was defined in the World Commission on Environment and Development's 1987 Brundtland Report, *Our Common Future* (United Nations, 1987). The Commission aimed to guide nations toward sustainable development, which then became an essential concept in the vocabulary of politicians, practitioners, and planners. Sustainability relies on three pillars: environment, society, and economy. A system is sustainable when each of these three pillars is equally evaluated and addressed. Additionally, the core principle of sustainability requires the environment, society, and economy to always be in balance—equally assessed and supported—regardless of the system. The aviation industry is an extensive and complex system with numerous interactions inside and outside its boundaries. Sustainability can be integrated into all aviation operations, bringing not only change but also benefits to the industry. It is a concept that should be applied holistically to a system, an organization, a business, and even to people's way of thinking. Hence, there is an obvious need to find ways to apply sustainability principles in the aviation sector (Maleviti, 2023a). After the COVID-19 pandemic, the aviation sector experienced a significant shift in

mindset toward sustainability. The need to remain viable and, ultimately, to grow as a system became a paramount issue for the aviation industry. During this time, there was much discussion about sustainability in aviation. While COVID era, the reduction in CO2 emissions due to halted aviation operations was even characterized as a "sustainable" approach or option. However, this observation highlighted a common misunderstanding of what sustainability truly means and how aviation can become a sustainable industry. After 2020, technologies such as Sustainable Aviation Fuels (SAF), new aircraft designs with aerodynamic structures that reduce emissions and noise levels, along with new policies and regulations, began to expand rapidly. Undoubtedly, SAF pathways and new technologies strongly support the environmental aspect of aviation sustainability, as they significantly reduce recorded emissions and noise impacts. However, as previously mentioned, a sustainable system must support not only the environmental aspect but also the social and economic aspects. A sustainable system, specifically a sustainable aviation system, should seek and propose ways to support the social element of the industry, both internally and externally. The external social element concerns the wider society in which an aviation company or entity operates. The internal social element refers to the people who work in, support, and adhere to the regulatory requirements of the aviation industry.

Moreover, the internal social element is the core factor in bringing and enhancing sustainability within an aviation management system. It is this element that will implement the necessary changes to make the aviation system sustainable. In any systemic formation, the change and acceptance of that change must apply to the system's entire structure—from its initial processes to top management commitment. After all, this is one of the main principles of systemic perspectives, such as those found in ISO standards, ICAO safety management systems, and other regulatory requirements. In each of these different systems and goal orientations, there are key features that connect them: culture, processes, and, of course, people—the social element. However, in a systemic intervention, such as the one sustainability brings to all industries, including aviation, the change must begin in the early stages of training. This allows individuals to become knowledgeable on the topic, learn how to embed sustainability principles in their daily tasks, and take action through their work without deviating from the mandatory safety and quality standards required in aviation operations. A prime example of how aviation professionals actively pursue sustainability through legitimate initiatives is the implementation of the Performance-Based Navigation (PBN) scheme by pilots and air traffic controllers. In 2009, the ICAO emphasized the need for new navigation specifications to enhance performance, equipment functionality, and infrastructure, which led to the creation of the PBN scheme. PBN represents a significant shift from traditional ground-based navigation aids to a system in which aircraft utilize onboard performance capabilities and navigation systems to fly more precise and flexible routes. This modern navigation approach allows aircraft to operate along more efficient paths by maximizing their performance capabilities. PBN relies on advanced satellite technologies, such as Global Positioning Systems (GPS) and inertial navigation systems, and does not depend on traditional ground-based aids. ICAO member states have various reasons and benefits for adopting PBN. An onboard navigation computer, known as an Area Navigation (RNAV) system, facilitates area navigation, thereby optimizing airspace capacity. With RNAV, an aircraft can follow

