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Development of an aviation aerospace mechatronics technician curriculum

Project Result 2

Collection of all reports finalised by partners and presented to readers in their integral form

Co-funded by the European Union

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Country snapshot and capacity gap assessment

COUNTRY: EU LEVEL

DATE: 20/05/2022

Co-funded by the European Union

1. Summary

The industry of unmanned aircraft (aka *drones*) is expected to represent a powerhouse for the employability, innovation and development of the EU aeronautics industry.

Industrial application of drones benefits a wide cohort of sectors (agriculture, energy, public safety, e-commerce, mobility, etc), with significant spill-over effects for entrepreneurs operating within these markets.

Despite the great technology advancements observed in the timeframe of the past ten years, further R&D efforts are needed to enhance the value that the drone industry can generate for end users. Most of potential industrial applications are still in an early stage of experimentation, with public opinion still divided on concerns for privacy and safety.

The work of regulators is aimed at easing the social acceptance of this new phenomenon, without posing excessive burden to the innovation paths traced by the many new organisations operating in the unmanned aircraft sector.

Competitive outlooks for businesses in the drone industry are bright and very promising, but on the other hand the sector might risk of reaming devoid of professional profiles that allow for the great technological effectiveness of this new state of art technology.

The analysis carried out in this report is aimed at assessing in a concise and comprehensive format the training needs informing the design, structure and following learning outcomes of the curriculum for aerospace mechatronics technicians.

The references extrapolated from literature are somehow indicative of what this curriculum should look like at VET level, what could be the knowledge and skills detained by such professional profile, etc. but most of the effort was invested into interpreting and decoding data so as to mold an archetype that is still in the making.

Data and resources collected allowed us to systemize an ideal curricula framework for drone maintenance-related operations that could fit indeed the professional profile seek by this project, and the needs of training and education providers.

The outline of this theoretical framework for education and training provided by IHF is divided into three training areas that, based on our assessment, are intrinsically related to the Human Factor of unmanned vehicles, hence strategically relevant for capacity building experiences: know-how of hardware, understanding of software, attitude to multifunctionality.

2. The aviation industry at EU level

General description:
- *Quantitative and qualitative indicators on job market dynamics in the aviation industry in your country*
- *Number of companies, number of workplaces*
- *Trend and dynamics of the aviation industry (foresight studies, papers, national/regional strategies)*

The European aviation industry is world leader in the development and manufacture of civil and military aircrafts, aero-engines, parts, and components. This includes helicopters, drones and other systems and equipment too, and, in broader terms, also the provision of support services such as maintenance and specific trainings due to consistent presence of specialised companies.

The backbone of the industry is represented by its civil branch as it represents half of the annual turnover, thus generating innovation and, therefore, high-skilled jobs.

Civil aeronautics is, indeed, one of the most successful EU's high-tech sectors, providing 405,000 jobs and generating EUR 130 bln of revenues. To this concern, it plays a preeminent role in exports, that in 2019 amounted to EUR 109 bln of revenues.

However, due to the heavy drop in air travels that originated from the Covid-19 pandemics, the whole aeronautics supply chain has been severely impacted, resulting in a one-third cut of the aircraft production rates.

The industry's competitiveness, as per most of other highly impactful industries in terms of raw materials usage and carbon emissions, strongly relates on its capacity to generate innovation to pursue the prime intent of delivering ever safer and greener products.

Global aviation itself, accounts approximately for 2.1% of the global carbon dioxide emissions[1]. To reduce such pollution, it is then crucial to tackle the problem at its foundations. This means that the very production of aircrafts and related products must be structurally and dramatically changed.

Such awareness was already clear in 2011 as in the "Flightpath 2050 - Europe's vision for Aviation" report was pointed out that research and technology developments for clean aviation should be further accelerated to effectively allow, by 2050, 75% reduction in carbon dioxide emissions per passenger kilometre, in comparison to the capabilities of typical aircraft of 2000. [2]

To this aim, considerable share of the industry's revenues is spent on research and development, with a 2019 total estimate of almost EUR 8 bln by both industry and governments.

[1] https://op.europa.eu/en/publication-detail/-/publication/85e03336-0e99-11eb-bc07-01aa75ed71a1/language-en/format-PDF/source-search

[2] https://www.acare4europe.org/sites/acare4europe.org/files/document/Flightpath2050_Final.pdf

The composition and geographical distribution of the industry's enterprises is characterised by a concentration of the largest firms in few Member States, particularly in Italy, France, Germany and Spain, and by an extended supply chain composed of very dynamic SMEs spread-out all over EU, with some of them being world leaders in their specific sub-sector.

According to the International Civic Aviaton Organisation (ICAO)[3], with 2.7 trillion US dollars, aviation represented in 2017 the 3.5 per cent of the worldwide GDP and was creating at that moment 65 million jobs globally.[4]

Switching now our focus on the drone market, by looking at the graph (Figure 1) it is quite evident to note that growth projection in 2018 (as the elaboration dates to that year) were consistently huge for the commercial sector in the following 4 years (so till today); whereas the same trend forecasts were significantly smaller for the military sector, but still growing, and totally opposite when it came to forecast the growth trend of the hobby-related drone industry.

The Covid-19 pandemic altered those projections, as the hobby sector has not been subject to such a decreasing trend; but as the general awareness of the drones' usefulness in many important sectors, and not just as a mere hobby, has seen a consistent increase over the very last years, it is fair to assume that the figure of a drone technician it will ever more needed.

[3]ICAO was funded in 1944 as a result of the Chicago Convention on International Civic Aviation, drafted on the same year by 54 nation, and was established to promote cooperation and "create and preserve friendship and understanding among the nations and peoples of the world."

[4]https://www.icao.int/Meetings/FutureOfAviation/Pages/default.asp

3. Opportunities

Training curricula, training courses available, existing formal and non-formal learning opportunities

Already in 2008, the EU Aviation Safety Agency (EASA) had provided specific guidelines to be followed for the implementation of aircraft maintenance courses under the "Aircraft Maintenance License: AML "Part-66" – general course".[5]

More recently, the Drone Leaders' Group[6], after four plenary meetings held in the past months, delivered a final report on the 26th of April, setting out a high-level vision to be pursued through an ambitious pathway to make the EU a global leader in drones[7].

The Group recommended the implementation of "education and training programmes" that will be crucial for the advancement of the knowledge and general skills concerning drone technologies, regulatory frameworks and integration to Sustainable Urban Mobility Plans (SUMPs) activities in all Member States – as prompted since 2013 by the EU Commission[8].

Academic programmes across Europe that, in addition to fostering the competences and technological progress, would also increase the broader public awareness, facilitating the general acceptance of drone's utility.

Based on our literature assessment the only training present in the EU territory that specifically address our research focus is the following one provided by the Belgian VET centre SyntraPXL: a 2-years professional training on "Drone maintenance and construction technician"[9] delivered in their Gent campus that allows the student to acquire and improve skills and capabilities in theorical and practical:

- drone maintenance, on a consistent manifold level as it deals with frame, engines, ESC (electronic speed control), and propulsion maintenance;
- drone building: remote control knowledge, flight controller, drone adjustments, batteries, assemble, fly and adjust, homologation procedures;
- groundstations and ground control: transmitters and protocols, key features, LRS links, MAVLINK, types of GUI Software, hardware;
- autopilot, flight controller and the different hardware and software that enable the implementation of such feature;
- remote ID sensors and accessories, drone positioning ADS-B;
- European drone legislation;

[5]www.easa.europa.eu/sites/default/files/dfu/approvals-and-standardisation-docs-syllabi-Syllabus_Part66_General_081028.pdf

[6]a stakeholder union that brings together individuals from 26 organisations and trade associations, including drone manufacturers and operators, U-space airspace service providers, manned aviation, national aviation authorities, UIC, the European Parliament and European partner organisations in the ATM field (EASA, SESAR JU, EUROCONTROL, EDA)

[7]https://transport.ec.europa.eu/news/drone-leaders-group-supports-preparation-drone-strategy-20-2022-05-02_en

[8]https://eur-lex.europa.eu/resource.html?uri=cellar:82155e82-67ca-11e3-a7e4-01aa75ed71a1.0011.02/DOC_3&format=PDF

[9]https://www.syntra-limburg.be/opleidingen/drone-onderhouds-en-bouwtechnicus

- applied business management.

On the other hand, going back to Drone Leaders' Group recommendation for academic training curricula, findings show that within the EU higher education landscape it is not possible to apply to specific training curricula for drone technicians. The proposed academic programmes are, therefore, yet to be implemented in EU countries.

However, the most relatable curricula resulting from our findings have been found within Spanish universities' Master of Science curricula.

Namely, a "Master of Science in Remotely Piloted Aircraft Systems" jointly provided by the Spanish University of Huelva and the Escuela Tecnica Superior de Ingenieria with the sponsorship of the Spanish Ministry of Defense; and a "Master's Degree in Unmanned Aerial Systems" that is provided by the University of Santiago de Compostela.
None of the two, if considered in their overall focus, are of particular interest for the aim of the project. However, if considered for specific operational modules that they embed, such as, for instance, "Operations and maintenance of civil and military RPAS".

Finally, broadening our sight and casting a glance at the existing international curricula, very relevant findings are those coming from India.

In 2021, the Ministry of Skill Development and Entrepreneurship through its Directorate General of Education, has developed 6-months "Drone technician" Craftsmen Training Scheme (CTS): a specific curriculum that trains the candidates to:

- "perform troubleshooting and maintenance tasks on unmanned aerial vehicles. Test different electronic components, circuits, boards used in Drone to find the faulty part by using instruments like digital storage oscilloscope, mixed signal oscilloscope, spectrum analyzer, waveform generator and multimeter. Replace the faulty board and components and perform basic /SMD soldering/de-soldering".
- "disassemble and assemble different parts of drone for testing and repair. Understand different batteries used for power supply of drone, their specifications and testing. Application and testing of different sensors used in drone. Testing of different motors BLDC etc, Electronic Speed Controller card and it's connectivity with motor. Testing of flight controller and the communication between transmitter and receiver and its calibration".
- "testing of landing gear, GPS Module, collision avoidance sensor and it's connectivity with console. Testing of transmitter, the control box to receiver at drone and the communication link. Testing of Gimbal Motor, Controller rand its programming.
  The individual in this job identifies different applications in agriculture, surveillance, security and to test the additional specific application-based components to connect with drone"[10].

Shifting our attention to the American continent, relevant hints can be found within the three-days "Drone Technician Course" provided by a private Canadian

[10] https://dgt.gov.in/sites/default/files/DRONE%20_TECHNICIAN%20_NSQF%20_LEVEL_4.pdf

VET centre[11]. This full-immersive course gives the attendee a broad and general, thus immediately operative, hands-on training on fixed-wing, multi-rotor and quadcopter drones.

[11] https://canadadroneaerospacecentre.com/drone-technician-course/

4. Needs: capacity gap assessment

Findings of the primary assessment of your country (What are the most sought-after skills in the aviation/drone sector in your country)

Thanks to the contribution of our German partner Centrum fur Innovation und Technologie (CIT), it is possible to highlight the most sought-after skills of a mechatronic technician, a figure that embodies the broader features of what a drone technician would be, as prompted by a relevant public authority in the VET field such as the German "Federal Institute for Vocational Education and Training".

CIT has indeed brought to our attention the "Ordinance on Vocational Education and Training in the Occupation of Mechatronics Fitter"[12], a document listing all the requisites and features that must be addressed by a training course aimed at developing the professional figure of a "mechatronic technician".

Similar inputs cannot be found on a general European level, as no EU institutions provided equivalent instructions.

Nonetheless, on the European Skills, Competencies, Qualifications and Outpus (ESCO) portal, under Skills & Competences' section it is possible to find the "Aviation standard and recommended practices" description that is the following:

> "Use mathematical tools and electronic equipment for managing activities with the vehicles and customers and performing routine operations that deal with numeracy and calculations".

This highlight is of dramatic relevance for the aim of the project, as the development of the drone technician figure cannot neglect the inputs of the most important EU institution with regard to professional framing.

The existing standards for the drone's regulation are relatively very broad when it comes to education and training. The best description that we found is available under appendix A, Article 11, *The personnel in charge of duties essential to the UAS operation*:

- A.1 Training and qualifications for the personnel in charge of duties essential to the UAS operation
  - A.1.1 The UAS operator should ensure that all the personnel in charge of duties essential to the UAS operation (i.e. any people involved in the operation) are provided with competency-based theoretical and practical training specific to their duties that consists of the following elements:
    - A.1.1.2 The basic competencies from the competency framework that are necessary for staff to be adequate for the operation, to ensure safe flight, are as follows:
    - A.1.1.2.1 the UAS regulation,
    - A.1.1.2.2 UAS airspace operating principles,
    - A.1.1.2.3 airmanship and aviation safety,

[12]https://www.govet.international/dokumente/pdf/5_govet_mechatroniker_ausbildungsrahmenplan_en.pf

- A.1.1.2.4 human performance limitations,
- A.1.1.2.5 meteorology,
- A.1.1.2.6 navigation/charts,
- A.1.1.2.7 UA knowledge,
- A.1.1.2.8 operating procedures,
- A.1.1.2.9 assignment of tasks to the crew,
- A.1.1.2.10 establishment of step-by-step communications,
- A.1.1.2.11 coordination and handover.

5. Challenges

As the specific curricula has yet to be developed in the EU, the prime challenge that stems from our assessment is therefore represented by the definition of such a training path.

To this concern, useful indications might be found merging the most relevant information from the Drone Leader's Group recommendation with the most essential and replicable features of both the Indian and the Canadian curricula that have been presented in the previous "Opportunities" section of the report.

Moreover, benefiting from the indications of an external consultant would be of terrific help in designing a training path that perfectly aligns the ESCO "Aviation standard and recommended practices" with the requisites and features of a mechatronic technician – as highlighted in the German "Ordinance on Vocational Education and Training in the Occupation of Mechatronics Fitter".

So to speak, the main challenges relates to the very same challenge of performing a needs-assessment at transnational level among reference that are either highly-fragmented – and not fully consistent to the scope and scale of this research – or non-existent.

Throughout this analysis of literature references, we stumbled across several (highly fragmented) sources each of which providing for a snapshot of the set of skills and knowledge that drone technicians should develop and master for the correct execution of their profession, and most importantly, for further employability potentials in such a fast-evolving industry.

The specific taxonomy depends from source to source of course, but there is still a substrate / common denominator that seems very recurrent. These needs seem to match somehow the references provided by EASA' standards, and fine-tuned based on the specific industrial applications of the UAV (surveillance, agriculture, logistics, defence, etc.) and the associated technical features.

Each segment of application has its own tech specifications (i.e., power, flight speed, carrying capacity, lifespan or operation battery, and other needs depending on the drone type, whether self-flying or piloted). On top of that, are to be considered the implications that come for training and educations from regulatory constraints and the overall trajectory of EU and National legislations.

6. Conclusions and remarks

As we mentioned already, the standardization of a curricula for mechatronics technicians is relatively complex due to the heterogeneity that there is in the many fields, of application, the divergence that there is between each of the considered segment, and the technology-driven requirements from sector to sector.

Based on our assessment, resources available are still very much oriented on attitudes, skills and knowledge of pilots. Nonetheless, the reliability of the entire system that comprises the vehicle, the ground station, and communication equipment is intrinsically related to a Human Factor of which mechatronics technicians certainly belongs to.

Evidences and findings suggest that this Human Factor can be break-down into three elements, and related sub-threads:

1. Hardware
    a. Logistics and handling of typically extremely fragile components
    b. Assembly of electrical systems and safe storage of raw materials
    c. Robust, specialised and reliable knowledge of vehicle-specific elements and distinctive features
    d. Battery maintenance, and compliance with charging / discharging cycles and safety procedures
    e. Knowledge of composite material, and knowledge of the specific equipment needed to handle hazardous materials
    f. Precise understanding of vehicle payload under environmental pressures and under eventual disruptions
    g. Waste management and waste reuse
    h. Insourcing of ordinary maintenance procedure for greater cost-effectiveness
    i. Crisis / failure management
    j. Data management of flight history and recording of trends
    k. Data management of maintenance history of single components
    l. Safe handling of fuels and other hazardous raw materials
    m. Basic understanding of alternative propulsion systems
2. Software/documentation
    a. Software management
    b. Monitoring and evaluation of vehicle performance
    c. Quick thinking on anomalous / out-of-ordinary conditions
    d. Data gathering / data storage / data management (and high quality of information)
3. Personnel
    a. Sensory and experience-based know how of vehicle performance
    b. Mutliskill-compliant attitude (i.e., combining knowledge of electric, mechanical and software engineering)
    c. In-depth understanding of the engineering features of the vehicle

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Development of an aviation aerospace mechatronics technician curriculum

Country snapshot and capacity gap assessment

COUNTRY: GERMANY

DATE: 23/10/22

Co-funded by the European Union

1. Summary

The German aerospace industry has enjoyed unprecedented success over the last two decades. Since the mid-90's, industry revenues have more than quadrupled - to over EUR 40 billion in 2018. Today, the sector belongs to the country's most innovative and best-performing industries.

Industry analysts forecast that between 30 to 35 thousand new aircraft will be put into service in the next 20 years to meet increasing global aviation demand – leading to a new golden age of aviation. With increasing demand for air travel and rising passenger counts, the industry is witnessing a sudden upsurge in disruptive technologies from companies willing to grab the market through innovation in services and customer experience. One of the innovations driving the aviation industry is 'Electrification'. As per industry experts Electrical power and propulsion systems will lead the way for Advanced Air Mobility (AAM), enabling silent short and vertical take-off and landing capabilities while lowering emissions and reducing fuel consumption (Rolls Royce, 2022). Alongside electrification, new materials and composites – as well as changes to overall aircraft design (e.g. retrofit with winglets) – are helping increase fuel efficiency levels through reduced weight and improved aerodynamics.

From smart manufacturing ("INDUSTRIE 4.0") to the airline planning cycle revolution and the dawn of in-flight connectivity – the digital revolution is having a significant effect on the aerospace industry. IT solutions will penetrate all aspects of airline production and operation (including maintenance and engineering, ground, and in-flight operations). In addition to that ongoing technological specialisation leads to the outsourcing of systems - such as avionic electronics - and the design and production of aircraft structures.

With all these industry transformations, it is evident that the workforce of tomorrow that designs, manufactures, operates, maintains and services these systems/platforms will require new skills. Since technology and industry standards evolve so rapidly, manufacturers themselves need to help shape and educate the next generation of workers. With interest in the trades still lagging, aerospace companies need to leverage public interest in space and drive enrollment in vocational studies. Interest in aerospace manufacturing could overflow into other sectors, with skills translating directly to other trades. Aerospace manufacturers could help end the labour shortage that has impacted the industrial sector for more than a decade.

Manufacturers' involvement in vocational training already takes many shapes, but there are unlimited ways to support education in the trades. The most direct way is building relationships with the local trade, vocational, and technical schools, especially ones offering programs relevant to the manufacturers' industry or needs. Also involvement of government and educational institutions cannot be ruled out as their participation in providing resources and funds would be detrimental to the success of such a program.

2. The aviation industry in Germany

General description:

- *Quantitative and qualitative indicators on job market dynamics in the aviation industry in your country*
- *Number of companies, number of workplaces*
- *Trend and dynamics of the aviation industry (foresight studies, papers, national/regional strategies)*

As a global aerospace hub, Germany is home to leading players from all civil and defence aviation market segments.

The country's world class R&D infrastructure and a powerful manufacturing base empowers international investors to develop cutting-edge technologies for tomorrow's aviation needs. Compared with other major aviation manufacturing countries like the US, Canada and France, Germany's rare mix of a powerful manufacturing base, ready availability of talent, and cost efficiency are unique competitive advantages for current and prospective investors (Müller, Dr. R, 2022).

The market trends predict that with an ever increasing demand for air travel the volume of passengers and the subsequent need for new aircrafts is only going to increase. Over the next 20 years, forecasts predict demand for between 30 to 35 thousand new civil aircraft worldwide - worth more than USD 5 trillion. As one of the country's most innovative and best-performing industries, aerospace engineering in Germany employs over a hundred thousand professionals. The German Aerospace Center (DLR) alone has over 8,000 employees at 20 locations in the country. An early career in this field, with 1 to 4 years of work experience, is estimated to earn an average annual recompense of around €50,000 (McClements. D, 2019). Some of the major players and job creators in the markets are:

1. Airbus

   Airbus has proven itself to be one of the global leaders in the aerospace industry. The company designs products and develops commercial and military aircraft, helicopters, and satellites. It is considered to be the 2nd-largest space company and has successfully delivered more than 10,900 aircraft and 12,000 helicopters worldwide.

   Airbus was established in the 1960s and now has over 30,000 patents. In Germany, the company has around 46,000 employees in 27 sites. Job opportunities for aerospace engineers are varied. Some interesting roles for aerospace engineering in Germany are Cyber Security Architect - Space, Cockpit Operations & Functions Engineer, and Stress Engineer.

2. Collins Aerospace

Collins Aerospace is one of the leading suppliers of aerospace and defence products in the world. To date, Collins Aerospace has over 70,000 employees in 300 sites worldwide.

The company has been operating in Germany for over 50 years, supplying customised complex electronics for a variety of high profile military aircraft programs. It is also considered to be one of the leaders in space wheel technology. Professionals of aerospace engineering can land roles such as Aerospace Thermal Fluid Engineer, Director for Advanced Materials and Processing, and Manufacturing Engineering Director.

3. Diehl Aviation

Diehl Aviation is an international supplier of Cabin Integration and Avionics. It's a division of the Diehl Group. Some of its products and services offered include fire prevention, lavatories, (aircraft cabin) monuments, air-conditioning, sanitary solutions for aircraft, water supply, and comprehensive retrofit solutions. The company is currently working with well-known aircraft manufacturers including Airbus, Boeing, Bombardier, Tiger, Eurofighter, and Gulfstream.

The company has been in operation for over 60 years and now has 17 locations in the world with over 5,400 employees. The company is also compliant with quality and safety management systems including AQAP 2110, CAAC, ISO 50001, ISO 14001, DE AEOF, and EN 9100.

4. German Aerospace Center (DLR)

The German Aerospace Center (DLR) is the national research center of the Federal Republic of Germany for aeronautics and space. The organization conducts extensive research and development work, particularly in space, energy, aeronautics, transport, security, and digitalization where findings are integrated into cooperative ventures nationally and globally.

Its research portfolio ranges from fundamental research to product development. The organization operates major research facilities for its own projects and for those of partners and clients too. Professionals of aerospace engineering in Germany can land roles such as Ground Operations Engineer, L2 Maintenance Engineer or Spacecraft Operations Engineer.

5. Liebherr Aerospace

Liebherr Aerospace is a manufacturer of aerospace equipment in Lindenberg, Germany. It is a division of the Liebherr Group that develops, manufactures and provides services in aircraft flight control and actuation systems, onboard electronics, air management systems, and landing gears.

The Group was founded in 1949 and now has more than 130 companies, 40 of which are manufacturers. Jobs roles for aerospace engineers include positions such as Safety Engineer, Project Coordinator, and Principal Engineer.

6. MBDA

MBDA is a developer and manufacturer of missiles in Europe. It is a global defense company that has locations in Spain, France, Italy, the United Kingdom, Germany, and the United States. The company was created in 2001 as a merger of the main missile system companies in the United Kingdom, Italy, and France. Currently, the company has more than 11,000 employees in 6 countries.

Among the services offered by MBDA Germany is the design, development, production, and maintenance of guided missile systems, components, and subsystems for the navy, army, and the air force. Professionals of aerospace engineering in Germany can apply for job roles such as Development Engineer: Structural Mechanics, Patent Engineer for Intellectual Property, Aerospace Engineer for Structural Mechanics.

7. MT Aerospace AG

MT Aerospace AG is a producer of various aerospace components. It started its operations in the middle of the 1960s and continues to produce high-quality products for space, aeronautics, and the mechatronics sector. Several of its notable products are advanced structural components, optical and radio telescopes, as well as aircraft equipment and deep-space antennas.

Currently, the company has 800 employees that develop and produce new products for its various sectors. For aerospace engineers in Germany, some exciting roles are Calculation Engineer for Additive Manufacturing, C/C++ Control Systems Engineer and Programmer, and Guidance, Navigation, and Control Engineer.

8. OHB SE

OHB SE is a multinational technology corporation in Europe that is first listed as a space and technology company. It consists of two business units, namely Aerospace and Industrial Products, and Space Systems. Some of the services that the group offers are satellite operations, launch services, logistics solutions, railway process control systems, and AIS for global maritime traffic.

The group has over 37 years of experience in high-level technology and has over 2,700 employees. Job roles for aerospace engineers in OHB SE include Electrical GSE Engineer - Operations, Security Systems Engineer, and Structure Analysis Engineer.

9. PFW Aerospace GmbH

PFW Aerospace GmbH is a producer of pipe systems, structural components, and fuel tanks in Germany. The

company is positioning itself as a global leader in tubing systems for aircraft. Its core competencies include state-of-the-art technology, product development, build to print, and prompt support.

It has been in operation for over 100 years and currently employs around 1,800 professionals. The company has 3 locations worldwide including operations in Germany, Great Britain, and Turkey. Aerospace engineers can find jobs in the company's research, development, and manufacturing areas.

10. Telespazio VEGA Deutschland

Telespazio VEGA Germany is an aerospace company in Germany that provides solutions and services for IT, and engineering for space travel, aviation, defense and security, and telecommunications. It offers services such as satellite operations, systems engineering, software solutions, modeling and simulation, ICT solutions, and mobile satellite services.

The company has been in operation for over 40 years and now has 350 highly skilled professionals. Professionals who are looking for jobs in the aerospace engineering field can take up jobs as GAIA Spacecraft Operations Engineer or Galileo Operations Service Engineer.

The companies working in German Aerospace industry can be broadly classified as OEMs (Original Equipment Manufacturers) and Suppliers (Tier 1 thru 3). A recent Supply Chain Excellence study done by the Federal Ministry for Economic Affairs and Energy (Bundesministirum für Wirtschaft und Enrgie) provides an overview of the German aerospace supplier industry with the aim of determining steps for improving their competitive capabilities. The study primarily classifies the companies working in the aviation industry in the following categories:

- OEM: Companies with approval to manufacture a particular type of aircraft are considered OEMs.
- Tier 1 / System manufacturers: System manufacturers are responsible for development and manufacturing technically complex systems and are also required to adhere to aviation regulations.
- Tier 2 / Component manufacturers: Component manufacturers construct component groups ready for installation by system manufacturers or OEMs. They are responsible for the manufacturing process, but not necessarily for component development.
- Tier 3 / Parts manufacturers: Parts manufacturers produce parts or components according to the specifications of the component manufacturer (“extended workbench”). These manufacturers have little or no aviation regulations responsibility, but are usually certified to aviation standards.
- Multi-Tier: Multi-tier manufacturers supply materials, normal parts or equipment to all levels of the supply chain. This also includes personnel services.

Figure 1 shows the concentration of aerospace companies by size.

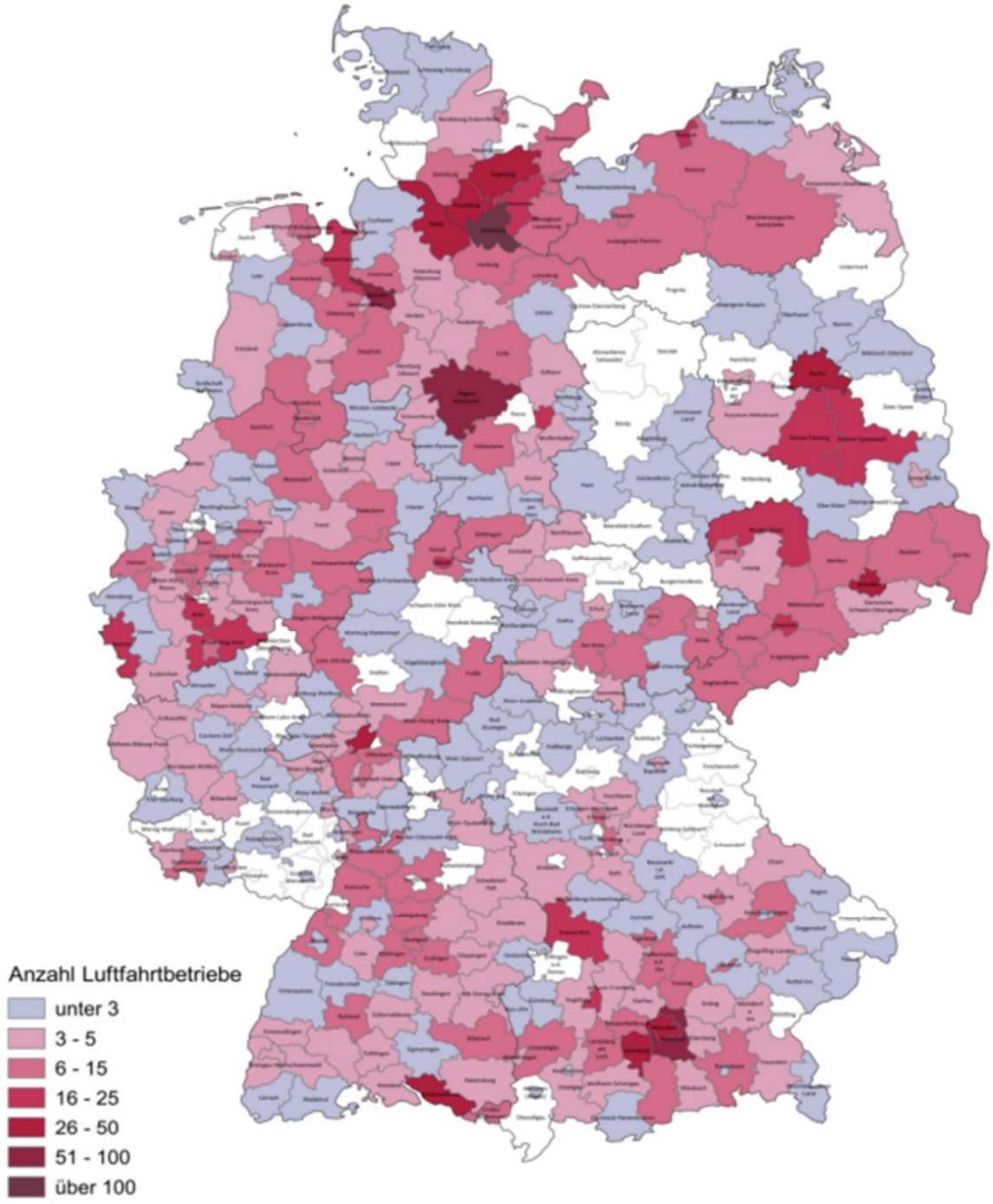

Figure1: : Regional distribution of aerospace supply companies in Germany (Source: SCE Initiative)

In addition to that there is a growing drone market that is opening up a new industry altogether. In Germany, there are a little over 500,000 drones in operation. Drones used for personal purposes outnumber those used for business purposes by a ratio of 24.

