



Research Paper

Women in aircraft maintenance: A gender analysis in aircraft maintenance training

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**Abstract.** An aircraft maintenance training is provided through vocational courses and higher education institutions in Türkiye, as it is worldwide. In Türkiye, various institutions, including the Faculty of Aviation and Astronautics, Aviation Vocational High Schools, Civil Aviation Colleges, and university-affiliated Vocational Schools, provide aircraft maintenance training. Technicians in mechanical and avionics fields are trained through these programs. University-level departments such as Airframe and Engine Maintenance, Aircraft Maintenance and Repair, Aviation Electrics and Electronics, and Aircraft Technology provide curricula aligned with industry requirements and international standards. One of the challenges faced in the aviation industry is the recruitment and participation of women in technical roles. Statistical data clearly reveals a significant gender imbalance in the aviation workforce, with women representation markedly lower than that of males. The gender imbalance is even more pronounced in the aircraft maintenance industry, where women remain significantly underrepresented in technical positions. This underrepresentation also extends to other areas of the aviation industry, including roles such as pilots, flight attendants, and air traffic controllers. This study aims to examine the enrollment trends of women students in aircraft maintenance departments at universities in Türkiye. Therefore, the study employs quantitative and descriptive research design. Enrollment data from aircraft maintenance departments at universities in Türkiye was collected between 2020 and 2024 and analyzed using frequency and percentage distributions to examine gender-based trends. The findings indicate that women enroll in these departments at significantly lower rates than their male counterparts, and that there is a persistent gender gap in technical aviation education.

**Keywords:** Aircraft maintenance, maintenance technician, maintenance education, women in aviation.

Araştırma Makalesi

Hava aracı bakımında kadınlar: Hava aracı bakım eğitiminde cinsiyet analizi

**Öz.** Uçak bakım eğitimi, dünyada olduğu gibi Türkiye’de de mesleki kurslar ve yükseköğretim kurumları aracılığıyla verilmektedir. Türkiye’de Havacılık ve Uzay Bilimleri Fakülteleri, Havacılık Meslek Liseleri, Sivil Havacılık Yüksekokulları ve üniversitelere bağlı Meslek Yüksekokulları gibi çeşitli kurumlar uçak bakım eğitimi sunmaktadır. Bu programlar aracılığıyla mekanik ve aviyonik alanlarda teknisyenler yetiştirilmektedir. Gövde-Motor Bakım, Uçak Bakım ve Onarımı, Havacılık Elektrik ve Elektronik ile Uçak Teknolojisi gibi üniversite düzeyindeki bölümler, sektör ihtiyaçları ve uluslararası standartlarla uyumlu müfredatlar sunmaktadır. Havacılık sektörünün karşılaştığı önemli zorluklardan biri, teknik alanlarda kadınların istihdamı ve bu alanlara katılımının artırılmasıdır. İstatistikî veriler, havacılık iş gücünde ciddi bir cinsiyet dengesizliği olduğunu açıkça ortaya koymaktadır; kadınların temsil oranı, erkeklere kıyasla belirgin şekilde düşüktür. Bu durum, pilot, kabin memuru ve hava trafik kontrolörü gibi alanlarda dahi gözlemlenirken, özellikle uçak bakım sektöründe kadınların temsili çok daha sınırlıdır. Bu çalışma, Türkiye’deki üniversitelerin uçak bakım bölümlerine kadın öğrencilerin kayıt eğilimlerini incelemeyi amaçlamaktadır. Bu doğrultuda çalışma, nicel ve betimsel bir araştırma deseni benimsemektedir. Türkiye’deki üniversitelerin uçak bakım bölümlerinden 2020-2024 yılları arasındaki kayıt verileri toplanmış ve cinsiyete dayalı eğilimleri analiz etmek amacıyla frekans ve yüzde dağılımları kullanılmıştır. Bulgular, bu bölümlere kadın öğrencilerin erkek öğrencilere kıyasla belirgin biçimde daha düşük oranlarda kayıt yaptırıldığını ve teknik havacılık eğitiminde kalıcı bir cinsiyet farkının varlığını sürdürdüğünü ortaya koymuştur.