desired paths based on the coverage of ground station-referenced navigation points. The RNAV method depends on the capabilities of self-contained aids or a combination of these aids. Both flight crews and air traffic control (ATC) must understand the features of the RNAV system to align them with airspace capacity and conditions. With PBN, pilots can fly more direct routes, select optimized flight paths, and reduce fuel consumption (ICAO, 2016; Maleviti, 2024a). Additionally, PBN promotes more efficient flight paths with reduced fuel consumption, and it supports procedures such as Optimal Profile Descent (OPD), Continuous Climb Operations (CCO), and Continuous Descent Operations (CDO). Moreover, PBN offers more predictable operations, which minimizes flight variability. It lowers landing minima, reducing weather-related cancellations and diversions. The likelihood of missed approaches, diversions, and airport holdings due to airspace and airport capacity issues is also significantly lowered with PBN (ICAO, 2016; Maleviti, 2024a). As a result, PBN contributes to decreased fuel emissions and lower fuel costs. Additionally, it reduces the risk of mid-air collisions and allows aircraft to pass over previously challenging areas due to ground morphology and weather conditions. While the primary goal of Performance-Based Navigation (PBN) is to enhance navigation performance, it also has a positive impact on environmental sustainability. Research has shown that PBN offers both direct and indirect environmental benefits, with one of the most significant being fuel savings. However, empirical studies have demonstrated that pilots are not always aware of the sustainability benefits of PBN and are often not fully knowledgeable about their role in the sustainability efforts taking place within their organizations (Maleviti & Stamoulis, 2017). Similarly, in terms of knowledge and involvement in sustainability efforts, employees may often be unaware of their participation in critical schemes for calculating emissions in airlines. The ICAO Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) requires airline personnel to contribute to data collection and emissions calculations during the Monitoring, Reporting, and Verification (MRV) process. Personnel involved range from pilots who enter data to IT support staff who manage and process the data, as well as sustainability officers and managers who input the data into the CORSIA Cert Tool, among others. It is important to note that ICAO's CORSIA is a global scheme, and reporting accuracy depends on recording detailed and precise fuel consumption data. Flight times, block-on and block-off times, and fuel quantities are some of the data used in emissions calculations. Pilots are responsible for entering this information, sometimes even manually (FAA, 2023; Mrusek & Maleviti, 2023). For operators of the most modern aircraft, this data is automatically entered and transmitted to the airline’s data systems. In their daily routine, professional pilots enter data into the journey log, which is the starting point of the MRV process. However, the verification process does not solely rely on the transmitted data; it is always cross-checked with the journey logs. Therefore, the more accurate this information is, the more precise the emissions calculations will be. It is crucial to demonstrate to pilots, starting from the early stages of their careers (or even during training), that they play a significant role in MRV reporting, which contributes directly to emissions calculation and environmental sustainability. Furthermore, many employees are involved in ensuring the accuracy and proper handling of this data. All verified reports from airlines are submitted to their national or state aviation authority.

This process briefly outlines how total aviation emissions are calculated and highlights the role of the social element—pilots—who contribute to environmental sustainability and the overall sectoral effort to meet emission targets, along with many other employees within the company. The process is then audited by a verification body and subsequently by the National Aviation Authorities. When a non-conformity is found during the audit, auditors trace the issue back to how the data were entered into the system, meaning how employees perform their part in the process. This illustrates that, even though they may not be aware of it or find it important, the way emissions are calculated starts with their actions. Empirical research shows that despite this process involving multiple personnel in the airline's emission calculation, the level of knowledge remains low and insufficient (Mrusek & Maleviti, 2023; Maleviti, 2024b).

Hence, any systemic process and change can be more efficient if proper knowledge and training are in place from the early stages. This research suggests the inclusion of sustainability training in pilot and maintenance training school curricula, aiming to deliver strong outcomes in meeting aviation's Net Zero targets. Undoubtedly, engaging aviation personnel in sustainability requires providing the appropriate training to enhance their knowledge and support cultural change (Mrusek & Maleviti, 2023; Maleviti & Stamoulis, 2017). However, what about active aviation professionals who are already at a mature stage in their careers, when a new set of concepts begins to emerge in their field? How can they be influenced to embrace change and become more knowledgeable about it? In an era where aviation professionals and researchers are making significant efforts to promote sustainability in the industry, the aim of this study is to explore the perspectives of aviation professionals on sustainability, its related concepts, and their application in the aviation sector. With this perspective in mind, the research project, survey, and methodology have been developed. As a first step, the scope of this paper is to analyze aviation professionals' perspectives on sustainability, providing a foundation for developing a training framework in later stages of the research.

3. Research Project and Methodology

The research project is based on an online survey consisting of twelve questions. The first four questions gather demographic data; the full list of demographic questions can be found in Table 1. The data collected are separated into demographic information and responses on a five-point Likert Scale. The survey was distributed to professional networks in the United States, Europe, Asia, the Middle East, and Africa, as shown in Table 2. Over a period of two months, 140 responses were collected. Based on the total number of responses, the current data presentation is not considered fully representative of the entire population of aviation professionals, due to the uncertainty regarding the total number of professionals in the field. The broader research goal of this project is to identify the most appropriate training format, content, and pathway. For the purposes of this paper, the focus is on exploring how aviation professionals perceive sustainability and how these insights can support the integration of sustainability into aviation education.

What is your nationality?
Year of birth
How many years have you been an aviation professional ?
What is your profession?

Table 1: Demographic questions in survey.

