The Future of the Aeronautics: 360º Reskilling and Upskilling Approach

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Abstract

The solution to challenges in aeronautics involves shifting traditional learning and development into reskilling and upskilling. However, some see it as a responsibility of industries, others as a responsibility of educational institutes, and some others as a responsibility of workers themselves. We review each stakeholder's role, importance, and actions to take, applied to the aeronautics sector. The pathway to overcome the skills challenge is through an interconnected action, where all stakeholders work in synergy, and consider other pressing challenges, such as age/gender inclusion, with benefits for both single business growth and for prosperity of Aeronautics in post-covid times.

1.Introduction and overview:

The paradigm regarding skills and professional training has been changing. Once, the idea was to shape the individuals to a static job function; today, the framework is to provide tools to help them adapt to a constantly changing job function. Before, education was only relevant until the individual left school; nowadays, it is a lifelong learning process. This is particularly visible in the scope of Industry 4.0, market globalization, and the global challenges imposed by the Covid-19 pandemic, accelerating transitions to the future of work [1]. Nowadays, the demands of fast-paced changes in industries, as well as demographic changes in the workforce require individuals to adapt to the evolution within dynamic job functions, by acquiring or improving their skills.

Skills are a mix of abilities, knowledge, capabilities, and attitudes learned through training or experience that allow individuals to do something competently and are usually listed in job descriptions [2]. There are different ways of professional development through skills, with upskilling and reskilling being the most important for the future of work in industries such as aeronautics. Upskilling is the learning process where individuals develop new skills to improve performance in their current job, while reskilling is a learning process to develop new skills to adapt to a slightly different or related job function [3].

The European Union generally agrees and enforces this skilling framework although there is no consensus among stakeholders about who is responsible for the skills development on the individuals, giving greater or lesser responsibility to specific key players: some see it as a duty of the industries, others as a responsibility of education/training providers, and some others view workers' skills development and, consequently, their employability as their own responsibility [4]. From a macro to a micro level, this paper offers a review of roles, initiatives, and

challenges regarding each type of stakeholder in the skills ecosystem, adapted to the aerospace sector: (1) political institutions and governments; (2) industry and educational institutions; and (3) individuals themselves. Despite of upskilling and reskilling being a concern among different types of industries and having an increased investment, included within Recovery and Resilience Plans [5], organizations seem to keep a narrow vision regarding these processes by focusing solely on their own company and their current employees [6]. They might be losing opportunities, particularly in countries where governments are not executing a coordinated skill development strategy. By focusing on a short-term narrow approach focused on their present needs and demands, organizations are losing potential clients and future workers, because upskilling and reskilling are not yet fully viewed as a long-term investment, but still a cost. [6]. Nonetheless, upskilling and reskilling may be the best solution for the future, since populational ageing is increasingly frequent across Europe. Some authors [7] have described the so-called skills ecosystem as "direction of attention to the interdependency of multiple actors in creating and sustaining the conditions under which appropriate skills can be developed and deployed in clusters of firms in particular regions" (p. 576). In the aerospace sector, the creation of clusters such as the AED (Aeronautics, Space and Defense) Cluster Portugal, is an example of such initiatives at the country level. This cluster aggregates AED related entities, including academia, companies and institutions, sharing synergies to overcome the challenges of the sector, instigate research and develop human resources competencies [8]. The Organization for Economic Co-operation and Development (OECD) reinforces the importance of regional- and international-based networks and partnerships organized around the principle of workforce development. The European Aerospace Cluster Partnership (EACP), for example, is similar to the AED Cluster, but at an international level, associating European countries in the name of evolution, by partners' mutual exchange [9]. The skills ecosystem also reinforces the idea of a wider vision of training and professional development beyond formal training institutions where every stakeholder should contribute and commit equally towards a better training, skills development, and professional adjustment not only leveraging the sector, but also, promoting innovation, and economic value and well-being to the professionals in the sector and society in general [7].

The aimed goal for the future is to implement dynamic ecosystems, such as Silicon Valley, that link working, living, and learning, potentiated by regional-based and same-sector stakeholders. To achieve this goal, it is necessary to build bridges by creating synergies with each stakeholder, valuing their knowledge and expertise, and establishing a common way of approaching skills in the aeronautic, space, and defense sectors.

These partnerships should bring together public and private training institutions, employees, industry representatives, unions, labor market and training intermediaries, local, regional, and international government institutions, and community representatives [10]. In the following, an overview of each type of stakeholder in the skills ecosystem will be provided.