**Anahtar Kelimeler:** Uçak bakımı, bakım teknisyeni, bakım eğitimi, havacılıkta kadın.

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## 1. INTRODUCTION

Aircraft maintenance operations are carried out to ensure that aircraft completes their flights safely and effectively. It must be lowered to prevent problems or malfunctions that may occur before, during, or after the flight. Carrying out aircraft maintenance operations in accordance with the specified rules and order is of great importance for the aircraft to complete the flight safely (Gunes, Turhan, & Yörük Açikel, 2022). An efficient maintenance system is an important factor in achieving the airline's cost objectives. Minimal flight cancellations, delays and air returns to be obtained by the efficient implementation of necessary maintenance will benefit organizations in this way (Van den Bergh, De Bruecker, Beliën, & Peeters, 2013). Maintenance operations are carried out by maintenance technicians in hangars and aprons with expertise and necessary competencies. Some of the competencies that maintenance technicians should have, technical competencies, safety culture, human factors, and English language proficiency.

An examination of job advertisements for maintenance technicians, along with relevant studies, reveals that the number of women employed in the aircraft maintenance industry remains considerably lower than that of men. This is observed despite the understanding that gender should not be regarded as a determinant in recruitment preferences. Increasing the women's workforce in every industry for the welfare of society will positively affect women's employment. The fact that the gender balance in business life is not fully achieved causes women to be weak in terms of workforce in most professions. According to the research, it is seen that the women workforce is insufficient in the aviation industry. When the data is examined, it is seen that the women workforce rate among maintenance technicians and airline managers is less than 5%. This percentage indicates high levels of gender imbalance in the maintenance technician and airline management professions. Among the pilots, the women workforce is between 5% and 10%. The reason for this may be due to the excess of gender imbalance because of seeing maintenance technician and pilot as a masculine job (Lutte, 2019).

Aviation has historically been a male-dominated field. However, it was their sister, Katherine Wright, who encouraged the Wright brothers, who built bicycles and are considered as the beginnings of aviation, to pursue their dream of flying. Although he was the first man to take to the air, it was only five years later that a woman flew the plane. Even though women have been in the aviation industry almost as long as men, it is still a very male-dominated field (Wilson, 2004). Studies have explored factors influencing this gender disparity, revealing that women's perceptions of physical limitations, career appropriateness, work environment safety, social acceptance, and advancement opportunities are interconnected. Men's perspectives on these issues differ significantly from women's, particularly regarding work environment safety and social acceptance (Clark, Newcomer, & Jones, 2018). Interestingly, research shows no statistically significant difference between men and women in most factors influencing the selection of aviation maintenance programs, with both genders citing passion, interest, and aptitude as primary motivators (Habig & Marete, 2023). To address this gender imbalance, exploring effective strategies employed in other STEM fields to attract women may provide valuable insights for enhancing women participation in the aviation maintenance industry (Rouscher, 2021). Ferla and Graham investigated why women are underrepresented in the commercial aviation sector. Interviews and reviews of agency reports revealed that women face various barriers to entry, career advancement, and the workplace. The study highlights the aviation sector's inadequate recruitment and retention of women, which could negatively impact sector growth. It also recommends inclusive policies and supportive practices to increase female employment (Ferla & Graham, 2019). The study "Reshaping Gender in Airline Employment" indicates that gender equality policies in the airline industry are largely limited to the pilot profession, hindering their inclusion in other professional groups. The study's analysis, conducted with a feminist poststructuralist approach, argues that traditional gender roles are strongly present in airline discourse and that more holistic policies encompassing all professions are necessary for organizational transformation (Smith, Cohen, Kimbu, & de Jong, 2021). Newcomer et al. (2018) examined men's perceptions of women's suitability for this field, career advancement opportunities, workplace safety, and social acceptance in aircraft maintenance engineering, one of the professions with the largest employment imbalance among women. Responses from 587 men were analyzed, and significant differences were found between men's and women's perceptions of job security and social acceptance (Newcomer, Clark, Button, & Weiland, 2018). Eitelberg examined the rise of women and minority groups in the military aviation maintenance field. The study addresses the growing role of these groups in military maintenance technicians and evaluates the potential impacts and challenges of this approach (Eitelberg, 1990). According to Boeing data, 649000 pilots, 690000 maintenance technicians and 938000 cabin crew will be needed until 2042. Considering these numbers and the competency expectations of the aviation industry, it is inevitable to develop

women's employment in the aviation industry (Boeing, 2023). Fewer than 20% of aviation employees are women. Occupations with the most significant gender gap in aviation; pilot, maintenance technician and senior management positions. The occupations with the highest gender gap are airline pilots (5%), maintenance technicians (2.6%) and aviation managers (3%). While women constitute 47% of the total workforce in the USA, they constitute 31.4% of the total number of employees in Türkiye (Lutte, 2021), (TSI, 2023). In Turkish civil aviation organizations, the rate of women employees by occupation is 65% in cabin services, 30% in engineers, 3.5% in pilots and 1.7% in maintenance technicians (Directorate of General Civil Aviation, 2018). One of the main concerns regarding the issue is that the proportion of women working in aviation has not changed significantly over time. Although it is pleasing that the total number of women employees holders has increased in the last 60 years, there has been a very small change in the ratio of women to total employees. Over a 60-year period, the percentage of women commercial pilots has changed by about 1% per decade and increased by about 0.5% in maintenance technicians (Lutte, 2021).

