ASSESSING THE EDUCATIONAL GAPS IN AERONAUTICS AND AIR TRANSPORT

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DELIVERABLE WP7:

JOB AVAILABILITY AND ANALYSIS OF LABOUR ATTRACTIVENESS OF THE AIR TRANSPORT AND AERONAUTICS SECTORS

Partner Responsible: IST

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Executive Summary

The recent dynamics and evolutions in the European Union's (EU) Air Transport and Aeronautics (AT&A) sectors have indisputably led to changes in the demand of professional competences. Naturally, the very nature of the competences has evolved in parallel with the progressive modification in economies, societies and, ultimately, in the air transport systems. Prospective employees – that is: the students – have thus to be flexible enough to permanently be able to develop new competences upon the existing ones. This may even be more relevant than mastering the new breed of competences that will most likely become obsolete in the near future. Recalling that prospective employees are nowadays the students, then universities and other education institutions have likewise to adapt their courses and the curricula. EU's AT&A sectors face then real risk of mismatch between the prospective employees' competences and the market's actual requirements. And if such mismatch is not addressed, there is the danger of creating a significant competence gap that will inevitably affect the competitiveness and efficiency of the European AT&A sectors.

EDUCAIR project aims to improve the match between needs in human resources, and the educational and training offer of engineers and researchers within the Europe Union for the horizon of 2020 in the domains of Air Transport and Aeronautics. EDUCAIR project's rationale is built on the concept of competence gap. Decomposing the concept accordingly with the fundamental agents – that are: Companies, Employees, Universities and Student – we can identify the four fundamental competence gaps (see next figure), as follows:

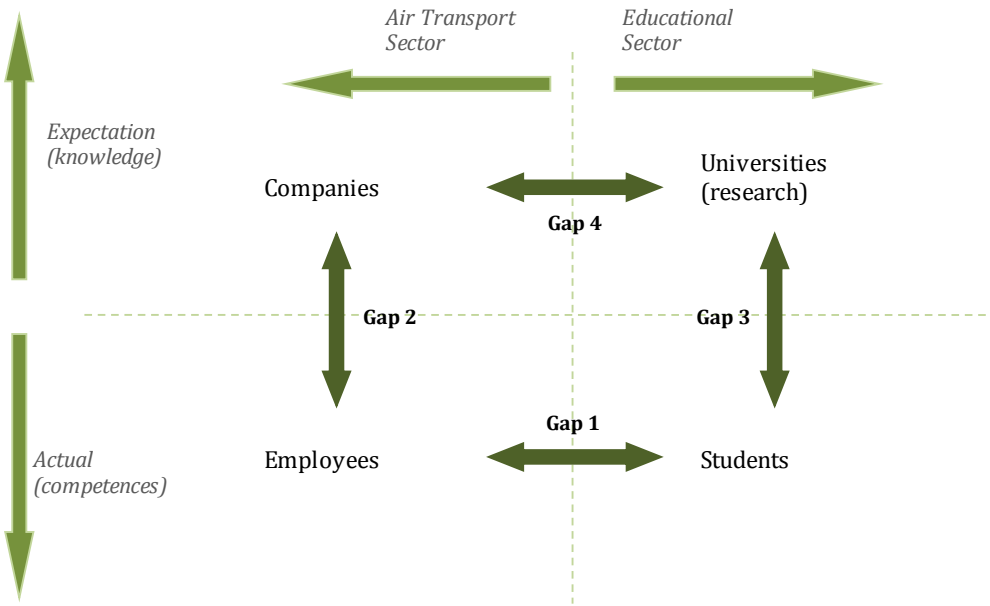

Figure 1 - The four gaps framework

A potential gap was identified between every pair of agents, leading to the identification of 4 potential gaps (Figure 1), being:

- **Gap 1** - Competence Gap - Gap between the competences that the employees need and the actual competences of the students (i.e. to what extend are the student's competences actually useful in their working daily activities?);
- **Gap 2** - Gap between the knowledge that the companies need and the actual competences of the employees (i.e. to what extend do the employees' competences actually fit in their companies' competences requirements?)
- **Gap 3** - Gap between the knowledge the universities generate and the actual competences of the students (i.e. is the knowledge generated in the research transferred in the courses?)
- **Gap 4** - Gap between the knowledge the companies need and the knowledge the universities have (i.e. is the universities' research and teaching activities of relevance for the companies?)

The present Delivery presents the works developed in WP7 aimed to i) to determine the likely number of jobs in air transport and aeronautics in European Union, and ii) to assess the attractiveness and repulsion factors of the air transport and aeronautics jobs. The attractiveness level of the AT&A industries depends on the nature of each competence gap, mainly, Gap 1 and Gap 4.

The current WP7 was developed in parallel with three other WP, being: WP4, WP5 and WP6. Each of these WPs contributes to the assessment of one or two competence gaps as follows, as follows: Gap 1 (WP4), Gap 2(WP6), Gap 3(WP4, WP5) and Gap 4 (WP5).

A set of five surveys was launched aimed to gather the necessary information to assess the attractiveness levels and of the competence gaps. One survey was tailored for every agent, in a total of four – Companies, Employees, Universities and Students – and Graduates of universities and colleges with engineering programs involving air transport/ aeronautics who are not working in the AT&A sector. The first four surveys are fully described and the results presented in the Deliverables of WP4, WP5 and WP6; whereas the last one is presented in this Deliverable.

This WP has made use of three surveys targeting Employees, Students and Graduates. The surveys have produced a considerable amount of information, despite the total number of respondents being bellow initial expectations, as follow and respectively:153, 409and 16

The results evidence a similitude between employees and students' perceptions, as both have reported similar repulsion factors that could be grouped in four categories, as follows:

1. *cumbersome regulatory and legal framework* - employees reported difficulties to obtain the necessary legal certificates to work in some AT&A jobs;

2. *above-average difficulty and lengthy of the programme* – students reported programmes as excessively difficulty (in terms of the amount of contents per available lecturing and studying time) and lengthy;
3. *excessive theoretical contexts with unperceived connection with real practice* – both employees and students reported an excessive emphasis on theory (and theoretical contents) without an equivalent concerns for linking it to the practice.
4. *reduced amount of practical working hours* – both employees and students reported an insufficient amount of hands-on lectures (including practicing in working environment) or contact with industries.

These repulsion factors are likely to have a geographical and time prevalence. In what concerns the former factor, respondents are from multiple EU member states, evidencing the geographical-wide nature of the repulsion factors. In what concerns the latter factor, we must take into consideration that respondents included employees that work for some years now.

Looking now into the attraction factors, we could again identify an overlap between employees and students' perceptions. Although varying the description among respondents, three key attraction factors emerged from the analysis of the results, as follows:

1. *Fascination of AT&A sectors* – the main attractiveness factor, for the respondents, was the fascination towards aviation, aeronautics and aerospace. Not only it was the main driver for choosing this educational path; as well as, it brings respect and admiration in the other people;
2. *Challenging carrier and development path* – the second attractiveness element was the ever-changing, ever-evolving nature of AT&S jobs; along with good plans for carrier development.
3. *Employment and working benefits* - final attractiveness factor is related with the high levels of employability and above-average working benefits offered by AT&A industries.

Again, a coincidence of perspectives between employees and students is visible, which leads to similar conclusions as the ones previously discussed.

There is a perception in the EU about a steady decline in the level of attractiveness of AT&A industry over the last years. Several factors and trends were already identified as lying at the root of this problem, including:

P1. Progressive loss of interest in scientific or technical carriers
P2. Progressive loss of prestige of the Air Transport and Aeronautic Sectors
P3. Progressive reduction of students' interest for mathematics, physics and other sciences
P4. Technical carrier is inferior to management carrier

P5. Job in AT&A still has a strong "male" image
P6. Educational paradigm has changed favouring the teaching of soft-skills in detriment of hard-skills
P7. Reduction of systems engineering-related courses

Every and each trend is believed to contribute, to some extent, to the decay of the attractiveness level although the actual contribution (if any) is still to be demonstrated.