2. Governmental/policy level

The European Commission has a five-year plan, until 2025 – The European Skills Agenda – whose focus is to bring together people and businesses to build economic resilience, social fairness, and sustainable competitiveness. One of their main goals is to develop a Pact for Skills – a joint force across Europe to invest in the upskilling and reskilling, especially of STEM (Science, Technology, Engineering, and Mathematics) professionals, not only in technical ways but also in transversal and digital skills. Another goal is to provide tools for individuals to use actively in their learning process through their life course [11].

This Agenda is bringing a synergetic descendent holistic approach, which demonstrates to be the best way to deal with this challenge [12]. An example of this cooperation and European investment is the Erasmus+ Project 'Skill-UP: skilling, upskilling and reskilling in the future Air Transport', which aims to establish the new and upcoming skills for the aeronautical sector, as well as prospect changes in the current professions and potential ones. This project joins forces from different countries and creates connections between industry and education institutions [13]. As the World Economic Forum reports, the aviation industry will outline the demand for reskilling at 68% because of skills obsolescence [1]. Consequently, this sector will have 64% of new or updated professions [14]. The European Commission is so aware of this need that, in total, has 13 funding programs dedicated to upskilling and reskilling, covering different key players and industry sectors [15].

Besides that, various countries have been developing and adopting strategies on their own to accomplish this same goal. As an example, in Portugal's Recovery and Resilience Program, until 2025, a set of organizations will allocate 200 million of their workers to take part in a reskilling program for digital skills [16].

3. Industry and educational level

The aeronautical and space industries rely on highly skilled and specialized professionals. To meet the new learning needs, the educational methods need to be in line with the new demands of the market. Thus, industries and educational institutions must come together to ensure the involvement of key stakeholders in order to create up-to-date and multidisciplinary educational programs [17]. Although they are shown as separated in the EU skills ecosystem, they share a bidirectional relation. The World Economic Forum [18] stated that this bidirectional relation between industry and education should consider: (1) job transitions and reconversions, (2) investment in continual upskilling and reskilling of the workforce, (3) awareness of the new skills demands, (4) adaptation of training courses, (5) promotion of on-the-job training.

The space industry is facing a shortage in skills. Not only do they have difficulties in attracting and retaining professionals - since college graduates appear to be unaware of what the space economy has to offer - but also, there is a mismatch between the exponential growth and rapid evolution of this sector, and the educational programs available, especially considering the changes many professions are facing due to automation and digitalization [19].

The sector continues to invest in this problem but faces difficulties in having a portrait of a situation that is constantly changing. Projects in this scope usually take a theoretical and research approach as a first step, to identify and understand the main changes and challenges in the current and future professions regarding skills. Once that is fully done, they delineate and implement adequate plans and measures to mitigate the challenges identified and update professionals' skills. Without theoretical insight, practical measures can be useless and ineffective as they are taken without direction. Theoretical and field knowledge is crucial to taking more effective practical steps towards goals achievement. Also, most of the projects that emerged regarding this topic joined industries and educational institutions [20] [21], demonstrating that organizations view the benefits of working together. As an example of this junction, the 'Knowledge Alliance in Air Transport (KAAT)', a co-funded project by Erasmus+, that ended in June 2021, had, as a primary goal, the analysis of current and future aviation professions in terms of skills. The project outcomes aimed to help educational institutions design new training pathways to skill, upskill and reskill the workforce. The KAAT project resulted in the identification of 120 professions, whose technical and soft skills were also identified, resulting in the creation and implementation of the Masters program 'IT applied in aviation' launched in 2019 by University POLITEHNICA of Bucharest [20].

Moreover, in 2016, a non-profit association was created - the 'European Association of Aviation Training and Educational Organizations' (EATEO) - with the main goal to disseminate the best training and education practices across Europe and promote the importance of training in aviation by bringing together key players such as educational organizations (e.g., Coventry University, University of Nicosia etc.) and industry (e.g., Deepblue etc.), also including military institutions [22].