Private owners of drones number about 455,000. Nearly a third of this amount is made up of toy drones with a price tag of up to 300 euros. The remaining two thirds of drones that are used privately are so-called prosumer drones, which have tiny cameras and are utilised by their owners for various purposes, including taking pictures while on vacation.

At 19,000, the number of drones employed for business purposes is substantially less. The majority of these drones, which may cost up to 10,000 euros, are prosumer drones with cameras. Less than 5% of drones used for business purposes are larger, more expensive professional drones.

Professional users often use their drones for multiple commercial purposes: a drone that supplies images for film and

television productions is also used for aerial photography as part of the project management of a construction site. Due to the relatively low margins on the surveying business, surveying is one of the leading applications. Drones contribute to time savings, increased output, and improved quality. Without the use of drones, inspection and mapping duties are also labor-intensive, time-consuming, and occasionally dangerous. Drones are being utilised more frequently to assess structures and infrastructure, including wind farms and high-voltage power cables. The maturity levels of the individual applications vary greatly. How use will evolve depends on technical developments, legislation (e.g., enabling flights out of visual range), infrastructure and, last but not least, public acceptance. Fig 2 shows the response from a survey indicating applications where drones are mostly widely used in Germany.

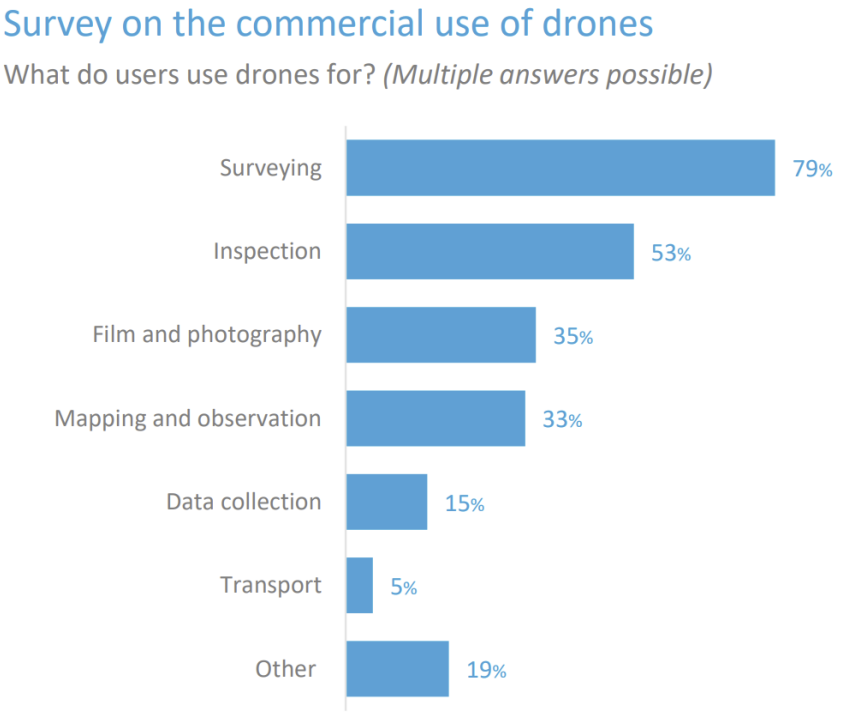

Fig 2 : Survey of Commercial Drone usage in Germany (Source: Verband Unbemannte Luftfahrt, 2019)

The nearly 400 businesses in Germany that deal with unmanned aviation or air taxis as their primary business are not evenly spread; many drone businesses are located in the south and west of the country. Fig 3 shows the regions where these companies operate from. Most of which are located in the southern state of Bavaria. Bavaria is the source of every fifth firm. Additionally, there are a sizable number of businesses in this industry in the sizable states of Hesse, Baden-Württemberg, and North Rhine-Westphalia.

The two businesses that are pioneering the development of air taxi technology in Germany are located in the southern portion of the nation: Lilium in Weßling (Bavaria) and Volocopter in Bruchsal (Baden-Württemberg).

Additionally, there are more drone businesses than usual in Hamburg, one of the world's largest aerospace industry hubs, and Berlin, which is known for its vibrant start-up scene and thus complements the emerging technology.

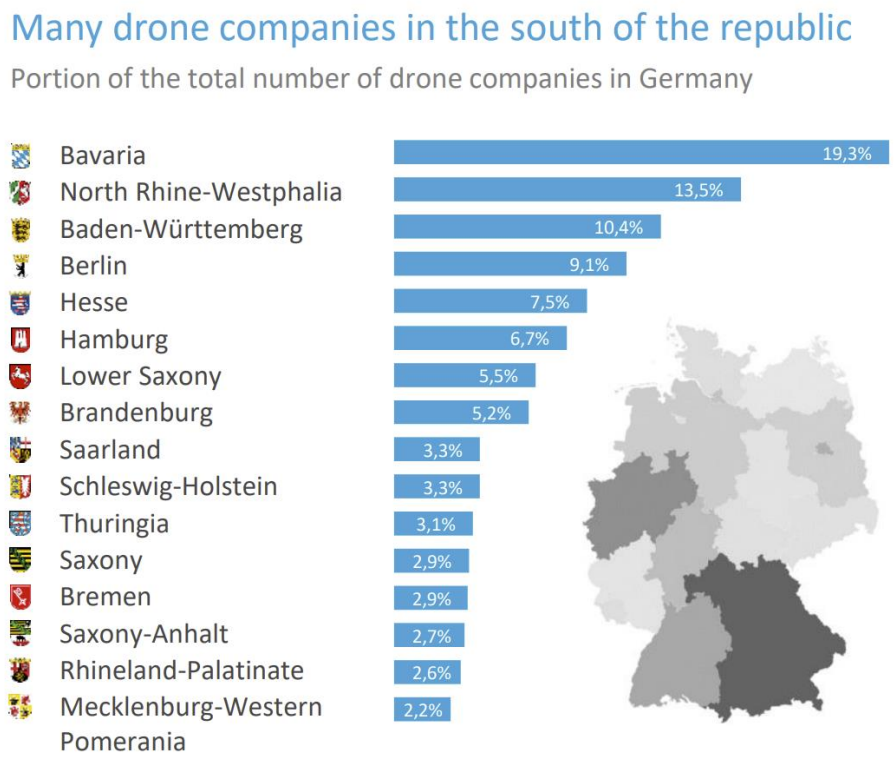

Fig 3 : Geographical distribution of drone startups and companies in Germany (Source: Verband Unbemannte Luftfahrt, 2019)

3. Opportunities

Training curricula, training courses available, existing formal and non-formal learning opportunities

In Germany training in Aerospace or engineering related subjects is provided according to the skill level required to perform a specific job. For a successful career in Engineering, a solid foundation as well as continuing education and training are significant. All engineering tasks require a combination of theoretical and practical approach. The necessary emphasis on theory and practice in differing groups of a company's technical staff can be found in fig. 2 from Hernaut (1993). The required education profile for semi-skilled, skilled workers ('Facharbeiter'), technicians ('Techniker'), engineering assistants, engineers ('Ingenieurs') and natural scientists. With that view, German government provides the following courses of study (Skyfuture, 2020):

- Bachelors
- Masters
- Diploma
- Vocational Training (State-certified Master, Technician, Specialist)

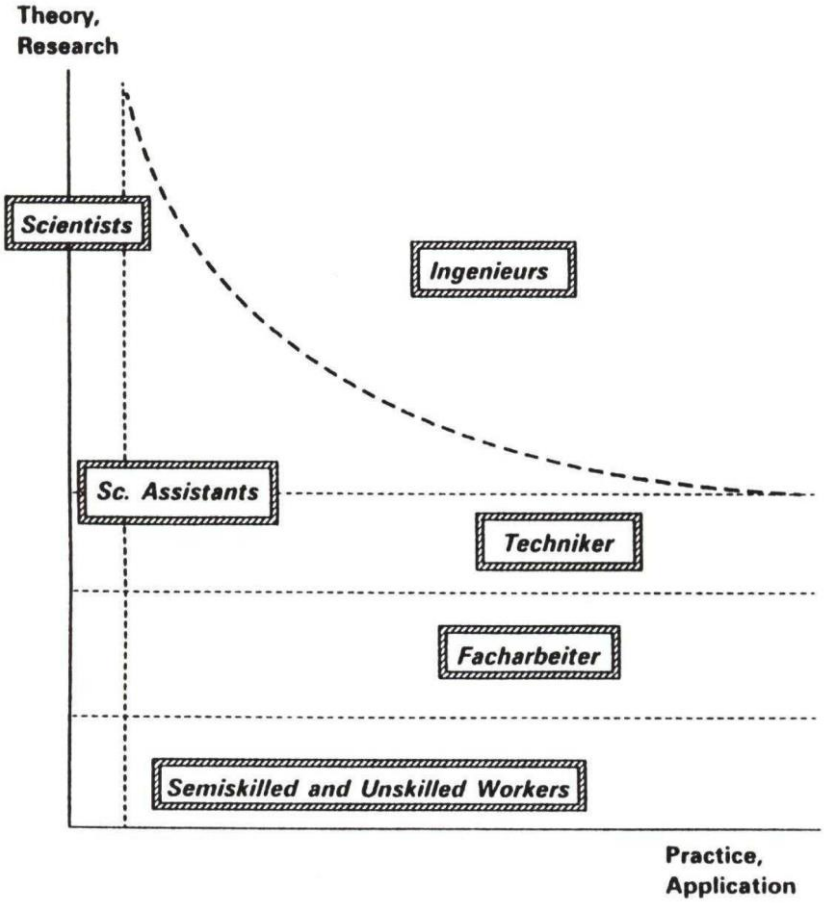

Fig 2 : Emphasis on theory and practice in engineering and scientific professions (Source: Hernaut, 1993)

The bachelors is the lowest academic degree and usually the first degree in a graduated course at a university or vocational academy. The standard period of study for this degree is three or four years, which varies from institution to institution and subject to subject. The degree is obtained by writing a bachelor's thesis and passing numerous semester-long exams for each course. A bachelor's degree is a basic qualification for entering the job.

Masters is the academic degree that follows an undergraduate (bachelor's) degree. The standard period of study for this degree is two to four semesters. The master's thesis is written at the end of the course. The master's degree qualifies for a job and entitles the candidate to do a doctorate, i.e. to strive for a doctorate.

The Diploma is an academic degree that can be obtained at academic and non-academic educational institutions. It is usually associated with the subject, for example, graduate biologist, graduate sociologist, etc. Diploma courses are divided into two phases: the two- to four-semester basic course, which is completed with the preliminary diploma, consisting of written and oral exams, and the three to six-semester main course, which is completed with oral or written exams. In addition, there is still a diploma thesis to be written.

In Germany, companies train their blue collar workers traditionally with vocational training programs. In German the term is 'Ausbildung', 'Berufsausbildung' or 'Duale Berufsausbildung'. An English synonym is 'apprenticeship'. Unlike in other states, a German Berufsausbildung is highly formalised. Curricula and exams are nationwide standardised for more than 350 professions. Participants learn as well at specialised vocational schools as in the employing company. These are programs where the trainees get paid during the study program itself. Some of these apprenticeships/training opportunities can be found below:

Apprenticeship electronics technician (Elektroniker/-in) for automation technology

Training tasks and activities
Electronics technicians specialising in automation technology are responsible for highly complex and computer-controlled industrial systems. To do this, they analyse the processes of automated systems and plants. Your area of responsibility includes configuring, installing, adjusting and assembling pneumatic, electric or hydraulic drive systems. The complex automation devices that are produced are maintained by electronics technicians in this field, and they fix possible errors and the causes of malfunctions.

Duration of training
3.5 years

Apprenticeship electronics technician (Elektroniker/-in) for industrial engineering

Training tasks and activities
Electronics technicians for operating technology install, maintain and repair electrical components for systems such as production, process or operating systems. In addition, the expansion and modernization or electrical upgrade of the systems falls within their area of responsibility. Furthermore, they plan the assembly of the plants and systems, monitor the work processes and hand over systems and devices to the future users and instruct them in their operation. Electronics technicians for industrial engineering analyze sources of error and rectify the causes in the event of a fault.

Duration of training
3.5 years

Apprenticeship electronics technician (Elektroniker/-in) for devices and systems

Tasks and activities of training
Electronics technicians for devices and systems work together with technicians and engineers to produce devices and systems for communication and information technology and for medical use. They are involved in the realization of orders by planning, controlling and monitoring production processes. The electronics technicians are responsible for procuring components and equipment, checking devices and components and analyzing sources of error in the event of technical problems. In addition, software creation, the installation of operating systems and networks, and the manufacture of hardware are also part of their area of responsibility. With the repair and maintenance of technical devices and systems, they contribute to quality assurance.

Duration of training
3.5 years

Apprenticeship electronics technician (Elektroniker/-in) for information and system technology

Tasks and activities of the training
Electronic technicians for information and systems technology are jointly responsible for the development and implementation of industrial information technology systems. These include, for example, information and communication systems, control elements or signaling and security systems. Electronics technicians for information and systems technology configure and install software and operating systems, but also assemble hardware components and electronic devices. In addition to installing security mechanisms, they are also responsible for analyzing and eliminating software and hardware errors through software adjustments or the replacement of defective components.

Duration of training
3.5 years

Apprenticeship electronics technician (Elektroniker/-in) for machines and drive technology

Training tasks and activities
Electronics technicians for machines and drive technology are responsible for the assembly of electrical machines and drive systems. In addition, the analysis of individual customer requirements and the design of the appropriate drive systems are part of her area of responsibility. They set up production machines, put them into operation and provide the materials required for production. In addition, the assembly of mechanical, pneumatic, hydraulic or electrical/electronic components is part of their area of responsibility. Electronics technicians for machines and drive technology put the developed machines and systems into operation, service them and maintain them. They also eliminate sources of error and causes of malfunctions.

Duration of training
3.5 years

Apprenticeship as an IT specialist (Fachinformatiker/-in) for application development

Training tasks and activities
IT specialists for application development design and program customer-specific software. To do this, they analyze and test existing applications, adapt them and plan new IT systems using software engineering methods. Furthermore, the area of responsibility of the IT specialist for application development includes advising and training users.

Duration of training
3 years

Apprenticeship as an IT specialist (Fachinformatiker/-in) for system integration

Tasks and activities of the training
IT specialists specializing in system integration plan, configure and implement customer-specific IT systems. They create complex systems from hardware and software elements according to the requirements of their customers. In

order to be able to advise customers professionally and up-to-date, one of the tasks of the IT specialist is to observe the market for IT technologies and systems. In addition to configuration, they are also responsible for instructing customers on how to use the systems, for problem analysis and troubleshooting, for the operation and administration of the IT systems.

Duration of training
3 years

Apprenticeship as a specialist (Fachkraft) in warehouse logistics

Tasks and activities of the training
specialists for warehouse logistics are responsible for incoming and outgoing goods as well as for logistical processes and planning. During the goods receipt process, the specialists accept the goods and check them with the help of the accompanying documents. During storage, they are responsible for planning the storage locations and maintaining optimal storage conditions. The activities within goods issue include packing, loading and dispatching the goods. Specialists in warehouse logistics optimize logistical processes and plan delivery routes. To procure the goods, they compare offers, create inquiries and are responsible for ordering and payment.

Duration of training
3 years

Apprenticeship as a precision mechanic (Feinwerkmechaniker/-in)

Tasks and activities of the training
Precision mechanics are responsible for the production of metallic components for precision mechanical devices and machines. The production takes place by means of cutting processes as well as forming, stamping or cutting techniques or by mold construction and device techniques. For the manufacture of the components, precision mechanics operate CNC-controlled machine tools, perform turning or milling work, but also manually. In addition to manufacturing, precision mechanics are also responsible for assembling the individual components and maintaining and repairing the precision mechanical devices.

Duration of training
3.5 years

Apprenticeship as production mechanic (Feinwerkmechaniker/-in)

Tasks and activities of the training
Production mechanics are responsible for the assembly of individual parts and assemblies into various products according to technical drawings and assembly plans. The provision of the necessary operating resources and materials is also part of their area of responsibility. In addition to assembly, she is also responsible for laying, fastening and connecting electrical cables. Production mechanics check the quality of the manufactured products and are responsible for maintenance and repair tasks.

Duration of training
3 years

Apprenticeship as an aircraft electronics technician (Fluggerätelektroniker/-in)

Training tasks and activities
Aircraft electronics technicians are responsible for installing, testing and measuring electronic and electrical systems and devices in aircraft. They are also responsible for setting up, commissioning and replacing these devices and systems. They lay and connect control, data and signal lines and analyze systematic errors in the control, measurement and regulation technology, correct them if necessary and replace defective components. With the appropriate authorization, aircraft electronics technicians can also carry out the technical approval of aircraft.

Duration of training
3.5 years

Apprenticeship as an aircraft mechanic (Fluggerätmechaniker/-in), specializing in production technology

Tasks and activities of training
Aircraft mechanics specializing in manufacturing engineering are involved in the manufacture of commercial and transport aircraft, military and sports aircraft and helicopters. They plan the work on and in the aircraft. Flight mechanics are responsible for the production of the components, assembling individual components and assembling them. They are also responsible for various assemblies within an aircraft: they carry out structural, upgrade, equipment and final assemblies. During assembly, they carry out functional measurements and functional tests and install system components such as hydraulic or electrical systems. Other tasks include inspecting and maintaining the aircraft, repairing damage or malfunctions and carrying out safety checks.

Duration of training
3.5 years

Apprenticeship as an aircraft mechanic (Fluggerätmechaniker/-in), specializing in maintenance technology

Tasks and activities of the training
Aircraft mechanics specializing in maintenance technology are responsible for the maintenance, inspection and functional control of commercial and transport aircraft, military and sports aircraft and helicopters. The aircraft mechanics carry out the functional and safety checks before each take-off and after each landing. They check the safety devices, evaluate the on-board computer, clean and examine the components for possible defects and wear. Defective components are replaced by them. In addition to the planned maintenance and inspection work, unexpected problems or defects also result in unplanned maintenance, during which you are responsible for the quick repair and installation of new components.

Duration of training
3.5 years

Apprenticeship as an aircraft mechanic (Fluggerätmechaniker/-in), specializing in engine technology

Training tasks and activities
Aircraft mechanics specializing in engine technology examine, test and maintain engines and aircraft engines. You are responsible for cleaning, maintaining and replacing defective or worn parts. Aircraft mechanics test functions, fix minor faults and carry out check checks during ongoing flight operations. The assembly and repair of components and the assembly of engines are also part of their area of responsibility.

Duration of training
3.5 years

Air traffic controller (Fluglotse/Fluglotsin) apprenticeship

Tasks and activities of training
Air traffic controllers monitor, control and direct all movements of aircraft at airports and in the airspace allocated to them. They do their work in towers and control centers with the help of radar screens and aeronautical radio services. The tasks of the air traffic controllers include the temporal and spatial coordination of aircraft, issuing instructions for take-off, landing, descent and climb. They inform the pilots with information that is necessary for a safe flight and keep in touch with the weather service and airport companies.

Duration of full-time training
3 years

Apprenticeship as an industrial clerk (Industriekaufmann/-frau)

Training tasks and activities
Industrial clerks are responsible for business processes in companies in all sectors. This includes materials management, sales and marketing, finance and accounting, and personnel planning. Her area of responsibility includes comparing and negotiating offers with suppliers and supervising the receipt and storage of goods. They plan, control and monitor the production of goods or services. Furthermore, customer talks and sales negotiations fall within her area of responsibility. To do this, they develop targeted marketing strategies. In addition to recruiting and planning the deployment of personnel, they are also responsible for the financial processes that arise.

Duration of training
3 years

Apprenticeship as an industrial mechanic (Industriemechaniker/-in)

Tasks and activities of training
Industrial mechanics manufacture, maintain and repair devices, machines and production systems. To do this, they produce the corresponding components. After assembly, they are responsible for setting up the machines, putting them into operation and checking the functions. They then instruct employees and customers on how to operate the machines, eliminate the sources of error in the event of faults and carry out repair work. Furthermore, industrial mechanics are responsible for the control and quality assurance of machines and production facilities.

Duration of training
3.5 years

IT clerk (Informatikkaufmann/-frau) apprenticeship

Tasks and activities of the training
IT clerks are responsible for the procurement of information and telecommunications systems and their administration. They analyze problems and tasks and offer companies solutions through the use of IT systems. To do this, they plan application solutions, procure the appropriate hardware and software, and advise and train users in handling and use. Their tasks also include ensuring a high level of user-friendliness and cost-effectiveness of the recommended systems.

Duration of training
3 years

Apprenticeship as a clerk (kaufmann/-frau) for forwarding and logistics services

Training tasks and activities
Clerks for forwarding and logistics services are responsible for organizing shipping, handling and storing goods. They also sell logistic and transport services. As part of the calculation, they compare prices, draw up both offers and contracts and are responsible for insurance cover. Furthermore, customer care, complaints and damage reports are part of her area of responsibility. Clerks for forwarding and logistics services are responsible for finance, processing payment transactions and processing reminders.

Duration of training
3 years

Apprenticeship as a clerk (kaufmann/-frau) for office management

Tasks and activities of the training
Clerks for office management are responsible for the organization and execution of office management and commercial-administrative activities. In addition, dealing with internal and external correspondence as well as planning and monitoring appointments are part of her area of responsibility. They also create presentations, prepare and organize meetings. She is also responsible for customer care and order processing, accounting, marketing and personnel administration. In the public sector, they support and advise citizens on administrative matters.

Duration of training
3 years

Apprenticeship construction mechanic (Konstruktionsmechaniker/-in)

Tasks and activities of the training
Construction mechanics produce metal constructions such as steel and sheet metal constructions. You construct individual components and groups based on technical drawings and produce them in the company. The manufactured components for bridge structures, elevators, cranes, vehicles, etc. are assembled at the respective place of use using various methods. In addition to instructing customers in the manufactured constructions, construction mechanics are responsible for the maintenance, servicing and repair of the constructions.

Duration of training
3.5 years

Apprenticeship as a light aircraft builder (Leichtflugzeugbauer/-in)

Training tasks and activities
Light aircraft builders produce light aircraft such as gliders, microlight aircraft, gliders and smaller motorized aircraft. They mainly produce these for sport aviation. The materials used are light metal and fiber composites. The light aircraft builder is responsible for the production of the components and their final assembly with prefabricated equipment parts. Furthermore, they are responsible for the maintenance, repair and replacement of defective parts as well as the control of all on-board systems.

Duration of training
3 years

Apprenticeship mechatronics engineer (Mechatroniker/-in)

Tasks and activities of the training
mechatronics technician assemble complex mechatronic plants and systems from electronic, electrical and mechanical components. To do this, they manufacture the individual components and program and install the required mechatronic software. In addition to the commissioning of the devices and their maintenance and repair, they also upgrade outdated devices to the latest standard.

Duration of training
3.5 years

Apprenticeship as a microtechnologist (Mikrotechnologe/Mikrotechnologin)

Tasks and activities of the training
Microtechnologists manufacture microtechnical products such as semiconductor components and microsystems in process engineering processes - eg computer chips or airbag sensors. Microtechnologists are involved in the planning and organization of micro- and nanotechnological manufacturing processes. You are responsible for the provision and handling of the required working materials and carry out in-process safeguards, inspections and final tests on the manufactured products. Furthermore, the analysis of sources of error and malfunctions are part of her area of responsibility.

Duration of training
3 years

Apprenticeship as surface coater (Oberflächenbeschichter/-in)

Training tasks and activities
Surface coaters coat or finish surfaces of metals and plastics. To do this, they coat the surfaces with a metallic coating using various chemical, electrochemical and physical processes. The tasks of surface coaters include the pre-treatment of the objects to be coated, the coating itself, the control and, if necessary, the after-treatment of the surfaces. They are also responsible for cleaning the coating systems, the professional disposal of the chemicals and the maintenance and repair of the systems.

Duration of training
3 years

Apprenticeship as a service clerk in aviation (Servicekaufmann/-frau)

Tasks and activities of the training
Service clerks for air transport are responsible for advising, supporting and informing passengers at the airport. Her responsibilities include selling airline tickets, reserving seats, checking in passengers and receiving luggage. At the customer's request, they also book hotel rooms and rental cars. The commercial tasks of service clerks for air transport include the conception and implementation of marketing strategies and financial tasks such as processing payments and complaints.

Duration of training
3 years

Apprenticeship system electronics technician (Systemelektroniker/-in)

Training tasks and activities
System electronics technicians develop and produce electrical and electronic components, systems and devices. To do this, they first design a prototype, select suitable components and materials for production and install the required software. During the serial production of the prototype, they monitor the manufacturing processes, repair the electronic devices and advise their customers on the operation and handling of the devices.

Duration of training
3.5 years

Apprenticeship as a technical product designer, specializing in machine and plant construction (Technischer Produktdesigner/Technische Produktdesignerin)

Tasks and activities of training
Technical production designers for machine and plant construction are involved in the development of plants, machines and vehicles. They create three-dimensional data models and technical documentation for components and assemblies. Together with the development department, technical product designers specializing in construction and plant construction work on CAD systems with detailed models, eg for the modernization of machine tools. In doing so, they must observe the relevant standards and enter dimensions suitable for production. You will also take into account electrotechnical components and select suitable standard parts that meet the requirements and materials. You create assembly plans and parts lists for production, maintain product documentation,

Duration of training
3.5 years

Apprenticeship as a technical product designer, specializing in product design and construction (Technischer Produktdesigner/Technische Produktdesignerin)

Tasks and activities of the training
Technical production designers for product design and construction are responsible for the design and construction of technical products, components and groups according to customer requirements and are involved in the design of everyday objects. To do this, they create three-dimensional models and technical documents for the components. For production, technical production designers often use existing models and solutions, optimize them and adapt them to new framework conditions. In addition, technical product designers operate CAD systems, select materials and standard parts and the corresponding manufacturing techniques.

Duration of training
3.5 years

Apprenticeship as a process mechanic, specializing in coating technology (Verfahrensmechaniker/-in)

Training tasks and activities
Process mechanics specializing in coating technology are responsible for planning, controlling and monitoring the processes for coating wood, metal or plastic surfaces with paints, varnishes, plastics or anti-corrosion agents. The surface coating is done with the help of various application processes and is usually carried out mechanically. Process mechanics in coating technology adjust, monitor and control the machines, clean them and maintain them.

Duration of training
3 years

Apprenticeship as a process mechanic for plastics and rubber technology, specializing in components (Verfahrensmechaniker/-in)

Tasks and activities of the training
Process mechanics for plastics and rubber technology specializing in components plan and produce components and assemblies made of polymer materials, such as pipeline parts and systems, based on order data and special customer requirements. Process mechanics in this field are responsible for the selection and preparation of the materials. They set up the production machines, operate them and monitor the entire production process. In addition to production, the post-processing of the manufactured piping systems and components as well as their assembly and disassembly are also part of their area of responsibility.

Duration of training
3 years

Apprenticeship as a process mechanic for plastics and rubber technology, specializing in compound and masterbatch production (Verfahrensmechaniker/-in)

Tasks and activities of the training
process mechanics for plastics and rubber technology specializing in compound and masterbatch production plan and manufacture composites and colored granules from polymer materials and other substances and colorants. This is done as part of the order data or special customer requests. Process mechanics in this department calculate the processing parameters for production and carry out the production process according to the parameters. Furthermore, the physical and chemical testing of the materials as well as the implementation of recycling measures are part of their area of responsibility.

Duration of training
3 years

Apprenticeship as a process mechanic for plastics and rubber technology, specializing in fiber composite technology (Verfahrensmechaniker/-in)

Tasks and activities of training
Process mechanics for plastics and rubber technology specializing in fiber composite technology are responsible for the production of components made of polymer materials together with other materials. To do this, they plan the production of the components based on technical drawings and the order data. Planning includes the selection of suitable manufacturing processes and the materials and components required for this, the determination of process-specific parameters and the setting up of the production facilities. Process mechanics for plastics and rubber technology in this field are responsible for and monitor the entire production process. After manufacturing the fiber composite components, they assemble, process and assemble individual components.

Duration of training
3 years

Apprenticeship as a process mechanic for plastics and rubber technology, specializing in molded parts (Verfahrensmechaniker/-in)

Tasks and activities of the training
process mechanics for plastics and rubber technology specializing in molded parts plan and manufacture molded and finished parts made of polymer materials. This is done as part of the order data or special customer requests. Process mechanics in this department determine the processing parameters for production, set up the production equipment and monitor the entire production process. The area of responsibility also includes ensuring the functionality of means of production and tools as well as the processing of the molded parts produced.

Duration of training
3 years

Apprenticeship as a process mechanic for plastic and rubber technology, specializing in plastic windows (Verfahrensmechaniker/-in)

Tasks and activities of the training
Process mechanics for plastic and rubber technology specializing in plastic windows are responsible for the production of window, door and facade elements that meet the noise, burglary and heat protection requirements. Process mechanics in this field plan and monitor production. You carry out process-related calculations, optimize the production process and control the production machines. Furthermore, the post-processing of the manufactured products and their quality control are part of their area of responsibility.

Duration of training
3 years

Apprenticeship as a process mechanic for plastics and rubber technology, specializing in multi-layer rubber

parts (Verfahrensmechaniker/-in)

Tasks and activities of the training
process mechanics for plastics and rubber technology specializing in multi-layer rubber parts plan and produce finished parts and semi-finished products made of rubber. The manufactured products are reinforced with textile or similar reinforcements. Process mechanics for plastics and rubber technology in this field are responsible for the selection and preparation of the materials. They operate the production machines and monitor the entire production process. In addition to the production, the post-processing of the manufactured multi-layer rubber parts and the quality control of the end products are also part of her area of responsibility.

Duration of training
3 years

Apprenticeship as a materials tester, specializing in plastics technology (Werkstoffprüfer/-in)

Training tasks and activities
Materials testers specializing in plastics technology are responsible for monitoring, testing and quality assurance of plastics and intermediate products made from plastics. With the help of measurements, sampling and testing, they examine the material properties and ensure consistent product quality. To do this, they prepare material samples using different test methods and equip the appropriate test devices. You evaluate the results of experimental investigations and manage the investigation results and samples.

