

Gender equality potential in aviation

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Abstract. The aviation sector seeks to attract and retain women not only to face the gender imbalance that generally affects the transports sector but also to consider the potential talent source that is currently not being fully exploited. Several factors influence the participation of women in aviation: women's interest and self-confidence in Science, Technology, Engineering and Mathematics subjects; the gender stereotypes that women are exposed to, especially in the educational context; and the employment opportunities and labour conditions and practices for women. Considering these factors, the implementation of interventions in the educational and employment contexts that could enable substantial and sustainable changes regarding the increase of women interest and involvement in the aviation sector is needed. Among others, some examples include positive influences in childhood from educators; awareness-raising of science and engineering education and career opportunities; mentoring relationships; making all aspects of job recruitment, from the announcements to the interview, to the benefits, gender-equal, and try to compensate for eventual gender differences. The combination of different talents in a cooperative and open-minded environment of equality promotes the emergence of new ideas and allows pursuing them to perform tasks more efficiently. Thus, greater participation of women in aviation is an enrichment in quality and talent, which are the foundations of inventiveness and competitiveness on which depend the continuing European leadership in an ever more competitive world with new challenges, such as the current COVID-19 pandemic situation that is highly impacting the aviation sector.

1. Introduction

The project PARE is a Coordination and Support Action (CSA) supported by the European Commission (EC) through the Horizon 2020 Programme. Its main aim is to assess the progress towards the 23 ACARE (Advisory Council for Aeronautics Research and Innovation in Europe) Goals stated in the Flightpath 2050 document and to propose measures to support their achievement. Within its activities, the PARE project proposes measures to attract more women to aeronautics in order to promote a more gender-balanced sector

The transport sector plays a crucial role in the European Union (EU) economy. In 2017, it provided 10.5 million jobs – which totals around 4% of total employment. However, despite being an important contributor, the sector is facing major challenges for the future, namely gender equality in the workforce (whereas only 22% of women's work). Within the transport sector, aviation is also an important source of employment, as ~~had~~ directly generated 2.6 million jobs in EU (in 2016) including: airport operators (operations, planning and engineering); other on-airport (retail, car rental, government agencies such as customs and immigration, freight forwarders and some catering); airlines (flight and cabin crews, executives, ground services, check-in, training and maintenance staff); civil

aerospace (engineers and designers of civil aircraft, engines and components); and air navigation service providers (air traffic controllers and executives) [1, 2, 3].

Comparing with other transport modes (*e.g.* in land and nautical, the women account for 14% and 20%, respectively), the aviation sector has been more successful in terms of gender equality where c.a. 40% of the total workforce in air transport in Europe is female. However, this percentage is deceptive because it reveals little of the skill distribution between the sexes or the extent of female presence in senior roles. For example, even though there is a high share of female cabin crew, it is estimated that only around 4-5% of the world's commercial airline pilots are female. The same goes to technical positions, which require STEM (Science, Technology, Engineering and Mathematics) skills, which will likely skew towards men. In airport operational roles and ground handling, women make up 25.8% of employees, although in the lower age bracket (those under 30) over 32% of staff are women. A sample survey of air navigation services providers conducted in 2017 found that 25% of air traffic controllers were women. In airline's executive roles, the gender gap is as great as in technical positions, with women making up 3% of the top 100 airline chief executive officers; 8% of chief financial officers and 3% of chief operating officers. In human resources, women constitute 32% of HR directors [2].

In the educational context, according to EIGE [4], only 13% of Europe's graduates from STEM vocational education are women, whereas 32% graduate from STEM tertiary education. Among these female graduates, only one-third work in STEM occupations, compared to one in two men. Among vocational education graduates, the gap is even greater, with only 10% of women but 41% of men working in STEM occupations. Among those moving away from STEM, 21% of women at the tertiary education level work as teaching professionals and 20 % of women with vocational STEM education work in sales.

'She Figures 2018' publication [5], the sixth iteration of the European Commission (EC)'s 'She Figures' publication since the release of its seminal version in 2003, presents the latest available official statistics on the footprint of women in the research landscape. According to that, the EU is approaching gender balance among doctoral students. Nevertheless, the proportion of women still varies between the different fields of education: in 2016, women doctoral graduates at EU level were under-represented in the field of information and communication technologies (21%) and the fields of engineering and manufacturing and construction (29%). A lot of European women are excelling in higher education, and yet, women represent only a third of researchers. As we move up the academic ladder, women are less represented. The gap between women and men was wider in STEM: while women made up 37% of doctoral students and 39% of doctoral graduates, they held only 15% of grade A academic position, reducing the possibility to have a female role model in STEM fields university study.