Following the specialization in skills, in 2018 the European Defense Skills Partnership (EDSP) was launched, with the goal of bringing together 20 EU countries and connect crucial key players such as academia, industry, authorities, researchers, and vocational organizations, to promote cooperation between them in closing the gaps in the field of skills in the European defense industry. EDSP members are partners in a project co-funded by Erasmus+ ('ASSETs+'), ongoing until 2023, which aims to develop training and related activities for upskilling and reskilling in the area of new and emerging technologies for the needs of the defense sector. ASSETs+ intends to: (1) design and develop new courses on emerging technologies for the defense workforce and (2) promote an alliance to strategically address the skills required for the emerging technologies in the defense sector, aiming in the long-term to upskill and reskill 30% of the workforce by 2026 [21] Once again, this partnership is formed by Vocational Education and Training (VET) providers (e.g., Rzeszow University of Technology, University of Pisa, etc.), industry members (e.g., Airbus, Navantia etc.) and associations, regional clusters, and partnerships (e.g., European Aerospace & Defense Industry Association (ASD), European Aerospace Cluster Partnership (EACP)). The ASSETs+ project is the precedent on which the Pact for Skills was based, which demonstrates the increasing pertinence of this thematic. Its value has been so extensively recognized that it has been extended to different sectors and industries, with projects of the same nature continuing to emerge [23].

The United Kingdom (UK) Space Agency, through the Space Skills Alliance, carried out the first Space Census (2020), a sociodemographic overview of the UK's space workforce. Besides, in the same year, a Space Sector Skills Survey was conducted, providing recent insights into skills issues. They concluded that 73% of the businesses analyzed in the survey upskilled their staff in the year before [24]. This proportion might be increasing, since studies point out that private-sector organizations view upskilling and reskilling as an urgent investment [25]. The results

above are in accordance with the Future of Jobs Report (2020) where it is stated that by 2025, 50% of the workforce would have to pass through an upskilling or reskilling process [26].

4.Individual/worker level

Where does the individual stand regarding this subject? Who is responsible for upskilling and reskilling processes? Who is willing to invest in these processes? Which stakeholder takes the lead?

In a survey conducted by Delloitte, 73% of the respondents said it was the employer's responsibility to upskill and reskill their employees, 54% of them stated that it is a responsibility of the individuals themselves, and 19% of them stated it is a responsibility of educational institutions [4].

The Space Skills Alliance argue that it is exceedingly difficult for individuals to invest in upskilling and reskilling on their own, since many existing programs are low capacity and/or imply heavy financial costs [27]. In addition, if their current employer/supervisor is not supportive of the process, it is difficult for the individual to conciliate their job with an upskilling or reskilling process. Noting this fact, some companies are beginning to develop their own internal academies in order to skill, upskill and reskill their professionals, for example, PwC has a Digital Academy to upskill 15% of the workforce every year [28].

The individuals' mindset is also changing regarding what they intend to take from work. Nowadays, workers look for more than a paycheck: they intend to reach a sense of fulfilment in a workplace they feel comfortable in, which is both challenging and allows them to evolve by giving opportunities to learn [27]. Taking this into account, we can say individuals are more willing to be involved in upskilling and reskilling processes and learn continuously, and they expect opportunities to do it in their workplace. Also, it is in the interest of the individual to develop their skills and keep evolving in order to keep themselves attractive in the market [29]. Of course, this is dependent of several factors, such as work centrality, i.e., the importance that the individual assigns to work in comparison to other life spheres.

In conclusion, the responsibility should be shared both by the organization and the employees. As the main interested party (the ones investing financially) organizations have the right and duty to provide upskilling and reskilling opportunities. However, the employees should also view the benefits for themselves (and their employers) and engage fully in the process, taking the most advantage of the opportunities provided. Every individual is in charge of their own learning process, and motivation to learn is one of the most important elements for the upskilling or reskilling process to be successful [30].

5. Additional challenges ahead

Many EU countries are engaging in the skills ecosystem in aerospace, which seems to be the best way to overcome disruptions caused by Industry 4.0 and quick digitalization. However, there are still gaps in the process. STEM professions are characterized by high technical specialization, but (still) less focus on soft skills [31]. The problem is since STEM professions are facing a hard time, not only in attracting and retaining workers [9] but also regarding up-to-date and optimized skills, the professionals should be trained, aiming at both high specialization and high transversality [5]. In other words, they should be specialists in their area, but also have knowledge in related domains so that they can act or help in case of need since many domains are interconnected and dependent. Also, a high specialization and transversality empowers the worker with bigger versatility and polyvalence, which is valuable, especially in fast-changing industries [5]. In the medical sector, this has been the case for many years. Even though medical doctors might specialize in one area (e.g., cardiology), they must also understand adjacent areas (e.g. neurology), as well as some general understanding of every human body function and organ, since the body is an interconnected and dependent system. This transversality is important in every profession, even more in high technological disruption sectors, especially in emergency cases where few human resources are available [5]. Double degrees, for example, are an attempt to do so, since students can obtain a high specialized education and a high technical skills transversality in both related areas [32].