Although EUCAIR's surveys cannot provide evidence to support the existence of these trends, they can be used to infer about their relevancy and validity. From the surveys we can infer the following conclusions for each trend:

P1. Both employees and students referred that the technological nature of aviation and aeronautics was a relevant factor in their decision making process (Attractiveness factor 1 and 2);
P2. Attractiveness factor 1 provides strong evidence towards the validity of this factor;
P3. It is indirectly supported by the surveys in the sense that some students referred that a reason to choose AT&A education was the emphasis in mathematics and analytical reasoning
P4. It is not supported by the surveys, as any employee mentioned a feeling of inferior by having a more technical job.
P5. Only one respondent (out of several tens) pointed out that the reduced quantity of female students was as a negative factor; therefore, even if the trend P5 holds true, there is little evidence that it would have significant impact in the attractiveness level of AT&A..
P6. Surveys do not provide definitive answer, but many students complain about the too heavy lectures on mathematics, physics and other analytical disciplines (repulsion factor E2). This repulsion factor may denote that the teaching of these disciplines has not been softened.
P7. The surveys cannot conclude anything towards this factor.

In 2010, the direct employment by aviation within the European Union is estimated to be about 1.7 million jobs, while the indirect effect includes 2 million jobs, the induced effect 0.9 million jobs and the catalytic effect due to tourism 3.2 million jobs (Air Transport Action Group, 2012b).

The evolution of employment numbers was predicted based on previous years evolutions in relation with different independent variables such as GDP, FTK etc. As basis the share of engineering jobs in aeronautics was estimated to be between 30% and 35%, at airport operators

between 15% and 25% and in airlines between 5% and 10%. The amount of direct engineering-related jobs in 2010 was around [103,200; 120,400] in civil Aeronautics, around [20,500; 34,100] in Airports, and around [21,200; 42,400] in Airlines. The number of jobs in AT&A is calculated to evolve, in 2020, to about [121,000; 141,200] jobs in Aeronautics, around [34,200; 57,000] jobs in Airports, and [26,667; 53,300] in Airlines. The number of jobs for Air Traffic Control Officers are estimated to grow from between 13,236 and 13,857 in 2010 to between 16,839 and 17,628 in 2020.

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1 Introduction

Deliverable 3.3 of WP3 - *Setting the assessment framework for education and training*, explores the roots of the eventual divergence between the demand of and the supply of competences and set the scene for the works undertaken in the current WP7, as well as in WP4 to WP6. Deliverable 3.3 also identified the core competences in Air Transport and Aeronautics (AT&A). These competences are the focal points along which the gaps may emerge and that ultimately may impact the attractiveness of the AT&A. Finally, it proposed a first draft version of the surveys to collect the required information from the sector. The surveys are the primary source of information for assessing the attractiveness levels.

In parallel with WP7, other three WPs were developed, being: WP4, WP5 and WP6. Their purpose was to assess the competences. Each one studied different relevant stakeholders and perspectives, as follows:

- WP4 – Universities (1st and 2nd Level of Bologna) and Graduating Students;
- WP5 – Universities and Research Centres (3rd Level of Bologna) and Graduated Students and Post-Doctoral Researchers
- WP6 – Companies and Employees.

Together these three WPs offer a complete view of the competences in AT&A sectors. Accordingly, each deliverable only reports the findings of the respective WP, therefore it provides a segmented description of the sectors. In order to obtain the full picture the reader is required to read the three deliverables.

These three deliveries provided inputs for the development of the current WP – WP7, as follows:

- Deliverable 4.8 – students' competences and perspective on the current educational supply;
- Deliverable 5.9 - researchers' competences and perspective on the current educational supply;
- Deliverable 6.10 – employees' competences and perspectives on the current working conditions.

The present Deliverable reports the works and achievement of EDUCAIR *WP7 - Competences required by Industry and Research Centres in the AT&A*. The objectives of WP 7 include: i) to determine the likely number of jobs in air transport and aeronautics in European Union, and ii) to assess the level of attractiveness of the air transport and aeronautics industries. By level of

attractiveness we consider the capacity of these industries in attracting enough capable graduates to fill in their jobs vacancies. What we see are some difficulties of the air transport and aeronautic courses in attracting high-capable students, as well as, some of them, after completion of studies, end up working in different areas. This WP will then evaluate the gap between the number of students graduating from European schools and universities, and the needs of engineers and scientists in European industry, education and research centres, at present and in the future, and shed some light on the underlying attraction and repulsion factors of air transport and aeronautical industries.

WP7 was divided into five tasks, as follows:

- *Task 7.1: Assessment of the number of jobs in AT&A*
    - The objective of Task 7.1 is to identify the current and future number of jobs of the European AT&A sectors by areas activity. Scenario analysis technique will be deployed to assess the future developments of the jobs. Owing to budgetary constraints, our analysis will focus on key functional areas. The competence gaps will be assessed on these key functional activities, in order to avoid the dispersion and wasting of the limited resources (budget and time).

  Task 7.1 was led by UA with contribution from IST, AUEB-RC/TRANSLOG, ULPGC, TUD and NLR.
- *Task 7.2: Assessment of the attractiveness factors for the employees*
    - This task aims to understand the factors that the employees valuate the most (and the least) in their work in the AT&A. The task will be based on the inquiry developed in Task 6.3. Direct interviews to some students may be done to complement the inquiry.

  Task 7.2 was led by IST with contribution from UA, AUEB-RC/TRANSLOG, ULPGC, TUD and NLR.
- *Task 7.3: Assessment of the attractiveness factors for the students*
    - This task aims to understand the critical factors that students valuate the most (and the least) in the choice of a course in general, and a course in AT&A, in particular. The task will be based on the inquiry developed in Task 4.2 and Task 5.2. Direct interviews to some students may be done to complement the inquiry.

  Task 7.3 was led by IST with contribution from UA, AUEB-RC/TRANSLOG, ULPGC, TUD and NLR.

- *Task 7.4: Reasons for loosing graduates*
  - This task focuses on those students that after studying in AT&A courses end up working in different areas. This task will identify and conduct an inquiry (eventually complemented with interviews) to these so-called 'lost' students, aiming to understand the reasons underlying their abandonment for a carrier in AT&A and to obtain an approximate number of withdraws.

  Task 7.4 was led by IST with contribution from UA, AUEB-RC/TRANSLOG, ULPGC, TUD and NLR.
- *Task 7.5: Assessment of the attractiveness*
  - This task will summarise the findings obtained in the previous tasks, namely:
    - the critical factors influencing the students' decision in pursuing a carrier in AT&A,
    - the attraction and repulsion factors of AT&A industry.

  Task 7.5 was led by IST with contribution from UA, AUEB-RC/TRANSLOG, ULPGC, TUD and NLR.

This report is structured in six sections, each one dedicated to a specific topic and task of EDUCAIR in general and WP7 in particular, as follows:

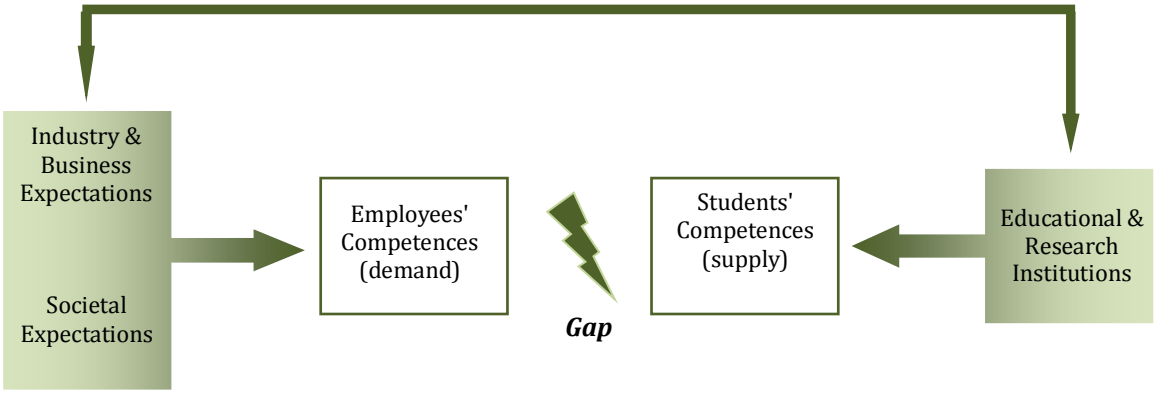
- **Section 1**, the present one, introduces the reader to the contents of the report and provides a description about the WP7 including: objectives, scope, tasks and rationale.
- **Section 2** provides an overview about the objectives, scope and rationale of EDUCAIR project, frames WP7 within EDUCAIR project (that is, clarifies the relationships with the remaining WPs);
- **Section 3** describes the structure of the surveys conducted in EDUCAIR, in general, and in WP, in particular, and presents the results.
- **Section 4** presents the expected evolution of the number of jobs in AT&A.
- **Section 5** assesses the attractiveness levels of the AT&A industries to attract and retain graduates and researchers.
- **Section 6**, the final section, concludes the report.