According to Federal Aviation Administration (FAA) data, the rate of women employees in 2020 is 79.2% in cabin crew, 19.7% in dispatchers, 16.8% in air traffic controllers, 11.6% in engineers, 5.6% in pilots and flight engineers and it is 2.6% in maintenance technicians (Lutte, 2021). As the results show, the ratio of women employees is the least in maintenance technicians. The five biggest barriers to women working in aviation are; negative culture, cost of entry, family/life/work balance, training-related issues and lack of support (Lutte & Morrison, 2022). In addition, implicit prejudice, discrimination, lack of women in leadership positions, and the need to provide more support to young people are also barriers for women to work in aviation (Lutte, 2021).

According to International Civil Aviation Organization (ICAO) data, as of 2021, only approximately 3% of aircraft maintenance technicians worldwide are women. FAA data shows that the proportion of women in maintenance technicians has reached only 2.6% over the last 60 years, and the increase is very slow (FAA, 2022). It is emphasized that women still face a significant underrepresentation in technical fields other than piloting, with rates remaining around 3% in senior positions (Yanikoğlu, Kılıç, & Küçükönel, 2020). In Türkiye, 32% of technician candidates taking the SHY-66 module exams are in the avionics category, while 68% are in the mechanical category. The overall distribution of licensed technicians is approximately 70% in the A category, 25% in the B1/B2 category, and 3% in the C category. While the study does not specifically focus on gender ratios, it does imply that the proportion of women remains low within candidate profiles (Ateş, Kafalı, & Lik, 2018).

In a study conducted by Neşet Vefa Erden in SHY-145 licensed maintenance organizations in Türkiye, 362 employees were surveyed, examining the effects of manager support on creativity and finding no differences in demographic characteristics, including gender. The study did not examine participation trends by gender (Erden, 2025). Reports from international organizations such as ICAO and EASA address the structure of maintenance technician licensing systems and gender-based participation/data issues (Tyagi, Tripathi, & Bouarfa, 2023). There is no numerical or time-series quantitative analysis based on the proportion of women students in aircraft maintenance training in Türkiye. Studies have addressed topics such as SHY-66 exams and management support, technical competence, or student/exam perception (Ateş, Kafalı, & Lik, 2018), (Erden, 2025).

As can be seen from the results of the research, the rate of women employees working as maintenance technicians is quite low compared to other departments. In order to increase the number of women working as maintenance technicians, it will be necessary to increase the interest of women students in training institutions serving in this field and to make improvements in this sense. In this study, the number of women students studying in aircraft maintenance training departments of higher education institutions serving in Türkiye was analyzed, the analyses were interpreted, and solution suggestions were presented.

## 2. MATERIALS AND METHODS

Aircraft maintenance technicians are categorized as mechanical maintenance technicians and avionics maintenance technicians. Technicians trained in these relevant categories may be licensed and authorized based on their education and qualifications. Aircraft maintenance training in Türkiye, as in the rest of the world, is provided by university faculties, vocational schools, and vocational schools of higher education. In addition to these, industry-supported vocational courses also provide training for maintenance technicians. The creation and implementation of licensing processes for aircraft maintenance technicians are the responsibility of each member state under the Chicago Convention. In European Union countries, the licensing of maintenance technicians is conducted under the European Union Aviation Safety Agency (EASA) Part 66 regulations. According to EASA Part 66, maintenance

technician licenses are classified into three categories: A, B, and C. These categories are further divided into subcategories according to mechanical, avionics, and aircraft/engine types.

- The Category A license authorizes the technician to perform scheduled line maintenance and simple defect rectification and to issue a maintenance release certificate.
- The Category B1.1 license permits maintenance on aircraft structures, power units, and mechanical systems, and the issuance of a maintenance release certificate.
- The Category B2 license allows maintenance on avionics and electrical systems and the issuance of a maintenance release certificate.
- The Category C license authorizes the issuance of a maintenance release certificate following base maintenance operations (EASA, 2021).