Duration of training
3.5 years

Apprenticeship as a materials tester, specializing in metal technology (Werkstoffprüfer/-in)

Tasks and activities of the training
Material testers specializing in metal technology use samples, tests and measurements to examine metallic materials for properties and possible damage. They document the results of their quality control in test reports. If material defects or defects in building material parts are detected, they are responsible for determining the cause and for any post-treatment of the materials and components.

Duration of training
3.5 years

Apprenticeship as a materials tester, specializing in systems engineering (Werkstoffprüfer/-in)

Training tasks and activities
Materials testers specializing in systems engineering are responsible for checking the condition of parts and components of technical systems. When planning and coordinating the audit assignments, they must ensure that the audit is carried out as smoothly as possible in ongoing operations. Material testers are responsible for measurements and tests during production and assembly. In the event of damage, determining possible causes and defects for the failure of a component is part of their area of responsibility.

Duration of training
3.5 years

Apprenticeship as a materials tester, specializing in heat treatment technology (Werkstoffprüfer/-in)

Training tasks and activities
Materials testers specializing in heat treatment technology are responsible for the planning, control and monitoring of heat treatment processes, e.g. tempering or hardening metal workpieces. The tasks of the materials tester specializing in heat treatment technology include testing the materials for their properties, taking and analyzing material samples and, if necessary, examining for material defects. This helps them in the development of new materials or the production of materials with improved properties.

Duration of training
3.5 years

Tool mechanic apprenticeship (Werkzeugmechaniker/-in)

Training tasks and activities
Tool mechanic apprentices produce different types of tools as well as pressing and embossing moulds. They also manufacture metal and plastic parts as well as surgical instruments. For these tasks, they process metals, carry out measuring and testing work and check the dimensions of the workpieces produced. The production of the tools and molds can be done manually or by using a CNC-controlled machine tool, which the toolmakers may program

themselves. Furthermore, the maintenance, servicing and repair of tool parts is part of their area of responsibility.

Duration of training
3.5 years

Apprenticeship as a cutting machine operator (Zerspanungsmechaniker/-in)

Training tasks and activities
Machining mechanics are responsible for the production of mostly metal precision components for technical products. They produce these with the help of CNC machine tools or production systems using machining processes such as turning, grinding, drilling or milling. The tasks of the cutting machine operator include programming the CNC machine tools, setting up, cleaning and maintaining the machines, as well as clamping the workpieces and monitoring the production process.

Duration of training
3.5 years

4. Needs: capacity gap assessment

Findings of the primary assessment of your country (What are the most sought after skills in the aviation/drone sector in your country)

With aerospace companies transitioning to new energy platforms and business models it seems that one of the key blockers is a lack of capabilities and skillsets, with 70 percent companies admitting that they lack the capabilities to develop new-energy business models. Additionally, 62% of businesses say they lack the internal expertise needed to create, market, and manage services.

Strategies for new-energy business models must include upskilling current staff and bringing in fresh knowledge. In a few fields, including hydrogen and carbon capture, utilization, and storage (CCUS), corporations are already doing this by internally training personnel and modifying hiring procedures.

But isn't it simpler to say than to do? According to Pecknold's (2022) survey, 67% of the firms said they were unable to reskill their personnel to meet the needs of the new models. Nevertheless, in the future, the move to new-energy business models will be based on upskilling talent and developing competencies connected to products and services.

Young people today will help create and maintain solar panels, wind turbines, low emission vehicles, and other green economy technology, according to the World Economic Forum. The World Economic Forum's Davos Labs Youth Recovery Plan 2021 notes that over half of young people currently believe they lack the necessary skills. According to a Policy Brief from the International Labour Office, "Massive investments need to be made in reskilling and upskilling to achieve targets set by the 2015 Paris Agreement and UN Sustainable Development Goals (SDGs) beyond 2030 (Pecknold, 2022).

Between 2012 and 2019, the German drone and air taxi startups have received 170 million US dollars in investment. This sum corresponds to about 6% of investments made in the worldwide drone sector during the same period. German investors only make up about 55% of the total investment in German enterprises; the rest comes from foreign investors. The majority of investment worldwide is provided by US contributors. The market sector of platform manufacturers, or businesses that make drones or air taxis, accounts for over 60% of investments in German enterprises. The remaining funds are split between software, services, and drone protection. The investments focus on the urban air mobility segment, putting Germany in second place internationally for investment in this area. The two air taxi start-ups Lilium and Volocopter were able to obtain larger investments. A third company in this market segment, Dedrone, has now moved its headquarters to Silicon Valley in the United States. Outside the market segment of urban air mobility, investment in German drone companies is rather low.

In Germany, 10,300 workers are primarily employed by drone companies. The service market category is where the vast majority of the workforce is engaged, at 80%. This primarily refers to those who use hardware and software in the course of their employment to perform tasks for other businesses, but it also covers those who work in fields like research and development, maintenance and repair, and consulting. Employees of businesses whose primary business is unrelated to drones but where specific employees are in charge of drone-related duties are also included in this segment.

The hardware market sector employs roughly 13% of the total workforce in the drone industry. This covers work on systems related to unmanned aerial vehicles, such as ground control systems, navigation systems, drone defense systems, and the fabrication of drones and air taxis as well as individual components and accessories. Comparatively speaking, the hardware segment's share is quite significant.

The remaining 7% of workers are employed in the software market sector, where they create and deploy software for training, data analysis, flight planning, and other functions. (See figure 4)

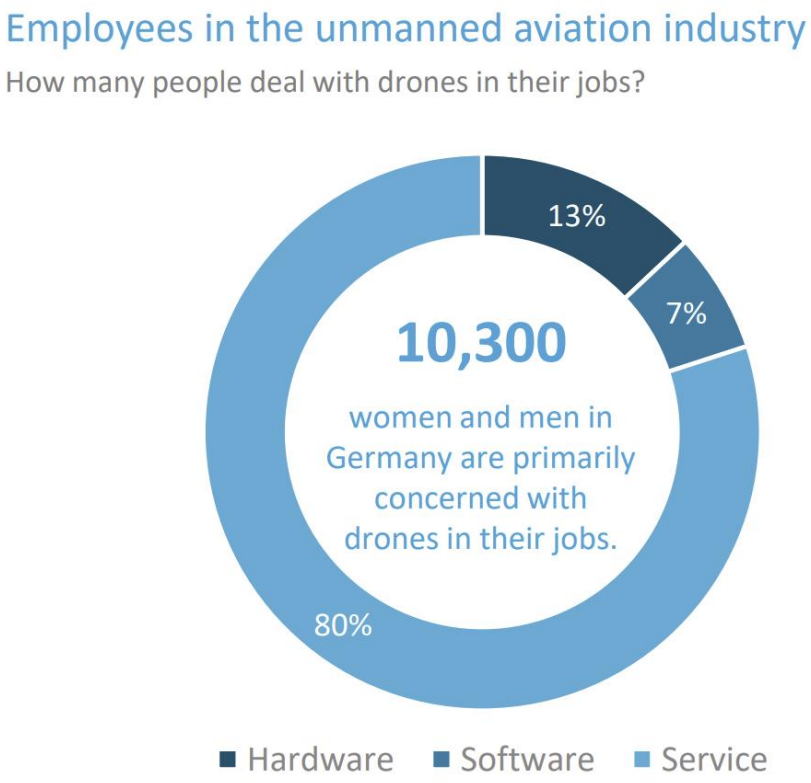

Fig 4 : Employees in the drone industry in Germany (Source: Verband Unbemannte Luftfahrt, 2019)

5. Challenges

One of the biggest challenges that Germany currently faces is the lack of skilled workforce to take up jobs related to electric aircrafts and unmanned aerial systems (UAS) a.k.a drones. Since these novel platforms are foundationaly based on new technologies arising from different engineering disciplines such as Electrical engineering, Materials Technology, Electro-Chemical engineering, Computer Science, Information Technology, Machine Learning, Artificial Intelligence (AI) etc. the educational curriculum needs a major overhaul.

According to reports published by Verband Unbemannte Luftfahrt in 2019, Europe is the second largest market for drones after North America. Within Europe Germany accounted for the second largest commercial drone market after France with a total worth of 404 million Euros in 2019. When considering the private drone market the total revenue comes to 574 million Euros. However, Germany's high position is put into perspective if the ranking is based on the size of the market per employee rather than the market's overall size. In this instance, Germany is in tenth place, after Switzerland and Norway.

Large hardware and software firms with a beneficial impact on the use of commercial drones can be found in Switzerland. A high number of drone operators are allowed in Norway thanks to advantageous laws, which increases demand for drone technology.

Fig 5 : Commercial drone market comparison for Europe (Source: Verband Unbemannte Luftfahrt, 2019)

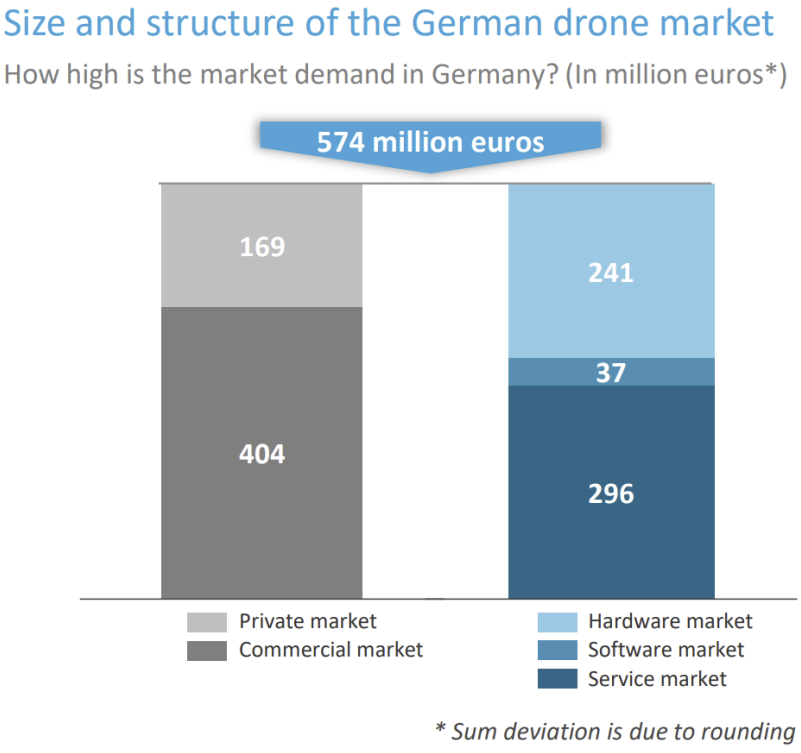

Fig 6 : German Drone Market by size (Source: Verband Unbemannte Luftfahrt, 2019)

A ranking of the biggest commercial drone markets worldwide was created using data from 63 European nations. The biggest drone markets are in the USA and China. These two nations together make up around two thirds of the global market for commercial drones. When it comes to allowing drone flights outside of the pilot's line of sight and awarding rise permits, for instance, the framework requirements for the use of drone technology in both countries are more advanced than in many other nations. France, Germany, and the United Kingdom are well behind China and the United States in the global rankings.

However, If the ranking is not based on the absolute size of the market but on the size of the market per employee, Switzerland and Norway are also among the leaders in an international comparison. Germany comes in 17th.

Fig 7 : International Drone Market by size (Source: Verband Unbemannte Luftfahrt, 2019)

Figure 7 shows how absence or lack of skilled workforce in Germany has put it behind in the Global ranking. Although Drones from German manufacturers are in high demand abroad which accounts for 80% of the export quota. Especially professional use platforms which are of value more than 10000 euros. But around 60% of the professional drones in commercial use in Germany also come from abroad and are imported. The majority of the high-quality drones on the German market are therefore produced by foreign manufacturers. (See Figure 8)

Drones with cameras that are intended for prosumer use, or both business and personal use, are virtually always imported. The high import and low export restrictions reflect Germany's lack of prosumer drone producers, but they can also be attributed to a small number of powerful suppliers who control the world prosumer market. Though reasons for the weak supplier market can be many, a skilled workforce is one of those many reasons that needs to be urgently addressed.

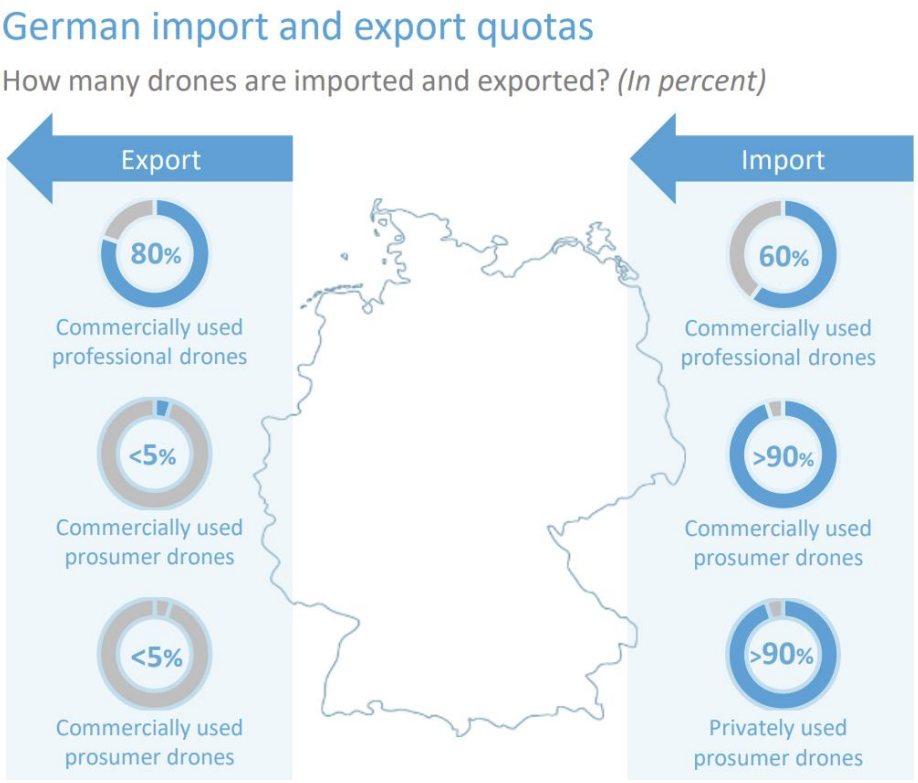

Fig 8 : Import/Export quotas for drone related products for Germany (Source: Verband Unbemannte Luftfahrt, 2019)

6. Conclusions and remarks

Other remarks (mostly with findings from the interviews)
Conclusions for the next steps of the project and for the global report

The number of privately used drones in particular has risen sharply. Drone Industry Insights forecast future development based on a market model and took drone wear and tear into account. As a result, the numbers are always expressed as the number of drones that are ostensibly available for usage at any given time.

By 2030, there will be 847,000 drones in use worldwide, a 79% increase from today. Strong growth is anticipated in the private-use market over the next two to three years. This will subsequently be considerably curtailed, and from the middle of the following decade onward, there won't be much growth to speak about. Between 2018 and 2030, the total number of drones used for personal purposes will rise by 58% to 721,000 (Verband Unbemannte Luftfahrt, 2019). For the commercial sector the number of commercially used drones will increase by 563% to 126,000. While in Germany at present only one in 24 drones is operated commercially, it will be one in six drones in 2030 (Verband Unbemannte Luftfahrt, 2019).

A prognosis for the growth of the German drone market has been provided by Drone Industry Insights. The forecast is predicated on the idea that European and national governments will soon enact the legislation necessary to fully utilise the technology's potential (drone flights outside of sight range, etc.). In light of this, the German drone market will experience rapid growth until 2030. The overall market (commercial and private) is anticipated to reach almost 3 billion euros by 2030, at an average annual growth rate of 14%. The commercial market will increase by over 2.5 billion euros, or 16% annually on average. The commercial software industry is anticipated to increase by 22%, commercial hardware by 19% annually, and the commercial service market by 14%.

On the other hand, there are indications that growth is slowing in the private market area. By 2030, this market will have grown from its current size of 170 million euros to about 220 million euros, or about 2% annually.

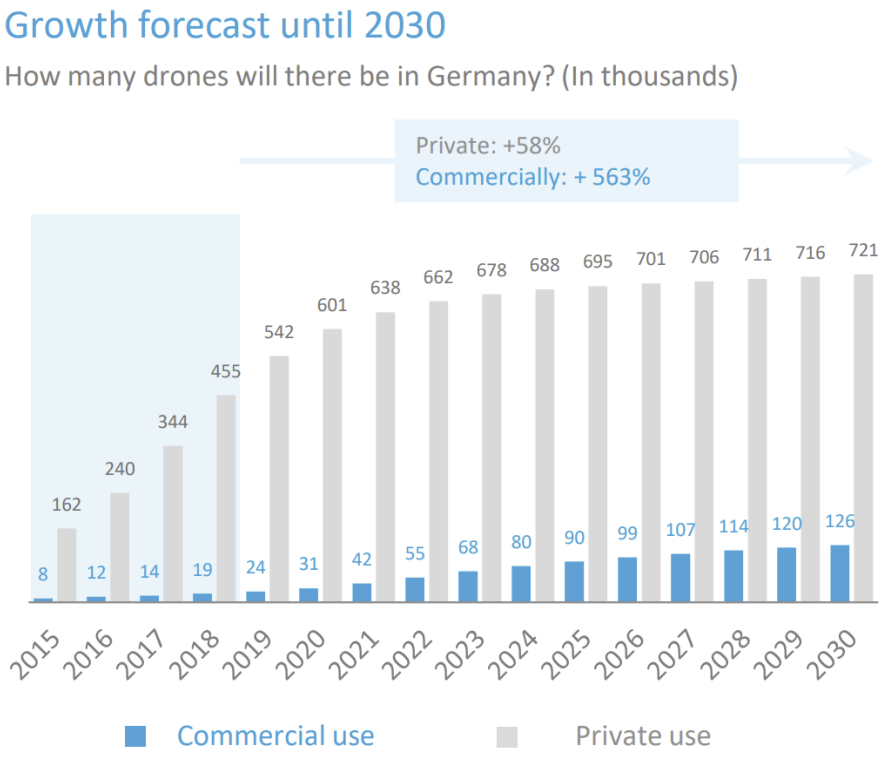

Fig 9 : Growth forecast for drone industry in number for Germany (Source: Verband Unbemannte Luftfahrt, 2019)

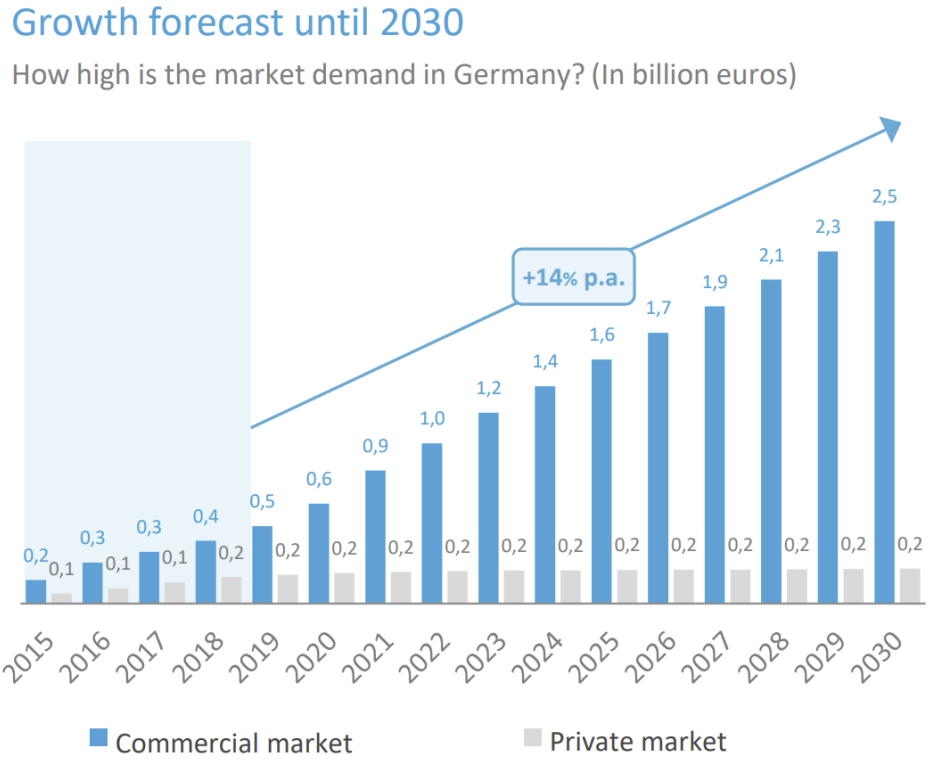

Fig 10 : Growth forecast for drone industry in value for Germany (Source: Verband Unbemannte Luftfahrt, 2019)

Keeping this magnitude of growth in mind the future workforce will witness an influence of digital information and workflows. New job profiles will develop, and traditional occupations will shift. Virtually all sectors of the economy and professions including Aerospace will see an increase in the importance of digital technology and Internet-based applications. Beyond the arena of employment, new ways of interacting and producing knowledge will have an impact on virtually every aspect of daily life. Knowledge of digital technologies and collaborative methods will become a crucial requirement against the backdrop of a society that is always evolving, not only for participation in society but also for

economic success.

According to a Stifterverband and McKinsey report Businesses will face two issues as a result of digitization and changing working models, both at the top and generally (see Figure 11). First, there will be a further movement in the job portfolio toward IT positions, for which hiring will become increasingly difficult, particularly in the fields of transformational technologies like blockchain and artificial intelligence. Second, the vast majority of all employees' types of work and activities will change, necessitating the requirement for a new set of digital and nondigital key qualifications for many of them.

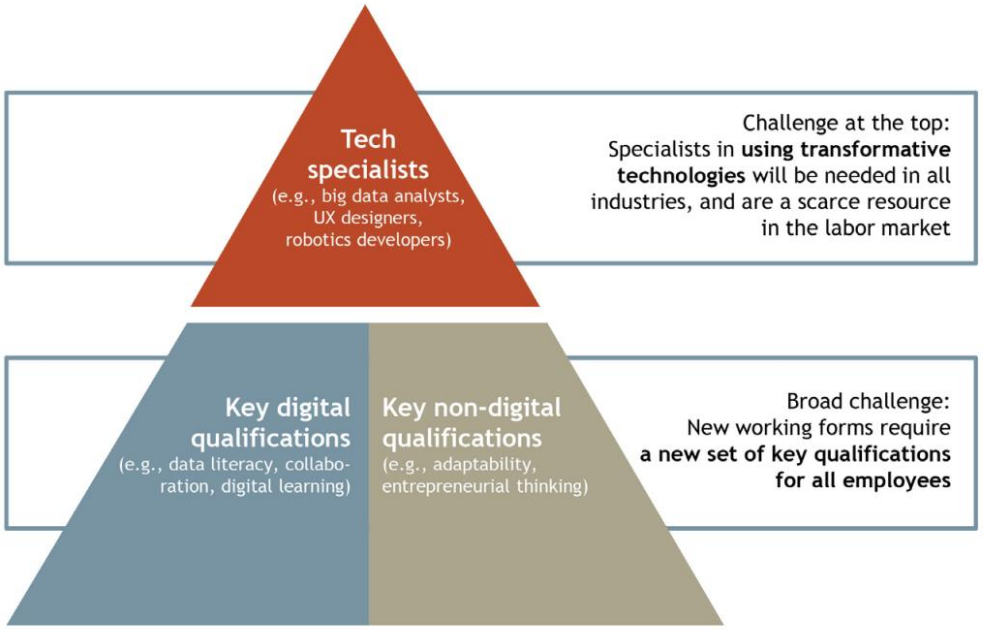

Fig 11 : The Dual Challenge in skill development for Germany (Source: Stifterverband, McKinsey)

Some classic examples of skills in the above three categories, namely - Technological skills, Key digital qualifications (Basic digital skills) and key non-digital skills (classic skills) can be found in Table 1.

Technological skills cover those skills that are needed to shape transformative technologies. These include established transformative technologies such as the Internet (web development, UX design) as well as emerging fields (blockchain technology and smart hardware). The ability to evaluate complicated data and the corresponding advancement of artificial intelligence are two areas that are of great importance. Those who are proficient in these technological abilities have access to the most recent IT knowledge and know how to use it. In all industries, this category will produce new job profiles, such as data scientists. Even today, a lot of job profiles, especially in startups, are dominated by technology abilities.

Basic digital skills as a second category refers to skills that allow people to play an active role in a digitized world. These abilities are becoming more in-demand by businesses and will be necessary in the future for both a person's professional life and to engage in society (Digital Citizenship). They include the creation of digital knowledge (digital learning), the assured use of online data (digital literacy), and the capacity for teamwork. In an increasingly digital world, those who have mastered these skills can collaborate successfully, work in agile teams, and make important judgments.

While certain technological abilities are only needed by specific persons, everyone should be able to understand the fundamentals of digital technology i.e. basic digital skills.

Classic skills will be the third most important category. These include traits and qualities that will be more valued in the future workplace, such as adaptability, inventiveness, and perseverance. The ability to assess and solve problems in a volatile and complicated working environment will come naturally to those who have these timeless talents.

Delivering a blend of technological abilities, fundamental digital skills, and traditional talents is essential for businesses to survive in the future. Employing workers who "only" have unique, specialised abilities is insufficient. The difficulty lies in choosing or training individuals in a way that allows them to provide the widest potential variety of all future talents pertinent to their working setting.

CATEGORY	SKILL	DESCRIPTION
Technological skills	Complex data analysis	Analyze large data volumes efficiently using analytical methods to mine information; also covers developing artificial intelligence (AI)
	Development of smart hardware/robotics	Develop physical components for "intelligent" hardware-software systems (Internet of Things), e.g., robots
	Web development	Master programming languages for back-end and front-end development of web applications (mobile in particular)
	User-centric designing (UX)	Design products that aim to offer optimized functionality, intuitive handling, and an attractive user experience
	Conception & administration of networked IT systems	Apply a complex IT infrastructure with cloud functionality and interfaces to other IT systems, including continuous administration and further development
	Blockchain technology development	Build decentralized databases ("distributed ledgers") using blockchain technology
	Tech translation	Moderate between technology experts and non-experts
Basic digital skills	Digital literacy	Command the most basic digital skills, e.g. careful handling of digital personal data, use of the latest software, interaction with AI
	Digital interaction	Understand others by interacting via online channels and respond appropriately ("digital etiquette")
	Collaboration	Collaborate on projects effectively and efficiently across distance and disciplines to achieve better results as a team than as individuals
	Agile working	Develop precisely what delivers added value to the customer working in a team responsible for the end product using iterative methods (rapid prototyping)
	Digital learning	Build solid knowledge on selected topics from a range of digital information sources
	Digital ethics	Critically examine digital information and the impact of digital actions, and take the appropriate ethical decisions
Classic skills	Problem-solving	Using a structured approach and reasoning, resolve concrete problems for which there is no ready-made answer
	Creativity	Develop original improvement ideas (e.g., for existing business processes) or ideas for innovations (e.g., for new products)
	Entrepreneurial thinking & self-initiative	Independently work using initiative as part of a project or organization
	Adaptability	Show an open mind to new technological developments, use them to the benefit of the organization, and apply them to different situations
	Perseverance	Complete tasks such as challenging projects with focus and responsibility, while overcoming resistance

Table 1 : Examples of future skills by category (Source: Stifterverband, McKinsey)

7. Bibliography

Erasmus+

amtechtraining.eu

AMTECH

Development of an aviation aerospace mechatronics technician curriculum

Country snapshot and capacity gap assessment

COUNTRY: ITALY

DATE:

Co-funded by the European Union

1. Summary

Please provide a short summery about the key facts and the main findings

The Italian unmanned vehicle industry is characterized by dichotomous trends. Based on latest analysis from the Italian Drone Observatory of Polytechnic of Milan, a top-notch research centre at national level, the inhibitors / drivers model for this industry includes five key distinctive variables: evolution of legislation, organisations' culture and internal competences (i.e., referred by this report as "Human Factor"), networking and external collaboration with STKHs and other groups of interest, technology maturity, gathering, collection and processing of data. The lag of regulation compared to technologies, frequent changes in the normative outlook, and last but not least, the overall lack of understating from the demand side of concrete potentialities and benefits that this technology is able of guaranteeing seem pretty recurrent discussions among businesses and sectors' operators.

Worthy to mention is also the fact that the unmanned industry is populated for the very most by microenterprises, that despite their very high innovation driven culture, they deal with the same identical challenges typically faced by any other small enterprise regardless of their occupied sector (i.e., internationalisation, networking and access to finance, even by alternative credit means).

But in spite of all of these, the Italian unmanned industry shows also great potentials for innovation, development and employability. Official stats from the Polytechnic's observatory confirm indeed that the drone sector is recovering very rapidly from COVID's crisis and it is forecasts margins of high competitiveness and profitability.

In the context of this report, we looked specifically into training and education opportunities available among legislation and existing literature for the aviation aerospace mechatronics technician, a professional profile that is not still defined at formal level, but identified by the project's background as of instrumental valorisations for the outreach of the sector.

Compared to capacity building for drone pilots, the training and education resources for drone operators and technicians, let alone aviation aerospace mechatronics technician seem nowhere to be found in literature, or to better say, in a compiled, institutionalised and structured framework of common reference for interested parties. This is mainly due to the high fragmentation of technical / regulatory requirements that exists within the sector, and influenced by the industrial application of drones, the specific sector to which this application is in force, and field specific regulatory frameworks.

Nonetheless, besides few coordinates indicative of the technical skills and knowledge that should be possessed by such profiles, IDP provided for a theoretical model of curricula centred as well on attitudes and qualitative features that should be applied to this profession and are instrumental for further employability opportunities.

2. The aviation industry in Italy

General description:

- *Quantitative and qualitative indicators on job market dynamics in the aviation industry in your country*
- *Number of companies, number of workplaces*
- *Trend and dynamics of the aviation industry (foresight studies, papers, national/regional strategies)*

With more than EUR 10 billion, more than 180,000 employees throughout the supply chain and almost 100 per cent exports for its civil products, the Italian aeronautics industry operates in a global market and as a whole is fourth in Europe and seventh in the world in terms of size, with leadership positions in civil helicopters, regional aircraft and propulsion[1].

To be more precise, when talking about such industry we must refer to the whole "Aerospace, Defense and Security Sector" as per classification made by the Italian Ministry of Economic Development (MiSE)[2].

In the first nine months of 2020, deliveries of new products globally fell sharply in all segments and applications, and demand for maintenance services more than halved.

The outlook for a return to pre-Covid levels is now looking ahead to 2024-2025, and it is estimated that a 23% loss in revenue over the decade compared to pre-Covid forecasts will accumulate.

The 4.000 companies in Italy, around 70% of which are SMEs, make the sector second only to the automotive industry in terms of overall size.