2 EDUCAIR Project

2.1 Objectives

The recent dynamics and evolutions have indisputably brought changes in the demand of professional competences for working in air transport- and aeronautics-related professions. Arguably, the very nature of the professional competences has evolved in parallel with the progressive modification in economies, societies and, ultimately, in the air transport systems. As such, we are led to conclude that prospective employees have to master the current (and ideally future) competences if they aspire becoming competent professionals. Since prospective employees are firstly students, then this entails that universities and other education institutions have to permanently update the courses and the curricula.

In face of the constant changes, there is a real risk of mismatch between the prospective employees' competences and the market's actual requirements. And if such mismatch is not addressed, there is the danger of creating a significant competence gap that will inevitably affect the competitiveness and efficiency of the European AT&A sectors (Figure 2).



Source: Struyf and Kupfer (2012)

Figure 2 - Potential competence gap

EDUCAIR project aims to improve the match between needs in human resources and the educational and training offer of skills across the Europe Union. EDUCAIR will identify the AT&A needs in terms of staff training and education in the horizon of 2020, in order to recommend improvement in the current educational offers.

On the other hand, the expectable growth in traffic will lead to an increasing demand for labour in AT&A. The industry thus needs to remain attractive in order to attract and keep the most skilled human resources. However, the globalisation and other dynamics is leading to a fierce competition among companies located in different regions and continents, often operating under

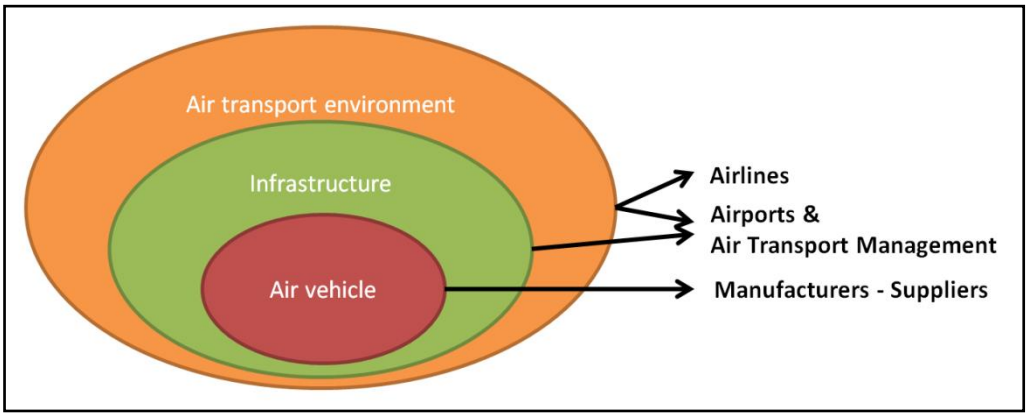
different labour and educational regimes. This is leading the industry to a great pressure for reducing costs, which necessarily reflects in the wages and other working benefits. There is thus the real danger of either graduated students (and researchers) or employees start looking to other industries for better working conditions. If this happens, it may threaten the longstanding competitive hedge of the European Union AT&A industry. Assessing the current attractiveness of the industry is consequently important so that, if necessary, corrective measures could be implemented.

2.2 Scope

2.2.1 Demand Side

The demand side refers to the labour market that recruits the graduated students in AT&A. Owing to time and budget restrictions, EDUCAIR's scope was limited to the key sectors of the marker. These sectors correspond to the large majority of the demand basic demand and the derived demand for educated staff. Foremost, EDUCAIR will only focus on the civil aviation labour market and restrict the geographical coverage to EU27.

EDUCAIR's demand side scope is illustrated in Figure 3. EDUCAIR focuses on four sectors, being: manufacturers and suppliers of air vehicles, airports, airlines and companies that deal with air transport management. It is also important to add that air vehicles comprise aircraft as well as helicopters, but the latter goes beyond the scope of the project.



Source: Struyf and Kupfer (2012)

Figure 3 - Demand side of the aviation market which will be studied by the EDUCAIR project

At the lowest level, there is the air vehicle. Design and construction of the air vehicle on the one hand and the maintenance of the air vehicle on the other hand can be distinguished. A large fraction of airline costs and activities are related to Maintenance, Repair and Overhaul (MRO).

Some airlines do MRO themselves, other use MRO suppliers or rely on the OEM (Original Equipment Manufacturers). Often, there is a combination of all three.

However, as the aeronautics and air transport sector is more than only the aircraft, we have to broaden the view and, in first instance, also look at the necessary infrastructure and infrastructure management, as well as infostructure, that is needed by the sector, such as airport landside and airside infrastructure management and air traffic control navigation and communication air infrastructure. General air transport management cannot be ignored in this analysis. Air transport management influences the aviation environment, the aircraft specific domains and the infrastructure and makes sure that the different domains and layers work well together.

The third layer comprises the air transport environment. This environment contains aircraft operations and training, the airport operations, air traffic management and the air transport companies (airlines). It is important to add here, that, next to the air traffic management, there is also the management of the aircraft design, development, testing, certification, production and new versions along the entire life cycle. Managing an aircraft development and production programme is far more complex than managing an airline or airport and should not be omitted or ignored. For example, is it generally known that developing a new airliner costs around ten billion euros; the production of a thousand is worth 100-250 billion euros and life-cycle costs are much higher (Airliner, 2012, several articles). Development takes five to six years, production may span ten to twenty years in different versions and lifetime can be over 40 years. The process involves hundreds of suppliers at four or five levels. Therefore, the technical managers are often senior engineers after some years of experience and aircraft and equipment producers also employ economists, personnel managers etc.

2.2.2 Supply Side

The supply side refers to the higher-education and long life learning institutions that provide training in AT&A. In EDUCAIR the universe of European Union institutions was narrowed down to the universities offering engineering education programmes on the 1st and 2nd level of Bologna. For the education on the 3rd level of Bologna (i.e. PhD programs) and the post doc research, also other educational areas are analysed, for example management/business economics, law, economics/public policy. Table 1 summarizes the various supply entities that will be covered by the EDUCAIR project.

2.3 Rationale

To explore the sources and extend of the competence gap, the assessment framework presented in Figure 4 will be used. The framework is based on two core concepts, being: *competence and knowledge*. Competence may be understood as the ability to retrieve the *right* skill from our mental *warehouse* of skills to solve some problem. The more adequate our skill is to solving the problem, the higher our competence will be. Knowledge, on the other hand, may be understood as the information, understanding and skills of someone on some domain. A person's competence depends on the ability to pin-point in her body of knowledge the adequate skill to do something. Naturally, if there is no knowledge or the skill is not correctly identified, then the person's competence is affected.

Table 1: Overview of levels and types of education concerning AT&A

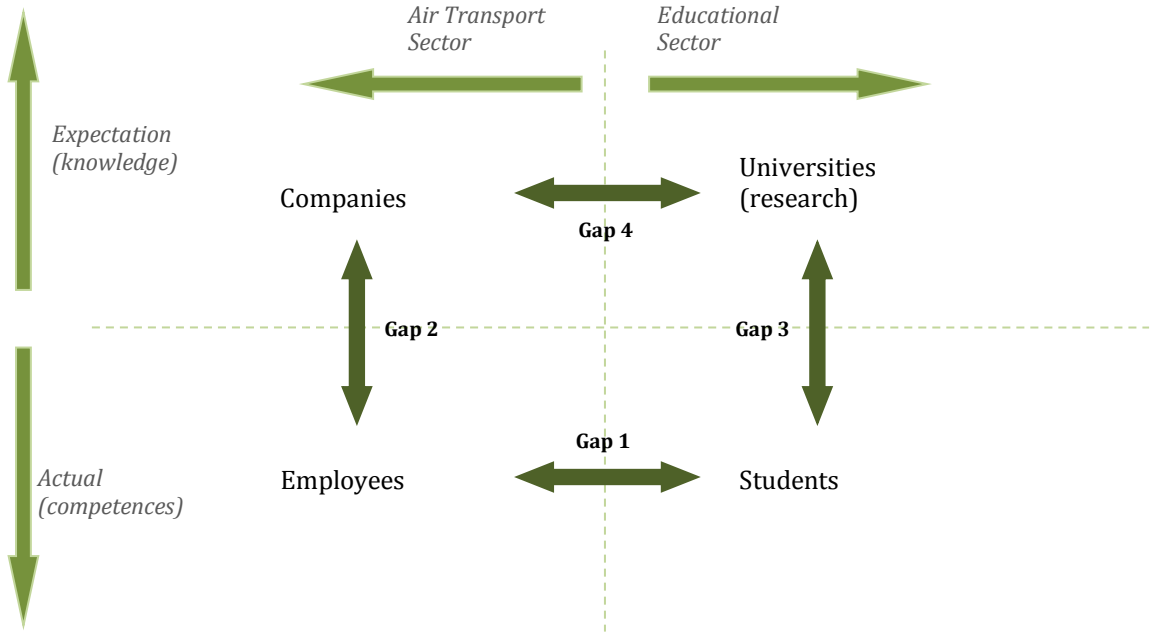
	Level of education	**Type of education**
Academic: University	1st and 2nd cycle of Bologna	Engineering
	3rd cycle of Bologna	• Engineering • Management/ Business Economics • Law • Economics/ Public Policy
	Research (post-doc)	• Engineering • Management/ Business Economics • Law • Economics/ Public Policy