Also, a Deloitte UK report [6] concludes that, since girls are significantly underrepresented in STEM subjects at school, at university and consequently in working life, there is potential talent among girls not being fully exploited, which could help fill skills shortages existing in STEM-related occupations.

Considering this, the aviation sector seeks to attract and retain women for its future and growth, not only to face the gender imbalance (that generally affects the transport sector) but also to consider the potential talent source that is currently not being fully exploited. The combination of different talents in a cooperative and open-minded environment of equality promotes the emergence of new ideas and allows pursuing them to achieve the best results in less time and with reduced effort. Aviation is not a gender-balanced sector, thus being a consequence - albeit not exclusively - of the existing gender stereotypes in education as such the factors that affect the professional career of women which may not be too apparent in childhood but may have effects in secondary school and university. There are several factors that influence the participation of women in aviation: the women interest in the aviation sector and the women's self - confidence in STEM subjects; the educational context, specifically the gender stereotypes that women are exposed to; and the employment opportunities and labour conditions and practices for women. Taking these factors into consideration, the implementation of interventions in both the educational and employment contexts that could enable substantial and

sustainable changes regarding the increase of women interest and involvement in the aerospace sector is required [7].

Starting from the information provided above, the purpose of this paper is to collect and present a review of the state-of-the-art gender issues within the aviation sector in order to better understand how to best attract and recruit such individuals to counteract the gender imbalance and improve their representation as one method of increasing the talent pool. This analysis also aims to further investigate the possible cultural, organisational, or other issues that perpetuate low representation of women in aviation, especially among pilots, engineering and leading positions. More specifically, this paper will focus on three main pillars:

- Tackling women's interest in aviation and self-confidence in STEM (section 2.1);
- Changes in the educational context (section 2.2);
- Improvement of the employment context (2.3).

2. Tackling the gender equality potential in aviation

2.1. Tackling women's interest in aviation and self-confidence in STEM

Evidence suggests that women are underrepresented in some areas of work, notably those where some knowledge of STEM subjects is required. Main reasons for this pattern include a lack of encouragement from friends, family and teachers; a lack of awareness, this is, reduced prior knowledge of STEM as a career option; and a lack of young women's self-confidence in STEM roles [7].

A EIGE report [4] defends that positive STEM experiences and development of "STEM identities" start from an early age, even before children enter formal education (*e.g.* in providing caring toys such as dolls for girls and exploring toys such as cars and planes for boys) through family relations (*e.g.* a strong bond with fathers increases women's likelihood to enter STEM studies).

To understand why more European girls and young women aren't studying STEM, Microsoft commissioned a Europe focused research in 2017 [8] involving 11.500 schoolgirls (ages 11 to 18) and young women (ages 19 to 30) from 12 European countries. The Microsoft research concluded that most European girls become interested in STEM subjects between the ages of 11 and 12, but that interest drops off significantly between the ages of 15 and 16, this is, by the time girls are in high school. The Engineering UK Report 2018 [9] reinforces this conclusion, stating that interest in engineering drops off for girls as they get older, but this is particularly pronounced for girls after the age of 16. This means there is a four – a year or five – year window of opportunity to nurture girls' passion for STEM subjects before they turn their backs on these areas.

Women's low self-confidence in STEM is mainly due to gender-stereotypes in science, *i.e.*, the dominant association of science as masculine (which makes women start doubting they won't perform some tasks in STEM fields as well as boys) and the existent gender-imbalance in STEM roles (which leads women to fear being treated differently than men and/or feeling they don't belong). These two factors demotivate women to aspire to STEM careers and make it challenging to see STEM as a potential career choice [7].