This study focuses on gender-based enrollment trends in university-level aircraft maintenance programs in Türkiye. The analysis covers departments such as Aircraft Maintenance and Repair, Airframe and Engine Maintenance, Avionics, Aviation Electrical and Electronics, and Aircraft Technology. These programs prepare students for licensing and employment in various aircraft maintenance categories defined by EASA.

The data used in this study was obtained from the Council of Higher Education (CoHE), which oversees higher education institutions in Türkiye. The study used a quantitative and descriptive research design.

Frequencies and percentages were used to assess the number of male and female students enrolled in each department and to identify gender disparities in enrollment. Student data were collected based on enrollment numbers during the academic years of 2020–2021, 2021–2022, 2022–2023, 2023–2024, and 2024–2025. Data from all 29 universities in Türkiye that provide aircraft maintenance education were individually gathered.

The analysis method included:

- Calculating the gender distribution (men/women) for each university and department individually,
- Consolidating the data to determine the overall gender distribution,
- Expressing the distributions as percentages (%) to enable a comparative evaluation of men and women students.

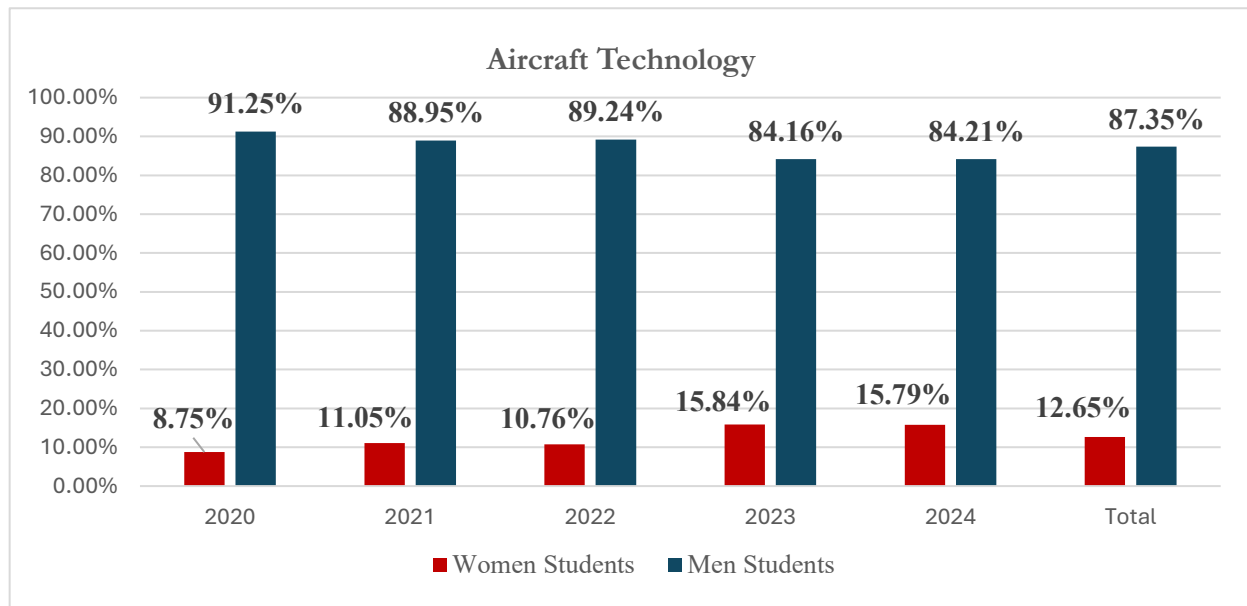
Gender classification was applied according to the official categorization in CoHE data system as “men” and “women”. Since the data used in this study were anonymized and published collectively by CoHE, ethical approval was not required. The scope of the study was limited to universities and did not include industry-supported vocational courses or other training institutions.

The findings highlight the underrepresentation of women in technical aviation training programs and contribute to a broader discourse on gender equality in aviation education. In this study, data publicly available on the official website of the Turkish Council of Higher Education (CoHE) were used and analyzed.

### **3. FINDINGS**

#### **3.1. Aircraft Technology Departments**

Aircraft Technology departments are one of the programs that train aircraft maintenance technicians. The education period of this program, which is available in 23 universities in Türkiye, lasts two years. In these departments, which aim to train A-category maintenance technicians, students receive theoretical and practical training. The number of women students who preferred these departments in 2020 is 111 (8.75%), 162 (11.05%) in 2021, 176 (10.76%) in 2022, 251 (16%) in 2023, 270 (15.79%) in 2024 and the total number is 970 (12.65%). These values are given in Figure 1.