Large Italian aeronautics companies are now prime contractor in several military, helicopter and engine programmes and have structured collaborations with leading European and US companies in both the civil and military sectors.

Characterised by an ongoing commitment to innovation, statistically the industry spends up to 20% of turnover on research and development with a ROI of up to 10 years.[3]

In recent decades, the aeronautics sector has also developed thanks to the support of public funding that have been made possible by law n. 808 of 1985, which encouraged research and development projects by companies.

[1] Data elaborated by the National Technological Aerospace Cluster (CTNA), Which is a non-profit association founded in 2012 on a MIUR initiative that aimed to bring together all the key players of the national aerospace system. https://www.ctna.it

[2] https://www.mise.gov.it/index.php/it/component/organigram/?view=structure&id=611

[3] https://www.industriaitaliana.it/agusta-leonardo-thales-alenia-space-ohb-italia-aerospaziale/

However, the National Technological Aerospace Cluster (CTNA)[4] has brought to the attention of the responsible institutions that Italy still lacks a "Sector Plan" that provides for industrial policy guidelines and a long-term sustainable vision.

Moreover, the CTNA highlighted that adequate planning of resources is needed to ensure the development and competitiveness of the sector, as well as support for the preservation of strategic capacities and technologies; specialisation of the supply chain in attractive sectors must be expeditiously provided as it is a crucial feature for the advancement and recover of the whole industry.

It is therefore considered necessary to set in motion a process promoting the recognition of the strategic value of the aeronautical sector and its safeguarding through dedicated initiatives.

Another interesting study conducted by CTNA, analysed the response to the Covid-19 inducted crisis.

A questionnaire with 38 multiple-choice questions, plus an additional open-ended section, covering seven fields of interest (Company Identification, Perceived Impact of Covid-19, Reactive Actions, Financial Strategy, Digitalisation, Public Support Policies and Programmes, Technology Policies), has been drew up and administered electronically, with the cooperation of the Aerospace Districts, to which about a thousand companies belong to.

More than 40% of the answers indicate the ability of SMEs to contain the effects of the crisis by shifting part of their production to new services and products. In terms of cross-sectoral transfer, 20% of the responding aerospace companies have produced medical products or IPRs, using 3D printing techniques or even patenting new equipment.

Of these, more than 80% are enterprises with less than 100 employees. This is indicative of the structural, technical, and operational capacity of small-medium enterprises and their great potentials in terms of flexibility and resilience to external disruptions.

Nonetheless, despite such positive responses the sector is still experiences many struggles towards a recovery path.

Shifting the attention to big companies, the spotlight must be given to the absolute leader of the sector: the Leonardo group. Its helicopter-focused division holds primacy in terms of orders from all over the world as it leads a cluster of over 200 SMEs in Lombardy alone – the northern Italy region whose capital city is Milan – that excels in the segment, but also in military training aircraft and satellites.

[4] https://www.ctna.it/wp-content/uploads/2021/03/CTNAREP20_Rev01low_sing.pdf

The Lombardy cluster accounts for one third of the exports of the Italian aeronautics sector, which is 4th in Europe and 7th in the world, with over 16 billion euros of turnover: 70% represented by export, half of which is represented by civil aeronautics and helicopters.

Now, the main technological challenge is to keep up with the leaders Leonardo and Thales Alenia Space (jointly owned by Leonardo), "prime contractors" of numerous international projects in the civil, military and aerospace fields, are artificial intelligence, modelling and 3D printing, while the challenge of the near future will be on short and medium-range mobility models up to new paradigms of air mobility in urban and metropolitan areas.

In particular, the future of Urban Air Mobility (UAM) is at stake in Lombardy, an area where autonomously guided drones that will act as taxi services are planned to be developed, as well as a number of other experimentations such as: the future tiltrotors, hybrid aircraft with the speed of a plane, and the ability to land in a restricted area like a helicopter.

Finally, addressing the Italian classification of the professional figure that the project aims to deal with, it is possible, to find relevant definitions provided by the Italian national institute for statistical analysis' (ISTAT).

Surfing its website, it is possible to find a section called "Nomenclature and classification of professional units" which provides a detailed description of the specific features of each profession.

Searching among the "Technical professions in science, engineering and production", and specifically among the "Air, naval and rail transport technicians", is possible to find the professional unit that goes under the description of "Avionics technicians" which states the following: "The professions included in this unit check, calibrate, repair and ensure the functioning of on-board avionics, integrated navigation, communication and security systems"[5].

[5] https://professioni.istat.it/cp2011/scheda.php?id=3.1.6.2.2

3. Opportunities

Training curricula, training courses available, existing formal and non-formal learning opportunities

Based on our literary assessment, the only academic curricula available to students in Italy is the "Master in Remote Pilot Aircraft Systems" (PARS)[6] jointly provided by University of Tor Vergata (Rome) and ENAC[7], the Italian Civil Aviation Authority.

Although it is does not specifically focus on the development of a drone technician figure, the course structure is made up of many relevant modules to the purpose of the AMTech project.

It is indeed structured as follows:

- "Flight Mechanics (Aircraft Schematisation, Flight Arrangements, Manoeuvres)"
- "Manufacturing Technologies (State of the art materials and manufacturing technologies for SAPR)
- "Propulsion (Aircraft propulsion, engines and storage systems)"
- "Aerodynamics (Concepts of fluid dynamics and airfoil theory)"
- "Geoinformation (Remote sensing and satellite data, GIS systems)"
- "Automatic Controls (Stability and Dynamic Response, Control of SAPR Systems)"
- "Sensors (Sensor devices, electronic interface and communication systems)"
- "Regulations and Safety (Authorisation procedures, Risk Assessment, Airspace Management)"
- "Use of SAPR (Operational aspects of SAPR use with practical exercises)"
- "Design Laboratory (With practical assembly and flight tests)"

Shifting now the focus of our research to the VET universe, a better-matching training opportunity is the course offered by the VET provider "Difly" under the name of "Drone Maintenance Technician"[8].

It consists in a highly qualified informal master course aimed at training technicians with expertise in the setting up and maintenance of remotely piloted aircraft (drones) and professional sensors.

Moreover, two other findings can be considered relevant if compared to this latter one. The first is the three-in-one professional course provided by the VET centre "Ceiform" that trains not only to become a "Drone technician" but gives further insights also on the "General occupational safety" and on the "Fire safety".[9] The

[6] http://masterpars.uniroma2.it/il-master/
[7] https://www.enac.gov.it
[8] http://difly.it/formazione/formazione-abilitante-e-professionalizzante/tecnico-manutentore-droni/
[9] https://ceiform.it/courses/corso-droni-rls-tecnico-drone-saprsicurezza-sul-lavoro-generaleantincendioformazione-lavoratore-2

second one, yet to be launched but which already has a validated framework is the one provided by the VET centre specialised in the training of avionic-related professional figures, called "Accademia del Volo" (i.e., Flight Academy).

The course is just called "Drone Maintenance Technician Course" and is aimed at creating "a task force of specialised technicians" who: "can carry out the relevant activity on drones (RPAS) as established by law. Regular checks are required on these aircraft to allow them and their pilots to perform operations to the highest safety standards (active/passive) and to maintain the aircraft in a perfectly efficient state".[10]

[10] https://www.accademiadelvolo.it/eng/drones-courses/drones-maintenance-course.asp

4. Needs: capacity gap assessment

Findings of the primary assessment of your country (What are the most sought after skills in the aviation/drone sector in your country)

When it comes to the actual the needs' analysis, there are some considerations to be made that, unfortunately, prevents us from providing for a truly comprehensive and one-size outlook on this specific research's dimensions.

Contrary to what we saw for the first section of this report, which include trends and dynamics that are data-centred by design, the need assessment involves a higher scale of analysis much more oriented to qualitative features, which on the other hand are relatively difficult to intercept.

Our literature review confirmed in fact a dispersion of data due to the fact that: the application and operationalisation of unmanned vehicles might vary a lot from sector to sector, a coefficient of heterogeneity that is widen also by the different regulations that apply for compliance within different industries, and by the very IT / technical features of the vehicle that is most suited to operate on that sector.

Nonetheless, regardless of such high fragmentation, we managed to collect some human-centred skills and knowledge that are instrumental to operate drones, and enhance the employability opportunities of people working on this capacity building areas.

Some of them are more technical, see the case for:

- Cybersecurity – every piece of technology might be subject to cyber-breaches, and drones make no exception. Hijackers targets typically the codes that transmit the communication from the remote to the vehicle. Of course, solutions exist for military drone, which disruption might have considerably greater implications, but they are not as easy to implement as for commercial drones. Cyber-awareness represents often the first line of defence against any digital threat
- Social responsibility – commercial drones are typically of small dimension, very fast and agile, and most importantly, are relatively difficult to track on flight. People operating with drones should be aware of the implications and dangers for public safety that a use too reckless / naïve of drones might cause
- Full compliance with the EU and national regulation in force – this pertains to both pilots, manufacturers and operators
- Basics of meteorology and physics – as the weather can have a significant impact on how drones react to pilot's inputs

Interestingly enough, there are also skills and knowledge that involve a horizontal and behavioural dimension, and that become specifically relevant when on-ground technicians need to engineer and programme the vehicle for safe and "socially responsible" piloting (i.e., technicians need to understand what the vehicle needs from the perspective of the pilot and the person operating on-air manoeuvres). Beside a strong interest and passion for aviation, the case includes as well:

- Mental fitness, endurance and robust self-control – ability to make effective decisions in a very short timeframe, to react fast in case of emergency without causing harm to people and things, to detect small details that might make the difference
- Aviation-specific math / IT / computer programming skills – data management specifically, use and interpretation of large dataset for monitoring, evaluation and fine-tuning interventions
- Crisis Management – Strong and reliable attitude to work under pressure and excellent problem solving
- Spatial and "3D" awareness – understanding and quick decoding of the surrounding environment
- Excellent hand-eye coordination – high sensory reflexes
- Strategic planning thinking – ensuring for the most peasant and safest flight conditions
- Basics of radio communication and geo-information mapping

Moreover, the labour market of drone operations is expected to be very competitive, people that decide to undertake this career path should be aware of the fact that continuous professionalization will be the key to thrive in the sector.

5. Challenges

COVID-19 outbreak has reduced the value of the Italian professional drone market – represented mainly by innovative startups and small businesses – of an astonishing 38%. At the same time, however, he highlighted the enormous potential of this technology.

The future growth of the sector requires businesses to forge robust, reliable and long-term oriented R&D partnerships with the numerous stakeholders populating the ecosystem.

The sector of unmanned vehicle is still relatively very young, and opportunities for growth and development are perceived as tangible and concrete, but there is still uncertainty on the given potentials to capitalize on.

In the sense of training and education for aspiring aerospace mechatronic technicians in the unmanned vehicle industry, one of the key challenges is represented by the fact that there is no clarity yet on what these challenges might be, being inputs from literature sources so fragmented and at times still too vague.

In compliance with the EU standards on force, ENAC provides for numerous recourse that can be of use for the on-air operation of drones, but not much that relates specifically to the on-ground maintenance.

Talking about regulations and EU standards, results from a pool published recently by the Drone Observatory of Milan's polytechnic reports that 64% of the Italian businesses involved in the unmanned vehicles' industry are very skeptic about the boost to innovation that the new EU regulation can provide for.

81% of the industry players (700 in total) is represented by microenterprises (<10 employees). Although it is most certainly true that their "lean" and agile organizational structure benefits and ignites the innovation process, at the same time they are challenged by all the typical issues faced by small organizations (lack of diversified internal know how, difficulties in accessing finance and credit, networking and Internationalisation, etc.).

All in all, and based on our considerations, it is required by AM TECH partners quite an interesting and "stimulating" exercise of abstraction thanks to which we will build up the curricula from scratch. The needs identified by partners under paragraph 4 represents indeed a very solid and reliable foundation for further development – and coordinated later with ESCO interlinkages.

Unfortunately, it is also worthy of mention the fact that, despite its G7 member status, and compared to peer countries, Italy lags behind for what concerns both digitalization and industrializations indexes: coefficients that are indicative of two trigger conditions for the nation-wide development and long-term sustainability of the unmanned vehicles industry

6. Conclusions and remarks

Other remarks (mostly with findings from the interviews)
Conclusions for the next steps of the project and for the global report

Conclusion and remarks can focus on food for thoughts for open discussion on suitable approaches that we can adopt at project level to move on from here.

The analysis of the Italian aviation sector report both flaws and strengths. For the first, we refer mainly to the strong sense of distrust that exist at business level toward the on force regulation, perceived as an inhibitor to innovation, rather than a driver, and the low social acceptance and cultural understanding on the phenomenon of unmanned transportation – so much so to slow down the new stream of employability opportunities that might emerge from the sector, and the very lack of market demand.

The most reliable reference for the consolidation in draft version of the curricula might stem from the cross-national benchmark of partners' findings: the trans nationality of the AM TECH consortium indeed represents for a great sample and overall testing ground of this given deliverable – being also given the compliance and coherence that we will demonstrate with ESCO and EQF.

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Development of an aviation aerospace mechatronics technician curriculum

Country snapshot and capacity gap assessment

COUNTRY: LATVIA

DATE: 11/07/2022

Co-funded by the European Union

1. Summary

The Latvian aeronautics industry is a small sector with big oputinitys and **exporting vocation**, whose technological developments are incorporated into other sectors of activity present in our daily lives. Specialy the drone industry is at the begining in our country.

The aeronautical industrial activity in Latvian is mainly concentrated in privat sectors, or big company is only one AirBaltic. The sector is characterized by **very few large companies, and medium-sized companies and a much larger number of small companies**.

There aro no current data regrading to drone industry as a industry in Latvia.

Some factorys are based on **defense markets and some are based on private folower for sport activity, some for shows.**

Training in the aeronautical industry in Latvia is mainly based on the AirBaltic needs, and the teach specialists for they company, and make some cooparation with local vet schools. In the privat sector is mainly teached the trayning how to pilot a drone and the law where can it be piloted.

- **With a few exceptions, no training is offered in electronics, mechanics or mechatronics fields.**

As a result of this situation, when we turn directly to the UAV sector, we find that **one of the main problems for employers is that they cannot find qualified personnel due to the lack of specific training**.

In conclusion, we can highlight good overall aeronautical training, especially in the VET ecosystem. But in the specific sector of drones and unmanned aircraft, the training is mainly focused on the operation of the aircraft, ignoring other fundamental elements to train a good professional such as electronics, computer science, assembly, etc.

2. The aviation industry

The aeronautics industry is a sector with high added value and exporting vocation, whose technological developments are incorporated into other sectors of activity present in our daily lives.

It is a fully globalized sector whose products are characterized by very long life cycles (about 30/40 years). The industry is also very capital-intensive, as product development involves very high costs that require very high investments whose returns begin to be generated, in most cases, in the very long term.

The aeronautical industrial activity in Latvia is mainly concentrated in airBaltic needs.

Figure1: Aeronautical industrial activity in Latvia

The aeronautical sector in Latvia is quite similar to the rest of Europe. The sector is characterized by very few large companies, with a larger number of medium-sized companies and a much larger number of small companies.

Key elements of competitiveness of the Latvian aeronautical sector

The key element of competitiveness in the global aeronautical sector is knowledge. This knowledge is only acquired through research and development projects of technologies with long development times witch lower coast as the big companys.

3. Opportunities

In Latvia, there are three lines of formal and non-formal training related to aeronautical/aerospace education.

- Vocational Training
- Private training academies

Vocational Training:

Vocational training offers the following degrees developed in both public and private centers:

As a chance to lear drones like a option in the main programm for in forest management, farmer etc.

Academies and private initiatives

From the private non-regulated initiative, practically all the training is oriented toward operating with Drones, which we will see in more detail below.

Drone operation in Latvia:

The following is an analysis of the drone operation sector in Latvia in order to know the main elements offered in its training programs.

Drones A1-A2-A3

New European regulations for drones:

Since December 31, 2020, the European UAS regulation has been applicable in Latvia. This regulation affects all drones regardless of their use or size.

Consolidated Implementing Regulation (EU) 2019/947, including changes to Implementing Regulation (EU) 2020/639, Implementing Regulation (EU) 2020/746, Implementing Regulation 2021/1166 and Implementing Regulation (EU) 2022/425.[1]

Consolidated Delegated Regulation (EU) 2019/945 including changes to Delegated Regulation (EU) 2020/1058.[2]

EASA Management Resolution approving national standard scenarios (STS-ES) for UAS operations in the "specific" category under an operational declaration in accordance with Implementing Regulation (EU) 2019/947.[3]

[1] https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A32019R0947

[2] https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A32019R0945

[3] https://www.seguridadaerea.gob.es/sites/default/files/0_20201202__resolucion_escenarios_estandar_nacionales.pdf

Easy Access Rules for Unmanned Aircraft Systems (Regulations (EU) 2019/947 and (EU) 2019/945).[4]

Drone pilot training is organized in 2 categories:

The 'open' category encompasses low-risk UAS operations and does not require authorization or declaration.

In the 'open' category, the UAS operator must register at AESA's electronic headquarters as long as the UAS with which he operates has a maximum take-off mass (MTOM) greater than 250g, transfers an impact energy greater than 80J or is equipped with a personal data capture sensor such as a camera or microphone.

Programm:

Theoretical training part:	**Practical training part:**
History Unmanned aerial vehicle (drone) Structure of BGK Management and control BGK control devices and peculiarities of their use. Unmanned Aircraft Manufacturer's Handbook The most important technical indicators of BGK, the clash of reality and theoretical possibilities. Normative regulation Discussion of EU-level and national-level regulatory framework - with which BGK can I fly, and how much distance should I maintain from persons not involved in the flight or environmental objects? What are the responsibilities of the pilot and operator? Air space What are the structural elements of airspace and where are they found? Where, with what and at what height can I fly? What are the permanent restrictions in LR airspace? What are temporary restrictions and how are they communicated to airspace users? The human factor Limits of human capabilities and their impact on flight safety. How to assess your ability to fly safely? What are the main threats that arise from our abilities and perceptual peculiarities? Environmental conditions The influence of weather, terrain and anthropogenic factors on flight safety. Procedures Standard procedures, emergency and emergency procedures. BKG pre- and post-flight inspection and maintenance. What to do if GBK stops listening to commands? What to do when the situation becomes dangerous for other airspace users or those on the ground? Failsafe settings and how they work.	Before and after the flight activity - accompanied by the instructor, the cadets inspect the flight site, assess the flight conditions, possible obstacles, prepare the take-off and landing area, prepare the BGK for flight and other activities. Action in emergency cases - based on the knowledge learned in the theory course, plan and discuss with the instructors actions in emergency cases. Introduction to the BGK remote control program - cadets learn general information about the range of functions and settings of a specific BGK remote control program, which are necessary for flight performance. Practical training "Flight" - includes a demonstration of the piloting tasks defined by the CAA (equated to the practical exam in the CAA) and piloting the BGK itself.

[4] https://www.easa.europa.eu/document-library/easy-access-rules/easy-access-rules-unmanned-aircraft-systems-regulation-eu

Practical tasks during training Work with identification of technical characteristics of BGK, identification of airspace restrictions and necessary coordination, finding and analysis of temporary restrictions. The test of theoretical knowledge is equated to the CAA test (test).	

4. Needs: capacity gap assessment

For the primary assessment in Latvia, we have chosen a self-completed survey. We consider it to be the best option because it requires less time for both interviewees and interviewers, it is easier to contact interviewees via email, and they can answer the questionnaire whenever they want, which brings flexibility and freedom to the process.

In order to carry out the primary assessment, we have designed a Latvian Google form, which we have sent via email to the pre-selected companies, centers and institutions.

We have distributed the link to the form with an introduction and summary of the Project to 42 stakeholders:
This practice has been essential for gathering information for the primary assessment. Also, it has been a critical action for the project dissemination since we have informed a large number of stakeholders about the name, contents and project objectives.

Thanks to this action, we have incorporated an important Vet center in the aviation sector as associated Partner, CFELYA (Training Center in Electricity, Electronics and Aeronautics).

We have received 23 responses to the self-completed survey so far and these are the main findings:

Participating Organizations / Companies:

- Micro enterprise up to 10 employees 15 answers
- Small and Medium enterprise (more to 250 employees) 5 answers
- Big enterprise (more to 250 employees) 1 answers

  State provided companys

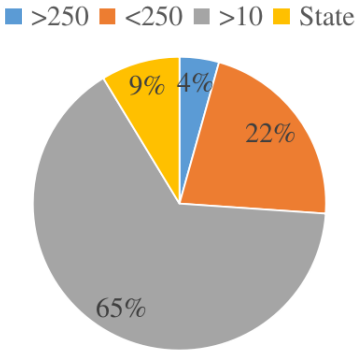

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Figure 2: Participating organizations / companies

We have received a balanced participation between companies and training centers in order to have imputs from the training field and the labor market.

All the centers consider that the aviation industry and drones will play an important role in the future.

Companies:

The companies that answered the questionnaire are involved in auxiliary fields of the aviation industry and drone

operations, as well as training and sales.

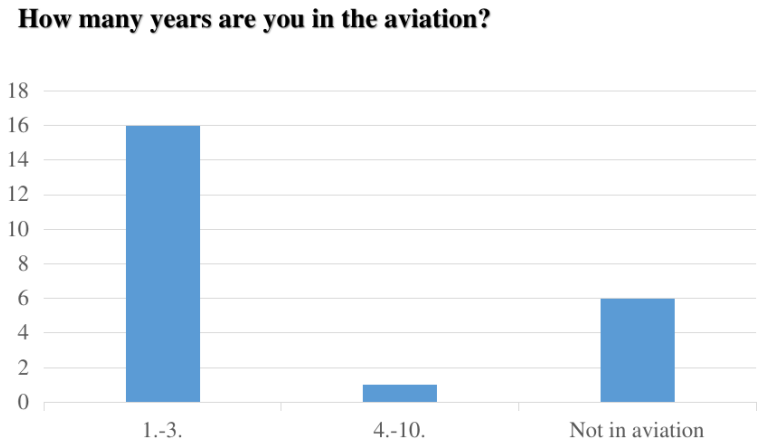

Figure 3: Number of years of respondents working in the aviation industry

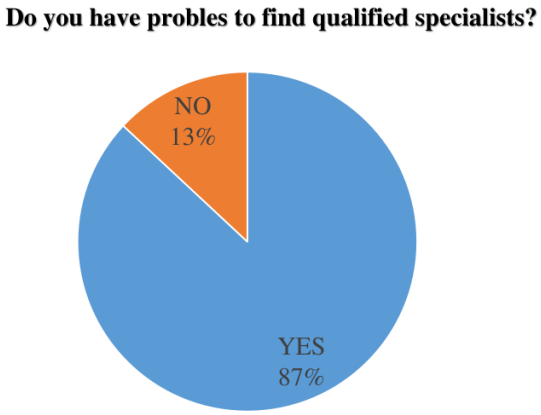

Figure 4: Respondents' problems in finding qualified personnel

Problems finding qualified personnel:
87% of those surveyed have problems finding qualified personnel.

The main problems in finding qualified personnel:
Lack of specific training
Lack of experience

Relevance of core competencies (programming, electrical knowledge, mechatronics knowledge, safety and security).

The most important skills for companies:

- Programming
- Mechatronics
- Electronics
- Electricity
- Aeronautics
- Photogrammetry and remote sensing

5. Challenges

The aeronautical sector is facing a year of challenges marked by the recovery of the sector after the crisis caused by Covid-19.

The crisis generated by the Covid-19 pandemic has significantly impacted the aviation industry due to a drastic reduction in demand. This situation has led to a decrease in revenues, profitability and liquidity, as well as an increase in indebtedness. As a result, the financial stability of companies in the sector has been weakened.

The aeronautical sector, and especially the civil aviation sector, has challenges ahead, including reaching pre-pandemic activity levels, the implementation of digitalization in the industry, progress in sustainability and the environment, and quality participation in CDTI support programs for aeronautical R&D, among others.

Future prospects.

The future outlook for the civil aeronautics market assumes a stable growth situation in the coming years in terms of manufacturing activity, including sales of developments maintained over the last decade and excluding the crisis period caused by Covid-19.

The outlook for the defence market is more optimistic than in previous years. Defense budgets have been marked for several years by budgetary restrictions, with a few exceptions, and the trend has changed in the last fiscal year. Future aeronautical systems for defense will be technologically very advanced and therefore very expensive. In Europe, not even the most developed countries will be able to cope with them alone, so they will have to be tackled in cooperation.

In general terms, companies with a presence only in the defense market face a more uncertain future, while those diversified in civilian markets or in other non-aerospace activities are in a better position to overcome the current situation.

This new situation may compromise the technological and industrial base if companies are forced to reduce their engineering departments, which would be difficult to recover when economic circumstances allow new investments in defense. It should be borne in mind that defense developments are always generators of new technologies, which in many technologies, which in many cases then have civilian applications in various sectors (dual-use technology).

However, this trend in the defense market, as mentioned above, has begun to change as a result of the European Union's firm commitment to Common Defense, and the new Preparatory Action for Defense Research, whose main objective is to promote strategic R&D&I initiatives, among which defense aeronautics may be included. Together with this initiative, the European Defense Action Plan foresees more favourable prospects for the defense aeronautics industry in the cooperative development of defense capabilities.

One of the most promising technologies where governments seem to be willing to put more resources is that **of Remotely Piloted Aerial Systems (RPAS).** All major countries currently have ambitious programs of their own in this area, although it is necessary to coordinate common interests in order to achieve a program covering different types of these systems and consolidate the sector's prospects.

Main challenges facing the Latvian aeronautical sector

- **IMPROVING THE COMPETITIVENESS OF THE AEROSPACE INDUSTRY**

At present, the challenges facing the aeronautical sector stem from internal factors of diverse nature:

- Its position in the supply chain as prime contractors or subcontractors.
- Its structure (industrial, capabilities, and capital)
- Its company size
- Its level of specialization in the civil and defense markets.

- **TRAINING IMPROVEMENT**

The Administration is aware of the relevance of training in developing the country's industrial structure and, through its competent bodies, reviews and updates measures to improve training.
The Administration already establishes general standards in formal training, occupational training and continuous training.

However, the specificity of aeronautical technology and the continuous emergence of new processes and technologies force companies to internalize them long before they become established in formal training. Companies meet this need, either with internal training or by turning to external agents.
Although there are occupational training and continuous training tools that address them to a greater or lesser extent, they are limited in amount and scope.

Competition on two levels, with countries with lower labor costs and with countries with a broad technological base, has led to the offshoring of work and, in the best of cases, to the incorporation or

substitution of more advanced processes that require continuous training of employees, as a recurring dynamic.

Aeronautical companies require training that allows:

- Quick incorporation of new manufacturing technologies in the production cycle and incorporate the professional requalifications demanded by the so-called Industry 4.0.
- Broad dissemination in the company and the associated supply chain.
- Develop comprehensive training plans in the new behaviours that facilitate the maintenance of the competitiveness of the industry.
- Incorporation of the dual training model
- Transform learning models by promoting cooperative learning in the industrial world.

IMPROVEMENTS IN TRAINING FOR AERONAUTICAL COMPANIES

Sustainability in the aeronautical sector's leadership lies to a large extent in adapting the training schemes from which the sector is fundamentally nourished to the standards of excellence available in the most advanced societies.
These needs and their improvement actions are focused on three pillars:

NEW NON-ACADEMIC SKILLS:
Training in new skills applicable to all levels of the company, technical, administrative and production professionals must have skills such as collaborative communication, innovation and business management, as well as technologies derived from the new Industry 4.0 when they join the company.

TECHNICAL SPECIALIZATION OPTIONS:
In terms of higher education, the deployment of new technologies and simulation techniques cannot create the appearance that specialization and deepening in traditional areas of knowledge are unnecessary.
It is necessary to ensure the availability of these training options and facilitate the vocational approach to them because of the expectation of immediate entry into the labour market, with agreements on university-enterprise content, doctorate options and facilities to make specialization studies compatible with incorporation and practice in the company.

As for vocational training, the new industrial capacities are generating new vocational training needs. Thus, to the traditional middle-level vocational training related to the aeronautical sector, the "Aircraft Maintenance Technician", new qualifications should be easily added, such as:

- Technician in Assembly of Structures and Installation of Aeronautical Systems.
- Technician in Composite Materials Manufacturing
- And others related to new technologies and processes that will be developed in the future thanks to R&D&I efforts.

Providing the educational system with sufficient flexibility to create new degrees according to industrial demand.

IMPLEMENTATION OF THE DUAL TRAINING MODEL:
That improves the attractiveness of vocational training for students and adapts the skills and knowledge of graduates to the industrial and labour reality of the company.

6. Conclusions and remarks

The UAV sector is growing in Latvia. It is increasingly being introduced in new fields in addition to those traditionally known, such as:

- audiovisual production
- surveillance,
- delivery sector
- emergency response
- search for people
- fiscal control
- border surveillance
- agriculture
- forest fire control
- archaeological research
- geology
- underwater research
- handling of harmful materials...

These innovative applications of UAVs have created new needs in the labour market that cannot be fully satisfied since complete professionals are not being trained. The complete professional will not only be qualified to operate drones but also to carry out complementary and related tasks such as manufacturing, assembly, repairs, etc.

The Latvian educational system offers a fev training, these training itineraries do not include training in the UAV field, or if they do, it is only partially.

On the other hand, training from the private sector is focused on drone operation. There are self made programms and regulated exams to obtain a license, which is essential to operate drones from a professional point of view.
The training centres, with a few exceptions, focus on this theoretical/practical training necessary to obtain the operator's license without paying attention to other skills or competencies.

We can conclude that the high-quality professional aeronautical training adapted to the aeronautical industry does not pay the necessary attention to unmanned aircraft. And the training specifically dedicated to UAVs is mainly focused on the handling and operation of the devices without addressing other competencies or skills.

Through this country report, we found that the situation generates an imbalance between labour market demand for professionals of this profile and the reality. Employers in the sector have stated that they do not find professionals with the appropriate training. They consider it very useful and necessary to address those competencies and skills that the official training itineraries have so far overlooked.

For all these reasons, we think it is necessary to expand the existing training itineraries with a new curriculum for aerospace mechatronics technicians. A specific training adapted to the needs of this emerging profession and already highly demanded in the market.

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Development of an aviation aerospace mechatronics technician curriculum

Country snapshot and capacity gap assessment

COUNTRY: POLAND

DATE: 26.10.2022

Co-funded by the European Union

1. Summary

General information

Official name: Republic of Poland (abbreviated name: Poland)

Poland is located in Central Europe, bordered by Germany, the Czech Republic, Slovakia, Ukraine, Belarus, Lithuania and Russia (Kaliningrad Oblast). Its northern border (440 km long) runs along the coast of the Baltic Sea.