EIGE [4] defines gender stereotypes as "preconceived ideas whereby females and males are arbitrarily assigned characteristics and roles determined and limited by their gender". Gender stereotypes develop due to complex socio-cultural factors (*i.e.* nationality, social status, age, etc.) and can have both a direct and indirect impact on gender segregation. They also impact the choice of study fields or occupations that women and men take by driving interest towards specific subjects that are deemed "appropriate". People's choices can, therefore, be interpreted as a sign of what the culture accepts and enforces as appropriate gender behaviour concerning a specific field of study or occupation, which highlights the influence of the cultural context in the creation of gender stereotypes.

There are two predominant stereotypes with relation to gender and STEM - "boys are better at math and science than girls" and "science and engineering careers are masculine domains". Other common preconceptions are that "science is for men, not for women" and that women have a disinclination to science, by her selves or compared with men. In fact, there are countries where the majority of women choose science and they are not necessarily the nations rated as the most gender-equal. This dominant

association of science as masculine and the fact that scientists are usually described or drawn as males makes it particularly challenging for girls to see STEM as a potential career choice and, on the other hand, may equip boys with easily available and pre-established roles in science and technology. Women are also found to be less likely to aspire to STEM careers due to expectations of feeling less good in contexts with unfavourable gender stereotypes [7].

A research article from Leiden University [10], when addressing gender stereotypes in science education, it is important to consider stereotypic education materials and gender-biased teaching. For instance, in schools, it is frequent the assumption that “girls are diligent, neat and calm while boys are loud, laidback and naturally clever” and the presence of only a male version in science school books instead of both (e.g. he/she) in the images and text. In fact, the EIGE report [4] defends that the participation in STEM is traditionally associated with various stereotypically masculine identity traits and roles and is enforced by the long-lasting historical and cultural idea that science is male-gendered.

As seen before, gender stereotyping and gender imbalance affects women’s self-confidence in STEM. There is also a correlation between both factors, being that gender stereotypes can have an impact on gender segregation, and gender segregation by itself is considered, according to the EIGE report [4] to further reinforce gender stereotypes.

2.2. Changes in the educational context

Nowadays, the practice of mixed primary and secondary schools means that there are similar opportunities for both boys and girls, as far as their choices are not too much influenced by educators, relatives and friends, and these young people have their inclinations and are willing to follow them. Therefore, the traditional attitudes of parents, family and school educators towards which toys girls should play and what careers are more suitable for girls can have a big role in the formation of girls’ personalities and self-concept and therefore influence their future career choices. Gender segregation caused by stereotyping in education creates gender inequalities in and beyond the labour market, acting as a barrier to increasing women’s labour market participation – narrowing life choices and employment options and possibilities. Therefore, it is fundamental to tackle these gender stereotypes by making changes in the educational, taking into account the use of appropriate role models, the influence of the peers, the recruitment and retainment of students, and the enhancement of classroom activities and contents (hands-on and project-based learning) [7].

The five major factors identified in the Microsoft report [8] that can sustain a girl’s interest in STEM subjects and careers are: 1) Female role models: having visible female role models both in school and at home to help girls to picture themselves pursuing STEM-related careers; 2) Practical experience and hands-on exercises: gaining practical experience and hands-on exercises during their education – inside and outside the classroom – to increase girl’s interest in STEM subjects; 3) Teacher mentors: having teacher mentors who talk to girls about STEM subjects, clarifying expectations and providing insights, and actively encourage them to pursue STEM subjects; 4) Real-life applications: being able to conceive what they can do with STEM subjects, how they can be applied to real-life situations and how relevant they might be to their future; 5) Confidence in equality: being confident that men and women will be treated equally while working in these subjects.

Some measures have been adopted so far in Europe to minimize the existing gender differences, thus influencing girls’ and women’s participation, progression and achievement in STEM fields. Among others, some examples include: 1) making available on the internet and to primary school’s children stories and cartoons where girls drive cars and fly aeroplanes as much as boys do and let them play with vehicle models or ask for them as presents; 2) developing a toolkit for primary and secondary school teachers to fight gender stereotypes and raise awareness about transport professions among young people, e.g. including flight experiments equally accessible to boys and girls in the primary and secondary school programs and activities; 3) identifying good practices on how to organize rosters in the best family-friendly way, to be made available to all stakeholders; and 4) reinforcing and accelerating visits to universities and industry, role models of success stories and the same fascinating technologies [11]. Also, introducing technologies can help female students to create and explore virtual worlds, learn basic coding, and develop social skills. It is important to introduce more creative and hands-on experiences in classes since young girls love creativity and practical

experiences and classes must be gender-neutral because a gender-neutral environment in classes help young women to participate and feel engaged [8].