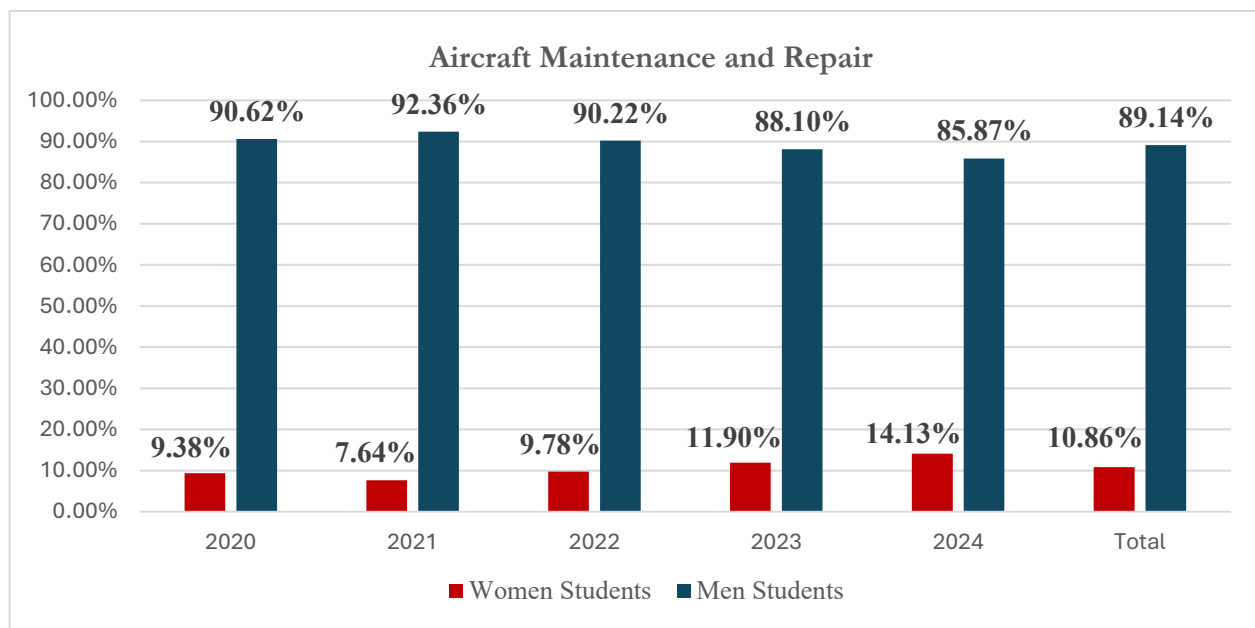


**Figure 1.** Gender Distribution among Students in the Aircraft Technology Departments

When the data are examined, the number of women students who prefer the department tends to increase, albeit at low rates, with fluctuations over the years.

### 3.2. Aircraft Maintenance and Repair/Airframe and Powerplant Maintenance Departments

In Türkiye, bachelor programs that provide education for mechanical maintenance technicians are academically referred to as Aircraft Maintenance and Repair or Airframe and Powerplant Maintenance departments. There are 12 universities in Türkiye that train in the Aircraft Maintenance and Repair/Airframe and Powerplant Maintenance departments. Students in these departments are mainly trained in aircraft fuselage structures and power systems. Graduates of this department work with the title of aircraft mechanic technician. In these departments, which aim to train B1.1 category maintenance technicians, students receive theoretical and practical training. The number of women students who preferred these departments in 2020 is 44 (9.38%), in 2021 31 (7.64%), in 2022 54 (9.78%) in 2023 60 (12%), in 2024 90 (14.13%) and the total number is 279 (10.86%). These values are given in Figure 2.