Source: Struyf and Kupfer (2012)

Looking again to Figure 2 and using this assessment framework, we may identify the four gaps and better understand the positioning and origin of the Competence Gap (Gap). Figure 5 identifies the four gaps. Using the concepts of competence and knowledge, and analysing from two perspectives – industry (demand) and educational institutions (supply) – the assessment framework presented in Figure 4 identifies four gaps, being:

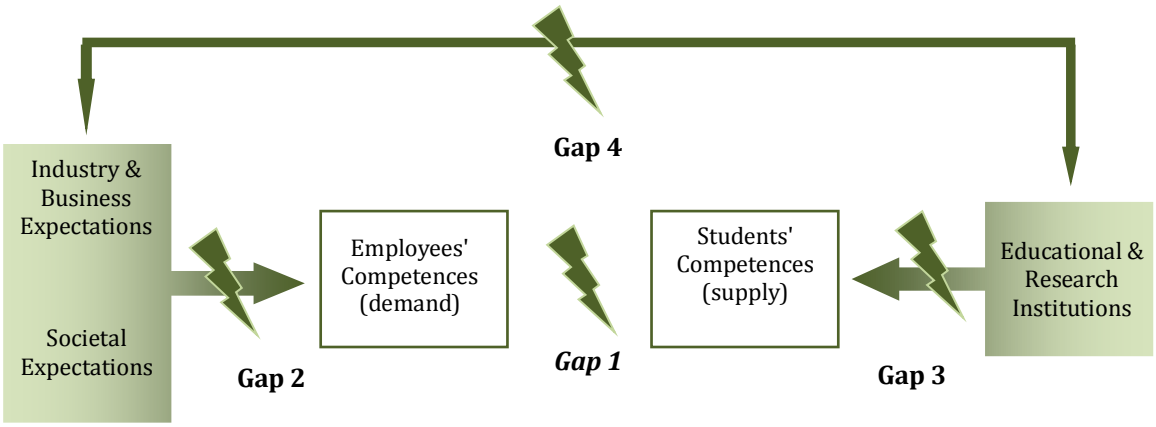
- **Gap 1** - Competence Gap - Gap between the competences that the employees need and the actual competences of the students (i.e. to what extend are the student's competences actually useful in their working daily activities?);
- **Gap 2** - Gap between the knowledge that the companies need and the actual competences of the employees (i.e. to what extend do the employees' competences actually fit in their companies' competences requirements?)

- **Gap 3** - Gap between the knowledge the universities generate and the actual competences of the students (i.e. is the knowledge generated in the research transferred in the courses?)
- **Gap 4** - Gap between the knowledge the companies need and the knowledge the universities have (i.e. is the universities' research and teaching activities of relevance for the companies?)



Source: Struyf and Kupfer (2012)

Figure 4 - The four gaps framework



Source: Struyf and Kupfer (2012)

Figure 5 - Competence Gaps

A detailed description on the various competence gaps can be found in Deliverable 3 of EDUCAIR project (EDUCAIR, 2012).

Figure 6 presents EDUCAIR's overall methodological approach to assess the attractiveness level of AT&A sectors. The methodological approach is divided into three stages, being:

1. **Conceptual development** of the competence gap framework and **Identification of the key competence** – already done in WP3;
2. **Collection of information** (relevant stakeholder's views and perspective) on the current state of those competences - done in WP4 , WP5, WP6 and WP7
3. **Attractiveness Level Assessment** – critical analysis of the perspectives and expectations of students, employees and graduates which nowadays are working in other areas – done in WP7.

The first stage corresponded to the identification of the key competences in the various relevant stakeholders (that is, companies, employees, universities and students) that led to the conceptual development of the Four Gaps Framework. This part was developed and completed in WP3 (See Deliverable 3 (EDUCAIR, 2012). The design of the survey included the elaboration of five questionnaires that were structured to allow assessing the attractiveness levels and the competences gap (more information about the survey can be found bellow in Section 5 and in the Deliverables 4 and 5). To complement and validate the surveys a set of interviews, meetings and other desktop research were conducted. Upon completion of this second stage, the surveys were disseminated and the interviews and meetings were conducted. Finally, the information from the surveys and other sources were compiled and compared. The assessment of the attractiveness level was done through the analysis and cross comparison of collected information.

The calculation of the evolution of the jobs in AT&A (Task 7.1) followed a different analysis, based in economic fundamentals, that is described in detail in Section 4.

The present deliverable describes the results of the tasks conducted under WP7 that led to the calculation of the jobs in AT&A, until 2020, and the assessment of the attractiveness level in these sectors. The scope of the deliverable (and WP7) corresponds to the green shadow in Figure 6.