As previously mentioned, data collection for this study was conducted online through the distribution of a survey questionnaire. Survey research is a key method of measurement in applied social research. It involves posing questions to respondents, which allows for the creation of baselines and the tracking of changes over time as various factors are applied (Maleviti & Stamoulis, 2017). When surveys are carefully designed and applied, they can effectively highlight gaps and weaknesses in processes by analyzing the responses collected. This approach was chosen for this research, as the responses can establish a baseline framework and identify areas where the framework lacks consistency or is weak. For this paper, the responses from aviation professionals help pinpoint areas where knowledge about sustainability is lacking and demonstrate the level of acceptance of potential sustainability topics in aviation training curricula. A qualitative methodology was used to collect the data for the survey, while the data analysis employed a quantitative descriptive approach, including a Cramér's V statistical association test. In this research paper, the questions from the survey are analyzed and described, in Table 4.

Continent	**No of respondents**
Europe	41
North & South America	25
Asia	55
Africa	18

Table 2: Geographical distribution of respondents

Table 3 shows the frequency distribution of aviation professionals who participated in the survey. The total responses are 136, after clearing gap data.

Profession	**Frequency**
Pilots	29
Engineers (various types)	41
Management	20
Flight Crew	6
Air Traffic Controller	8
Safety/Security Officer	21
Academic	11

Table 3: Frequency of aviation professional participants

4. Data Analysis and Discussion

The data analysis is divided into two parts. The first part presents correlation statistics between professional positions and the questions included in the survey. The correlation test used in this research is Cramér's V statistical test. Cramér's V is a measure of association between two categorical variables, helping to determine the strength of their relationship without indicating causation. Since both variables—professional positions and Likert Scale responses—are categorical, this test is considered the most appropriate. Its purpose is to measure the strength of the association between the two variables, similar to correlation but specifically for categorical data. The Cramér's V statistical test values range from 0 to 1:

0.00 – 0.10 → Very Weak or No Association
0.11 – 0.20 → Weak Association
0.21 – 0.30 → Moderate Association
0.31 – 0.40 → Strong Association
> 0.40 → Very Strong Association

Question	Cramér's V	Strength of Association
1. Sustainability must apply to the aviation industry	0.15	Weak
2. Sustainable Aviation Fuels (SAF) is the only initiative to support sustainability in aviation.	0.24	Moderate
3. Aviation Sustainability should focus only on the environmental aspect to meet the NetZero Pathways.	0.22	Moderate
4. The role of people is important to meet aviation sustainability goals.	0.14	Weak
5. The aviation industry and its culture must change if we want to see a shift towards sustainability.	0.28	Moderate
6. The concepts of sustainability must become part of theoretical aviation training (ie flight training, maintenance training etc.).	0.26	Moderate

Table 4: Strength of Associations from the Cramer's V test

The Cramér's V association factor in Table 4 shows weak to moderate associations between professions and the survey responses. In particular, the association between different aviation professions, the necessity to apply sustainability initiatives in the aviation industry, and the role of people in meeting aviation sustainability goals is weak. A weak association (Cramér's V: 0.11 – 0.20) indicates that the type of profession has little influence on the responses in this study. Therefore, no clear trend emerges regarding how aviation professionals perceive sustainability applications. This is also true for the importance of the role of people in achieving aviation sustainability goals. The type of aviation profession does not strongly influence views on sustainability, since a pilot, an engineer, or an air traffic controller may hold similar opinions on sustainability. Other factors, such as personal beliefs about sustainability, education/training on sustainability topics, and work environment (e.g., airlines vs. regulatory agencies), may play a more significant role. When the association is weak, profession alone is not a strong predictor of sustainability perspectives. For the remaining four questions, there is a moderate association between responses and aviation professions. A moderate association (Cramér's V: 0.21 – 0.30) suggests a moderate relationship between the two categorical variables, though it is not particularly strong. The highest association factor is seen in the last two questions, as shown in Table 5.

Question	**Cramér's V**	**Strength**
The aviation industry and its culture must change if we want to see a shift towards sustainability.	0.28	Moderate
The concepts of sustainability must become part of theoretical aviation training (ie flight training, maintenance training etc.).	0.26	Moderate

Table 5: Stronger association of aviation professions and responses.

The second part of the data analysis was based on the responses to each question, using a simple descriptive methodology. This process helped build the baseline framework for the next steps of the research. All questions are presented exactly as they appeared in the survey.

The first question/statement was: "Sustainability must apply to the aviation industry." The responses to this question show a high consensus on the importance of sustainability. Specifically, an overwhelming majority (136 out of 139, or 97.8%) either strongly agree or agree that sustainability needs to be applied to the aviation industry. This reflects a very strong, almost unanimous recognition of the need for sustainability within the field, as awareness of the aviation sector's environmental and social responsibilities continues to grow. Only one respondent (0.7%) strongly disagreed, and nobody outright disagreed, indicating that resistance to the idea of aviation sustainability within this group is minimal, if not non-existent. This suggests that cultural and ideological barriers to sustainability initiatives are very weak or absent within this demographic. Moreover, very few respondents took a neutral stance—only two—suggesting that participants are

highly inclined to take a stand on this issue, likely due to the prominence and relevance of sustainability in today's aviation landscape.