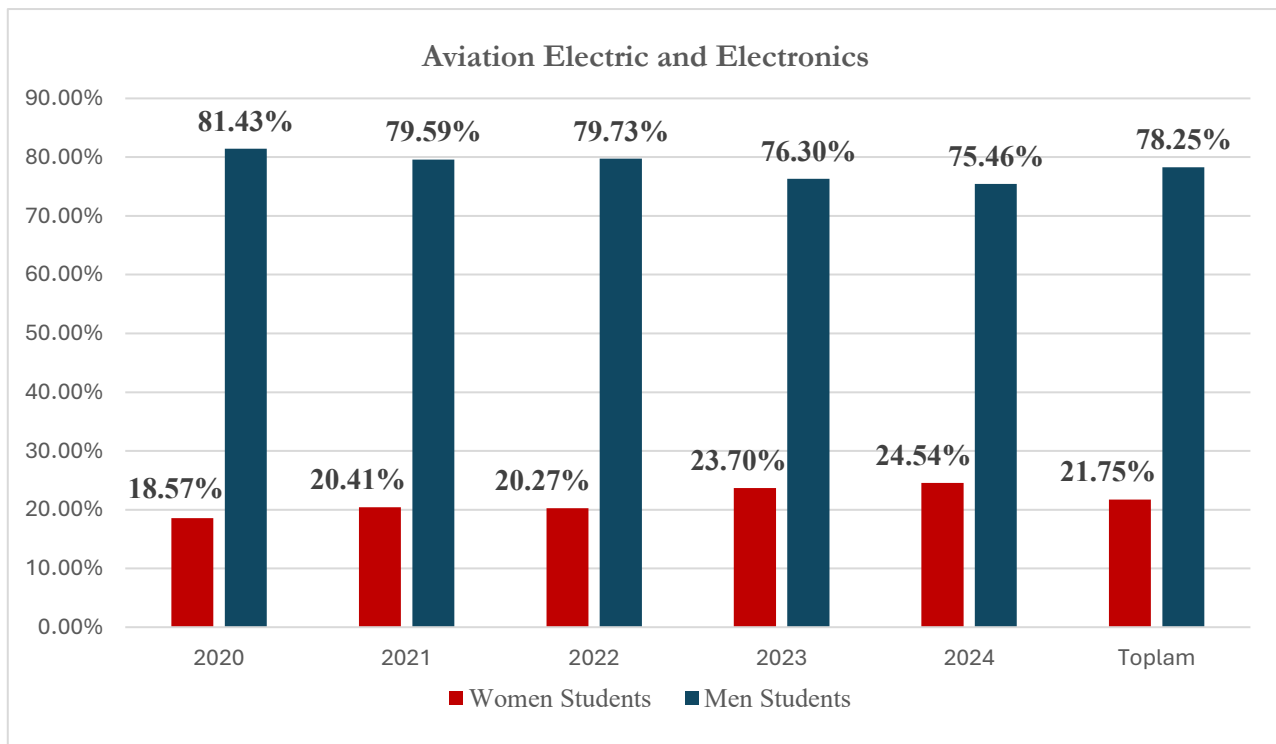
**Figure 2.** Gender Distribution among Students in the Aircraft Maintenance and Repair Departments

When the data is examined, it is seen that the number of women students studying in these departments is lower than in other departments providing aircraft maintenance training. Although the rate of students preferring departments has not changed dramatically over the years, the rate of women students has never reached 15% in any year.

### 3.3. Aviation Electric and Electronics/Avionics Departments

Due to the rapid development in electronic and computer technology, the performance of the aircraft designed today is increasing day by day. An aircraft's electrical and electronic systems and components are vital to flight safety and efficiency. For this reason, maintenance personnel who will work in Aviation Electrical and Electronics/Aircraft Electrical and Electronics should have received sufficient training and have the necessary competencies. In Türkiye, bachelor programs that provide training for avionics maintenance technicians are academically designated as Aviation Electric and Electronics or Avionics departments. Students who graduate from these departments are entitled to receive the title of aircraft avionics technician. An aircraft avionics technician is a maintenance technician who performs the necessary tests on aircraft structures and components, troubleshooting, assembling electronic components, and adjusting fuses and electrical control surfaces (Gunes, Turhan, & Acikel, 2020).

There are 10 universities in Türkiye that provide training in Aviation Electric and Electronics/Avionics departments. Students in these departments study both theoretical and practical subjects, primarily concentrating on aircraft electrical and electronic systems and components. In these departments, which aim to train B2 category maintenance technicians, students receive theoretical and practical training. The number of women students who preferred these departments in 2020 is 70 (18.57%), in 2021 70 (20.41%), in 2022 91 (20.27%), in 2023 100 (24.54%), in 2024 132 (24.54%) and the total number is 463 (21.75%). These values are given in Figure 3.