2.3. Improvement of the employment context

As the traditional masculine beliefs and values have been rooted in the aviation industry for a long period, despite several efforts made, the percentage of women pursuing a career in the field remains low, particularly in the technical side. To oppose this, it is necessary to raise awareness of all career opportunities in aviation, to offer the guarantees of equal treatment and prevention of abuse, to ensure the protection of the family, maternity and parenthood and to recognize the achievements of female employees and to compensate for eventual gender differences.

A study prepared for the EC's Directorate-General for Mobility and Transport (EC's DG MOVE) [1] identified 10 specific communication good practices and strategies, from a shortlist of 25 communication initiatives implemented within the last two or three years in the EU, able to be transferable across the full spectrum of transport sectors and believed to promote transport jobs effectively to young women and men. These are: 1) Using research to confirm the approach – generating new evidence to support the promotion and communication activities in order to better understand target groups, support the strategic business case and generate buy-in for action, and listen to the experiences of young people and staff; 2) Taking a strategic approach (a long term plan with specific targets) – defining SMART (specific, measurable, achievable, realistic and timely) targets to steer communication efforts so that they generate the desired results, and having a very detailed level of planning and implementation; 3) Going into schools, colleges and universities –generating opportunities for direct face-to-face contact between students and companies in order to provide detailed information to young people regarding career choices in the aviation sector; 4) Providing opportunities to experience the job – enabling young people to experience a job of their interest, with the aim of giving them a better understanding of the diverse range of roles available across the aviation sector; 5) showcasing real people as role models – providing young people with concrete examples of successful employees working in the transport sector, which show what it would be like for them, with the goal of really influencing them on the prospects of jobs in aviation. One way to do this is by providing a platform for young people doing the job to tell others what it is about; 6) working with men to engage women – working with existing male workers to better understand the focus of recruitment promotion, since they can provide insights into the challenges of the work and how best to overcome them; 7) communicating with young people on their terms – using the channels and tools that young people use, e.g. social media, and trying to replicate the world that they live in, in order to attract their attention; 8) building in careers advice provision to promotional strategies – including a career advice aspect in the organization promotional drive with the goal of raising young people awareness on the professional opportunities offered by the sector, this is, ensuring their sufficient understanding of what is involved in the wide range of roles available; 9) using networks & mentoring to support female retention – using networks and mentoring as key mechanisms to support female employees in technical jobs, where women can be very few in number and therefore fell somewhat isolated, experience sexist attitudes and intangible or invisible barriers when it comes to promotion or wage increases; 10) using existing resources & networks to increase cost effectiveness – making the most of what each organisation has in – house to help reduce the costs of the activities undertaken within the initiative. In general, The EC's DG MOVE study concluded that promotional efforts which engage young people on a face-to-face basis work well, particularly when they: (1) provide opportunities to explain what is involved in the range of jobs available; (2) help young people to understand the fit between their skills and transport jobs; and (3) give young people opportunities to meet others who are employed in these jobs. Also, it is important to support female career progression, recognize the contribution of female employees and facilitate more flexible working for careers.

In the Microsoft report [8], it is stated that 59% of girls admitted they would feel more confident pursuing a career in STEM if they knew that men and women have equal opportunities. Accordingly, all aspects of the job recruitment, from the announcements to the interview, to the benefits (including salary) must be gender equal and if there are eventual gender differences, these should be compensated [7].

Specifically about recruitment, according to the book entitled *Women Scientists and Engineers Employed in Industry: Why so few?* [12], effective recruitment approaches are centred on six elements: 1) The recruiters are engineers, scientists, and managers of engineers and scientists, not the Human Resources Division representatives; 2) Employees chosen as corporate recruiters are those who exhibit strong interpersonal skills, who "care and go the extra mile"; 3) Recruitment occurs at a targeted group of universities. Additional linkages with universities have been developed by many companies to identify prospective employees; 4) The company maintains a corporate presence on each campus, interacting with faculty, students, and staff; 5) Entry-level recruits rotate through a series of technical and management assignments to learn about program opportunities; 6) Co-op programs enable the company to evaluate potential employees while they pursue projects that support the work of the company laboratories.