From the overall responses, the implication for training and curriculum development in aviation is clear. The unanimous agreement on the importance of sustainability underscores the urgency of embedding sustainability concepts into aviation training. It supports the idea that aviation schools and training programs should proactively include sustainability in their curricula, aligning with the views of future aviation professionals. Some additional perspectives are highlighted in the following bullet points:

- **Cultural shift in the industry**: The strong positive response suggests that participants are ready to embrace sustainability initiatives. This could mean that the next generation of aviation professionals will support and advocate for sustainable practices, driving a cultural shift within the industry.
- **Potential leadership roles in sustainability**: Given their strong alignment with sustainability, participants may act as ambassadors or leaders in promoting sustainable practices within their organizations, including fuel optimization, supporting Sustainable Aviation Fuels (SAF), and implementing carbon offset programs.
- **Implications for industry stakeholders**: The findings highlight an opportunity for airlines, regulators, and flight training institutions to collaborate on policies and training materials tailored to this new generation of sustainability-aware aviation professionals. These observations emphasize the growing importance of sustainability in aviation education and suggest that the next generation of professionals will play a key role in driving the industry's transition toward sustainable operations.

The second question analyzed is: *"Sustainable Aviation Fuels (SAF) is the only initiative to support sustainability in aviation."* The survey responses for this question reveal a very strong consensus regarding the role of SAF as the primary sustainability initiative in aviation. Out of the total 139 respondents, an overwhelming majority (136 respondents, or 97.8%) either strongly agree or agree with this assertion. This near-unanimous response indicates that, within this group, there is a prevailing belief that SAF is the key, if not the only, avenue for achieving sustainability in the aviation industry. Only one respondent (0.7%) strongly disagreed, and just two participants adopted a neutral stance. This near-zero opposition suggests that the surveyed population holds little to no cultural or ideological resistance to the idea that SAF should be the primary focus for sustainability efforts. From a broader perspective, these results point to a somewhat narrow conceptualization of sustainability in aviation. While SAF is undeniably an important technology, the near-total endorsement of SAF as the sole sustainability initiative might indicate that respondents are either less aware of or less convinced about the viability of other complementary measures. These might include operational efficiency improvements, carbon offset programs, electric propulsion research, and other emerging technologies. The minimal disagreement also implies that there is little challenge among the participants to this view, which may have implications for how sustainability is taught and communicated within the sector. Given this strong consensus, there is a clear need to broaden the scope of sustainability training in the aviation field. While SAF appears to be a cornerstone in the minds of these respondents, educators and training

institutions should consider diversifying the curriculum, addressing misconceptions, and preparing future leaders. Training programs should ensure that sustainability is not taught solely through the lens of SAF. Instead, they should incorporate a wider range of initiatives—covering topics such as fuel efficiency, alternative propulsion systems, and carbon management—to provide a more holistic view of how the industry can achieve sustainable operations. Additionally, the almost unanimous support for SAF as the only initiative suggests that there may be misconceptions or an overly narrow focus on one solution. Curriculum developers have an opportunity to challenge this view by highlighting additional strategies and innovations that contribute to sustainability in aviation.

Finally, as the next generation of aviation professionals is poised to become industry leaders, a diversified understanding of sustainability will be critical. Educating them on the array of available initiatives—not just SAF—can empower them to make more informed decisions and drive comprehensive sustainability practices within their organizations. Some additional perspectives are highlighted in the following bullet points:

- **Cultural shift and focus**: The strong positive response points to an industry culture that is currently very focused on SAF. This could be due to its prominence in media and policy discussions. However, this singular focus may limit broader innovation if other sustainable practices are not equally recognized and adopted.
- **Opportunities for industry stakeholders**: The findings present a valuable opportunity for airlines, regulators, and training institutions to collaborate. By developing policies and training materials that embrace a multi-initiative approach to sustainability, stakeholders can better prepare the industry for future challenges while ensuring a more balanced strategy.
- **Future research directions**: Further research could explore why respondents overwhelmingly favor SAF over other initiatives. This could involve delving into the sources of information, media influence, or educational exposure that might have shaped their views. Additionally, comparative studies across different demographics or regions could reveal whether this perception is widespread or limited to specific groups.

The third question/statement analyzed is: *"Aviation sustainability should focus only on the environmental aspect to meet the NetZero Pathways."* Based on the responses, there are differing views on the scope of sustainability, as shown in Figure 1. Specifically, the responses indicate a division over whether aviation sustainability should focus solely on the environmental aspect. While 51 respondents (36.7%) agree or strongly agree, a similar number, 57 respondents (41%), disagree or strongly disagree. Another 31 respondents take a neutral stance, likely due to uncertainty or ambiguity about the issue. The total number of participants who disagreed (38) and strongly disagreed (19) is greater than those who strongly agreed, indicating that most participants believe aviation's sustainability efforts should not be limited to environmental concerns. This aligns with the broader, more inclusive definition of sustainability, which encompasses social and economic dimensions as well. The relatively high number of neutral responses (31) suggests that some participants may lack sufficient knowledge or understanding of the multidimensional nature

of sustainability. This highlights the opportunity for educational initiatives to better explain how environmental, social, and economic factors work together to achieve NetZero goals.