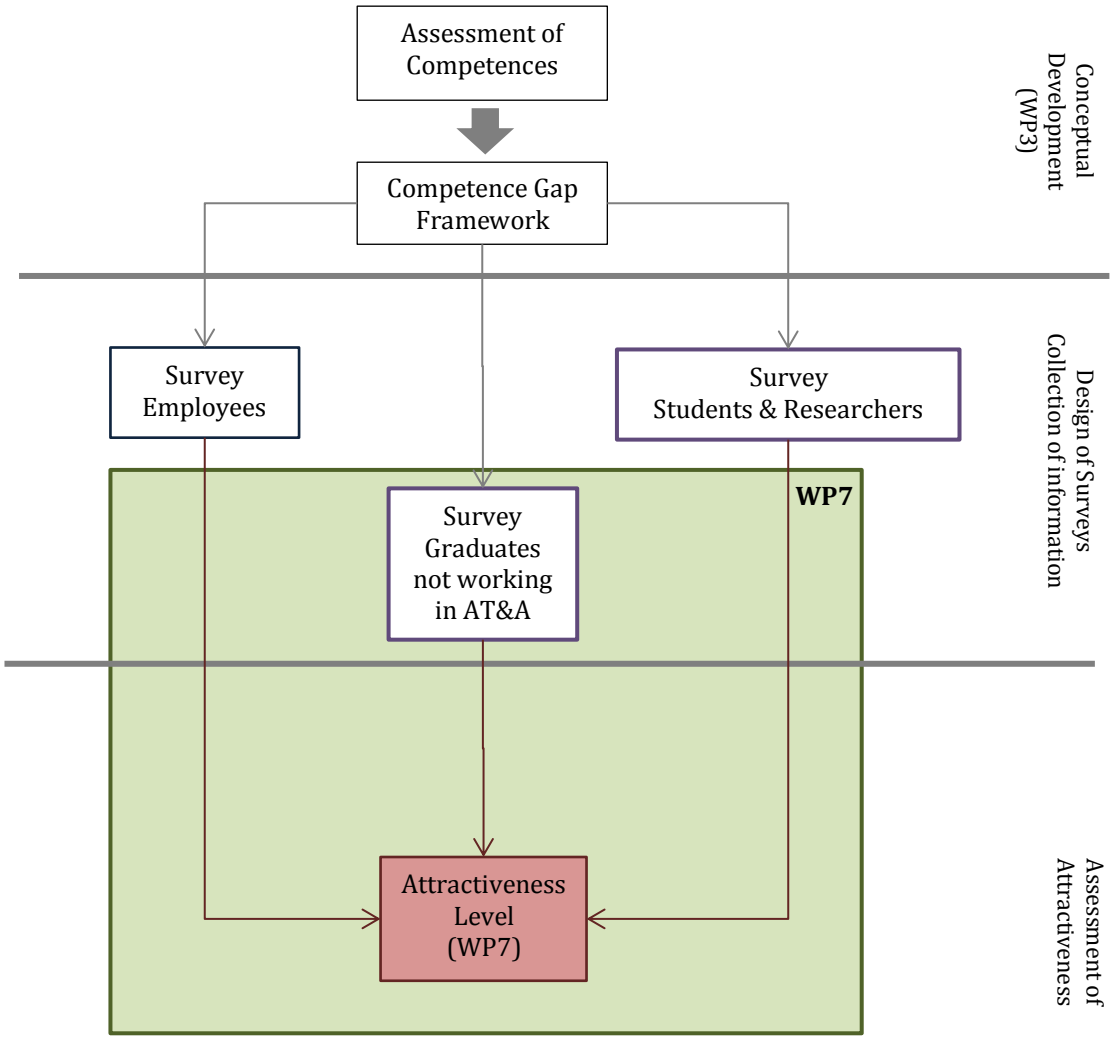


Figure 6 – EDUCAIR rationale for assessing the attractiveness level

3 Surveys (Rationale)

3.1 Introduction

The surveys (Step 2 of EDUCAIR's methodological approach, see Figure 6 in Section 2.3) provided the bulk of the information for the assessment of the competence gaps. The interviews, meeting and other, although relevant, served mainly for calibration purposes.

The adaptation of the Four Gaps Framework (Figure 4) to the scope of the EDUCAIR project led to the identification of the *relevant stakeholders* as the key sources of information for analysis the various competence gaps – that is, the target of the surveys. Table 2 gives an overview of the relevant stakeholders (the upper panel shows the scope, while the lower level shows the stakeholders). Four types of relevant stakeholders were identified, being:

1. companies (human resources),
2. employees,

Table 2: Overview of target group of survey

INDUSTRY (demand side)	EDUCATION (supply side)
• Airlines • Airports • Companies involved in air traffic management (such as air traffic control organisations) • Aircraft manufacturers and suppliers	• Universities and colleges with engineering programmes involving air transport/aeronautics • Universities and colleges with research and PhD programmes in air transport/aeronautics • Vocational and Professional training institutes
Relevant Stakeholders: 1. Managers of new employees and people recruiting new employees (human resources) 2. New employees (max. 5 years' experience) 3. The employees/professionals (with more than 5 years' experience	Relevant Stakeholders: 1. Heads of departments, professors or lecturers related to air transport/aeronautics 2. Graduating students only 3. Graduated students (pursuing a doctorate) 4. Graduated students that are not working in air transport or aeronautics 5. Researchers (post-doctoral fellows)

Source: Struyf and Kupfer (2012)