Additionally, it has been noted that support for women's needs should also exist at the organizational level. Leadership should make efforts through the creation of a positive work environment where mentoring and networking has been also indicated to be helpful. Even if leadership simply connects corresponding individuals or even assigns mentors or role models to encourage female employees, these efforts can greatly improve job satisfaction and, as a result, retention. Human resource personnel should also be trained to be considerate of the recruitment and retention of minorities. Ideally, formal practices are put into place to create an inclusive work environment and recruitment process [12, 13].

According to a Deloitte UK report [6], women are disproportionately more likely to go into jobs in industries or sectors where pay levels are lower. The gender pay gap has various causes and therefore, no single measure will be sufficient to eradicate it. It is partly related to the fact that many women take time out from work for family reasons and may only take on a part-time job when they eventually return to work, which in general is paid less per hour than full-time work. To find a suitable balance between family and working life, combined with lower pay for part-time working contributes significantly to the pay gap. If more women are encouraged to study STEM subjects during their education and are taught in a way that recognises their cognitive preferences, they are not only being prepared for a more dynamic world of work but it simultaneously starts to bridge the gap in pay.

However, on a final note, it is important to point out that the recognition of professional achievements must, of course, be objective and fair, using the same criteria applied in the same way, regardless of gender, age or belief. However, fairness also means equal opportunities, and while applying the same final criteria, all should have the same opportunities to attain those objectives. Reverse discrimination may not be the best way to correct gender inequalities nor forced statistical equality: *women do not need favours they only need equal opportunities and fair treatment*, and this applies not only to gender issues but also to other potential forms of discrimination that could creep into the workplace.

3. Conclusions and future considerations

In conclusion, women are underrepresented in some areas of work, notably those where some knowledge of STEM subjects is required. More women typically work in jobs where the importance of soft skills is higher but where technical skills are not as important; on the other hand, men typically work in occupations where there is a more even blend of cognitive, social and technical skills. This clear divide in skills between genders, needs to be addressed so that all students – whether male or female and at all stages of their education – are provided with an equal foundation upon which they can build the career of their choice. To do so, it is important to encourage more women in STEM fields and careers, to increase the diversity of ideas in the related workplaces, thus reducing the gender gap in these fields and encouraging teamwork among women and men.

This will require greater equality in the nature of the support provided to students, improved recognition that the way males and females are taught may need to be different, and greater encouragement and breadth of careers advice from schools and parents. Only then will women be able to make better – informed choices about the potential of their future careers.

In sum, some strategies and changes are presented below:

- By removing existing barriers and impediments: It is important to identify characteristics that are impeding the progress and remove both real and perceived barriers, thus making gender equality a reality in the field of aviation. This also includes examining potential mechanisms to improve work-life balance;
- By increasing visibility and outreach to younger girls through the existence of role models: Young girls did not consider or even imagine becoming a pilot because they rarely if ever, saw a woman piloting a plane. People need to have role models and to see people who look like them for it to occur to them to strive for a career in such an area;
- By providing support for women while they are students, trainees, and employees;
- By addressing retention in addition to recruitment: Further analysis is needed to perceive why women's numbers are dropping after training. While recruitment efforts can be improved by increasing awareness and role models, on the other hand, retention seems to be an issue that also needs to be addressed (*e.g.* difficult schedule and lifestyle);
- By providing more options and flexibility in scheduling and structure so that work has more work/life balance;
- By reinforcing leadership and organisational support: ensuring the existence of role models, including a mentoring system, as well as promoting diversity training which addresses attitudes, practices, and approaches to working with people who are different than yourself;
- And, by changing cultural perceptions: If a culture has been traditionally male-oriented, it will be difficult for diversity to take hold. Cultural attitudes need to change in order to open up more paths for the career development of previously underrepresented occupations.

The combination of different talents in a cooperative and open-minded environment of equality promotes the emergence of new ideas and allows pursuing them to achieve the best results in less time and with reduced effort. Thus, greater participation of women in aviation is an enrichment in quality and talent, which are the foundations of inventiveness and competitiveness on which depend the continuing European leadership in an ever more competitive world with new challenges, such as the current COVID-19 pandemic situation that is highly impacting the aviation sector.

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