The mixed responses also indicate that current industry messaging on the scope of aviation sustainability may not be effectively reaching aviation professionals. This underscores the need for clearer communication about how environmental goals integrate with broader sustainability principles, including operational efficiency, workforce well-being, and economic viability.

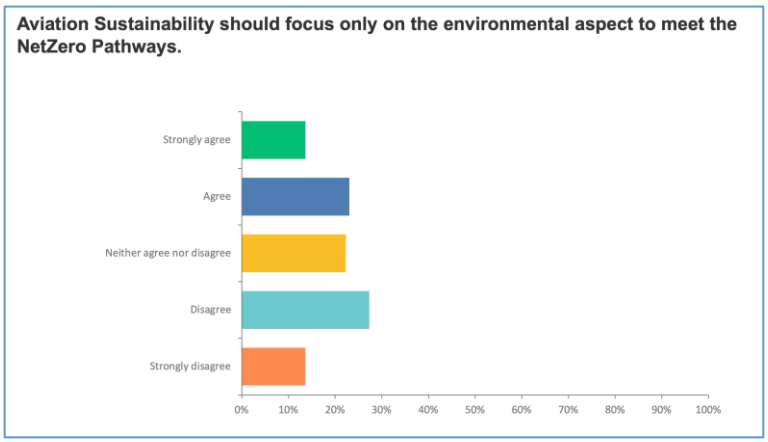

Figure 1: *Results for the question Aviation Sustainability should focus only on the environmental aspect to meet the NetZero Pathways.*

Some additional insights are as follows:

- **The need for a holistic approach**: The results underscore the importance of addressing all three pillars of sustainability—environmental, social, and economic. Industry professionals who reject a narrow focus likely understand that achieving NetZero targets requires systemic changes. These changes should include fostering sustainable organizational cultures, promoting equity, and ensuring economic resilience alongside environmental efforts.
- **Curriculum recommendations:** Training programs should emphasize that sustainability is a holistic concept. They should highlight how social and economic aspects—such as grassroots engagement, community involvement, and cost efficiency—can be linked with environmental goals. Case studies, like the role of sustainable aviation fuels in both an economic and social context, could be used to build broader awareness and understanding.
- **Individual contribution to wider sustainability:** Most respondents seem to view themselves as contributors to outcomes that go beyond just the environmental aspects of sustainability. Embedding discussions about their role in the social and economic dimensions of sustainability—such as promoting fuel-efficient operations and supporting community-focused initiatives—could inspire and motivate them further. These findings suggest that a balanced, multidimensional approach to sustainability is not only necessary but also aligns with the evolving perspectives of future aviation professionals.

The fourth question/statement analyzed is: The role of people is important to meet aviation sustainability goals. The responses for this question show a strong consensus on the importance of people in achieving aviation sustainability objectives. Out of the total 139 respondents, an overwhelming majority (105 out of 139 or 75.5% strongly agree, and 30 out of 139 or 21.6% agree) affirm that human factors are critical. This results in approximately 97.1% of participants endorsing the idea, reflecting near-universal recognition of the essential role that people play in driving sustainability within the aviation industry. With only three respondents (2.2%) taking a neutral stance and a single respondent (0.7%) disagreeing, there is minimal opposition to this view. This indicates that the cultural and ideological barriers to prioritizing people in sustainability initiatives are extremely low among the surveyed group, suggesting that the majority are firmly convinced of the importance of human capital in the field. From the overall responses, the implications for training and curriculum development in aviation are significant. The widespread acknowledgment of the pivotal role of people in reaching sustainability goals underlines the need to embed human-centered approaches into aviation training and educational programs. It supports the argument that aviation schools and training programs should not only focus on technological and operational innovations but also invest in developing leadership, change management, and human factors expertise among future aviation professionals.

Some additional perspectives are highlighted as follows:

- **Emphasis on workforce development**. The strong support for the role of people indicates a clear mandate for investing in workforce development. This can include specialized training and education that focus on sustainability leadership and the effective management of human resources to drive sustainable practices.
- **Curriculum and training enhancements.** Given the near-universal agreement, aviation training curricula should incorporate modules that emphasize sustainability from a human perspective. This may include courses on sustainability leadership, team-based innovation, and effective communication to foster a proactive and empowered workforce.
- **Cultural and organizational transformation.** The survey results reflect an industry culture that recognizes that sustainable change is not solely about new technologies or regulatory frameworks but also about empowering individuals. This cultural shift can encourage organizations to nurture environments that reward innovation, collaboration, and a strong commitment to sustainable practices.
- **Leadership and advocacy potential.** With almost all respondents valuing the human element, there is considerable potential for future aviation professionals to emerge as leaders and advocates for sustainability. Their role could extend to influencing policy, driving internal sustainability programs, and championing initiatives such as employee engagement in sustainability efforts.