Poland's population is the seventh largest in Europe (excluding Russia) and the sixth largest in the European Union - 38 million inhabitants.

Poland's greatest asset is its people, especially their ambition, motivation to learn and high work ethic, loyalty and entrepreneurship. In addition, companies starting up in our country can count on consumers who are open to modern solutions.

Poland ranks 3rd in the prestigious international PISA assessment of students' skills. As one of the few countries, thanks to educational reforms, Poland has kept the share of underperformers below 15% in all assessed areas in PISA 2018. This result is possible thanks to a highly developed education system that makes every effort to ensure that students receive the highest quality education.

As many as 92% of Polish citizens aged 25-64 have at least a secondary education. This result places Poland in 5th place among all OECD countries and is well above the average, which is 78%.

Almost 1.3 million students study at Polish universities, placing Poland 4th inEurope in terms of students' numbers. What makes the Polish higher education system stand out is the large number of students in STEM subjects (science, technology, engineering and mathematics).

Poland is a member of the European Union (EU), the Schengen Area, the North Atlantic Treaty Organisation (NATO), the United Nations (UN), the International Monetary Fund (IMF), the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the United Nations Children's Fund (UNICEF), the World Health Organisation (WHO), the World Trade Organisation (WTO), the Organisation for Economic Cooperation and Development (OECD) and many others.

There are 22 industrial districts in Poland: Górnośląski, Rybnicki, Krakowski, Bielski, Opolski, Częstochowski, Piotrkowsko-Belchatowski, Warszawski, Łódzki, Staropolski, Lubelski, Tarnobrzeski, Rzeszowski, Karpacki, Kalisko-Ostrowski, Wrocławski, Legnicko-Głogowski, Sudecki, Poznański, Bydgosko-Toruński, Szczeciński .

Currently, the coal, fuel and energy industries are considered to be the most rapidly growing industries in our country.

The largest contribution to GDP is made by the SME (Small and Medium-sized Enterprises) sector and especially micro-enterprises. In the case of SMEs, the largest group is made up of companies in the service sector, while large enterprises are dominated by industrial activities. The SME sector still accounts for the overwhelming majority of enterprises in Poland .

Summary

The legitimacy of the project's implementation is confirmed by the analyses presented in this report of the aviation market in Poland, especially the drone market, which is characterised by high growth dynamics.

Drones, as a tool, as a system should be looked at in three levels.

The first is the equipment itself, its design, the use of the latest materials, power systems. And this is where the huge challenge of building educational, technical and service facilities comes in. Just as in aviation the process of design, construction, maintenance of continued airworthiness and eventually repair is clearly regulated by international aviation laws, so too in the case of drones, whose presence will become more and more common in our living space, the oversight of their creation and servicing must be bound by legal standards. This is due to the need to ensure high safety standards. Hence, the development of technical education in this area is considered essential.

The second aspect is the question of using IT solutions and artificial intelligence. The idea behind drones is their autonomy, which allows them to be used to their full potential without the constant presence of a human. BSP flights are possible in the area of visibility and out of sight of the operator. In particular, the development of solutions that allow drones to be used as autonomous units, reacting to each other, learning the management system represents the greatest opportunity for the widespread use of drones. The use of artificial intelligence (AI) for the creation of these systems is therefore becoming essential.

The third pillar is the areas of application. Transport, monitoring, entertainment, military use are just some of the areas where drones are finding their place. The development of technology and, above all, the development of new, efficient and long-lasting power systems for drones will allow for their full application, which is difficult to predict today.

It could be said that the only limit to the use of drones is our, human, imagination. It is not a new flying device, but a completely new technical plane with applications that are still difficult to foresee. The use of drones can dramatically change the approach to their use in, for example, urbanised spaces, in broadly defined services for the public strongly changing the quality of life of the population.

2. The aviation industry in Poland

Aviation

The history of the Polish aerospace industry includes the hard-fought construction from the moment Poland regained its independence in 1918, the wartime collapse and difficult reconstruction after World War II, the renewed stagnation caused by the systemic transformation of the 1990s and, most recently, the period of the COVID-19 pandemic, bringing huge and unpredictable losses in all areas of our lives.

Despite many unfriendly geopolitical factors, the aviation industry has always been one of the most rapidly developing areas of Polish industrial life. It is enough to trace the achievements of Polish constructors, scientists, engineers and pilots over the centuries to see that this is undoubtedly an industry that deserves special attention, considerable funding and more fokus than ever before.

From the very beginning of the Polish state, the Central Aviation Workshops (CWL) , later transformed into the State Aviation Works (PZL) in Warsaw, were established and still exist today (although under a different name). It was there that the first prototypes of the Polish WZ-VIII combat aircraft were born, as well as the PZL-P-1 fighter, the PZL-Ł-2 liaison aircraft, the PZL-3 four-engine bomber, the PZL-4 passenger aircraft and the PZL-5 trainer. The most successful designs of that period were the PZL-P.7 and PZL.11 fighters and the PZL-P-24 reconnaissance-bomber aircraft PZL.23 Karaś and PZL.37-Łoś.

The pre-war period saw the creation of two new aircraft factories in Mielec (Państwowe Zakłady Lotnicze Wytwórnia Płatowców) and Rzeszów (PZL- engine facility no 2). The outbreak of war halted work on the PZL 38 Wilk and PZL 50 Jastrząb designs.The period of the Second World War saw the seizure of aviation facilities by the Germans and their subsequent ,almost complete, destruction.In the post-war period, the traditions of PZL were continued by the Aircraft Experimental Workshops in Lublin, then in Łódź. At the turn of the 1940s and 1950s, the existing Central Aircraft Study in Warsaw changed its name to Wytwórnia Sprzętu Komunikacyjnego Nr 4 Okęcie. The flagship product of this period was the licence production of the Jak-12 family of aircraft.

The first aviation plant established after the war was Wytwórnia Sprzętu Komunikacyjnego PZL-Świdnik (PZL-Świdnik Communication Equipment Works), which was established in 1951 and over time specialised in the production of helicopters . The plant's most famous design is the PZL-W-3 Sokół helicopter. After the political transformation, the plant entered into cooperation with western concerns and in 2009 it was privatised and bought by the AugustaWestland company.

The last group are plants specialising in the overhaul and modernisation of aircraft equipment. Since 1957, it has been Lotnicze Zakłady Remontowe renamed in 1982 to Wojskowe Zakłady Lotnicze No. 1. Since 2014, it has been part of Polska Grupa Zbrojeniowa (a Polish company established in 2013 by the State Treasury, one of the largest defence concerns in Europe. It brings together more than 50 companies and holds shares in 32 others -branzes: defence, shipbuilding, new technologies).

Aircraft Repair Works No2 was launched in Bydgoszcz after the war. Currently, the F-16 National Service Centre operates within WZL nr2.In Dęblin, after numerous name changes, there is a branch of WZL No. 1 in Łódź. In Warsaw, the Lotnicza Baza Remontowa has merged with Wojskowy Zakłady Lotnicze No. 2 as a joint stock company since 2020. Although the systemic transformation of the 1990s brought the Polish economy into the modern age and ensured its spectacular worldwide growth for decades to come, in the case of the domestic aerospace industry it brought rather a reduction in production capacity and a reduction in capability. The most important aviation plants were bought by international aeronautics giants and today mainly produce more or less complex components for them. Thus, companies remaining in the hands of the state or based on Polish capital have lost the capacity to produce any manned aircraft .

At present, the aviation industry consists of two groups of enterprises: private plants owned by international concerns and plants owned by the State Treasury - the Polish Armaments Group, which includes Wojskowe Zakłady Lotnicze No. 1 in Łódź and No. 2 in Bydgoszcz. The first plant deals with the repair of helicopters and the manufacture of rubberised composite products and electrical harnesses, the second with the servicing and modernisation of combat aircraft used by the army. The flagship hits of the Polish aerospace industry are the aforementioned Sokół helicopter, the M 18 Dromader agricultural aircraft and the best-recognised Black Hawk multi-role helicopter used by dozens of armies around the world for more than 40 years.

The Polish state currently has little influence over private companies operating on a commercial basis which are part of large global aircraft manufacturers, especially those operating in the civil dimension. Nevertheless, the state-owned company LOT may prefer those with a large number of components produced in Poland when selecting aircraft. The starting point for building a truly Polish (i.e. based on Polish capital) aerospace industry will primarily be the plants in Łódź, Bydgoszcz and Kalisz and the Warsaw institutes. Their development, however, depends on overcoming three key and interconnecting problems, i.e. competence primarily in Soviet-era systems, the issue of offset policy and the lack of technology.

An important point in the development of the aviation industry is close cooperation with academic and research centres related to this sector of the economy. Currently, the following centres in Warsaw, Rzeszów, Wrocław, Lublin and Łódź play a significant role in this respect. The development of the aviation sector would not be possible without qualified employees - every year Polish technical universities graduate over 40 000 engineers (including 3 250 automation and robotics graduates, 6 000 mechanics and machine design graduates and 530 aviation graduates). An excellently developed system of university education, as well as vocational education and rich traditions, are factors influencing the quality of personnel in the aviation sector.

When characterising the Polish aviation industry, it is impossible not to mention the Aviation Valley - located in south-eastern Poland and known for its developed aviation industry and pilot training centres. Just two years after its creation, the Valley signed agreements with schools that promised to prepare specialists for it. There was a need for 1,500, and five Valley companies provided patronage to schools in Rzeszów, Ropczyce, Stalowa Wola, Mielec and Krosno. The companies helped to equip workshops and train teachers. It was then that the idea to build new laboratories for schools was born. This dream is only now coming true. Using EU money, 12 such laboratories are being built in the Podkarpacie region for 112 million PLN. The Valley also cooperates, of course, with universities from which it recruits engineers. Most closely with the Rzeszów University of Technology. But commentators point out that the link between DL companies and science should be even greater. The valley was helped by the launch of the Podkarpackie Science and Technology Park 'Aeropolis' - on almost 200 hectares around the airport, land was developed, to which Goodrich - a manufacturer of landing gears for aircraft - moved part of its production. MTU Aero Engines, one of the world's largest manufacturers of power units, was located there.

Space sector

It is worth mentioning that Poland also has a long tradition in the space sector and participates in many international scientific and technological projects. In November 2012,Poland became the twentieth member of the European Space Agency with an annual budget of EUR 5.75 billion. This membership allows Polish companies and scientists to fully participate in numerous European space programmes and missions. In addition to ESA membership, the Polish Space Agency (POLSA) was established in 2014 to fulfil governmental tasks in the field of research and development of new space technologies. In 2022, the Polish space sector consists of 330 entities - including more than 150 that are directly involved in international projects, around 12,000 employees in companies and R&D centres (in 2020 there were more than 300) and contracts worth more than EUR 140 million.

Drone industry

The drone industry also deserves separate attention. The aerospace industry, and in particular the construction and production of unmanned aerial vehicles, has enormous economic potential that is worth developing, as there are great opportunities for global success in this field. A number of drone-related entities are conducting their business in the Silesian Voivodeship and, in addition, many of them are members of the Silesian Aviation Cluster. This provides an opportunity to act together and join forces in order to gain a competitive advantage on the national as well as the international market.

A separate topic is the rapidly developing drone industry and market in Poland. Indeed, in 2020, Poland achieved one of the highest rates of readiness to implement drone services in the world and is the EU leader in the digitalisation of services supporting

unmanned aerial vehicle operations. This is the result of, among other things, the Polish Air Navigation Services Agency's implementation of the operational concept and the PansaUTM system, which enables the coordination of drone flights in the controlled space of airports. The drone industry in Poland currently consists primarily of a group of small domestic companies engaged in the development of indigenous designs. The drone potential on the Vistula is also being created on the basis of strong research and development units, the largest of which is the Aviation Institute in Warsaw. The army is successfully using indigenous designs in its operations, which is why several solutions have already been used by the Polish army (WB Electronics Group), and in the future other solutions (such as the Orlik programme implemented by WZL2 in Bydgoszcz from the Polish Armed Forces Group) or solutions from the Asseco Group are likely to be used by the army. A major order for the Polish army will be the delivery of the entirely indigenous WIZJER system, developed by the Air Force Institute of Technology and manufactured by the Polish Armed Forces Group and Wojskowe Zakłady Lotnicze in Łódź.

Poland was the first country in Europe to launch a system for coordinating drone flights. The development of the PANSA UTM system, which was created thanks to the involvement of the Polish Air Navigation Services Agency and the Civil Aviation Office, is considered a huge success in laying the foundations for the development of the drone market in Poland. A large number of companies related to this industry operate in our country , and Poland has the largest number of drone operators in the entire European Union.

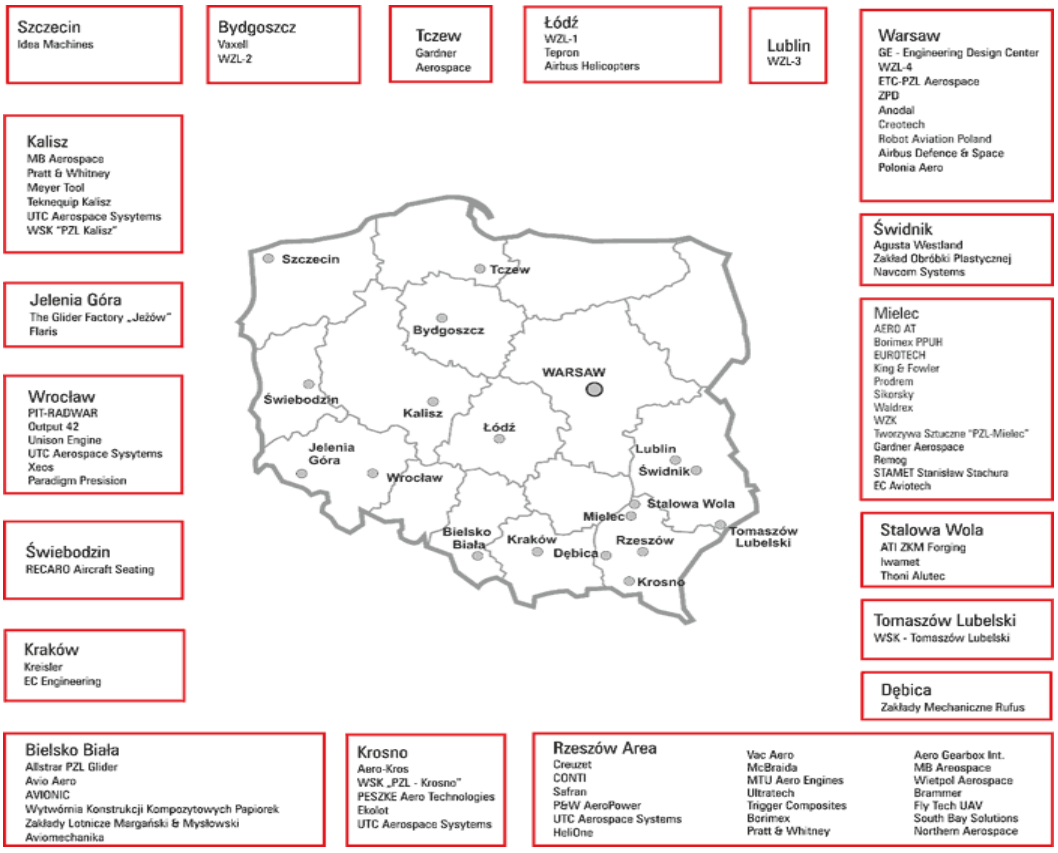
Sector in figures

- Sales value: EUR 1.25 billion (2020).
- Share of industrial production: 0,5% (2020).
- Number of employees: 17,900 in aerospace manufacturing and 98,400 in machinery and equipment manufacturing (CSO data for 2020).
- Number of companies in the sector: 29 companies (manufacture of aircraft and space vehicles, companies with more than 49 employees).
- Average salary in the sector: PLN 6 257.88 (national average in the industrial sector in 2020: PLN 5 404.07).
- Export value: EUR 0.8 billion (in 2020).
- FDI liability balance: EUR 1.49 billion (NBP, 2020).

In total, more than 200 companies from the aerospace sector have located in Poland, with annual sales reaching PLN 8.5 billion and creating more than 18,000 jobs. The majority of these are small and medium-sized enterprises (SMEs) and companies with foreign capital and the already few companies with a minority shareholding in the State Treasury. About 80% of the establishments are located in the south-eastern part of our country in one of the three existing clusters.

Selected aerospace companies:

Company name	Town	Employment
Pratt & Wittney Rzeszów	Rzeszów	4050
WSK "PZL - Świdnik" / Augusta Westland	Swidnik	2900
GE EDC Poland	Warsaw	1800
PZL Mielec, Sikorsky a Lockheed Martin Company	Mielec	1700
Thoni Alutec	Stalowa Wola	1500
Pratt & Whitney Kalisz	Kalisz	1400
HS Wrocław	Wrocław	900
PZL "Warszawa Okęcie", Airbus Defence and Space Company	Warsaw	850
HS Wrocław	Wrocław	500
Safran Transmission Systems Poland	Sędziszów Małopolski	700
MTU Aero Engines Polska	Rzeszów	700
PZL "Warszawa Okęcie", Airbus Defence and Space Company	Warsaw	680
WSK PZL Kalisz	Kalisz	600
Avio Aero	Bielsko-Biala	400
UTC Areospace Systems (Goodrich)	Krosno	400
MB Aerospace	Rzeszów	300
Hamilton Sundstrand Polan	Rzeszów	250
Gardner Aerospace	Mielec	200
Paradigm Precision	Wrocław	200



Internationally recognised quality of products offered

The plants in operation specialise in the production of aircraft (agricultural, training, training, disposition), helicopters, gliders and components (aluminium, composites, GRFP) and accessories. The export value of aerospace production reached €0.8 billion in 2020. The main export markets are : USA, Ukraine, Russia, Italy, Iceland, Saudi Arabia, Canada, France.

Aerospace clusters

- Aviation Valley - It is located in south-eastern Poland, known for its developed aviation industry and pilot training centres. The region is characterised by Poland's largest concentration of aerospace companies, research and development centres and developed facilities for education and training. Currently, the Association comprises 158 entities from the region.
- The Silesian cluster - the Leader of the Silesian Aviation Cluster - the Federation of Aviation Companies - was created naturally, as a result of real and concrete cooperation between 15 companies. Currently, several dozen entities, including universities and business environment institutions, belong to the cluster.
- Wielkopolski Klaster Lotniczy - Brings together six companies producing components for the aviation industry: Pratt & Whitney Kalisz, Wytwórnia Sprzętu Komunikacyjnego "PZL Kalisz", Vac Aero Kalisz, Meyer Tool Poland, Hamilton Sundstrand Kalisz and Teknequip Kalisz. These companies employ a total of nearly 2,500 people.
- Dolnośląski Klaster Lotniczy (Lower Silesian Aviation Cluster) - It was established under the auspices of the Minister of Economy in 2014 in connection with the growing role of the aviation sector in south-western Poland, bringing together companies and

institutions willing to cooperate for the development of the aviation industry in the region.

- Lublin cluster
- National Centre for Space and Satellite Engineering

In November 2012. Poland became the twentieth full member of the European Space Agency with an annual budget of EUR 5.75 billion. This membership allows Polish companies and scientists to fully participate in numerous European space programmes and missions. In addition to ESA membership, the Polish Space Agency (POLSA) was established in 2014 to fulfil governmental tasks in the field of research and development of new space technologies.

High quality of human resources

The development of the aeronautics sector would not be possible without qualified employees - every year Polish technical universities graduate more than 40,000 engineers (including 3,250 automation and robotics graduates, 6,000 mechanics and machine design graduates and 530 aviation graduates). An excellently developed university as well as vocational education system and rich traditions are factors contributing to the quality of the aviation sector's human resources. In addition, initiatives such as AREOnet (www.areonet.pl) have led to closer cooperation between industry, local authorities and school and university authorities in order to further improve the preparation of human resources by, among other things, developing a training programme and matching the profile of schools with the needs of the labour market.

Selected universities and research centres related to the aviation sector

- Warsaw University of Technology
- Rzeszów University of Technology
- Institute of Aviation
- Silesian Science and Technology Centre for the Aerospace Industry
- Military University of Technology
- Wrocław University of Technology
- Lublin University of Technology
- Technical University in Łódź
- Silesian University of Technology

Higher education in the academic year 2021/2022 (preliminary results) - "CSO data source – 15-06-2022

- As of 31 December 2021, there were 1218.2 thousand students in higher education institutions, 2.9 thousand more than in the previous year. In the 2020/21 academic year, the diploma of completion 297.4 thousand graduates received their degrees, 3.9 thousand more than in the 2019/20 academic year. A 0.2% increase in the number of students compared to 2020/2021
- Technology, industry, construction were respectively selected by 14.0% of the total number of students

Useful links

- www.dolinalotnicza.pl - Aviation Valley
- www.aerosilesia.eu - Silesian Aviation Cluster
- www.wkl.org.pl - Wielkopolska Aviation Cluster
- www.ilot.edu.pl- Institute of Aviation
- www.itwl.pl - Air Force Institute of Technology
- www.areone.pl - Areonet Advanced Technology Centre - Aviation Valley
- www.scntpl.pl - Silesian Science and Technology Centre for the Aerospace Industry
- www.parklotniczy.pl - Bielski Aviation Technology Park for Entrepreneurship and Innovation
- www.aeropolis.com.pl - AEROPLIS Podkarpackie Science and Technology Park
- www.cbk.waw.pl - Space Research Centre PAS
- www.ulc.gov.pl - Civil Aviation Authority
- www.porty-lotnicze.com.pl - Airports
- www.kpk.gov.pl - National Contact Point
- www.kpk.gov.pl/en/potential/platforms/pl.html - Technology platforms
- http://www.ncbir.pl- National Centre for Research and Development

Air passenger and cargo transport - based on CSO data as of 31-05-2022

Cargo and passenger transport compared to the previous year- there was an increase in cargo transport in most transport modes. The number of passengers carried increased in all modes of transport.

- In 2021, air transport carried 43.3% more freight than the previous year. Air transport prevailed in international transport.
- In 2021, there was an increase in passenger transport by all modes of transport. The largest increase in transport was recorded in air transport (by 92.7%) compared to the previous year. Such a significant increase in the number of passengers carried was due to the lifting of restrictions on passenger travel introduced in connection with the pandemic state associated with the spread of the SARS-CoV-2 virus

Summary and conclusions

In summary, the aerospace, drone and aerospace industry in Poland has a huge scientific potential, a good technological base, opportunities. The pandemic situation has significantly hampered the thriving aerospace industry, which, despite the huge losses, is recording increasingly better business results. The strengths of the aviation market are the relatively modern infrastructure of airports, the high qualifications of staff (mainly pilots and controllers), the increasingly dynamic growth in air traffic since 2004, and the profitability of airports. The Polish state invests considerable outlays in the development of the latest technologies, improvement of air traffic safety . The position

of the national carrier PLL LOT S.A has also increased against the background of carriers from the region of Central and Eastern Europe.

Noteworthy is the activity of the Aviation Valley, located in south-eastern Poland and known for its developed aviation industry and pilot training centres. The region is characterised by a high concentration of aviation industry companies, research and development centres and developed educational and training facilities. The heart of the Aviation Valley lies in the capital of the Podkarpackie Voivodeship - Rzeszów. 100 years of aviation history . The location is not accidental. The location of the Valley was determined by:
more than 80 years of aerospace history

- 90 % of Polish production in the aerospace industry
- competitive labour and production costs
- Rzeszów University of Technology with a developed Faculty of Mechanical Engineering and Aeronautics
- an investor-friendly environment
- low corporate income tax (CIT)
- centrally located airport with international character
- the main motorway connecting south-eastern Poland with its south-western part

The weaknesses of the Polish aviation industry are undoubtedly the lack of capacity at airports (mainly the largest ones), the shortage of qualified staff (pilots, mechanics, engineers with a specialisation in aviation), the slow rate of implementation of new technologies, the difficult financial situation associated with the COVID-19 pandemic, and the fact that the aviation industry is still based on outdated post-Soviet technologies. An opportunity for the development and economic improvement of this industry will undoubtedly be provided by the construction of the Central Communication Port (Baranów Commune at a distance of approximately 37 km from the centre of Warsaw), combining air, road and rail transport. With the creation of the CPK, new jobs will be created for hundreds of specialists in various fields. There will also be an increase in the importance of Polish transport in the world. Investment in and access to the latest global technologies, support for research, education already at secondary school level, changes to curricula and professional qualifications guaranteeing the acquisition of an employee who is well-prepared for market expectations, and finally cooperation between the Ministry of Education and Science and entrepreneurs, economists and labour market analysts, are of great importance.

And when it comes to the strictly drone market, the importance of this sector is evidenced by the fact that investment in drones has been written into the draft National Recovery Plan. A total of €164 million is planned for activities including:

- the creation of conditions for testing and implementing solutions and services based on the use of BSP,
- creation of the Autonomy Cluster and Drone Technology Park,
- testing and implementation of drone pilots, standardisation of solutions, implementation of local infrastructure for the coordination of BSP flight operations,
- the creation of digital-drone support structures for Public Order and Emergency Medical Services,

- establishment of the Pomeranian Centre for Monitoring and Management of Environmental Information,
- the establishment of a Centre of Drone Competence at the Civil Aviation Authority.

3. Opportunities

The current system of secondary, upper secondary education in Poland includes general secondary schools, technical secondary schools and basic vocational schools. Most young people aged 13-19 attend these types of schools. In addition to upper secondary, post-primary schools, there are also post-secondary schools for those who have completed the general secondary education pathway. Admission of students to the selected types of secondary education schools is determined by the result of the examination at the end of the eighth grade of primary school. Pupils are examined on the basis of the requirements of the core curriculum after completing the required learning pathway. They aim to pass:

- in terms of education in general subjects, the baccalaureate examination for admission to higher education, held in secondary schools and technical colleges,
- in vocational subjects, a vocational qualification examination at basic, technical and post-secondary schools. Higher education takes place at polytechnic-type colleges or universities in the form of degree programmes.

Vocational training for the aerospace industry within the general education system:

Smooth operation of aerospace companies requires the following technical vocational training courses:

Symbol	Name of the profession	Designation qualifications	Name of qualification
315317	aviation mechanical technician	TLO.03.	Perform maintenance on the airframe and its installations and the aircraft powerplant
311504	mechanical technician	MEC.03 MEC.05. MEC.08. MEC.09.	Assembly and operation of machinery and equipment, either Use of cutting machine tools, or Making and repairing machine, plant and tool components Organisation and supervision of machinery and plant production processes
722204	locksmith	MEC.08.	Making and repairing machine, plant and tool components
722307	machine tool operator	MEC.05.	Use of machine tools
723310	machine and plant fitter mechanic	MEC.03.	Assembly and operation of machinery and equipment
Electrical-electronic-telecommunications in the professions:			
315316	avionics technician	TLO.01.	Perform maintenance on aircraft avionic and electrical equipment
311408	electronics technician	ELM.02. ELM.05.	Assembly and installation of electronic circuits and devices Operation of electronic equipment

351203	IT technician	INF.02. INF.03.	Administration and operation of computer systems, peripherals and local area networks Creation and administration of websites and web applications as well as databases
311410	mechatronics technician	ELM.03. ELM.06.	Assembly, commissioning and maintenance of mechatronic equipment and systems Operation and programming of mechatronic equipment and systems
742118	mechatronics	ELM.03.	Assembly, commissioning and maintenance of mechatronic equipment and systems
742117	electronics engineer	ELM.02.	Assembly and installation of electronic circuits and devices
Airport operations			
315406	Airport Operations Technician	TLO.02.	Airport operations and cooperation with air navigation services
Forwarding and shipping-logistics in the professions:			
333106	Port and terminal operations technician	SPL.02. SPL.03.	Passenger handling in ports and terminals SPL.03. Cargo handling in ports and terminals

Education is based on the core curriculum and the curricula created on its basis

The technical universities offer a number of courses of vocational engineering training necessary for the growing aviation industry: mechanics and mechanical engineering, electrical engineering, electronics and telecommunications, computer science, aerospace, transport, automation and robotics, materials engineering, mechatronics. The above fields of study are divided into numerous specialisations, e.g. aviation: avionics, aircraft engines, piloting, airframe construction, aeroplanes and helicopters, aircraft propulsion, aircraft armament. Today, almost all aerospace companies have engineering departments related to research and design, production technology, quality assurance and maintenance of ICT systems. In aerospace companies focused on research and development of new products and technologies, the share of employees in these departments in relation to the total number of people employed can be as high as 50%. In 2015, employment in research and development activities, measured in full-time equivalents in 2015 compared to 2014, increased by 4.6%. Thus, it is important for the aerospace industry to increase training especially in higher education. The increasing automation and complexity of production systems and increased investment in design will result in a gradual increase in the need for highly qualified people.

Practical technical education in the current education system is based on:

- school laboratories, university laboratories,
- school workshops that are centres of practical training for a particular group of occupations,
- internships and placements with employers.

4. Needs: capacity gap assessment

The most sought-after skills in the aviation sector

There is an increasing demand for specialists and managers in the aviation industry. Over the next 5 years, domestic and international companies in the aviation industry will employ around 4,000 new workers in Poland. The upward trend in employment in this sector has been going on for several years now and is increasing year on year, but the demands are also increasing. In the coming years, many specialists and managers with aviation education and experience and very good English language skills will be needed. Currently, the most sought-after for new aviation investments in Poland are mainly operational, production, quality and logistics managers, as well as production, quality, R&D, purchasing, construction and production process engineers.

In addition to management and engineering staff, CNC operators, mechanics, welders and quality department employees are and will continue to be sought after.

Every foreign aerospace company that has already invested in Poland is very satisfied with Polish specialists. The qualifications and skills of our engineers, as well as their competitive salaries, are highly valued, which continues to attract new companies to Poland. Like the rest of the world, the aviation industry in Poland is facing a huge crisis caused by a pandemic of more than two years. One might be tempted to say that it is an industry without employees. Based on Eurostat data, around 600 000 employees could leave in 2020. Analyses show that during the first period of the pandemic, 53% of men lost or were made redundant. The figures are improving for the moment, as there is an increase in the recruitment of workers.