One of the main problems regarding higher education is that courses are built to teach students the *know-that* and not the *know-how*. Higher education is traditionally more focused on conceptual knowledge, in comparison with professional/vocational courses that are more focused on linking practical knowledge with theory [33]. Even though,

efforts are being made in order to change this paradigm, with universities adopting mandatory internships and practical learning methods, promoting active learning [33].

Moreover, STEM higher education courses are mostly focused on technical/hard skills, leaving soft skills under students' full responsibility. That demonstrates the lack of importance given to those types of skills, which are now demonstrated to be the differentiating factor not only across industries, but specifically for STEM professionals [34]. According to the Future of Jobs Report of 2020, developed by the World Economic Forum, as a result of the technological disruption, market changes and Covid-19 pandemic impact in economy and society, employers point out ten (10) new skills that will be crucial in 2025: (1) analytical thinking and innovation; (2) active learning; (3) complex problem-solving; (4) critical thinking; (5) creativity and initiative; (6) leadership and social influence; (7) technology use, monitoring and control; (8) technology design and programming; (9) resilience, stress tolerance and flexibility; (10) reasoning, problem-solving and ideation [1]. By observing the list, we see that out of the ten skills, eight are indeed soft skills, being skills of problem-solving, self-management and working with others.

Specifically for the aeronautical industry, a similar study was conducted in the scope of the project Skill-UP, an Erasmus+ project composed of a consortium of five countries (Italy, France, Portugal, Turkey, and Malta), in which we not only have represented the educational and training institutions, but also the industry and aeronautical sector representatives. Skill-UP aims to define the knowledge, skills and competences required by the future employers of the Air Transport Sector to better align the training offered to the requirements of different occupational profiles, thus fostering synergies between educational institutions and labor market. To achieve its main goal, the skill-UP project began by conducting an international study among aeronautical industry stakeholders (workers, employers, and trainers) to understand the major trends in the aviation sector, the foreseen changes in the workplace, and the most important skills for 2030 [35]. A total of 204 participants answered an online survey. Most of the participants belonged to one of the four key professional profiles of skill-UP: air traffic controllers, airport operators, flight crew members, and Unmanned Automatic Systems' (UAS) pilot operators. The four target groups were pre-selected by the consortium due to the stakeholder's perception of a possible greater impact of the industry 4.0 revolution on the responsibilities and skills of these jobs. Focusing on the most important skills for 2030, these professionals selected: (1) Adaptability, IT skills, interpersonal skills and resilience as the top four skills for flight crew professionals; (2) Adaptability, IT skills, technical skills, compliance with regulations, and interpersonal skills as the top five skills for air traffic controllers; (3) IT skills, AI (Artificial Intelligence) skills, communication, and adaptability as the top four skills for airport operators; and (4) IT literacy, technical expertise, planning, situational awareness, and decision-making as the top five skills for UAS pilots. By observing the results, among the technical expertise and IT skills, the soft skills – such as adaptability, communication, decision-making - emerge again as crucial for the high-performance of the aeronautical professionals, and, consequently, for the survival and success of the aeronautical industry [36]. The importance of soft skills is even more crucial considering that globalization implies working with people from different cultures, or event working in a different culture altogether. Even within the so-called western world, important cultural differences at the level of individualism vs collectivism, or power distance between people [37],can contribute to misunderstandings if companies, managers and employees lack cultural skills. For instance, a company can enforce more horizontal relations in terms of power distance, but employees coming from a culture where relations are more vertical, might have more difficulties to adapt, and their silence, when lacking cultural skills, can be misinterpreted as lack of interest.

Even though the projects, studies, and other initiatives mentioned above have been contributing to theoretical and practical advances in understanding new demanding skills and professions in the sector, some projects have already put into practice the application of this knowledge. For example, as previously mentioned, the project KAAT implemented a combined Masters course in University POLITEHNICA of Bucharest, bringing together IT and aviation [11]. Outcomes like this provide a side of education more focused on the practical, but also a high transversality knowledge, as one of the enrolled students testimonies "(…) very pragmatic lectures (…)" and "(…) techniques that could make an impact on various industries." [38]. Although the process of curricula change in European universities is very complex in terms of time and bureaucracy due to a coordinated European education system, outcomes like this should be replicated as they are increasingly viewed both by students and industry as beneficial to the market. Contrarily, professional training such as upskilling and reskilling, is easier to implement, especially for private companies, which have more autonomy. Nevertheless, that is still dependent on: 1) their awareness of this topic (whether they have already perceived the gaps and needs for the future) [39]; 2) the benefits or consequences (whether they have perceived what they have to gain in implementing these programs, as well as what they can lose if they do not) [38]; and 3) to whom they attribute the responsibility for the process (whether they take the lead in implementing these programs, or leave skilling on the hands of individuals, in the hope that they have the resources to invest in their own training, potentially leaving companies in a fragile position) [30]. These three are dependent on many variables: organizational culture, leadership, employees' resistance to change, governmental/policy dissemination, support for this topic, etc. Being in the interest of everyone, private-public partnerships could be created to reduce costs, since the