In the fifth question/statement of analysis**:** The aviation industry and its culture must change if we want to see a shift towards sustainability, there is a strong agreement with the necessity for cultural change. Particularly, a majority of the respondents, 128 out of 139 (92.1%), strongly agree or agree that the aviation industry and its culture must change if sustainability is to be

achieved. This reflects a general consensus that cultural change lies at the heart of any attempt to render the industry sustainable. There is a minimal opposition or neutrality, with only four respondents (2.9%) disagree, and none strongly disagree, indicating that resistance to cultural change within the aviation industry is almost negligible. Additionally, only seven respondents (5%) remain neutral, further emphasizing the strong overall support for change. The high degree of agreement perhaps reflects that the respondents believe cultural factors are a major deterrent in the attainment of sustainability performance, which encompasses operational norms, resistance to innovation, and unsustainable awareness. The finding shows that these issues of cultural challenge have to be met with educational leadership and policy reforms. The responses also reflect an understanding that technical solutions, such as sustainable aviation fuels or fuel-efficient aircraft, do not go far enough, but need to be matched by a changed mindset and a shift in organizational culture. This would reinforce the argument for an integrated approach to sustainability at technological, operational, and cultural levels.

Additional Perspectives on the current question, include:

5. **Role of leadership and management.** From the results, it can be observed that such cultural change must be led from the front—the leaders and managers who will be able to set the tone in terms of sustainability initiatives. These industry professionals, therefore, could be assisted through training programs that include leadership in sustainability, for the purpose of influencing and shaping the culture within their organizations.
6. **Cultural awareness training.** Issues of desired cultural change should include training programs and schools for modules on the importance of cultural change in achieving sustainability. These may involve aspects such as collaboration, embracing innovation, and creating awareness about the multidimensional impact of sustainability.
7. **Industry-wide initiative collaboration.** The findings revealed that this change in culture has to be implemented through collaboration between airlines, regulators, manufacturers, and training institutions. In this regard, strong agreement by the participants indicated that they were ready to be part of this.
8. **Potential to become sustainability ambassadors.** Since the participants are ready for cultural change, they could also serve as sustainability ambassadors in their organizations, promoting sustainable practices, challenging outdated norms, and building a collaborative culture in line with NetZero pathways. These observations highly underline how relevant the cultural change is with respect to the goals of achieving sustainability and set a very sound basis for the integration of cultural awareness into aviation sustainability training.

The sixth question/statement is: The concepts of sustainability must become part of theoretical aviation training (i.e. flight training, maintenance training etc.). For this question there is a strong consensus on integrating sustainability into training. Particularly, an overwhelming majority of the respondents, 127 out of 139 or 91.4%, strongly agree/agree that there is a dire need to incorporate the concept of sustainability into theoretical aviation training. This shows that participants are very much aware of the importance of incorporating sustainability education into their formal, mainstream training. In parallel, there is a minimal opposition and

neutrality. Only three (2.2%) oppose, and none strongly oppose this assertion; thus, there is near-unanimous acceptance of the idea. The very small number of neutrals (9, or 6.5%) indicates some uncertainty as to whether such training would be applied, but it is not a widely felt concern. Within that context, support for proactive education might be required. These results show that participants believe sustainability education is an integral part of aviation professional preparation to deal with industry challenges. This would go hand in hand with the growing demand for a human resource base that understands the principles and practices of sustainability. Additionally, calls for curriculum update is apparent, since strong reinforcement among responses was seen for updating and revising aviation training curricula on aspects of sustainability, such as fuel efficiency, reduction of emissions, and SAF. It would also satisfy the expectations of the participants and make the industry contribute toward global goals on sustainability.

The analysis provides some additional perspectives:

Educating for informed decisions. The introduction of sustainability to theoretical training may enhance the ability of future leaders to make decisions that support sustainable operations, such as flight path optimization or understanding the benefits of SAF.

Broader industry ramifications. Given the strong level of agreement, this indicates that the integration of sustainability concepts within training could be one of the very first steps toward taking the entire industry in a different direction, creating a bottom-up culture of sustainability. The same training on sustainability would be useful for maintenance personnel, engineers, and other aviation professionals.

Trainees as enablers of change. The responses indicate that participants want to be part of changing the industry toward sustainability. Early education will help the industry bring in a generation of professionals capable not only of implementing sustainable aviation but also of leading and supporting such initiatives.