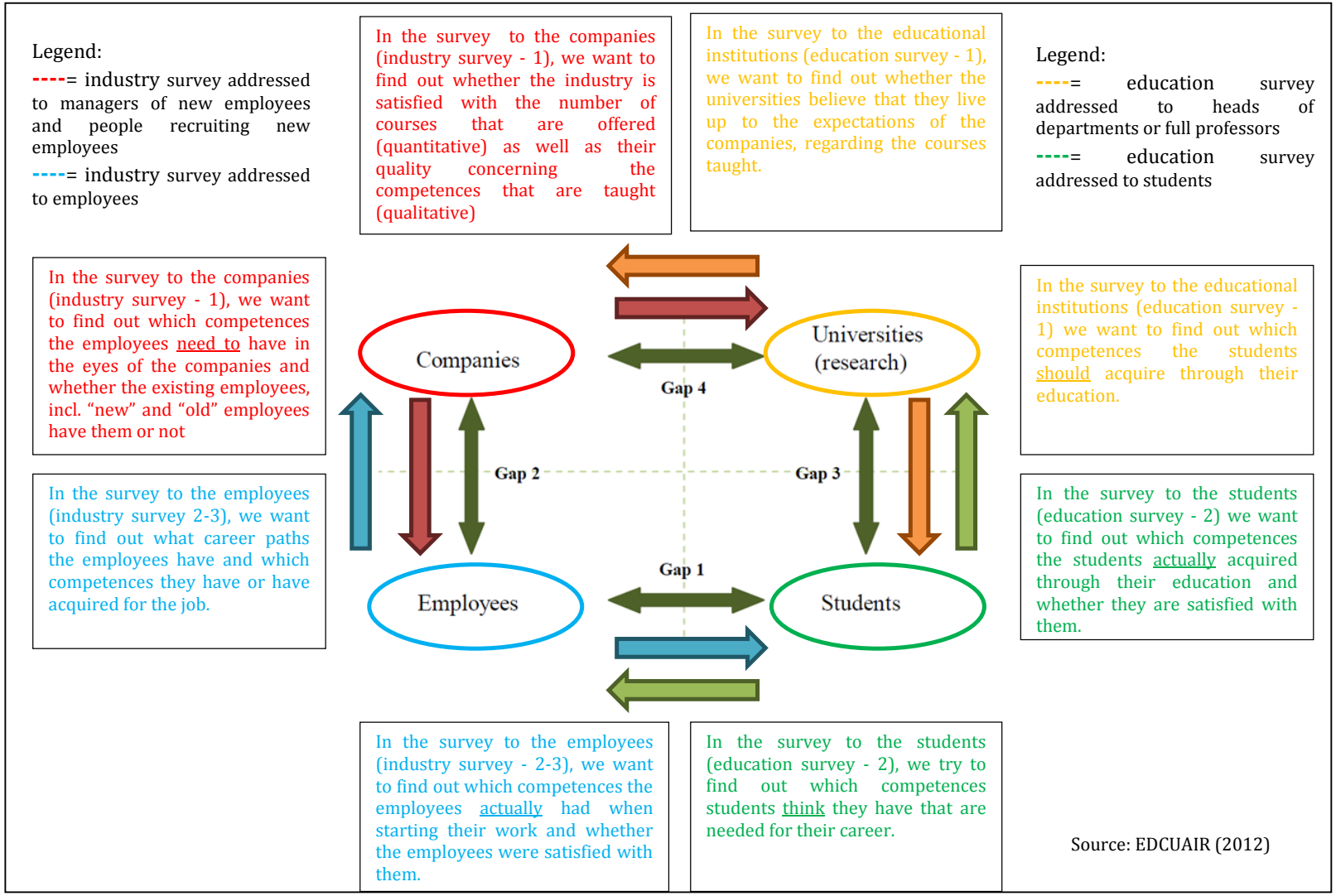


Figure 7 - Overview of different surveys in line with the educational gaps

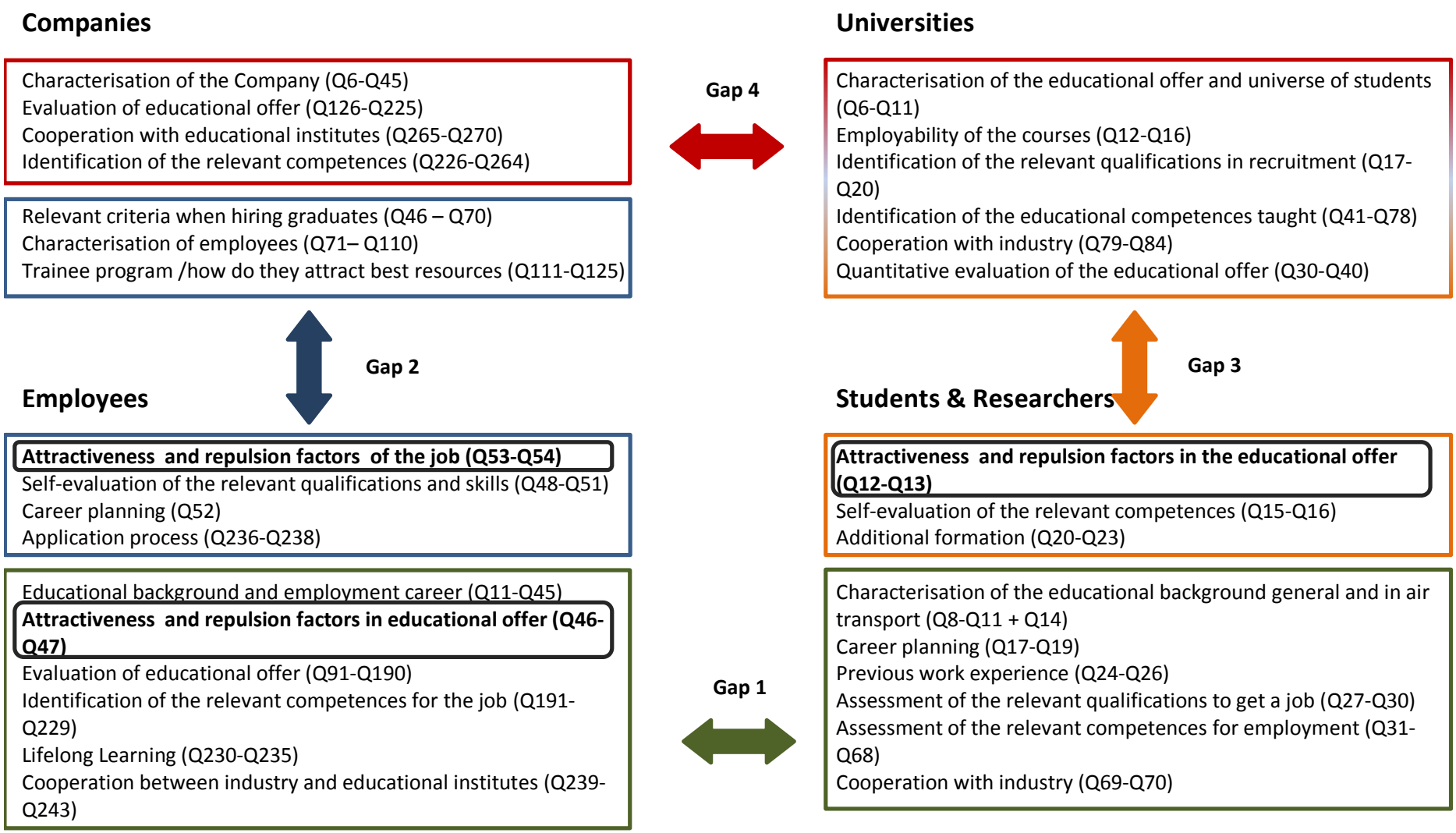


Figure 8 – Structure of the surveys and list of questions to assess the competence gaps and the attractiveness levels

3. universities (professors and lecturers),
4. graduating and graduated students.

A tailored survey was designed and launched for each stakeholder, in a total of four surveys. Figure 7 shows what was gauged in the survey and how this was linked to the specific relevant stakeholders. This is aligned with the assessment framework (Figure 4). The link between Table 2 and Figure 7 is shown by use of colours.

A fifth survey was designed and launched in parallel targeting those graduated students in AT&A but that have either not followed or abandoned a carriers in these sectors. The fact of these graduated students have decided working outside their educational area, reveals a lack of attractiveness of AT&A or, alternatively, a higher attractiveness of other working sectors. Regardless the situation, the AT&industries are losing competitive hedge. Thus, this people are the primary source of information to assess the (lack of) attractiveness of these sectors. The results of this fifth survey were only used in the current WP – WP7 – as it did not contribute for the assessment of the gaps.

For practical matters, each stakeholder received one survey. Looking to Figure 7, we may conclude that each stakeholder is the focal point for two gaps; therefore, each survey contained questions from two gaps. Bearing in mind that the competences and the gaps were assessed in different Work Packages (WP4, WP5, WP6 and WP8)(Figure 6), then the design of the surveys entailed a strong articulation and coordinating among WPs.

Figure 8 presents the rationale underlying the design of the four surveys. Within bracket, we present the number of the question. All surveys started and ended, in a similar fashion, with the basic characterisation of the respondent and a request about their interest in receiving further news and updates. The relevant surveys to the assessment of the attractiveness level are those targeting the employees and the students. In turn, the relevant questions within each survey are highlighted at bold. These surveys are fully described in Deliverables 4.8, 5.9 and 6.10. The fifth survey – targeting graduated students that do not work in AT&A – is smaller and structured in five parts. This survey is fully described below in Section 3.3.

3.2 Dissemination Efforts and Description of the Collected Surveys

All the information about the five on-line surveys, including the description of the different target groups and the hiperlinks to the surveys (in Survey Monkey) are at the project website (www.educair.eu). This helped the 'cross-dissemination' of the surveys through the different target groups, since the website visitors from one target group may acknowledge the other surveys and forward them to their acquaintances.

In parallel with the website, a profile in two well-known business-oriented and social-oriented networking websites Facebook and LinkedIn were created (http://www.facebook.com/Educair; pt.linkedin.com/pub/educair-project/5b/a71/651/). We also disseminated the surveys in several groups related to air transport and aeronautics in LinkedIn and Facebook. We also have sent target messages to EDUCAIR's first degree connections through Linkedin. EDUCAIR's LinkedIn profile has reached 380 first degree connections.

We have sent target messages to contacts in specific groups related to the air transport and aeronautics sectors from our mailing list and all partners did the same. A message to all the professors, students and alumni of than thirty Universities from EU27 (Table 3) was sent.

In addition, we contacted the PhD students of the worldwide scientific network for aviation research and policy – AirNeth.

The Air Transport Action Group – ATAG had also disseminated the EDUCAIR's surveys among its members as requested by IST while participants of AIRDEV conference have received a message to be aware of EDUCAIR surveys.

A second effort was made in order to achieve more answers to the surveys. Since we have received much more responses from Aerospace Engineering students in the first wave of dissemination, in the second wave we tried to disseminate between other students. Therefore, a message to all students of Civil, Environmental, Mechanical, Electrical and Computer Engineering courses of the Engineering Schools listed in Table 3 was sent.

Summarizing, a strong effort was made to disseminate the surveys among different target groups. We mobilized partners, associations and privileged contacts to help us in this task. We used the most important and well-known business-oriented and social-oriented networking websites Facebook and LinkedIn. In addition, several Universities were directly contacted to fill a short inquiry.

The detailed contact list can be found in ANNEX I.

Table 3 - List of contacted Universities

University name	Country	University name	Country
University of Vien	Austria	Rzeszow University	Poland
University of Liège	Belgium	Instituto Superior Técnico	Portugal
University of Limerick	Ireland	University of Beira Interior	Portugal
Politecnico di Milano	Italy	University of Bucharest	Romania
Politecnico di Torino	Italy	Technical University Košice	Slovakia
Universitá di Roma	Italy	Žilinská University	Slovakia
Universitá di Napoli SUN	Italy	Universidad de León	Spain
Universitá di Bologna	Italy	Universidad de Valencia	Spain
University of Bordeaux	France	Universidad de Sevilla	Spain
ENSMA	France	Universidad de Catalunya	Spain
FH Aachen	Germany	KTH Royal Institute of Technology	Sweden
Munchen University	Germany	University of Bath	UK
ILR - Aachen	Germany	University of Perth	UK
TU Braunschwieg	Germany	University of Manchester	UK
Bremen University	Germany	Queen's University	UK
University of Patras	Greece	University of Sheffield	UK
University of Warsaw	Poland	University of Bristol	UK

3.3 Detailed Description of the Survey

The surveys were thought to provide an intuitive and simple experience to the respondents. Aware that the targets (companies, employees, students, etc.) are constantly approached to provide information, the surveys were kept short and the amount of information was reduced the minimum necessary. The following rules guided its structure:

- Minimise and simplify the required information – the maximum duration of the surveys was kept below 20 min;
- Tailoring the surveys – as explained in Section 2.2.1, we have identified a set of core functions within the AT&A sectors, these were our targets. Yet, even so, they exhibit major differences in terms of needed competences or educational background. Likewise, we may expect changes the attractiveness level within the sectors. Therefore, the surveys were tailored to the function of the respondent;
- Minimisation of the open questions – this reduces the duration of the survey, focus the respondent on the purpose and minimise the number of empty questions. In any case, owing the variety and diversity of reasons (some of them entirely subjective) leading to abandon a carrier in AT&A, some of the question concerning the attractiveness level were open questions.

- Relaxation of the boundaries – we are aware that the precise answer of many information would require considerable efforts, whereas, other information is hardly known or recorded. On the other hand, precise information is not fundamental to assessing the attractiveness level or the competence gaps; we need to have confidence about their existence and a clear idea about the their dimension.

As already described in the previous sections, we have developed 5 Surveys in EDUCAIR project, with the following targets:

1. Students and Researchers in AT&A
2. Employees in AT&A
3. Companies in AT&A
4. Universities in AT&A
5. Gradated Students in AT&A but working in other fields.

The first four surveys are described in detail in other deliverables, namely: D4.8, D5.9 and D6.10. Herein, we will describe Survey number 5. The actual survey is listed in Annex I (Section 8).