number one cause that upskilling and reskilling is not in the order of the day is because of organizations' lack of budget [39].

The commitment of every stakeholder is crucial in this process, although the main booster should be on the organizations, supported by governmental/policy measures. They are (or will be, in the short-term) the most affected ones with a lack of specialized human resources. The individual, nowadays, expects more than a payment from work: 91% of the so-called millennial workforce intend to leave their current job within a time range of three years, which is potentiated if the job does not offer many expected professional evolutional opportunities [40]. Nonetheless, 94% of business leaders expect their employees to upskill themselves [1]. This is a crucial mismatch in expectations. Since organizations are interested in attracting and retaining professionals in the sector, but also have the interest that the employees do their best job, upskilling and reskilling should start with organizations. Although it is also in the best interest of the individuals, they will strive to perform to their best potential if they feel stimulated to do so, especially the younger generations, or else they will probably leave their current job [27]. Moreover, focusing the responsibility only on the individual may increase inequalities, since not everyone has the money and/or time outside working hours to invest in their own training. [19]

Finally, an important challenge lies in the fact that not all individuals are in the same standing. The pandemic, as well as the recent technological accelerations, have widened existent social disadvantages between those with more and with fewer opportunities and access to education and skills. For the EU, prosperous societies and industries are inclusive ones. Among important spheres of inclusion, age and gender are particularly relevant [12].

The EU population is ageing, reducing the proportion of those in working age [41], which translates into a shortage of skilled workers. The proportion of older workers is also increasing, with important implications. First, as the population is ageing with more quality of life, what constitutes an older worker depends not only on their chronologic age, but also on a social construction that downplays their actual capacities [42]. Second, available workers need to be upskilled/reskilled for the future, but in high technological intensity industries such as aeronautics, there is an expectation of technological savviness, often associated with younger workers [43]. For the older ones, upskilling and reskilling must be paired with a substantive effort of reducing stereotypes and other age-based biases, or else the newly qualified older workers will face barriers to their inclusion in these sectors. For instance, although there is extensive evidence that brain plasticity does not decrease with age [44], there is a prevalent stereotype about older workers that they are cognitively rigid and less capable of learning new things [45]. This is particularly problematic when older workers themselves internalize the stereotypes others have about them [46]. Younger workers have their specific challenges as well. They are generally more educated than older generations, but they lack stability and are expected to behave and perform in ways that are often conflicting or ambivalent. For instance, they are expected to be disruptive, bringing new ideas, but at the same time, they are expected to conform to the hierarchy and not question the ones in more senior positions [43]. Third, situations of crisis (of which the Covid-19 pandemic is a striking example) might exacerbate tensions between younger and older workers, in a word of employment scarcity [47]. As much as aeronautics is not among the sectors with a lack of job opportunities, generational tensions are not to be ruled out for a future work environment encompassing at least three generations working together. The pandemic is bringing to surface other inequalities affecting young people, related with geography/territory. For instance, the consequences of being a NEET (young people not in employment, education, or training) are more serious in rural areas, due to inadequate formal support from public employment services, or due to risks related to more informal support (e.g. families of lower socioeconomic status). These often intensify individual barriers (early school-leaving, low-skilled precarious employment from a very early age) [48]. In some, high technological intensity industries such as aeronautics and space need to take into account the challenges of both the older and the younger workers, as they cannot afford to risk losing a generation of experienced and "reskillable/upskillable" contributions, as well as a promising are increasingly rare generation of new talent. This stresses even further the need for industries to work closely with policy measures.