Potential for standardized training modules. The survey justifies the development of standardized sustainability training modules that schools and training programs can take up universally. In this way, it would ensure standardization in the way sustainability principles are taught and applied around the world. These observations highlight the need to embed the concept of sustainability in aviation training to prepare future professionals to effectively meet the environmental, social, and economic challenges of the industry.

Moving forward with the last and closing question of this research paper, the question analyzed is: Which one would you choose as the best option to enhance your aviation sustainability knowledge and education? As a first option, there is a high preference for professional education courses. The highest number of responses, 95, was for professional education courses as the best option to enhance aviation sustainability knowledge. This shows a strong preference for short-term, practical, and industry-focused training programs over longer, more theoretical academic degrees.

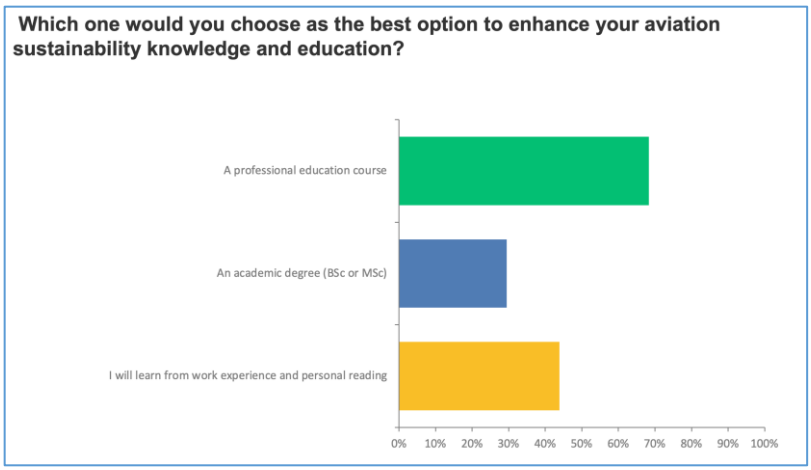

Figure 2: *Results for the question Aviation Which one would you choose as the best option to enhance your aviation sustainability knowledge and education?*

The second option and responses, show that work experience and personal reading are of moderate interest regarding aviation sustainability knowledge and education. A large number of respondents, 61, would look to work experience and personal reading to acquire knowledge in sustainability. This points to the importance of learning by doing and self-education as complementary means of acquiring practical knowledge in sustainability. It is evident that there is a least preference for academic degrees. Only 41 respondents chose the academic degree options, either BSc or MSc, indicating a lesser preference, though important, than more accessible or flexible options, such as professional courses or on-the-job learning. This is probably because one wants immediate applicability in a professional context. The distribution of responses in the survey depicts the different ways aviation professionals would want to learn about sustainability, suggesting that a 'one-size-fits-all' approach may not be effective. Such diversity in preference means that the training programs must be all-inclusive, comprising formal education, professional courses, and opportunities for experiential learning. Adding extra insights to the above analysis:

Industry-specific training appears to be desired. Based on preferences for professional education classes, one could conclude there is a pressing need for specialty aviation-specific focused training on sustainability. Modular courses could be created by the flight schools or training organizations on the subject as needed for different jobs, such as pilots, aircraft mechanics, and air traffic control.

Integration of work exposure in training. By considering the high-interest level in earning while learning work experience, organizations find it worth generating formal on-field sustainability training internships, modules, workshops, and actual case studies-based training events.

Academic institutions' support. Though academic universities are not an option preferred on a priority basis, they can be held for individuals requiring in-depth theoretical knowledge and research skills in sustainability. This can be achieved through more collaborations between academia and industry to focus on relevant programs with practical

cases to work upon and industry partnerships. Certification with shorter-term concentrated courses might also be presented as an alternative alongside degree programs.

Blended learning. To meet the manifold needs of today's aviation professional, blended learning approaches that merge professional course components with the study of underlying academic disciplines, coupled with work/industrial exposure, promise to be highly effective. For example, a professional course may be complemented with workshops that allow practical application and access to further academic research in the field. These results indicate that flexible, role-oriented, industry-specific training programs would be the most appropriate for creating sustainability education for prospective aviation professionals.