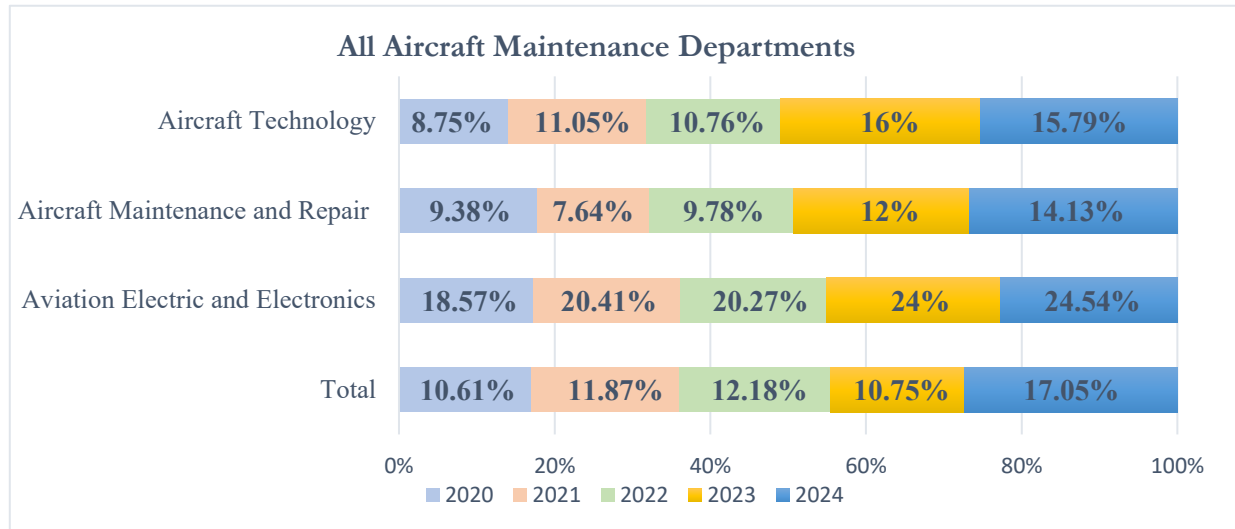
**Figure 3.** Gender Distribution among Students in the Electric and Electronics/Avionics Departments

It is observed that the number of women students training in these departments is higher than the other departments that provide aircraft maintenance training. Although the rate of students who prefer departments has not changed dramatically over the years, the average rate of women students is around 21%.

### 3.4. All Aircraft Maintenance Departments

There are 45 universities in Türkiye that provide aircraft maintenance training. In these universities, aircraft maintenance training is given to cover categories A, B1.1 and B2. When the student numbers of the relevant departments are examined for the years 2020, 2021, 2022, 2023 and 2024 the rate of women students is 8.75%,

11.05%, 10.76%, 16%, 15.79% in Aircraft Technology departments, 9.38%, 7.64%, 9.78%, 12% and 14.13% in Aircraft Maintenance and Repair/Airframe and Powerplant Maintenance departments, 18.57%, 20.41%, 20.27%, 24% and 24.54% in Aviation Electric and Electronics/Avionics divisions. When we look at the general total, the rate of women studying in 45 universities is 10.61%, 11.87%, 12.18%, 10.75% and 17.05% according to the years. These values are given in Figure 4.



**Figure 4.** Gender Distribution among Students in All the Aircraft Maintenance Departments

According to the data, although the number of women students in universities providing aircraft maintenance training shows an increasing trend over the years, the departments with the highest women-student ratio are Aviation Electric and Electronics/Avionics departments. Similarly, although it shows an increasing trend over the years, the departments with the lowest women-student ratio are Aircraft Maintenance and Repair/Airframe and Powerplant Maintenance departments.