Specialists are primarily sought by centres closely linked to the aerospace and drone industry. For potential employers, education, work experience, possession of additional qualifications, and good English language skills are particularly important. In research conducted by the Silesian University of Technology, it was found that among the qualities and abilities preferred by employers, the following skills are important:

- problem-solving skills - 43%
- adaptability to new situations (flexibility) - 33%
- Interpersonal skills (e.g. networking, communication skills) - 30%
- independence of action - 22%

An important thing that comes to mind when analysing the problem of the skills and competences required of workers in the aeronautics industry is the emphasis on the ability to work in a team, under time pressure, above-average resistance to stress, the ability to quickly assess a situation, the ability to apply knowledge to an appropriate situation or the ability to memorise simple mathematical calculations. A combination of technical knowledge and skills and aptitude will certainly be required of future employees in this industry. Analysing the labour market and the demand for specific employees, we can point to groups of shortage occupations according to the Occupation Barometer and after analysing job offers: olx, pracuj.pl, jobrapido and data from the Polish Air Navigation Services:

- pilots, air traffic controllers, flight dispatchers
- persons in charge of operational safety and ground handling
- Airport service workers: tarmac attendant, baggage handlers, sorters, baggage security workers, warehouse workers

- specialists: check-in, terminal passenger services, customs, airport relations, service sales, vehicle maintenance
- mechanics: aircraft, aircraft engines, airframes, deckhands
- technicians: air traffic equipment, aircraft mechanics, systems test operators, aircraft electrical fitters,
- Engineers: aerospace mechanics, mechatronics, software developers, IT analysts.

Online job portals have recently found offers for drone operators. Especially in the surveying, filming, environmental protection, emergency services and military sectors, licensed operators are in demand. Drone pilots are often expected to have VLOS/BVLOS, MR 25 licences, experience flying heavy drones, experience in thermal imaging or the operation of graphic programmes. As the drone market is very dynamic and growing, the demand for service technicians for these devices is beginning to increase. Nowadays, most outlets selling drones provide their customers with servicing in addition to specialist advice. The candidate for such a position requires knowledge of electronics, experience in servicing e.g. cameras or camcorders, experience in modelling. A good knowledge of English is a prerequisite.

The dynamic growth of air transport is generating an increase in demand for employees in the industry. The need for pilots, cabin crew members, mechanics and ground handlers continues to grow. The shortage of workers in the aviation industry is global. Hence, foreign markets offering competitive employment conditions may contribute to the outflow of qualified personnel educated in Poland. It is estimated that the aviation industry in Poland currently employs over 242 000 people. Due to the specific nature of the aviation industry and the narrow specialisation of professions related to civil aviation, the system of educating employees and their subsequent employment should be interrelated. Identified labour market needs for employees in particular professions should translate into the substantive and quantitative scope of the educational offer available to graduates of primary and secondary schools. Pursuant to art. 36 sec. 8 of the Act of 20 April 2004 on employment promotion and labour market institutions (Journal of Laws of 2021, item 1100), the minister in charge of labour specifies, by way of an ordinance, the classification of professions and specialisations for the needs of the labour market and the scope of its application. The implementing regulations issued on the basis of the aforementioned legal basis also apply to professions related to the civil aviation industry. Pursuant to Article 46b(1) of the Act of 14 December 2016. - Education Law (Journal of Laws of 2021, item 1082, as amended), the minister competent for education and upbringing establishes a forecast of the demand for employees in occupations of industry education in the national and provincial labour market. In the light of the cited provisions, in the current legal state, none of the professions in the area of civil aviation has been indicated as a profession for which, due to the importance for the development of the state, a particular demand for employees is projected on the national labour market.

Conclusions

Based on the analysis of the materials for this study, we note that the education of young people for the needs of the broader aviation industry is approached very responsibly in Poland. Confronting the hiring needs of the aviation industry with the possibilities of technical aviation education in Poland and the educational policy of the state is a priority, among others, during the annual National Conference of the Association of Technical Aviation Schools in Poznań (6 - 8 April 2022 - 10th Edition). The

professional group of education employees directly related to this branch of the economy is the fastest to notice the ills of the education industry and its opportunities, which can be collected below:

- the need to constantly confront the aviation industry's hiring needs with the possibilities of technical aviation education in Poland,
- monitoring the core curriculum for flight schools, in particular the number of hours allocated to subjects needed for aviation education and the requirements for obtaining a licence
- lack of link between technical education and the industry, i.e. the aviation labour market
- Lack of developed methods for the continuous intermingling of academic staff with professionals working in the aerospace industry. This results in a lack of mutual understanding of the needs of both parties during the training and hiring process.
- Internships, placements abroad ERASMUS+ and Worldskills competitions as an opportunity to develop innovation and attractiveness of vocational education

Greater flexibility in the creation of branches of technical and trade schools, and consequently greater autonomy for school principals, also seems justified. Such actions, combined with close cooperation with universities, employers or Job Centres, would be a guarantee of filling the deficit in occupations related to the broadly defined aviation industry. Earlier market analyses using available data produced annually by the Occupational Barometer would enable a more precise forecast of market needs in a region, voivodship or municipality.

5. Challenges

The broadly defined manned and unmanned aerospace industry is developing very dynamically in Poland. These words are confirmed by analyses:

- market research (occupational barometer)
- interviews with representatives of the uniformed services, emergency services, representatives of companies, firms, corporations, universities and research institutes, production companies

Number of conferences and exhibitions held in Poland in September 2022 alone:

- 6-9.09.2022 - 30th edition of the International Defence Industry Exhibition at the Kielce Trade Fairs conference complex
- 9-09-2022 - 5th Aviation Market Congress - Warsaw, Copernicus Science Centre
- 13-15 September 2022 -- 4th ACI Customer Experience Global Summit - Kraków Airport
- 18-09-2022 - Global Drone Conference - Targi Kielce conference complex. The photo coverage of the event at www.swiatdronow.pl is impressive.

On the basis of an analysis of the meeting programmes and topics discussed, it can be indicated that the challenge facing the broader aviation industry in Poland, in the context of European and global trends, is:

- to define the place of the Polish aviation market on the European and world aviation map
- to consider the impact of the war in Ukraine on air transport in Poland
- to look at aviation after the covid-19 pandemic (rebuilding broken transport, tourism and passenger chains)
- to consolidate changes in the aviation market and their impact on the industry
- to take an in-depth look at human resources for aviation (how to stimulate employment growth in the industry?)
- to adapt vocational education system, core curricula, programmes to the dynamically changing labour market
- to keep up with the educational process of vocational training with technical and technological advances in aerospace, IT

A major challenge for the industry will certainly be the need to invest in the development of teaching staff, the employment of industry specialists in the educational process and extensive specialist consultancy on curricula or specific qualifications for a particular profession. The analysis also resulted in a number of interviewees pointing out the need to raise the level of English language teaching to at least B2 for aerospace workers at technician or engineer level. Mathematical, IT, communication and social competences need to be taught in secondary education.

6. Conclusions and remarks

Vocational training by aerospace companies

In addition to education based on the general education system, employers have their own education systems resulting from the need to adapt the skills of newly recruited employees to the requirements of the specialised jobs found in the aviation industry. The general education system, especially at secondary level, is not able to provide adequate manpower in the occupations necessary for aerospace companies. Reasons for this include the inadequacy of the education system and the existence of positions in undefined occupations and not covered by vocational training.

At present, the Polish education system does not provide for the effective involvement of employers in the creation of new professions and the modification of existing core curricula at the secondary education level. The predominant form of business cooperation in the field of technical vocational education is apprenticeships carried out by vocational school students. The jobs most commonly receiving vocational training from employers in the aerospace industry are:

- equipment operator (e.g. machine tools, measuring machines, robotic workstations, specialised machinery),
- special processes operator (e.g. heat treatment, washing, special coatings),
- aircraft engine fitter,
- aircraft engine mechanic,
- electrical and avionics systems fitter,
- automation and electronics technician for production equipment,
- non-destructive testing and quality control techniques.

The selection of the content of education at employers is based on the knowledge and professional experience of the employees acting as vocational instructors, the so-called in-house teachers. The standards and content of education vary from job to job and from employer to employer. Some employers have now attempted to adapt the education standards to their needs by:

- establishing cooperation within associations (industry clusters, chambers of commerce), - identifying one's own needs for the job, the standard of knowledge and skills requirements,
- the creation within the structures of dedicated posts responsible for the training of new staff,
- concluding agreements with local vocational schools regarding the adaptation of training content for specific jobs,
- concluding agreements with universities on the creation of completely new fields of study with the same educational content as the requirements of the new jobs, e.g. aviation management,
- increasing the number of places for apprentices and trainees.

Often, entrepreneurs also participate in the creation of patronage classes, through which schools gain:

- new equipment, teaching materials,
- participation of students and teachers in lectures, workshops conducted by the employer,
- participation of employers in the life of the school,
- scholarships for students,
- the organisation of practical training at the employer's premises.

Employers, when undertaking employee training, incur costs associated with:

- exclusion of employed staff from productive work for the duration of their duties as internal teachers,
- the purchase of additional machinery, materials, equipment and software for teaching purposes,
- use of premises resources for training and practice.

Training directly with employers is characterised by high efficiency, as:

- workers as vocational school graduates have basic theoretical and practical knowledge,
- only learning content directly related to the workstation where the training takes place is taught,
- learning takes place under the supervision of a dedicated staff of company teachers - the most experienced members of staff with teaching skills,
- characterised by high motivation: apprentices and trainees to gain employment

and new employees to prove themselves to the employer, receive monetary gratification, gain recognition among colleagues,

- learners see the direct results of their work

There is now a need for changes to align the education system with the needs of employers through:

- the possibility to pass a practical examination in a vocational subject during the apprenticeship, - reimbursement of practical training costs to the employer,
- introduction of new professions,
- modification of core curricula and syllabuses

It should be mentioned that projects are currently being implemented on:

- ensuring the functioning of the Integrated Qualifications Register,
- increasing knowledge of qualification and vocational needs,
- increasing the transparency and coherence of the National Qualifications System,
- the development of tools for lifelong learning,
- vocational education and training adapted to the needs of a changing economy.

National/regional strategies

Regional Innovation Strategy of Podkarpackie Voivodeship for 2021-2030 - Annex No. 1 to Resolution No. 302/5960/21

Board of the Podkarpackie Voivodeship in Rzeszów of 3 August 2021. - pp. 48-53 "Potential of industries representing smart specialisations of the region".

"... 193 entities were active in 2018, an increase of 9% compared to 2014. Of this number, 51% were large enterprises with at least 50 employees. What is important for the development of the aerospace industry is that in the Podkarpackie Voivodeship there are both large entities that are able to fully realise the final product in the form of an aircraft or an aircraft engine, and a network of suppliers who realise details and sub-assemblies for their needs…"

"...The development of the Aviation and Aerospace IS in the Podkarpackie Voivodeship is evidenced, among other things, by an increase in the total revenue of the sector's enterprises. In 2018, this indicator reached PLN 17.6 billion, an increase of 7% compared to the previous year, 28.3% compared to 2015 and 74.4% compared to 2010…"

The growth of the specialisation is also evidenced by the number of people working in the industry. In 2018, this was more than 39 000 people. Between 2014 and 2018, an increase in the dynamics of average employment was evident. The exception was 2017, which saw a decrease in this indicator, in 2018 there was a renewed increase of 6.3% compared to the previous year95. An increase in capital expenditure on new property facilities or improvements to existing ones is also evident - in 2018 it amounted to PLN 1.55 billion, an increase of 55% compared to 2014."

"...The production of unmanned aerial vehicles (so-called drones) is becoming an increasingly important branch of this aerospace industry - due to the possibility of their use for both civilian and military purposes and an increasingly extensive catalogue of

applications, it may contribute to an even faster growth in its importance. The area related to the development and deployment of other technologies with dual use (i.e. civilian and military) is also expected to grow…"

"...Scopus, which is the largest database of peer-reviewed literature, contains almost 350 publications in the field of aviation and aerospace science reported from the Podkarpackie region. Thus, the share of these publications in the total number of scientific papers included in Scopus is more than six times higher than the average value for the country…"

"...Podkarpackie aviation companies have been cooperating with regional universities for many years, including above all with the Faculty of Mechanical and Aeronautical Engineering at the Rzeszów University of Technology. It conducts

aerospace education, which is graduating more and more students each year (between 2014 and 2017, it was almost double the number of graduates).97 The educational offer of the

The international Aviation Management course implemented under the auspices of Lufthansa and Polish Airlines Lot has also been introduced by the University of Information Technology and Management in Rzeszów..."

"... There is also an Unmanned Systems Cluster in the province, which currently has 13 members. Its aim is, among other things, to develop new technologies in the field of unmanned systems..."

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https://kongresrynkulotniczego.pl/

Erasmus+

amtechtraining.eu

AMTECH

Development of an aviation aerospace mechatronics technician curriculum

Country snapshot and capacity gap assessment

COUNTRY: SPAIN

DATE: 11/07/2022

Co-funded by the European Union

1. Summary

The Spanish aeronautics industry is a sector with **high added value and exporting vocation**, whose technological developments are incorporated into other sectors of activity present in our daily lives.

The aeronautical industrial activity in Spain is mainly concentrated in Airbus products, complemented by participation in Boeing, Embraer, Bombardier and Sikorsky programs, among others. The sector is characterized by **very few large companies, with a larger number of medium-sized companies and a much larger number of small companies**.
In Spain, there are 436 companies with EN9100 certification, distributed among 670 production centres. SMEs represent 96% of the companies in the sector, and 15 companies have more than 250 workers.

The Spanish industry is currently present in all segments of activity; most of the aeronautical sector (76%) works in "aircraft and structures", 11% in "engines" and 12% in "equipment and systems".[1]

A **key differential** from the rest of the European companies is that **Spanish aeronautical companies contribute complementary to the turnover of the civil and defense markets.**

Between 2014 and 2019, the overall evolution of the national defense and aerospace sector was always positive, to the point of being "the fastest growing industrial sectors in Spain".

The civil aeronautics industry was the hardest hit by the Covid-19 crisis in 2019, due to the decline in demand for new aircraft. The flights were suspended for much of 2020, leading to an overall decrease in production activities.

The sector's recovery depends on competitiveness, which will be achieved:
- dedicating great efforts to R&D&I
- investing in technology
- by maintaining the capacity to cover the entire course of an aircraft: conceptual phase, design, development, manufacturing, assembly, certification, sale and support of the product once in service.

Knowledge, training and investment in R&D&I are key to the development of the aerospace industry. Continuous training of qualified professionals is essential for the competitiveness of the industry.

Training in the aeronautical industry in Spain is mainly articulated through vocational training offered by the following programs:

- Aeromechanical Maintenance Training Cycle.
- Aeronautical Systems Structures and Installations Assembly Technician.
- Higher Technician in Aeromechanical Maintenance of Aircraft with a turbine engine.
- Higher Technician in Electronic and Avionic Aircraft Systems Maintenance.

These programs cover all types of subjects related to aeronautics but not directly related to UAVs.

At the university in Spain, we also have aeronautics and aerospace degrees.

In the drone and unmanned craft sector, training is carried out by private academies and is focused almost exclusively on drone operation and navigating.
With a few exceptions, no training is offered in electronics, mechanics or mechatronics fields.

As a result of this situation, when we turn directly to the UAV sector, we find that **one of the main problems for employers is that they cannot find qualified personnel due to the lack of specific training**.

In conclusion, we can highlight good overall aeronautical training in Spain, especially in the VET ecosystem. But in the specific sector of drones and unmanned aircraft, the training is mainly focused on the operation of the aircraft, ignoring other fundamental elements to train a good professional such as electronics, computer science, assembly, etc.

[1] Gobierno de España; TEDAE. Agenda Sectorial de la Industira Aeronáutica (2018)

2. The aviation industry in Spain

The Spanish aeronautics industry is a sector with high added value and exporting vocation, whose technological developments are incorporated into other sectors of activity present in our daily lives.

It is a fully globalized sector whose products are characterized by very long life cycles (about 30/40 years). The industry is also very capital-intensive, as product development involves very high costs that require very high investments whose returns begin to be generated, in most cases, in the very long term.

The Spanish aeronautical industry is an eminently technological sector, as it competes not only on costs but also on the knowledge and the ability to develop new technologies that lead to improvements in products and or processes.

Depending on the company size of the aeronautical sector, three types of companies can be established: **leading, tractor and first level integrators, and auxiliary companies.**

Leading:
In the first group are the Original Equipment Manufacturers (OEMs), who act as designers, system integrators and certifiers. They are the ones who make the decisions on the launch of new programs. However, more and more often, they count on the capabilities of the supply chain that collaborates in the definition of the solutions offered and in financing the non-recurring costs (NRC).

Tractor and first level integrators:
The second group includes first-level suppliers (TIER 1), who integrate large components and structures, participating from the first steps in the definition of solutions to the requirements set by the OEMs. It is becoming increasingly important for these companies to be perfectly qualified technologically to develop and produce the components ordered. Suppliers who only industrialize or manufacture what others have defined at a low cost are no longer useful because a large part of the cost is defined in the choice of solutions and the design.
Tier 1 suppliers are usually dedicated to one or at most two specific areas of collaboration, structures, systems, engines or interiors. In addition, these companies are responsible for managing the supply chain "downstream", hence the importance of their good health, not only technologically but also in terms of management.

Auxiliary Companies:
The auxiliary industry integrates the third group, companies manufacturers of small subcomponents, parts and even individual operations that are also necessary for the delivery of the final product.
The ancillary companies require the same, or greater, support to guarantee the correct functioning of the system, given their worse technological, managerial and financial conditions.

Together, they form an integrated, structured and interdependent supply chain that can only achieve its objectives by working together.

The aeronautical sector is also characterized by:
- Require long periods for the development of its products.
- Large tractor companies with highly qualified and specialized personnel and enormous economic resources.

In return, it is one of the most attractive sectors for government investment because of:
- the returns it generates for society in terms of the multiplier of the amount invested over GDP,
- its contribution to the State via taxes,
- the number of direct and indirect jobs with very high qualifications that it generates,
- its penetration of foreign markets

Entering this sector with guarantees is highly complicated since it requires excellent reliability in design and manufacture, is subject to numerous quality and certification requirements and, in addition, uses state-of-the-art technology.
This is the reason why few countries, including Spain, have the technological know-how and industrial capacity to cover the complete cycle of such a complex system as an aircraft:

- Conceptual phase,
- Design,
- Development,
- Manufacture,
- Assembly,
- Certification,
- Sale and support of the product once in service.

Although Spain has this full-cycle capacity, the launch of such systems does not depend on domestic demand. It is decided in an international and global market environment and is articulated based on large new aircraft or engine programs with a significant impact on a globalized supply chain.

The aeronautical industrial activity in Spain is mainly concentrated in Airbus products, complemented by participation in Boeing, Embraer, Bombardier and Sikorsky programs, among others.

Figure1: Aeronautical industrial activity in Spain

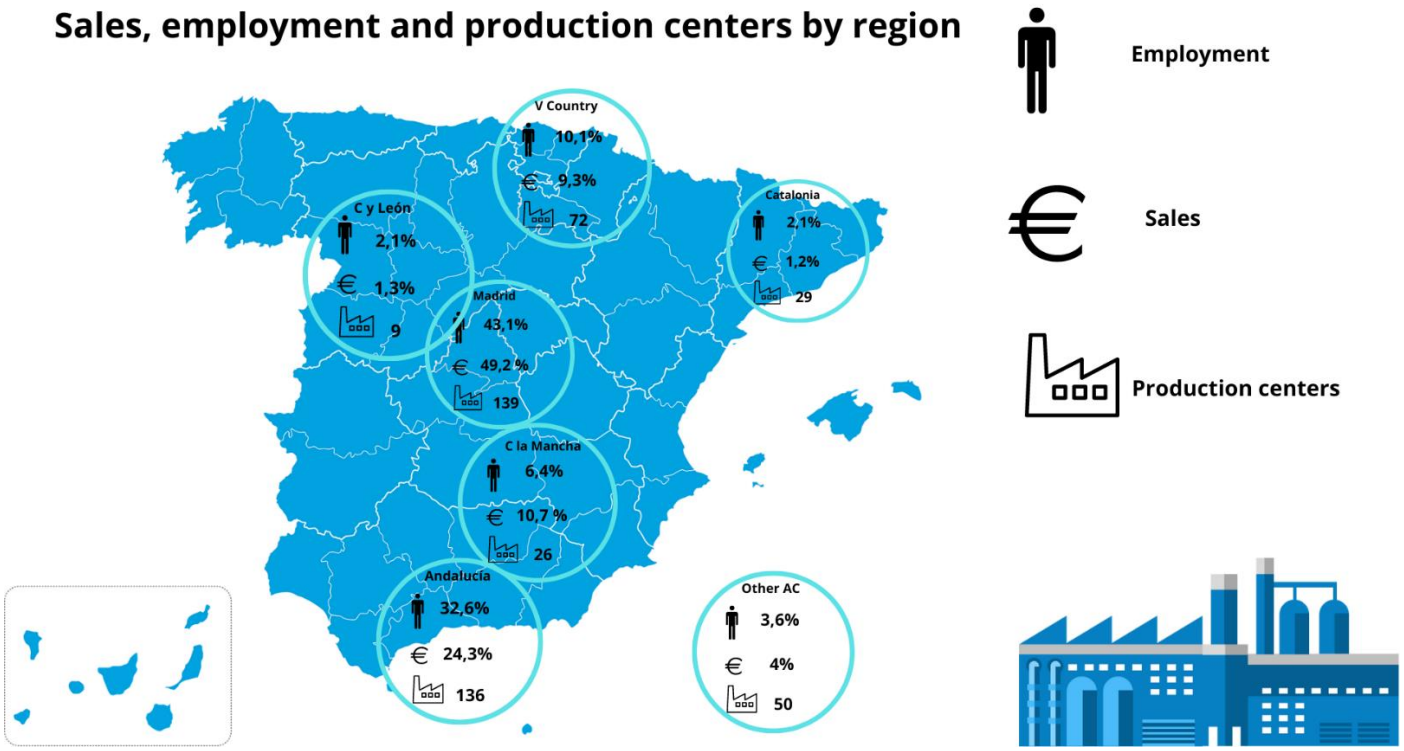
These developments are carried out in a time scale of 2 to 4 years, with a constant effort in research and technologies to be able to propose and approach them in a competitive way against other players that may propose other types of solutions that could also lead to a geographic change in their mass production.

The aeronautical sector in Spain is quite similar to the rest of Europe. The sector is characterized by very few large companies, with a larger number of medium-sized companies and a much larger number of small companies.

In the Spanish aeronautical sector, there are 436 companies with EN9100 certification, distributed among 670 production centres. SMEs represent 96% of the companies in the sector, and 15 companies have more than 250 workers.[2]

[2] Gobierno de España; TEDAE. Agenda Sectorial de la Industira Aeronáutica (2018)

Aeronautical activity in Spain is mainly focused in Madrid and Andalusia, where 75% of the total is concentrated.



Madrid: 43% of employment in the sector 49.2% of sector turnover 139 Production plants	**Andalusia:** 32.6% of employment in the sector. 24.3% of the sector's turnover 136 production plants	**Basque Country:** 10.01% of employment in the sector. 9.3% of the sector's turnover 72 production plants	**Castilla la Mancha:** 6.4% of employment in the sector 10.7% of the sector's turnover 26 production plants
Catalonia: 2.01% of employment in the sector 1.2% of sector turnover 29 Production plants	**Castilla y León** 2.01% of employment in the sector 1.3% of the sector's turnover. 9 production plants.	**Other Autonomous Communities** 3.6% of employment in the sector 4% of the sector's turnover 50 production plants	

Figure 2: Sales, employment and production centers by region[3]

[3] Gobierno de España; TEDAE. Agenda Sectorial de la Industira Aeronáutica (2018)

The Spanish industry is currently present in all segments of activity; most of the aeronautical sector (76%) works in "aircraft and structures", 11% in "engines" and 12% in "equipment and systems".

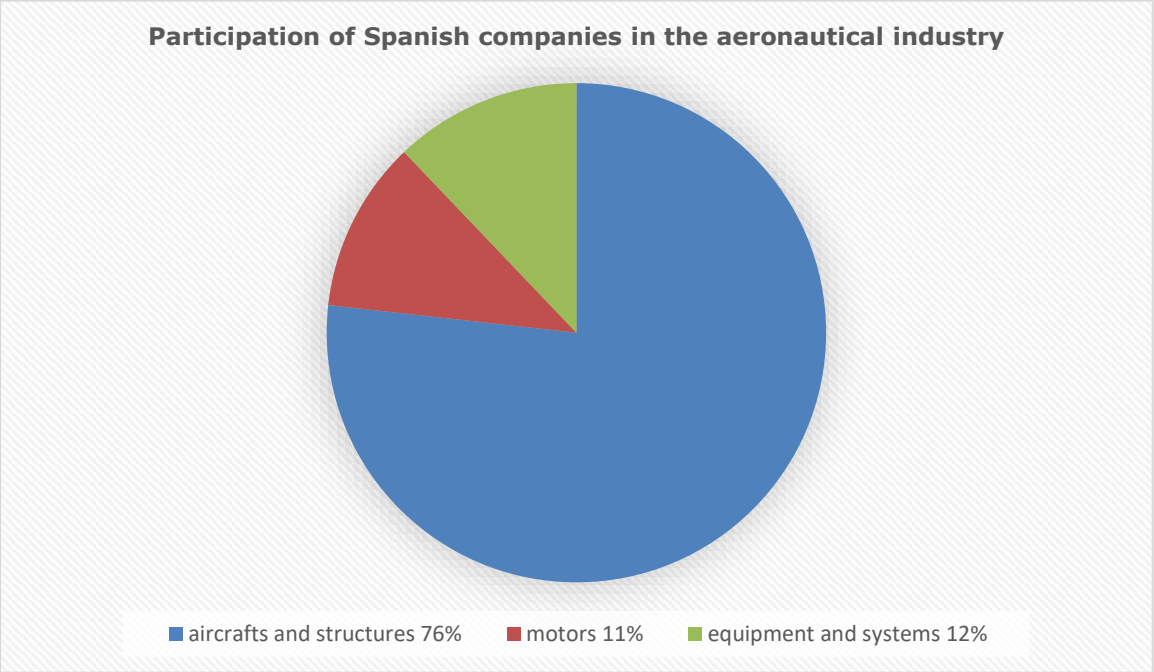


Figure 3: Participation of Spanish companies in the aeronautical industry

A key differential from the rest of the European companies is that Spanish aeronautical companies contribute in a complementary way to the turnover of the civil and defense markets.
Some of the largest companies have a relatively balanced presence in both markets, while in the rest of the supply chain, they are more active in the civil sector.

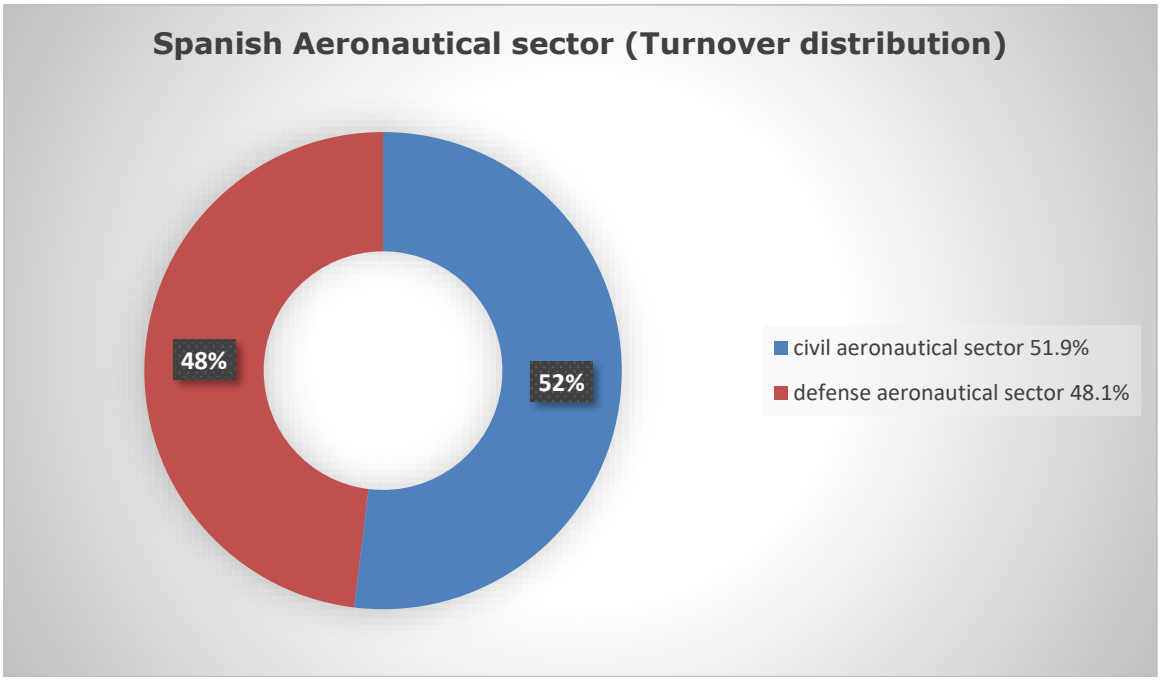


Figure 4: Spanish Aeronautical Sector (Turnover distribution)

Figure 5: Other relevant data on the Spanish aeronautics industry

Evolution of turnover in the Spanish defense, security, aerospace and aeronautics sectors

The consulting firm KPMG presented on October 21, 2021, the study "Economic and Social Impact of the Defense, Security, Aeronautics and Space Industry.[4]

The study is based on data provided by the Spanish Association of Defense, Security, Aeronautics and Space Technology Companies (TEDAE), which groups the 90 main companies that design, develop and manufacture weapons systems and equipment for the Armed and Security Forces and also for the civil and military aerospace world.

Between 2014 and 2019, the overall evolution of the national defense and aerospace sector was always positive, to the point of being "the fastest growing industrial sectors in Spain".

In those five years, aerospace, defense and security industrial activity increased by an average of 6.9%, above the gross value added (GVA) and national GDP.

This annual increase shows that "the degree of dependence" of the Spanish economy on the defense, security, aeronautics and space industry "increased progressively".

Figure 6: Evolution of turnover in the Spanish defense, security, aerospace and aeronautics sectors

The report stresses that the civil aeronautics industry was the hardest hit by the pandemic crisis and the decline in demand for new aircraft. The main reason lay in "its close relationship with the air transport industry," whose flights were suspended for much of the year 2020, the report explains, leading to an overall decline in production activities.

Key elements of competitiveness of the Spanish aeronautical sector

The key element of competitiveness in the global aeronautical sector is knowledge. This knowledge is only acquired through research and development projects of technologies with long development times and high R&D&I costs, which is absolutely necessary as a critical competitiveness factor.

This is why aeronautics in Spain is one of the sectors that dedicates the greatest effort to R&D&i. This fact has a direct positive effect on productivity and competitiveness and also produces a tractor effect on other industries.