5. Findings

The analysis of participants' views on sustainability reveals compelling insights that warrant attention. A striking 98% of those surveyed acknowledge the critical importance of sustainability in aviation operations, marking a decisive shift in the industry's mindset. This overwhelming level of agreement signals a fundamental transformation in the way sustainability is perceived within aviation. These findings challenge the common belief that sustainability in aviation is confined only to environmental concerns. Notably, 41% of participants advocated for a more inclusive approach, emphasizing the equal importance of economic viability and social responsibility. This broader understanding reflects the increasing complexity of sustainability discussions in the sector, moving beyond just environmental impact. Furthermore, the study highlights the crucial role of organizational culture in driving sustainable transformation, with 92% of professionals agreeing that cultural change is essential for achieving long-term sustainability. This underscores the need for institutional change that goes beyond implementing technical solutions alone, suggesting that fostering a culture of sustainability within organizations is key. Professional development also emerged as a critical factor. Over 91% of respondents supported the integration of sustainability principles into aviation education, indicating a strong desire for future aviation professionals to be well-equipped to address sustainability challenges. Interestingly, participants showed a marked preference for practical learning approaches, with 68.3% favoring professional courses over traditional academic qualifications. This preference suggests a more pragmatic orientation among industry professionals, with a focus on hands-on experience and real-world application. The research also uncovered encouraging signs of leadership potential. Many participants expressed a willingness to actively participate in or even champion sustainability initiatives within their organizations. This willingness signals the emergence of sustainability advocates who could drive change from within the industry. However, the study also highlighted knowledge gaps in participants' understanding of the complex and multidimensional nature of sustainability. These gaps suggest areas in which further education, training, and awareness are needed to ensure that aviation professionals are fully equipped to navigate the challenges of sustainability. The moderate and weak associations between responses and professional background demonstrate that there is no clear pattern in the way sustainability is perceived across different professional backgrounds within the sample. This lack of strong correlation suggests that sustainability perceptions are not strongly influenced by professional roles alone. However, it's important to note the limitations of

the small sample size, which means these findings may not be representative of the broader population of aviation professionals. Despite this limitation, several generalized recommendations can be made to foster a more sustainable aviation industry. One of the key benefits of integrating sustainability training early in the careers of aviation professionals is the long-term transformation of the industry. Early exposure to sustainability concepts encourages a proactive, rather than reactive, approach to environmental and operational challenges. Professionals who develop a sustainability mindset from the outset are more likely to support and lead sustainability initiatives throughout their careers, contributing to a gradual industry-wide shift toward sustainable practices. Furthermore, sustainability training could lead to operational efficiency and cost reductions in the aviation sector. Training young professionals in fuel-efficient flight planning, sustainable maintenance practices, and waste reduction can generate immediate cost savings. The adoption of these practices would likely result in lower fuel consumption, reduced emissions penalties, and overall streamlined operations. This could not only reduce costs but also enhance regulatory and policy compliance, ensuring that aviation companies stay ahead of environmental regulations. Sustainability-trained professionals can be instrumental in helping organizations anticipate and meet regulatory requirements, avoiding legal risks, financial penalties, and operational disruptions that could arise from non-compliance. Aviation companies that integrate sustainability education early on may also benefit from a competitive advantage, enhancing their reputation among passengers, investors, and regulators. This could translate into a more favorable public image and a stronger position in an increasingly sustainability-conscious market. Moreover, by embedding sustainability into the industry's foundational values at the early career stage, it becomes ingrained as a core principle rather than an afterthought. This approach can lead to a culture shift within the industry, where aviation professionals—regardless of their future roles—actively seek innovative, sustainable solutions for their work environments. Such a shift would ultimately foster greater acceptance of and engagement with sustainability initiatives across the sector. In conclusion, the data from this study highlights the critical need for coordinated action across the entire aviation sector. Achieving sustainability goals in aviation will require unprecedented levels of collaboration between aviation companies, educational institutions, and other key stakeholders. By developing a cohesive strategy that integrates sustainability into education, cultural practices, and industry partnerships, the aviation sector can accelerate its transition to a more sustainable future.

6. Conclusion

The industry finds itself at a pivotal moment regarding sustainability, with compelling evidence suggesting it will fundamentally reshape the future of aviation. Industry professionals unanimously recognize sustainability as critical, also recognizing a keen awareness of their responsibility towards environmental stewardship and societal well-being. The path forward requires more than a singular focus on environmental concerns. Rather, a multi-faceted approach incorporating social and economic factors is essential for developing robust, long-lasting strategies. These elements are intricately linked, calling for thoughtfully crafted solutions that can simultaneously address multiple challenges. A significant cultural transformation within aviation must occur for sustainable development. This requires strong leadership, comprehensive education, and unprecedented collaboration to challenge established paradigms and foster innovation. Sustainability must become embedded in the industry's foundation rather than existing as an after-

thought. The integration of sustainability principles into professional development programs is key, according to aviation professionals. These stakeholders have identified a marked preference for practical, role-specific training methodologies over traditional academic approaches. This implies a need for accessible, targeted educational initiatives that directly address industry requirements. It is particularly heartening to observe the considerable number of professionals eager to champion sustainability initiatives. With appropriate support and development, these individuals could become instrumental in driving the industry's evolution towards more sustainable practices. The aviation industry thus finds itself ready for change, supported by widespread commitment to sustainable practices. Through addressing educational needs, nurturing the cultural evolution, and implementing specialized training initiatives, the industry can develop a workforce capable of steering this transition towards success.

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