#### 4. RESULTS AND DISCUSSION

Aircraft maintenance training is carried out in universities, vocational courses and training programs of airline companies in Türkiye. In parallel with the development of the aviation industry, the need for well-trained aircraft maintenance technicians with professional competencies will increase in the coming years. According to Boeing data, 690000 maintenance technicians will be needed by 2042 (Boeing, 2023). In an industry where the need is so high, the training and employment of women technicians is of great importance for the future of world aviation. Unfortunately, when the current practices are examined, the number of women employees working in the aviation industry is quite low, but this number is even lower among maintenance technicians. Although the rate of women maintenance technicians is below 5% worldwide, the rate of women technicians is 2.6% according to the FAA data, and 1.7% according to the data of the Directorate of General Civil Aviation Türkiye (Lutte, 2019; Lutte, 2021; Directorate of General Civil Aviation, 2018). There are professional and cultural reasons behind this inadequacy. The ratio of women employees is at least in maintenance technicians. The five biggest barriers to women working in aviation are; negative culture, cost of entry, family/life/work balance, training-related issues and lack of support (Lutte & Morrison, 2022). Apart from these, prejudice, discrimination in the workplace, low employment of women in leadership positions, and insufficient support for young people are also barriers for women to work in aviation (Lutte, Women in Aviation: A Workforce Report 2021 Edition., 2021). Furthermore, the data indicates that women in the industry are significantly more likely to have both a lower guaranteed income and a lower gross monthly income than men, which further contributes to gender disparities in employment and retention (Harvey, Finniear, & Greedharry, 2019). Some of the barriers affecting women students' participation in vocational education and training were social-cultural factors, lack of role models and poverty (Andiema & Manasi, 2021). Apart from these reasons, the perception of maintenance technician as a job that requires intense physical strength, inadequacies in employment policies, and incomplete or inadequate promotions about the profession can be listed.

In order to increase the number of women maintenance technicians, it will be necessary to increase the number of women students in universities and training programs providing training in this field. Furthermore, international regulatory bodies also emphasize inclusive training and licensing standards. As stated in the ICAO Assembly Resolutions in Force (2016), ICAO's policies on personnel licensing and training provide a foundational framework for inclusive approaches that can facilitate women's entry into aviation professions. Equal opportunities in education should be integrated into ICAO's international standards (ICAO, 2016). In this way, the employment of women technicians will be increased and at the same time, women technicians will be provided to work more competently. As the results of the study show, the average rate of women students studying in departments providing aircraft maintenance training in Türkiye is 12.65% in Aircraft Technology departments, 10.86% in Aircraft Maintenance and Repair/Airframe and Powerplant Maintenance departments, and 21.75% in Aviation Electric and Electronics/Avionics departments. Although the number of women students has increased over the years, it is still very insufficient in training programs. The insufficient number of women students means that the number of women employees will be insufficient in the coming years. Considering the increasing number of flights, the number of aircraft and the number of airports, this situation will create a big problem for the future of aviation in terms of the number of employees and their competencies in the short and long term. In order to eliminate the problems related to the subject and to increase the interest and participation of women students in the universities and training programs that provide aircraft maintenance training, solution suggestions are listed as follows.

- To increase interest in aircraft maintenance departments, promotions are made by more effective and appropriate persons/units,
- Developing industry-supported collaborations and incentive programs,
- Extending career days in pre-university education institutions,
- Establishing an effective alumni/student interaction network,
- Encouraging employment programs for women employees,
- Increasing the number of women trainers in aviation maintenance training,
- Developing incentive programs such as scholarships and educational aid for women students,
- Developing aircraft maintenance areas to be more open to students within safety and security standards.

To promote gender diversity in aircraft maintenance, upcoming research should adopt a comprehensive strategy that includes cross-cultural analyses to identify globally best practices, as well as longitudinal studies of educational programs to assess the retention and career advancement of women students. Research should assess the impact of women role models, mentoring programs, and employer policies (such as flexible working options and anti-discrimination strategies) on recruitment and retention, while also examining societal perceptions and misconceptions that deter women from pursuing careers in this industry. Additionally, research could examine the effectiveness of financial incentives (such as scholarships and job guarantees) and technological innovations (such as automation and ergonomic equipment) in mitigating perceived barriers. Further research on the implementation of ICAO's inclusive education standards and early STEM education initiatives is necessary to challenge stereotypes and foster sustained interest. Finally, policy evaluations should investigate how regulatory frameworks (including gender quotas and diversity programs) affect workforce representation. Future studies emphasizing actionable outcomes such as data-driven hiring methods, industry collaborations, and advocacy for systemic reform can contribute to the closing of the gender gap and provide a sustainable and inclusive future for the aviation maintenance field.

## **ETHICAL STATEMENT & GENERAL STATEMENTS**

This paper meets the standards of research and publication ethics.

## **AUTHORS' CONTRIBUTIONS**

Idea/Concept: T. Güneş, S. Kale and B. Açıkel; Design: S. Kale and T. Güneş; Data Collection/Processing: S. Kale and B. Açıkel; Analysis/Interpretation: S. Kale, T. Güneş and B. Açıkel. All authors have read and approved the final manuscript.

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## AVAILABILITY OF DATA AND MATERIALS

Not applicable.

## COMPETING INTERESTS

The authors declare that they have no competing interests.

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