The survey is structured around 6 parts, as follows:

1. General information about the respondent (Q1 – Q4)
    - Personnel data,
    - Geographical location,
    - Language knowledge.
2. Educational Background (Q5 – Q12)
    - Graduation domain,
    - Educational level in the domain of AT&T (since it may differ from the graduation domain),
    - Professional education in the domain of AT&T,
3. Attraction and Repulsion Factors in AT&A education (Q11-Q12 & Q19)
    - Influence of the education in carrier choices,
    - Attraction and repulsion factors in the educational background in AT&T,
    - Competences needed to find a job in the AT&A sector, but that not acquired during education,
4. Current Employment Status (Q13 – Q14)
    - Working domain (necessarily outside AT&A),
    - Geographical Location,
5. Working experience in AT&A sectors (Q15)
    - Working function and roles performed in AT&A sectors (if any),

- Time experience,

6. Attraction and Repulsion Factors in AT&A sectors (Q16-Q19)
    - Attraction factors for working factors in AT&T,
    - Repulsion factors for working factors in AT&T,
    - Conditions needed to return working in AT&A.
7. Other Comments (Q20 – Q22)
    - Open field for inserting any question
    - Request authorisation for sending further information or for direct contact.

The survey was uploaded in the platform SurveyMonkey (www.surveymonkey.com) and it is available at: https://pt.surveymonkey.com/s/surveygraduates.

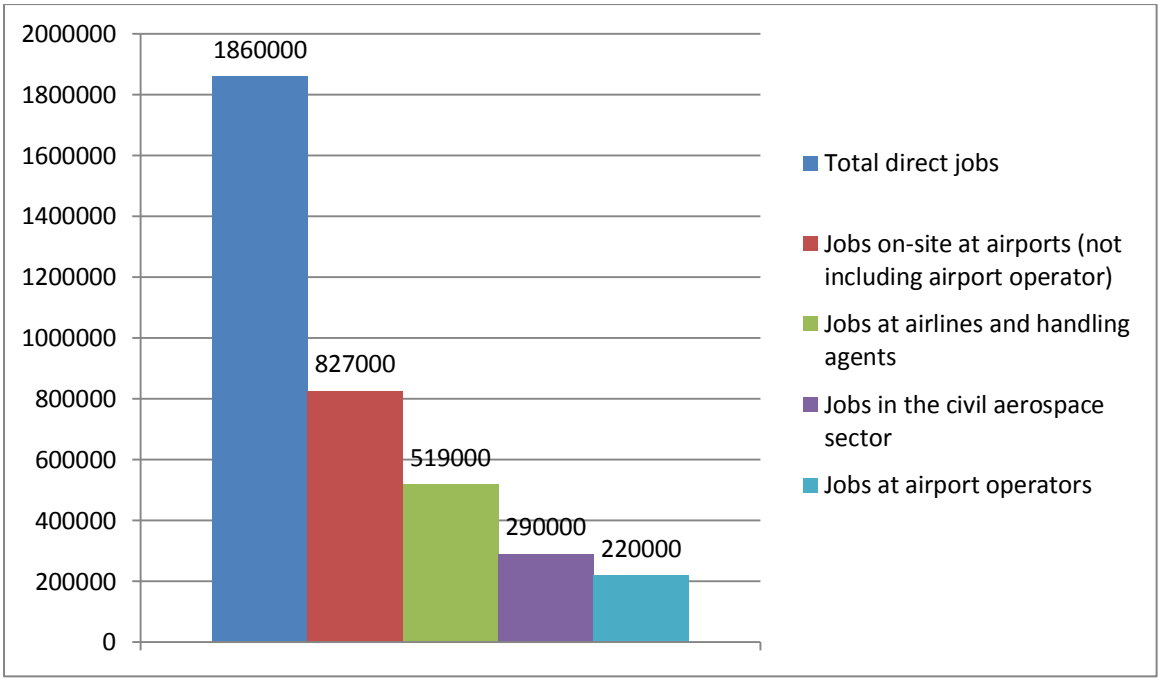
4 Assessment of the number of jobs in AT&A

The main object of task 7.1 was to assess the number of jobs in Air Transport and Aeronautics (AT&T) today and in the time horizon of 2020.

In 2010 about 56.6 million jobs were supported worldwide by the AT&A sector (direct, indirect, induced and catalytic effect)[1] of which 8.36 million directly by aviation. Of those jobs directly supported by the aviation sector, 2.26 million were provided in Asia-Pacific, 1.86 in Europe, 0.46 in Latin America and the Caribbean, 0.43 in the Middle East and 3.09 in North America. (Air Transport Action Group, 2009)

Focusing on Europe (see Figure 9), it can be seen that about 519,000 (28%) of the total of 1.86 million jobs are created by airlines and handling agents which include flight crew, check-in staff and maintenance crew. Furthermore, 220,000 people (12%) work directly for airport operators, while 827,000 (44.5%) work on-site at airports for e.g. government agencies such as customs and security or provide retail, restaurant or hotel services.

Figure 9 - Jobs supported by aviation in Europe (2010)



Source: Air Transport Action Group, 2012a

[1] The direct effect is the employment or value added which is for most part related to the operation of an airport. The indirect effect is defined as employment/value added which is generated in the economy of the region studied, in the chain of suppliers of goods and services. The induced effect is the employment/value added generated in economy of the region studied by the spending of incomes by the direct and indirect employees. Last, the employment/value added generated by the wider role of the airport when improving the productivity of business and attracting new economic activities and in the economy of the region studied, is called catalytic effect. (ACI & York Aviation, 2004, p.5)

This group therefore provides the highest share of jobs in AT&A in Europe. In 2010 the civil aerospace sector such as aircraft, components, airframes and engine manufactures, employed about 290,000 people (15%). When adding the direct, indirect and induced effects, one can say that in Europe air transport supports about 5.1 million jobs, which is 22.9% of the worldwide number of jobs provided by the air transport industry. (Air Transport Action Group, 2012a)

Table 4 - Jobs supported by aviation (by country, in thousands)

	Aviation sector	+ Indirect	+ Induced	+ Tourism catalytic (total)
Austria	32	50	60	75
Belgium	36	71	84	112
Bulgaria	18.2	29.7	38.8	141
Cyprus	9.6	12.2	15.5	63.9
Czech Rep.	14	25	31	43
Denmark	29	39	45	50
Estonia	3.3	5.5	7.1	10.3
Finland	62	86	104	121
France	297	596	780	989
Germany	323	623	816	1146
Greece	53	75	100	300
Hungary	18	29	37	48
Ireland	26	42	54	117
Italy	69	152	195	382
Latvia	4.4	6.5	8.2	18.6
Lithuania	7.9	12.8	16.8	28.3
Luxembourg	8.7	9.8	11.0	14.5
Malta	3.8	4.5	5.5	31.6
Netherlands	87	138	175	287
Poland	20	45	65	84
Portugal	24	44	59	183
Romania	28	41	54	78
Slovakia	13.6	22.1	28.9	32.3
Slovenia	5.6	9.1	11.8	25.6
Spain	120	203	260	872
Sweden	44	67	83	185
UK	326	672	921	1440
EU 27	1700	3700	4600	7800

Source: Air Transport Action Group, 2012b

When looking only at the European Union, the direct employment by aviation is estimated to be about 1.7 million jobs, while the indirect effect includes 2 million jobs, the induced effect 0.9

million jobs and the catalytic effect due to tourism 3.2 million jobs (Air Transport Action Group, 2012b). Table 4 shows the jobs supported by aviation in the different European countries. It is clear that countries such as France, Germany and the UK provide the most jobs in aviation in Europe. Together, those three countries provided about 55.6% of the jobs supported by aviation in the European Union in 2010.

One part of this task was to estimate the relationship between the evolution of jobs in AT&A and the evolution of air transport. Here, two different approaches could be followed (see Figure 10). First, data about past and present employment in AT&A could be related to the past and present traffic of air transport and the production of new aircraft. Traffic related data can include information on aircraft movements, passenger and/or cargo traffic. This information can be collected from organizations such as Eurostat, Eurocontrol etc.. The data on the production of new aircraft should come from the original equipment manufacturers such as Boeing and Airbus.