As for gender, the literature regarding occupational gender segregation states how women evaluate the consequences and impact that a certain career will have on their future family life when they choose an occupation or field of work. Although some progress has been made on the path to gender equality, society still has some expectations regarding women's role in family life, for example being the primary caretaker of the house and family [48]. Before the Covid-19 pandemic gender roles inside households were becoming more equally distributed among heterosexual couples. However, the pandemic and lockdowns brought us back some steps, so much that the recent pandemic is even being called "shecession", because of the negative economic impact on women, compared to men, especially mothers that had to take extra hours of care work of their children when schools and childcare centers shutdown [49],[50]. With these responsibilities in mind, women may opt to choose careers that may appear more flexible. Therefore, women may choose female-dominated occupations (e.g. nursing or primary school teacher) or neutral occupations (e.g. high-

school teacher) because of the perception that these fields will allow them to combine work and family more easily than male-dominated fields [51], like the aerospace sector. The perception that male-dominated fields can't adjust women's family and household duties can be, not only personally discouraging for the worker, but can also have economic costs to the organization regarding investment in women's skilling [48]. Furthermore, employers may be reluctant to invest in women workers' skilling if they perceived their family situation as being a risk of them reducing organizational and work commitment [52]. In high-technological intensity fields, such as aerospace, there is a demand for workers to have updated skills and knowledge not only on technology but also social skills. However, women may face barriers regarding the possibility of formal or informal training because of their family duties. Future skilling, upskilling or reskilling programs in organizations should integrate and consider family life in their programs by, for example, having flexible hours for workers to attend training, having training happen in work shift hours as much as possible or, instead of having only face-to-face training, having training happen in hybrid mode.
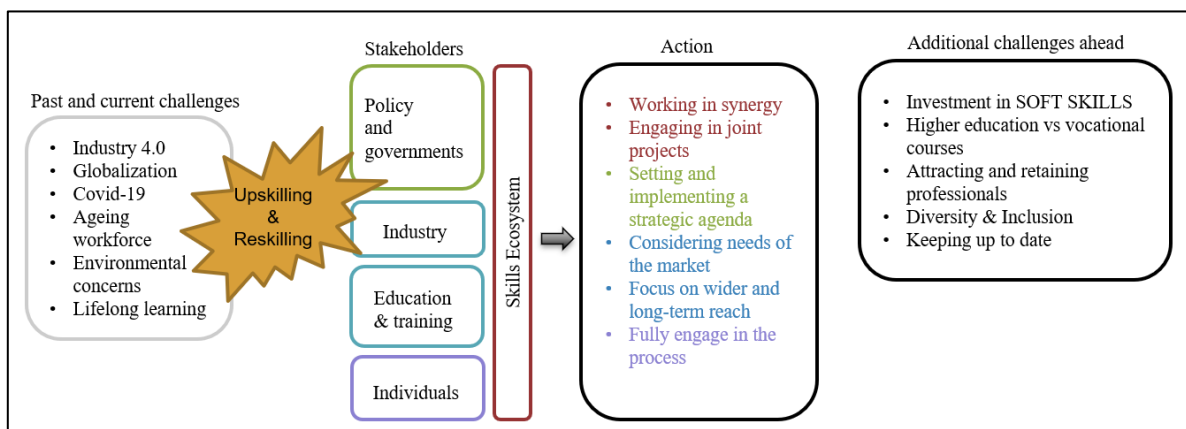

Figure 1: Overview of upskilling and reskilling in aeronautics and space, its challenges, stakeholders, and important actions

6. Conclusion

The best way to address upskilling and reskilling in a large scale is through the implementation of a skills ecosystem, which starts from a macro to a micro approach. In this paper, we aimed at showcasing actual projects and, initiatives on this issue, as well as the current challenges, concerns, and opportunities for the future of aeronautics (see Figure 1 for an overview). Local governments, industry players, academia, and training providers should take the lead, as the European Commission is promoting opportunities to support the upskilling and reskilling processes. Boosting stakeholders to acting and investing is crucial, while also instilling in workers and society at large the importance of upskilling and reskilling. In conclusion, well-coordinated synergetic cooperation is the key.

The EU traces a rather pessimistic outlook for 2030 in case upskilling and reskilling is not taken seriously [12]. In a vision scenario, where: (1) training systems are agile; (2) private investment is substantial; (3) a lifelong learning culture is established; (4) issues of inclusion and gender balance are considered; and (5) stakeholders work together, having upskilling and reskilling as default, the economic growth will be fast, and industries will thrive. Conversely, in a "muddling through" scenario, or even a middle ground one, where: (1) initiatives are scattered; and (2) training benefits only exist in large corporations and for those already highly skilled the success will be scattered, the growth will take longer time and will happen at the expense of some industries over others. Thus, upskilling and reskilling are not optional for a future of aeronautics that starts now.

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