The aeronautical industry, sure that technology is the key to success, has invested 7,582 million euros (an average of 12% of its turnover) in this type of process over the last 10 years, and it does so as the only way to safeguard competitiveness in a clearly growing market.

Another key element of competitiveness of the Spanish aeronautical sector is its industrial capacity to cover the complete cycle of an aircraft: conceptual phase, design, development, manufacturing, assembly, certification, sale and support of the product once in service.

[4] KPMG. Economic and Social Impact of the Defense, Security, Aeronautics and Space Industry (2021)

Spain has a broad and diversified supply chain that facilitates good competitiveness in the rest of the sector, although it is dependent on the driving companies in terms of knowledge and investment in technological developments.

Through the existence in Spain of AIRBUS, and the "TIER 1" of structures and equipment (Héroux-Devtek, ACITURRI, AERNNOVA, ALESTIS) or engine (ITP Aero), Spain is well positioned to channel projects throughout the supply chain.

The Spanish aeronautical sector is strategic. Its consideration as a "strategic" sector is a consequence of its intrinsic characteristics and its high capacity in terms of social return. Social return is understood as the capacity to generate wealth in the area in which industrial activity takes place.

The social return created by aeronautical sector technologies is one of the highest among economic sectors.
According to "Oxford Economics"[5] an economic research organization, investment in aerospace technologies generates a social return once the technologies developed have grown by 70% per year. In other words, the value of the initial investment, 10 years after the maturity of the developed technologies, will be multiplied by 7 in relation to their social return (which means that for every 100 euros invested in aeronautical R&D&I, in 700 euros will increase the GDP in 10 years).

The aeronautical sector generates highly qualified employment, which has been maintained even during the past global economic and financial crisis and is also a highly internationalized sector with a positive trade balance.
The sector has demonstrated its high growth capacity during favourable economic cycles and a great solidity during adverse economic cycles.

The presence in Spain of an OEM such as Airbus, and first-level contractors such as Aernnova, Aciturri, Alestis, Héroux-Devtek and ITP Aero, makes possible a tractor effect in the supply chain of continuous improvement of industrial competitiveness.
The great advantage of having first-tier upstream industries and integrators is the ability to convert global demand for a product into system or subsystem specifications and the ability to decide on the location of the workload.
The high levels of participation of Spanish industry in international programs with Airbus (10% on average of recurrent manufacturing activity) play in favour of the development of a Spanish-based aeronautical industry.

3. Opportunities

In Spain, there are three lines of formal and non-formal training related to aeronautical/aerospace education.

- Vocational Training
- Private training academies
- Higher education

Vocational Training:

Vocational training offers the following degrees developed in both public and private centers:

- Aeromechanical Maintenance Training Cycle.
- Aeronautical Systems Structures and Installations Assembly Technician.
- Higher Technician in Aeromechanical Maintenance of Aircraft with a turbine engine.
- Higher Technician in Electronic and Avionic Aircraft Systems Maintenance.

[5] Oxford Economics. 2011. Benefits of Aviation studies. http://www.benefitsofaviation.aero/Pages/download.aspx

Aeromechanical Maintenance Training Cycle:[6]

2,000 hours 2 academic years

This vocational training program belongs to the Transport and Vehicle Maintenance field, and once the qualification has been obtained, the following occupations can be performed:

Hangar/line chief technician.
Non-destructive testing inspector.
Line mechanic.
Hangar mechanic.
Workshop mechanic.

Curriculum:

First year:	Second year:
Piston engine, propellers and their systems. Aircraft systems I. Aircraft electrical/electronic systems. Maintenance legislation and organization. Hydraulics and pneumatics. Basic electromechanical techniques for maintenance. Safety in aircraft maintenance. Aircraft constitution and navigation.	Jet engine, its systems and auxiliary power unit (A.P.U.). Aircraft systems II. Aircraft materials and structures. Relationships in the work environment. Training and labour orientation. Training in work centers.

Aeronautical Systems Structures and Installations Assembly Technician [7]

2,000 hours 2 academic years

The general competence of this degree consists of:

- assembling metallic, composite and hybrid elements to obtain aeronautical structures;
- assembling equipment and associated installations of aeronautical systems,
- applying protective treatments, sealing and painting of surfaces,
- carrying out verification and functional tests,

all under quality conditions, following technical, safety and environmental protection specifications, and complying with the corresponding aeronautical regulations.

People who obtain this degree work in companies engaged in the assembly, maintenance, sealing, painting and installing systems and equipment for passenger, transport and military aircraft, non-powered aircraft, light aircraft and rotary wing aircraft.

The most relevant occupations and jobs are as follows:

a) Aircraft hydraulic and pneumatic systems assembler.
b) Aircraft power plant and mechanical systems assembler.
c) Aircraft electrical and electronic systems assembler.
d) Aircraft elemental and structure assembler.
e) Operator of verification and functional tests of the systems assembled in the aircraft.
f) Aircraft elements and structures sealer.
g) Aircraft surface protection and paint operator.

Curriculum

First year	Second year
Training and job orientation Electrical and electronic installations Basic machining Aeronautical structural assembly Surface Preparation and Sealing Mechanical and Fluid Systems	Business and Entrepreneurship On-the-job training Free configuration hours Aircraft protection and painting Power distribution, telecommunications and avionics systems Flight controls, landing gear and propulsion systems

[6] Generalitat Valenciana. Training Cycle: Aeromechanical Maintenance MAINTENANCE (2021) Link

[7] Junta de Andalucía. Curriculum corresponding to the Technical Degree in Assembly of Structures and Installation of Aeronautical Systems. (2018) Link

Superior Technician in Aeromechanical Maintenance of Turbine Engine Airplanes.[8]
2,646 hours 3 academic years

The main objective of the training is to enable students to carry out preventive and corrective maintenance of fixed wing and rotary wing aircraft, their systems, equipment and components in the mechanical area, covering the activity in the hangar, line and workshop.

The degree belongs to the professional family of Vehicle Transport and Maintenance.

The most relevant occupations and jobs are:

- Perform scheduled and corrective maintenance of engines, airframe and mechanical, hydraulic, pneumatic and electrical systems of the turbine engine aircraft both on the line and in the hangar and of the electronic and avionics systems.
- Perform maintenance on the line, as well as participate in the manufacturing and assembly processes of components, applying the current regulations and the quality required according to the technical documentation, complying with the specific aeronautical regulations, the occupational risk prevention and environmental protection plan, and participating in the maintenance management.

Curriculum:

First year	Second year	Third year
Fundamentals of electricity Fundamentals of electronics in aeromechanics Materials, equipment and tools in aeromechanics Maintenance practices with mechanical elements of the aircraft Basic aerodynamics Human Factors Aeronautical legislation Aerodynamics, structures and oxygen, water and protection systems of turbine engine aircraft Propellers Professional Foreign Language: English 1	Digital techniques and electronic instrumentation systems in aeromechanics Maintenance practices with avionics elements and aircraft services Aerodynamics, structures, electrical and avionics systems of turbine engine aircraft Aerodynamics, structures and flight control systems of turbine-powered aircraft Aircraft aerodynamics, hydraulic, pneumatic and landing gear structures and systems Gas turbine engines Business and entrepreneurship Professional foreign language: English 2	Workplace training Aeromechanical maintenance project for turbine-powered aircraft.

Senior Technician in Aircraft Electronic and Avionic Systems Maintenance.[9]

2,715 hours. 3 academic years.

The people who obtain this degree work mainly in the aircraft maintenance departments of the airlines or companies dedicated to passenger and cargo transportation, performing inspections on the line and maintenance operations, on the line and in the hangar or workshop.

The most relevant occupations and jobs are:

- Avionic systems maintenance technician.
- Electronic and avionic systems maintenance technician in hangar or workshop.
- Electrical and electronic equipment technician and adjuster.
- Line mechanic.
- Flight simulator mechanical and electrical systems maintenance technician.
- Technician in the manufacture and assembly of elements and components.

[8] IES. Segundo de Chomón. Aeromechanical Maintenance of Turbine-Engine Aircraft. 2018 Link
[9] Gobierno de Castilla La Mancha, Higher Level Vocational Training Cycles. Advanced technician in maintenance of electronic and avionic systems in aircrafts. (2019) Link

Curriculum:

First Year	Second Year	Third Year
Basics of electricity. Basics of electronics in avionics. Digital techniques and electronic instrument systems in avionics. Basic aerodynamics Materials, equipment and tools in avionics Maintenance practices in avionics Propulsion	Aviation legislation Human factors Aerodynamics, flight control structures and systems, hydraulic power, landing gear, and aircraft airframe Aerodynamics, pneumatics, fuel, oxygen, water, aircraft protection, and pneumatic structures and systems Aircraft Aerodynamics, Instrumentation Structures and Systems, Power Generation, Lighting, and Onboard Aircraft Maintenance Aircraft aerodynamics, communication structures and systems, passenger cabin and information. Aircraft aerodynamics, navigation and automatic flight structures and systems.	Technical English Business and entrepreneurship. Aircraft electrical, electronic and avionic systems maintenance project. Training in work centers

Summary of specific aeronautical subjects offered in vocational training.

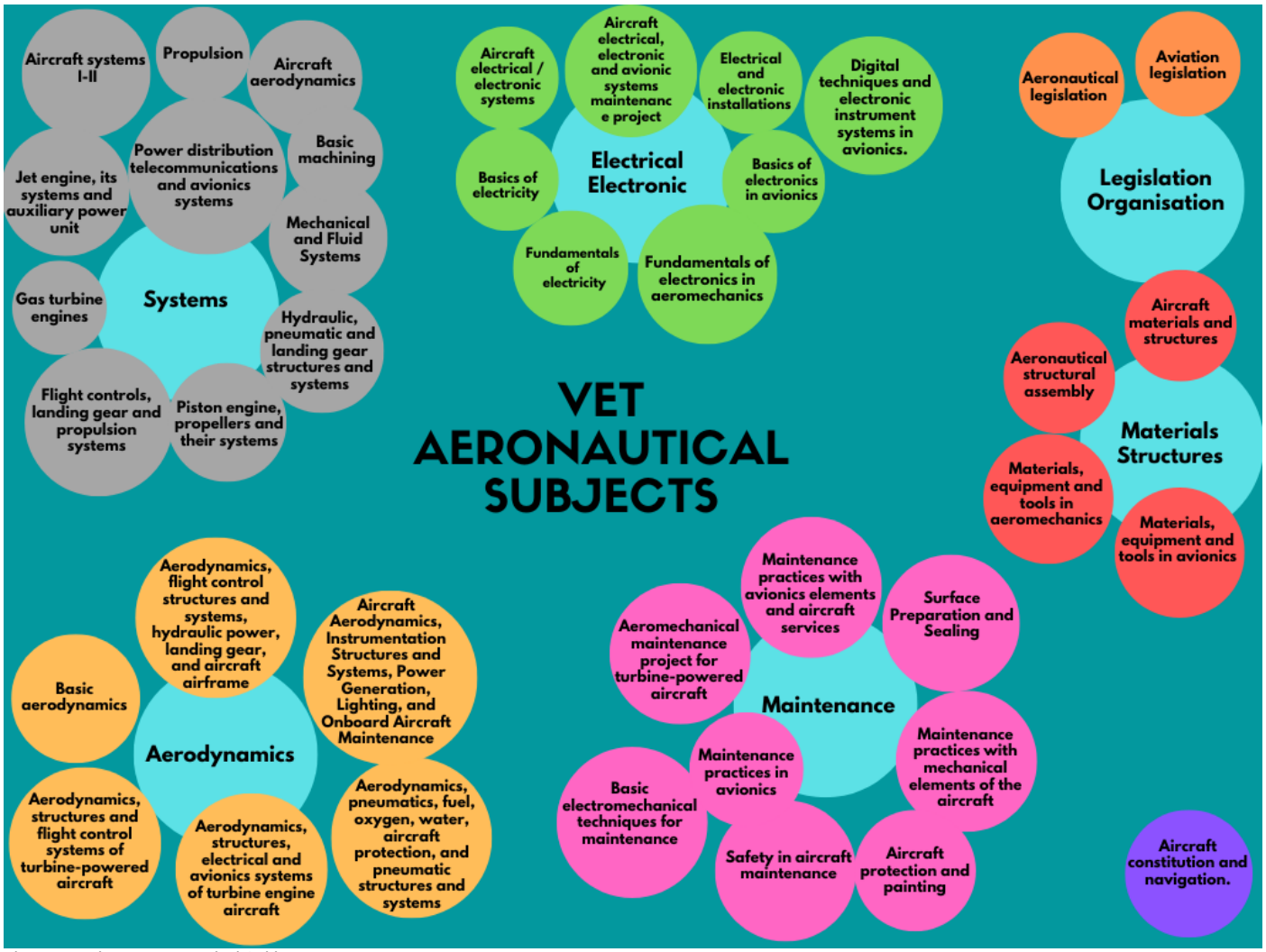


Figure 7: Main Vet Aeronautical Subjects

Academies and private initiatives

From the private non-regulated initiative, practically all the training is oriented toward operating with Drones, which we will see in more detail below.
In addition, there are some interesting initiatives for our Project dedicated to the maintenance and repair of Drones, which offer the following curriculum:

Dronak Academy: Curso mantenimiento y reparación de drones [10]

Curriculum:

- Basic components and typology of drones.
- Technical capabilities and limits (payloads and autonomy).
- Forces acting on the drone
- Flight mechanics
- Centering / load balancing in multirotor design.
- Electronics soldering
- Charging safety, balancing and handling of LiPo (lithium-O-polymer) batteries.
- Safety measures

Drone operation in Spain:

The following is an analysis of the drone operation sector in Spain in order to know the main elements offered in its training programs.

Drones A1-A2-A3

New European regulations for drones:

Since December 31, 2020, the European UAS regulation has been applicable in Spain. This regulation affects all drones regardless of their use or size.

Consolidated Implementing Regulation (EU) 2019/947, including changes to Implementing Regulation (EU) 2020/639, Implementing Regulation (EU) 2020/746, Implementing Regulation 2021/1166 and Implementing Regulation (EU) 2022/425.[11]

Consolidated Delegated Regulation (EU) 2019/945 including changes to Delegated Regulation (EU) 2020/1058.[12]

EASA Management Resolution approving national standard scenarios (STS-ES) for UAS operations in the "specific" category under an operational declaration in accordance with Implementing Regulation (EU) 2019/947.[13]

Easy Access Rules for Unmanned Aircraft Systems (Regulations (EU) 2019/947 and (EU) 2019/945).[14]

Drone pilot training is organized in 2 categories:

Open Category: Subcategories A1/A3 and A2

The 'open' category encompasses low-risk UAS operations and does not require authorization or declaration.

[10] Dronak Academy. Drone Mechanics Course (2022) Link
[11] https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A32019R0947

[12] https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A32019R0945

[13] https://www.seguridadaerea.gob.es/sites/default/files/0_20201202__resolucion_escenarios_estandar_nacionales.pdf

[14] https://www.easa.europa.eu/document-library/easy-access-rules/easy-access-rules-unmanned-aircraft-systems-regulation-eu

In the 'open' category, the UAS operator must register at AESA's electronic headquarters as long as the UAS with which he operates has a maximum take-off mass (MTOM) greater than 250g, transfers an impact energy greater than 80J or is equipped with a personal data capture sensor such as a camera or microphone.

Subcategory A1/A3 training and free online test provided by AESA

Curriculum A1/A3 [15]

Regulatory concept	General UAS Flight Knowledge:	Operational Procedures
1) Fundamental concepts 2) Historical Context 3) Regulatory framework a) Delegated Regulation (EU) 2019/945 of the Commission. b) Implementing Regulation (EU) 2019/947 of the Commission c) Royal Decree on UAS 4) Key Definitions 5) Main procedures applicable to UAS use a) Categories of operation and UAS classes I. Open" category II. Specific" category III. Certified" category b) Minimum ages of UAS operators and remote pilots I. UAS operator II. Remote pilots c) UAS Operator Registration and Responsibilities I. UAS operator registration II. Responsibilities of the UAS operator in "open" category. d) Responsibilities of the UAS pilot in "open" category	1) Fundamentals of flight a) Basics of flight I. Forces acting on the UAS II. Aerodynamic principles b) Effect of environmental conditions on the UAS flight I. Air density II. Air humidity I II. Wind 2) UAS general knowledge a) Command and control principles I. Description of the command and control system II. Control station III. Flight controls b) Communications c) Sensors included in the UAS d) Flight instruments e) Essential information of the UAS f) UAS maintenance 3) Airspace a) Introduction of UAS in airspace b) Airspace definitions c) Airspace structure d) Airspace restrictions e) Operational conditions applicable to UAS geographic areas 4) Human factors limitations a) Influence of psychoactive substances, alcohol or when the pilot at a distance is not fit to perform his tasks. b) Human perception 5) Privacy and data protection a) What is privacy and data protection? b) What can and cannot be done with a UAS with data capture capability? 6) UAS Physical Security a) Unlawful interference - Theft or hijacking of UAS b) UAS handling security 7) Insurance and UAS accidents and incidents	1) Pre-flight operational procedures 1. Meteorology 2. Operation environment 3. UAS 4. Human limitations 2) Operational procedures during flight 1. Normal flight procedure 2. Contingency or emergency procedure 3) Post flight operational procedures 1. Operation records 2. UAS maintenance

[15] https://www.seguridadaerea.gob.es/sites/default/files/Curso.Formacion.A1.A3.Completo.v6.pdf

	a) Civil liability insurance b) UAS Incidents and Reporting	

Subcategory A2 [16]

The pilot must have passed the A1/A3 examination and submit to EASA a declaration that self-practical training has been completed. In this training, the pilot must perform as many flights as he/she considers necessary to acquire a reasonable level.

The exam is also given by AESA

Curriculum A2

1) Meteorology:
i. The effect of meteorological conditions on the flight of an unmanned aircraft:
(a) Wind (e.g. turbulence, effects on urban environments, etc.);
(b) Temperature;
(c) Visibility; and
(d) Air density;
ii. Obtaining weather forecasts;

2) UAS flight performance:
i. Typical operational envelope of a multi-rotor, fixed-wing aircraft and gyroplane;
ii. Center of gravity (CG) and mass balance:
(a) Consider overall stability when installing gimbals and payload;
b) Understand the different characteristics of payloads and how these affect the stability of the unmanned aircraft in flight;
c) Understand that different types of UAS have different CG;
iii. Payload securing;
iv. Batteries:
(a) Understanding power supply operation to help prevent possible unsafe conditions;
b) Familiarization with the different types of batteries available;
c) Understanding the terminology used for batteries (e.g. voltage, capacity, charge and discharge, C-rate, etc.);
d) Understanding the operation of batteries (e.g. charging and discharging, installation, use, storage, hazards, etc.).
3) Technical and operational ground risk mitigations:
i. Function of the low-speed mode;
ii. Assessment of distance to non-participants in operation;
iii. Rule1:1

Specific category.

Under a standard scenario (STS)[17]

The theoretical training for the STS can be given by a training entity, a UAS operator, or on their own, always following the syllabus contained in the published syllabus. It corresponds to AESA's carrying out the theoretical knowledge examination of the STS and, if applicable, issuing the corresponding certificate.

Curriculum STS:

1) Aviation regulation:
(i) Introduction to EASA and the aviation system; and
(ii) Commission Implementing Regulation (EU) 2019/947 and Commission Delegated Regulation (EU) 2019/945:
- a. Applicability to Member States;
- b. Standard Scenarios (STS);
- c. UAS operator registration and operational declaration;
- d. UAS operator responsibilities;
- e. Remote pilot responsibilities; and
- f. Occurrence, incident and accident reporting;

[16] https://www.seguridadaerea.gob.es/sites/default/files/A-DUAS-FOR OP04_v4_Formacion.Subcategoria.A2.pdf

[17] https://www.seguridadaerea.gob.es/sites/default/files/Syllabus%20STS%20v1.pdf

2) Human performance limitations:
(i) The influence of psychoactive substances and alcohol, as well as when the remote pilot is not in adequate condition due to injury, fatigue, medication, illness or other causes;
ii) Effect of weather conditions on the crew;
iii) Human perception:
- a. Factors influencing the pilot's visual range ("VLOS");
- b. Assessment of distance to obstacles and distance between the unmanned aircraft and obstacles;
- c. Evaluation of the speed in flight of the unmanned aircraft;
- d. Evaluation of the flight altitude of the unmanned aircraft;
- e. Situational awareness;
- f. Night operations;
- g. Communication between different people involved in the operation;

3) Operational Procedures:
(i) Pre-flight procedures:
- a. Evaluation of the operation;
- b. Identification of a controlled ground area suitable for unmanned aircraft operations and in accordance with standard scenarios;
- c. Environmental conditions and methods for obtaining weather forecasts;
- d. Limitations and conditions applicable to the ground risk prevention zone in accordance with the operations manual;
- e. Flight planning;
- f. Verification of UAS conditions and use of checklists.

ii) In-flight procedures:
- a. Normal procedures;
- b. Contingency and emergency procedures;

iii) Post-flight procedures:
- a. Inspection and maintenance of the UAS;
- b. Reports and details on operation and records;

4) Technical and operational air risk mitigation:
(i) Definition of operational volume, reinforced by height and speed limitation systems;
ii) Consultation of airspace limitations through official sources; procedures for updating and uploading airspace limitations to the geo-awareness function;
iii) Evaluation of flight geography:
- a. Procedures required for UAS operations in controlled airspace, including a protocol for communicating with air traffic control and obtaining coordination and instructions, if necessary;
- b. Coordination with aerodrome managers for the conduct of UAS operations, if necessary;
- c. Selection and evaluation of airspace information that may have an impact on the planned operation;

(iv) Airspace monitoring and remote pilot coordination with airspace observers:
- a. Proper placement of airspace observers;
- b. Robust and effective means of communication;
- c. Phraseology;

(v) Definition of basic actions to be taken in emergencies, including problems with the UAS or the occurrence of a mid-air collision hazard during an operation.
- a. Particularization of an effective emergency response plan appropriate to the operational scenario;
- b. "See and avoid" procedures.

5) General knowledge of UAS:
(i) Advanced flight principles;
(ii) UAS environmental limitations;
(iii) Flight assistance systems and possible failures:
- a. GNSS;
- b. Inertial sensors;
- c. Compass.

(iv) Command and control principles:
- a. General knowledge;
- b. Link frequencies and spectrum;
- c. Flight modes;
- d. Safety systems.

(v) Requirements applicable to unmanned aircraft carrying Class C5 and C6 markings;
(vi) Familiarization with the user manual provided by the UAS manufacturer;

6) Meteorology:
(i) The effect of meteorological conditions on the flight of an unmanned aircraft:
- a. Wind (e.g. turbulence, effects in urban environments, etc.);
- b. Temperature;
- c. Visibility;
- d. Air density;

(ii) Obtaining weather forecasts;

7) UAS flight performance:
(i) Typical operational envelope of a gyroplane, fixed wing aircraft and hybrid configuration aircraft;
ii) Center of gravity (CG) and mass balance:
a. Consider overall stability when installing gimbals and payload;
b. Understand the different characteristics of payloads and how they affect the stability of the unmanned aircraft in flight;
c. Understand that different types of UAS have different CGs;
(iii) Payload securing;
(iv) Batteries:
a. Understand power supply operation to help prevent possible unsafe conditions;
b. Familiarization with the different types of existing batteries;
c. Understanding the terminology used for batteries (e.g. voltage, capacity, charge and discharge, C-rate, etc.);
d. Understanding the operation of batteries (e.g., charging and discharging, installation, use, storage, hazards, etc.);

8) Technical and operational ground risk mitigations:
(i) Low speed mode function;
ii) Evaluation of the distance to non-participants in the operation;

Upon request for special authorization

For these remote pilots, theoretical and practical training based on the concept of operation ('ConOps') requested is required. The training required will be determined within the context of the operational authorization request.

A large number of private entities offer this theoretical/practical training.

University.

Although the most significant number of specialities and training options are in professional training, we will briefly analyze the offer of university studies related to the sector.

Aerospace engineering degree[18]

6000-7200 hours 4 academic years.

The Aerospace Engineering Degree aims to train professionals to work in companies that design, manufacture and certify various products and systems: from space shuttles and satellites to helicopters and aeroplanes to rocket engines and turboprop engines.

Aerospace companies also design and certify airport and air navigation systems and the tools technicians need to maintain all these vehicles and systems.

Curriculum

First Year	Second Year	Third Year	Fourth Year
Calculus I	Fluid Mechanics I	Aerodynamics I	Aerospace Design II
Linear Algebra	Mechanics applied to	Fundamentals of Electronic	Professional Interpersonal
Physics I	Aerospace Engineering	Engineering	Skills
Programming	Mathematics Expansion	Aerospace Structures	Aerodynamics II
Statistics	Fundamentals of Business	Aircraft Systems and	Embedded Systems
Oral and written	Management	Installations	Integration
expression techniques.	Aerospace Materials I	Skills: Humanities II	Aeroelasticity
Calculus II	Modelling in Aerospace	Aerospace Propulsion I	Turboprop Design
Chemical Fundamentals in	Engineering	Search Techniques and	Combustion
Engineering	Thermal Engineering	Use of Information	Turbomachinery Design
Graphical Expression	Elasticity and Strength of	Flight Mechanics I	External Practices I

[18] https://www.uc3m.es/grado/aeroespacial#presentacion

Physics II Skills: Humanities I	Materials Aerospace Materials II Fluid Mechanics II	Navigation, Air Transportation and Airports Aerospace Design I Spreadsheets. Advanced Level Stability and Integrity of Aerospace Structures Aerospace Systems Control	Spacecraft and Orbital Dynamics Final Degree Project Aircraft Design and Calculation Flight Mechanics II Helicopters and Diverse Aircraft Aerospace Propulsion II Rocket Engines External Practices II Electronic Instrumentation in Energy Systems

4. Needs: capacity gap assessment

For the primary assessment in Spain, we have chosen a self-completed survey. We consider it to be the best option because it requires less time for both interviewees and interviewers, it is easier to contact interviewees via email, and they can answer the questionnaire whenever they want, which brings flexibility and freedom to the process.

In order to carry out the primary assessment, we have designed a Spanish Google form, which we have sent via email to the pre-selected companies, centers and institutions.

We have distributed the link to the form with an introduction and summary of the Project to 110 stakeholders spread as follows:

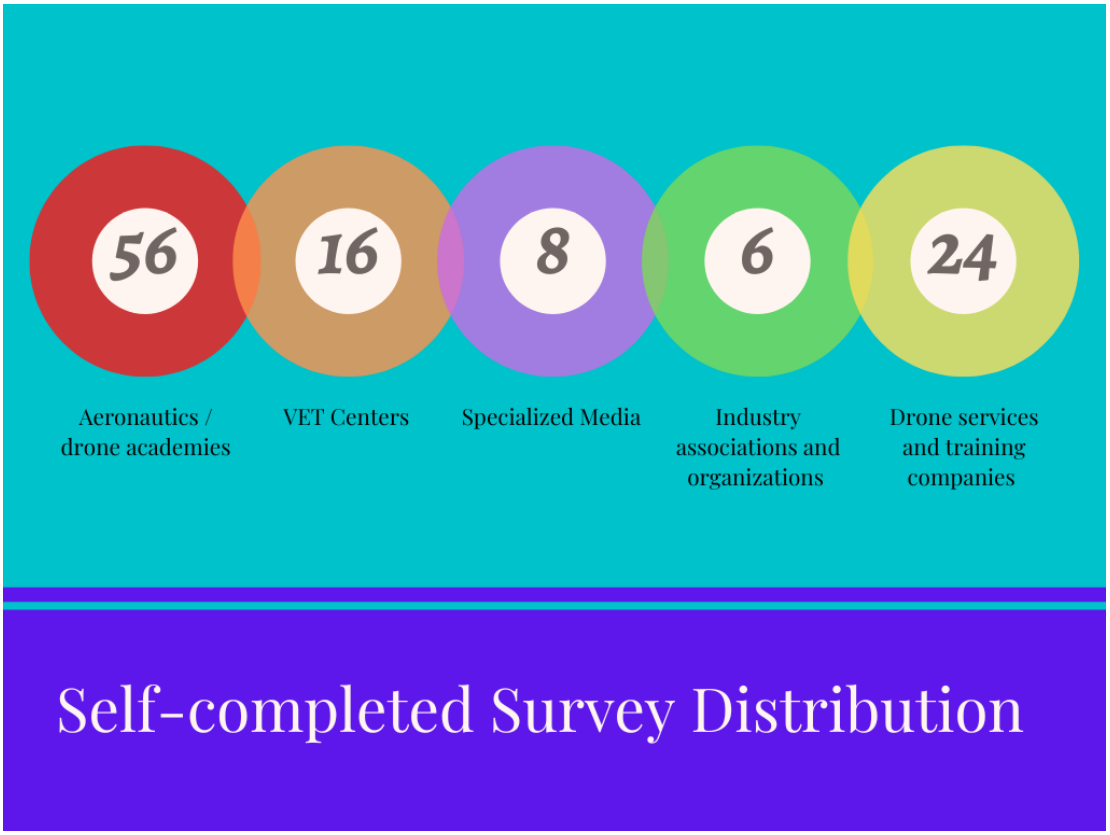


Figure 8: Distribution of self-completed surveys

This practice has been essential for gathering information for the primary assessment. Also, it has been a critical action for the project dissemination since we have informed a large number of stakeholders about the name, contents and project objectives.

Thanks to this action, we have incorporated an important Vet center in the aviation sector as associated Partner, CFELYA (Training Center in Electricity, Electronics and Aeronautics).

We have received 14 responses to the self-completed survey so far and these are the main findings:

Participating Organizations / Companies:

- Micro enterprise up to 10 employees 9 answers
- VET Center / VET Institution 3 answers
- Small and Medium enterprise (up to 250 employees) 3 answers

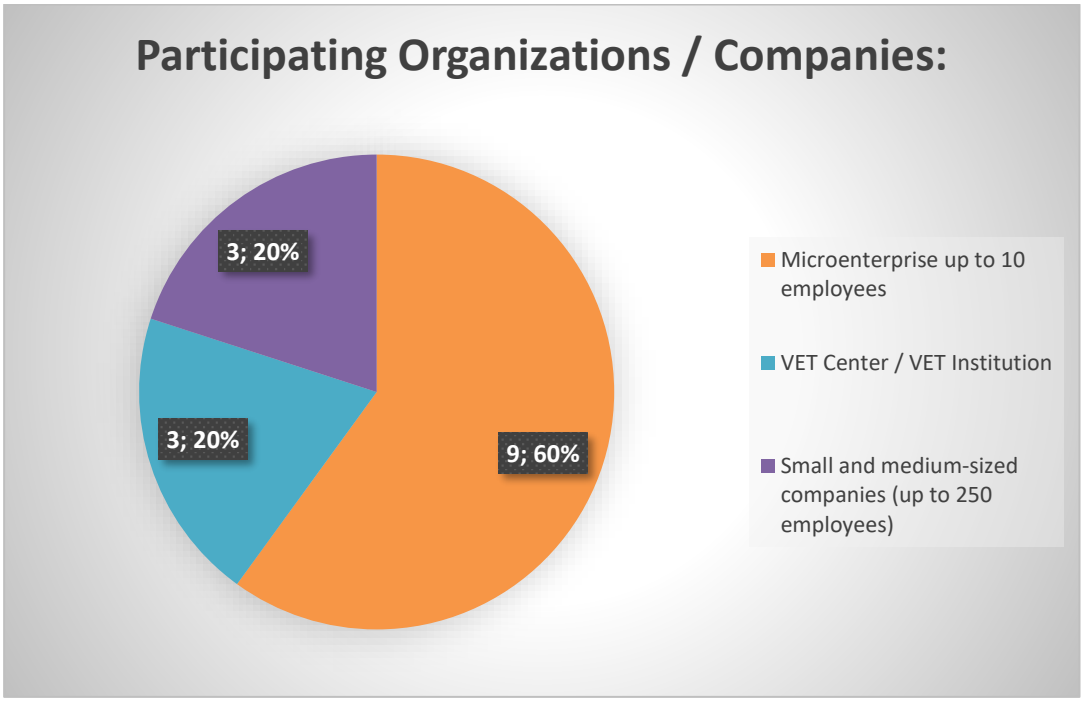


Figure 9: Participating organizations / companies

We have received a balanced participation between companies and training centers in order to have imputs from the training field and the labor market.

Vet centers:

The professions taught in the participating Vet centers are:

- Mechatronics technician
- Mechanic
- Aircraft maintenance technician.

All the centers consider that the aviation industry and drones will play an important role in the future.

The majority consider that vocational training in the field of aviation is ready to meet the challenges of the future.

Companies:

The companies that answered the questionnaire are involved in auxiliary fields of the aviation industry and drone operations, as well as training and sales.

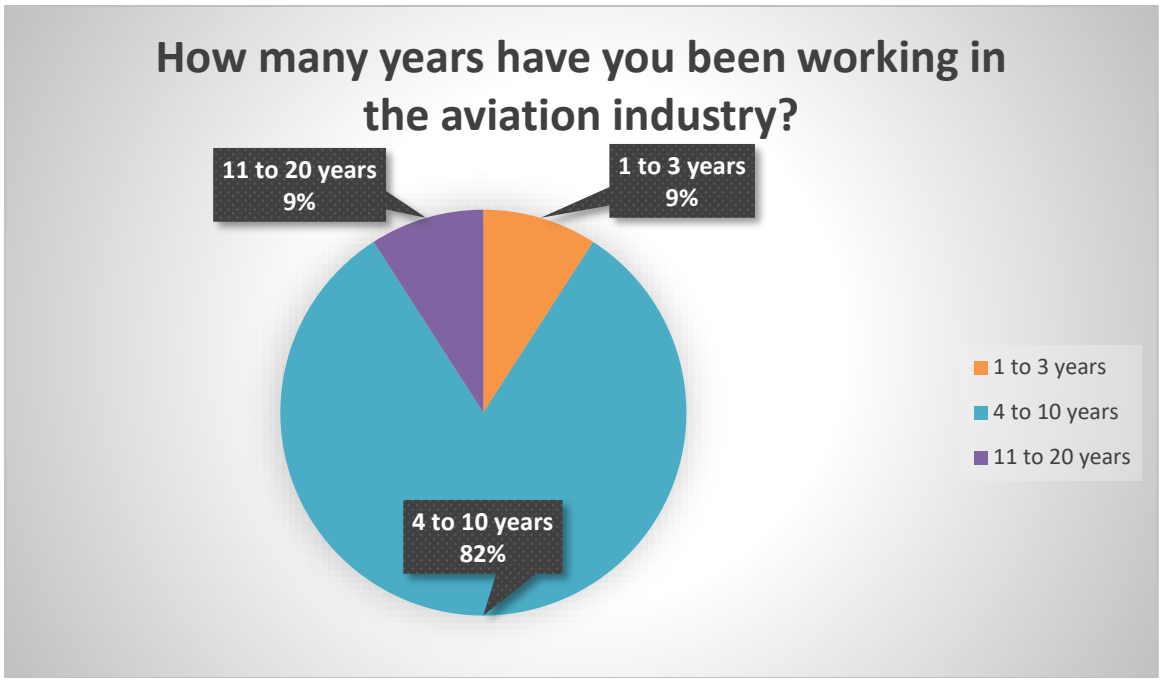


Figure 10: Number of years of respondents working in the aviation industry

90% of the companies have been in the sector for more than 4 years, so we consider that they have experience, which means that their answers will have great relevance for the objectives of this research.

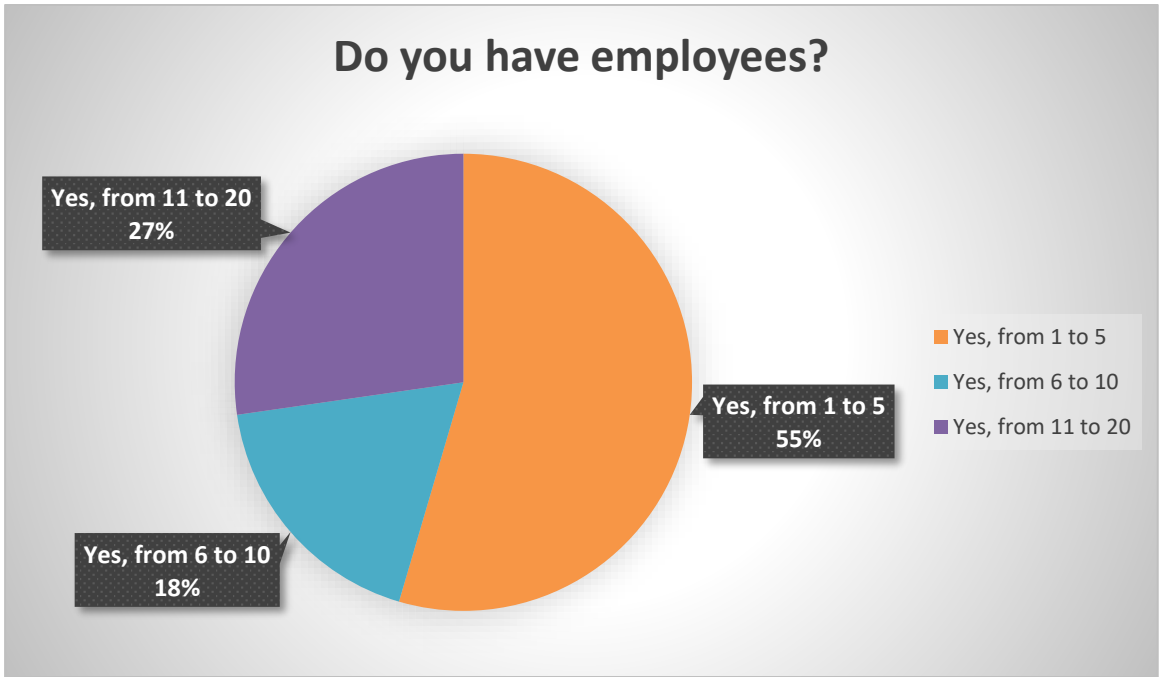


Figure 11: Number of employees of respondents working in the aviation industry

Regarding the number of employees, more than half have less than 5 employees, and there are none with more than 20 employees; this corresponds to the distribution of companies in Spain, mainly micro, small and medium-sized companies.

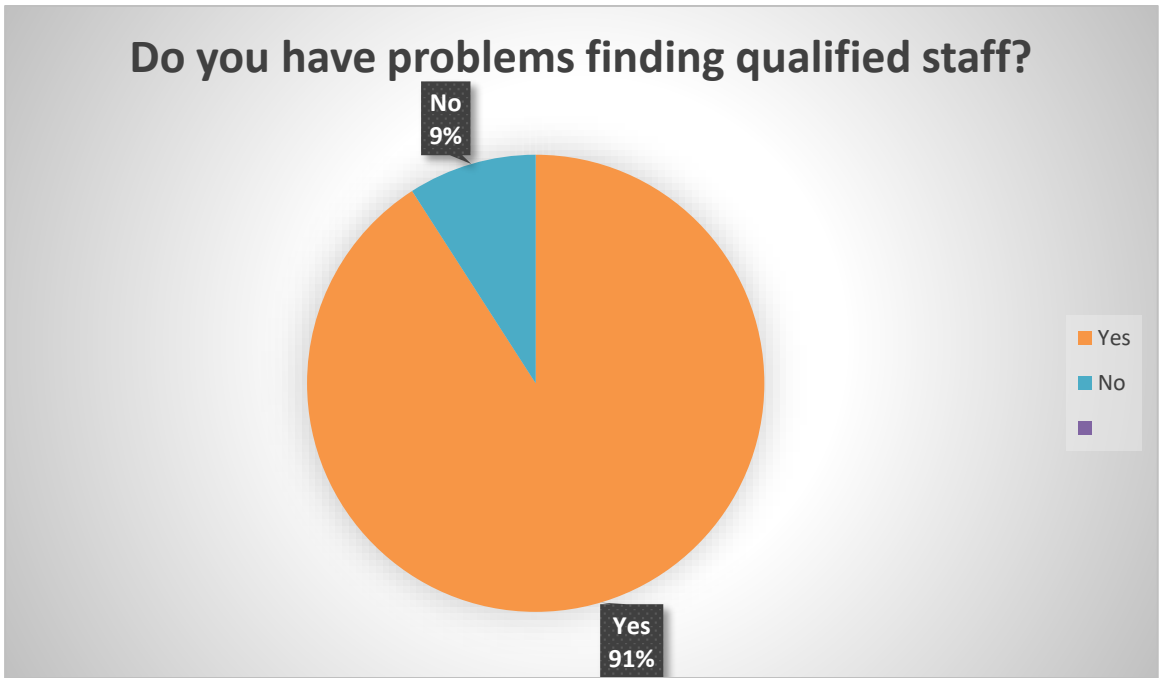
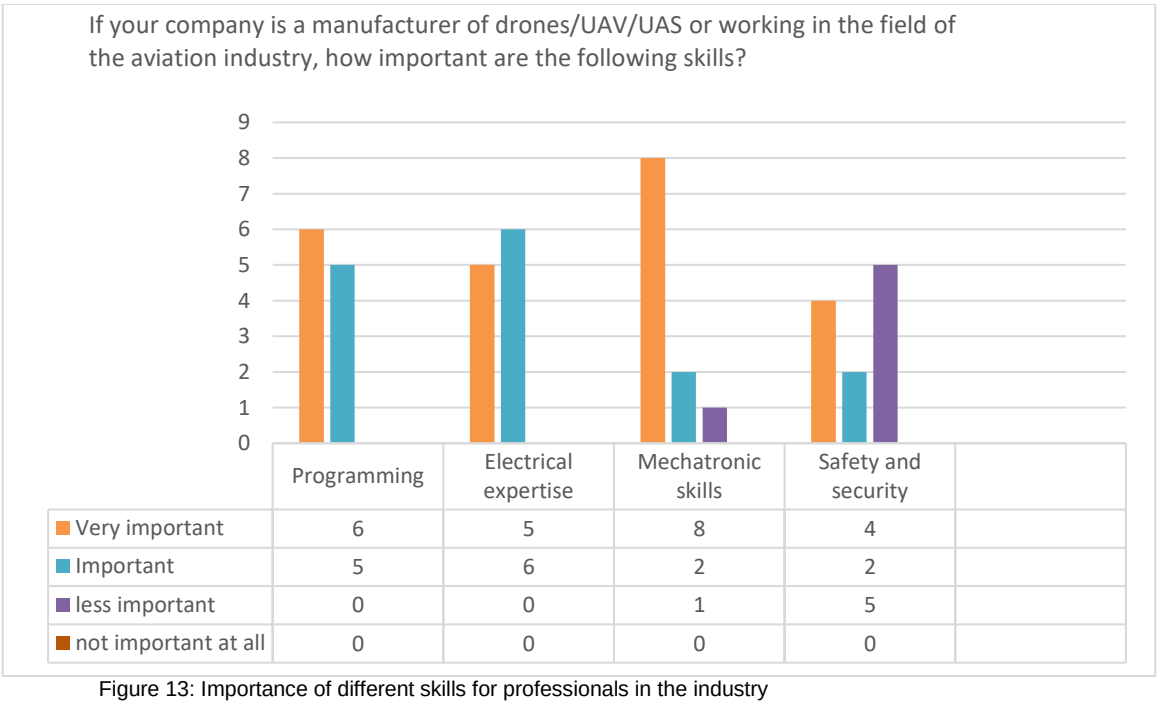


Figure 12: Respondents' problems in finding qualified personnel

Problems finding qualified personnel:
90% of those surveyed have problems finding qualified personnel.

The main problems in finding qualified personnel:
Lack of specific training
Lack of experience

Relevance of core competencies (programming, electrical knowledge, mechatronics knowledge, safety and security).



	Programming	Electrical expertise	Mechatronic skills	Safety and security	
Very important	6	5	8	4	
Important	5	6	2	2	
less important	0	0	1	5	
not important at all	0	0	0	0	

Figure 13: Importance of different skills for professionals in the industry

The competency most highlighted as very important is mechatronics knowledge.
Programming is also highlighted as very important by the majority.

The most important skills for companies:

- Programming
- Mechatronics
- Electronics
- Electricity
- Aeronautics
- Photogrammetry and remote sensing

The development of the drone industry, in general, is defined as:

- Slow
- Irregular
- Fast
- Very bureaucratic

It is remarkable that they qualify it as Fast and Slow at the same time, probably because it is a booming and growing sector, but as they have also indicated, bureaucratic hurdles affect it, complicating its development.

5. Challenges

The aeronautical sector is facing a year of challenges marked by the recovery of the sector after the crisis caused by Covid-19. To this end, it is necessary to support policies that help the economic recovery, also in Spain, from the recovery of the aeronautical industry.

The crisis generated by the Covid-19 pandemic has significantly impacted the aviation industry due to a drastic reduction in demand. This situation has led to a decrease in revenues, profitability and liquidity, as well as an increase in indebtedness. As a result, the financial stability of companies in the sector has been weakened.

The aeronautical sector, and especially the civil aviation sector, has challenges ahead, including reaching pre-pandemic activity levels, the implementation of digitalization in the industry, progress in sustainability and the environment, and quality participation in CDTI support programs for aeronautical R&D, among others.

Main objectives of the industry:

Figure 14: Main goals of the Spanish aerospace industry

Technological strategy of the aeronautical industry.

The Spanish aeronautical industry has designed a technological strategy to respond to the main needs of the sector, especially after the Covid-19 crisis, which will reinforce the pillars that make Spain one of the mainstays of the aeronautical industry.

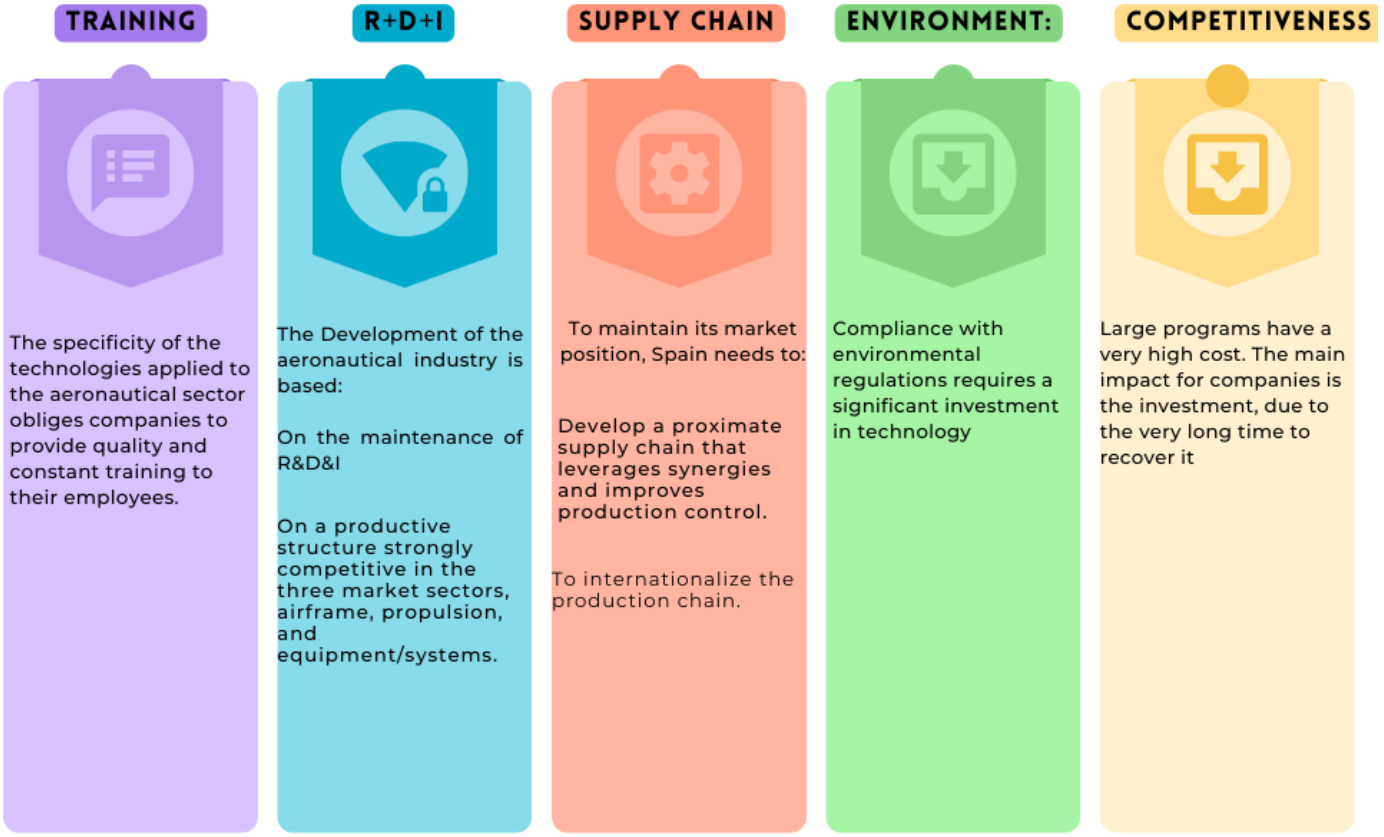


Figure 15: Technological strategy to meet the needs of the Spanish aeronautical sector

Future prospects.

The future outlook for the civil aeronautics market assumes a stable growth situation in the coming years in terms of manufacturing activity, including sales of developments maintained over the last decade and excluding the crisis period caused by Covid-19.

In the coming years, the leading role played by Boeing and Airbus may diminish considerably due to the fact that manufacturers initially dedicated to the regional segment, such as Embraer or Bombardier, already have models in the 100-120 seat segment, and other manufacturers have also appeared in China and Russia, which already have aircraft of up to 150 seats and will certainly obtain a significant share in their domestic markets, which will also experience significant growth.

In this sense, the civil market expectations for series production are highly optimistic with large programs underway (A380, B787, B777X, A350XWB, A320neo, B737Max, E190, CSeries, C919, SU-RRJ, H135 and others), which will guarantee high production activity in the Spanish aeronautical industry throughout the entire supply chain during the next decade.

A new activity that is becoming increasingly important is maintenance, understood as: maintenance + modernization + training. This activity, until recently in the hands of the operators and customers of aeronautical products (airlines and workshops), is beginning to gain importance for aircraft, engine and system manufacturers, who are compensating for the reduction in prices of their products as a result of fierce competition.

In addition, other EU initiatives such as Galileo, SESAR and CleanSky will also give rise to activity in the areas of simulation and air traffic control.

The outlook for the defence market is more optimistic than in previous years. Defense budgets have been marked for several years by budgetary restrictions, with a few exceptions, and the trend has changed in the last fiscal year. Future aeronautical systems for defense will be technologically very advanced and therefore very expensive. In Europe, not even the most developed countries will be able to cope with them alone, so they will have to be tackled in cooperation.

In general terms, companies with a presence only in the defense market face a more uncertain future, while those diversified in civilian markets or in other non-aerospace activities are in a better position to overcome the current situation.

This new situation may compromise the technological and industrial base if companies are forced to reduce their engineering departments, which would be difficult to recover when economic circumstances allow new investments in defense. It should be borne in mind that defense developments are always generators of new technologies, which in many technologies, which in many cases then have civilian applications in various sectors (dual-use technology).

However, this trend in the defense market, as mentioned above, has begun to change as a result of the European Union's firm commitment to Common Defense, and the new Preparatory Action for Defense Research, whose main objective is to promote strategic R&D&I initiatives, among which defense aeronautics may be included. Together with this initiative, the European Defense Action Plan foresees more favourable prospects for the defense aeronautics industry in the cooperative development of defense capabilities.

One of the most promising technologies where governments seem to be willing to put more resources is that **of Remotely Piloted Aerial Systems (RPAS).** All major countries currently have ambitious programs of their own in this area, although it is necessary to coordinate common interests in order to achieve a program covering different types of these systems and consolidate the sector's prospects.

Main challenges facing the Spanish aeronautical sector

- **IMPROVING THE COMPETITIVENESS OF THE AEROSPACE INDUSTRY**

At present, the challenges facing the Spanish aeronautical sector stem from internal factors of diverse nature:

- Its position in the supply chain as prime contractors or subcontractors.
- Its structure (industrial, capabilities, and capital)
- Its company size
- Its level of specialization in the civil and defense markets.

As indicated above, the presence of AIRBUS, and of the "TIER 1" structures and equipment or engine companies in Spain allows channelling projects to the entire Spanish supply chain. There is no other way to feed the supply chain in a stable and significant way if it is not leading or participating in the sequence of new international projects that the global aeronautical industry is launching.

But given the small number of prime contractors and TIER 1s, this category of companies is targeted by major industries (and developed countries), which compete for the three fundamental conditions that necessary to acquire and retain integrator status:

- State-of-the-art technological capabilities ready for commercial deployment
- Financial capacity to support development programs
- Industrial capacity to control the product and recover the value-added investment.

Equally important for the success of the sector's projects and of the tractors themselves are the subcontracting companies. Spain has more than 400 supply companies, most of them small in size, which are either saturated with the national workload or do not have the size to enter the international market.
At the same time, these companies are spread across a full range of possibilities, from production capacity only to engineering capacity only, with all the variables in between.

Many of these companies are exposed to the volatility of development campaigns or are unable to offer value-added services to prime contractors or first-tier subcontractors.

The future outlook regarding the manufacturing activity of the aircraft sold during the last decade (not yet delivered) implies an increase in production rates. This increase in production represents a CHALLENGE and will test the competitiveness of the Spanish supply chain, where the technologies included under the denomination Industry 4.0 will play a decisive role in assuming the pace of deliveries.
In addition, new program developments will be implemented.

The challenge for the Spanish industry is to establish technological standards that will force it to continue to be present in industrial operations after technology transfer processes.
After more than a decade of defense budget reductions, the new geopolitical circumstances invite us to think about a change of scenario.
The EU is aware of this reality and has taken the initiative with a more integrated and reinforced Common Security and Defense Policy with a focus on the importance of the industrial technological base (Preparatory Action, European Defense Research Plan and Capabilities Fund).

- **TRAINING IMPROVEMENT**

The Administration is aware of the relevance of training in developing the country's industrial structure and, through its competent bodies, reviews and updates measures to improve training.
The Administration already establishes general standards in formal training, occupational training and continuous training.

However, the specificity of aeronautical technology and the continuous emergence of new processes and technologies force companies to internalize them long before they become established in formal training. Companies meet this need, either with internal training or by turning to external agents.
Although there are occupational training and continuous training tools that address them to a greater or lesser extent, they are limited in amount and scope.

Competition on two levels, with countries with lower labor costs and with countries with a broad technological base, has led to the offshoring of work and, in the best of cases, to the incorporation or substitution of more advanced processes that require continuous training of employees, as a recurring dynamic.

Aeronautical companies require training that allows:

- Quick incorporation of new manufacturing technologies in the production cycle and incorporate the professional requalifications demanded by the so-called Industry 4.0.
- Broad dissemination in the company and the associated supply chain.
- Develop comprehensive training plans in the new behaviours that facilitate the maintenance of the competitiveness of the industry.
- Incorporation of the dual training model
- Transform learning models by promoting cooperative learning in the industrial world.

PRIORITY AREAS FOR ACTION

- **TECHNOLOGY ENHANCEMENT AND PROGRAM DEVELOPMENT**

The following is a list of the main technological priority lines of action taken from the Strategic Agenda for R&D&I in Aeronautics of the Spanish Aerospace Technology Platform (PAE)[19]

- More electric aircraft, including the electrification of aircraft and engine systems and the study of the impact of new hybrid and electric propulsion concepts.
- Advanced Manufacturing and Design leveraging digitization and simulation technologies to accelerate the concurrent design cycle and achieve optimized designs for manufacturing, assembly and in-line monitoring in future factories.
- Advanced composite materials, enabling dramatic cost reductions and increased production cycle speed and flexibility.
- Advanced low-weight metallic materials and high-temperature alloys, including behavioural predictions to extend their limits of use.
- Multifunctional structures to improve maintenance, conductivity, impact resistance, etc.
- Aerodynamic optimization for efficient and disruptive aircraft and powerplant configurations.
- Connected, intelligent, unmanned and autonomous vehicles, integrated into a system of systems with secure, cyber-protected communication and operation.
- More efficient, silent and sustainable engines, developing propulsive and non-propulsive systems that reduce weight, noise and emissions.
- New forms of in-service support, taking advantage of digitalization and the massive use of data to reduce time, costs and maintenance tasks, and propose new integrated service models to customers.
- Development of air traffic control systems (ATM/UTM) leading to time optimization, flight safety and integration of unmanned systems.
- Integral optimization of the generation, distribution and storage of non-propulsive energy.

[19] https://www.tedae.org/uploads/files/1613990275_aeie-pdf.pdf

- **COMPETITIVENESS IMPROVEMENTS**

- Improving the competitiveness of production processes
- The following innovative activities should be incentivized to the extent that they contribute to the industrial leadership of companies in the sector:
- Development of new materials and advanced industrial processes, new multi-year R&D&I projects in these areas.
- Feasibility studies, R&D&I projects or development of specifically aeronautical machinery, carried out in collaboration with Spanish machine tool manufacturers. The objective would be to develop new flexible, intelligent and efficient manufacturing systems.
- Development of technologies for the integral optimization of industrial processes in the aeronautical sector, and its supply chain implementation of new processes existing in other sectors to adapt them to aeronautical products.
- New production processes that represent a competitive advantage for the industry, such as in terms of energy efficiency
- Adoption and development of digitalization resources in the company's production area throughout the entire supply chain (Industry 4.0 deployment)
- Fine-tuning of new or recently implemented industrial processes, based on a real case, when this process is implemented for the first time
- Advanced manufacturing centers. These can be implemented in private or public/private technology centers, aimed at bridging the gap between process development at the laboratory level, and application in real conditions.

- **IMPROVEMENTS IN TRAINING FOR AERONAUTICAL COMPANIES**

Sustainability in the aeronautical sector's leadership lies to a large extent in adapting the Spanish training schemes from which the sector is fundamentally nourished to the standards of excellence available in the most advanced societies.
These needs and their improvement actions are focused on three pillars:

NEW NON-ACADEMIC SKILLS:
Training in new skills applicable to all levels of the company, technical, administrative and production professionals must have skills such as collaborative communication, innovation and business management, as well as technologies derived from the new Industry 4.0 when they join the company.

TECHNICAL SPECIALIZATION OPTIONS:
In terms of higher education, the deployment of new technologies and simulation techniques cannot create the appearance that specialization and deepening in traditional areas of knowledge are unnecessary.
It is necessary to ensure the availability of these training options and facilitate the vocational approach to them because of the expectation of immediate entry into the labour market, with agreements on university-enterprise content, doctorate options and facilities to make specialization studies compatible with incorporation and practice in the company.

As for vocational training, the new industrial capacities are generating new vocational training needs. Thus, to the traditional middle-level vocational training related to the aeronautical sector, the "Aircraft Maintenance Technician", new qualifications should be easily added, such as:

- Technician in Assembly of Structures and Installation of Aeronautical Systems.
- Technician in Composite Materials Manufacturing
- And others related to new technologies and processes that will be developed in the future thanks to R&D&I efforts.

Providing the educational system with sufficient flexibility to create new degrees according to industrial demand.

IMPLEMENTATION OF THE DUAL TRAINING MODEL:
That improves the attractiveness of vocational training for students and adapts the skills and knowledge of graduates to the industrial and labour reality of the company.

6. Conclusions and remarks

The UAV sector is growing in Spain. It is increasingly being introduced in new fields in addition to those traditionally known, such as:

- audiovisual production
- surveillance,
- delivery sector
- emergency response
- search for people
- fiscal control
- border surveillance
- agriculture
- forest fire control
- archaeological research
- geology
- underwater research
- handling of harmful materials...

These innovative applications of UAVs have created new needs in the Spanish labour market that cannot be fully satisfied since complete professionals are not being trained. The complete professional will not only be qualified to operate drones but also to carry out complementary and related tasks such as manufacturing, assembly, repairs, etc.

The Spanish educational system offers aeronautical training, mainly through the VET itineraries, a complete training adapted to the country's significant aeronautical industry. However, these training itineraries do not include training in the UAV field, or if they do, it is only partially.

On the other hand, training from the private sector is focused on drone operation. There are official curricula and regulated exams to obtain a license, which is essential to operate drones from a professional point of view.
The training centres, with a few exceptions, focus on this theoretical/practical training necessary to obtain the operator's license without paying attention to other skills or competencies.

We can conclude that the high-quality professional aeronautical training adapted to the Spanish aeronautical industry does not pay the necessary attention to unmanned aircraft. And the training specifically dedicated to UAVs is mainly focused on the handling and operation of the devices without addressing other competencies or skills.

Through this country report, we found that the situation generates an imbalance between labour market demand for professionals of this profile and the reality. Employers in the sector have stated that they do not find professionals with the appropriate training. They consider it very useful and necessary to address those competencies and skills that the official training itineraries have so far overlooked.

For all these reasons, we think it is necessary to expand the existing training itineraries with a new curriculum for aerospace mechatronics technicians. A specific training adapted to the needs of this emerging profession and already highly demanded in the Spanish labour market.

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