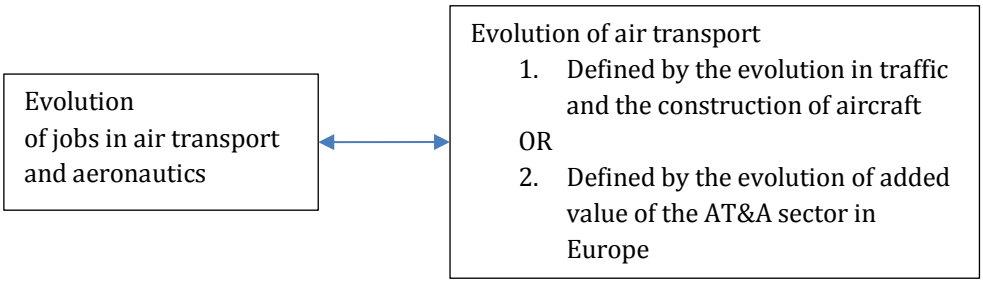


Figure 10 - Estimating the relationship between the evolution of jobs in AT&A and the evolution of air transport (Source: own composition)

A second possibility to calculate the relationship is to compare the evolution of jobs in AT&A and the evolution of the added value[2] of the sector. For the second part, the information might be available at Eurostat and national accounts of the European countries. As the second approach can be more clearly limited to Europe (the evolution of jobs in Europe and the added value of the sector in Europe), it is the more favoured approach. This is because the data for the added value of AT&A might be found on European level, while data on the production of aircraft by the main original equipment manufacturers such as Boeing and Airbus might also relate to the employment needed in all of their production facilities and not only their European ones. However, which approach to follow with the estimation of the relationship mainly depends on the availability of data. Based on expert analysis to be able to compute the relationships between

[2] The value added of an enterprise corresponds to the value that the enterprise adds to its inputs during the year, via the production process. A company's value added gives an indication of its contribution to the income (GDP) of the country or region etc. (Kupfer, Lagneaux, 2009, p.17)

the evolution of jobs in air transport and aeronautics and the evolution in air transport, historic data of at least 10 years is needed.

After a thorough search of available data, it was discovered that the data as input for the analysis is scarce. The problem is especially situated in the availability of time series for a longer time period. In particular, few data is available on the evolution of jobs in air transport and aeronautics at European level. Some studies that analyse the number of jobs in particular countries can be found (see for example CAA, 2004) while others give the number of jobs in AT&A at a specific point in time (see e.g. Air Transport Action Group, 2005, 2012a,b, booz&co, 2009 and ACI Europe and York Aviation, 2004), but without giving comparable data for a longer time period.

To estimate the demand for the direct employment[3] in the AT&A sector different approaches were used, not always with reliable results. First, an attempt was made to estimate the relationship between the development of employment and air transport using data on an aggregated level, which means for the AT&A sector in general. Here estimations for Germany and different European countries were made. However, as the results did not turn out to be reliable, those will further not be discussed in detail. Only the method for those estimations will be explained and the reasons why they did not reveal any sufficient reliable results. Furthermore, disaggregate estimations for the demand for employment at airports, airlines, at ANSPs and the AT&A sector were carried out. As the results from those estimations proved to be more reliable, they are discussed more in detail.

4.1 Existing forecasts

Not many forecasts can be found concerning the employment demand in the AT&A sector. One of the few existing studies concerning this topic is the "Global and Regional 20-year Forecasts – Pilots, Maintenance Personnel and Air Traffic Controllers" by ICAO (2011b). The study analyses the need for pilots, maintenance personnel and air traffic controllers worldwide and on regional level in the horizon of 2030.

Table 5 shows the worldwide training needs according to ICAO (2011a). The study reveals a shortfall of training capacity for 160,000 pilots, 360,000 maintenance personnel, and 40,000 air traffic controllers worldwide. (ICAO, 2011a)

[3] All estimations were made with regard to direct employment.

Table 5 - Worldwide training needs for pilots, maintenance and controllers up to 2030

Personnel category	**Population in 2010**	**Population needed in 2030**	**Training needs** (estimated on an average annual basis)	**Training capacity** (estimated on an average annual basis)	**Shortage** (estimated on an average annual basis)
Pilot	463,386	980,799	52,506	44,360	8,146
Maintenance	580,926	1,164,969	70,331	52,260	18,071
Controllers	67,024	139,796	8,718	6,740	1,978

Source: ICAO (2011a)

The estimations of ICAO are based on the development of the civil aircraft fleet (for maintenance personnel and pilots) and aircraft movements (for ATCOs) and on ratios with regarding to personnel. For the forecast of pilots and maintenance personnel ratios of personnel per aircraft were used and for ATCOs ratios of movements handled annually by the controller. (ICAO, 2011b)

Table 6 - Pilot population in 2030 and training needs[4]

		Pilots needed: 2030	**Training needs** (estimated on an average annual basis)	**Training capacity** (estimated on an average annual basis)	**Shortage/ surplus** (estimated on an average annual basis)
Worldwide	High scenario	1,214,006	69,338	44,360	-24,978
	Most likely scenario	980,799	52,506	44,360	-8146
	Low scenario	800,459	39,555	44,360	4,805
Europe	High scenario	325,668	20,127	7,955	-12,172
	Most likely scenario	262,329	15,552	7,955	-7,597
	Low scenario	214,046	12,090	7,955	-4,135

Source: ICAO, 2011b

Concerning the forecasting of the need for pilots, ICAO worked with different scenarios depending on the pilots per aircraft ratio. For the "high scenario" a high number of pilots needed

[4] An annual attrition of 4% is assumed in the forecast.

per aircraft were assumed, for the "low scenario" a low number of pilots per aircraft. The estimation show that in 2030 between 1,214,006 and 800,469 pilots are needed worldwide which can come down to a training shortage of up to 24,978 pilots. For Europe, an annual shortage of training capacity for between 4,135 and 12,172 for pilots is expected (ICAO, 2011b).

Concerning maintenance personnel, Europe has high training needs because of their large existing aircraft fleet which in 2030 will amount to 28% of the total world fleet. Although in Europe there will be a relatively modest fleet growth and a relatively high training capacity is present, the shortage for maintenance personnel will amount to 8,352 annually.

Table 7 - Population of maintenance personnel in 2030 and training needs[5]

	Maintenance personnel needed: 2030	**Training needs** (estimated on an average annual basis)	**Training capacity** (estimated on an average annual basis)	**Shortage/surplus** (estimated on an average annual basis)
Worldwide	1,164,969	70,331	52,260	-18,071
Europe	330,522	22,977	14,625	-8,352

Source: ICAO, 2011b

Last, the need for Air Traffic Control Officers (ATCO) was estimated by ICAO. As mentioned, the forecast was made using the development of aircraft movements as well as using a ratio of 370 movements/ATCO for the final estimation. The estimations show that, in 2030, there will be a worldwide need for ATCOs of 139,796 in 2030 and of 32,616 in Europe. Therefore, the annual shortage of ATCO training capacity is estimated at 1,978 worldwide and 315 in Europe. (ICAO, 2011b)

Table 8 - Air Traffic Control Officer population in 2030 and training needs[6]

	ATCOs: 2030	**Training needs** (estimated on an average annual basis)	**Training capacity** (estimated on an average annual basis)	**Shortage/surplus** (estimated on an average annual basis)
Worldwide	139,796	8,718	6,740	-1,978
Europe	32,616	1,755	1,440	-315

Source: ICAO, 2011b

[5] An annual attrition of 5% is assumed in the forecast.
[6] An annual attrition of 5% is assumed in the forecast.

4.2 Forecasting trajectory

The relationship between the employment in the AT&A sector and air transport was first calculated on an aggregated level. As mentioned before, the biggest challenge was the availability of data, especially for the employment in the AT&A sector for a longer time period. As most reliable data could be found for Germany, it was decided to first look at the employment in AT&A and the evolution in air transport for this country in order to get an idea about the general relationship. This choice is also supported by the fact that 19% of the direct employment in the air transport sector in 2010 was generated by Germany (Air Transport Action Group, 2012b). Specifically information for 2001 to 2006 could be found on employment at German airports (booz&co, 2009), at airlines in Germany (booz&co, 2009), at German Air Navigation service providers (ANSP, booz&co, 2009), in maintenance organisations (booz&co, 2009) and the employment in the German Aerospace sector (Bundesverband der Deutschen Luft- und Raumfahrtindustrie e.V., 2012). As independent variables, the registered carrier departures (World Bank), the passenger on board and carried (Eurostat) as well as the Airbus turnover for the years 2001 to 2006 (Airbus) were available.

However, the independent variables turned out to be correlated in such a way that they could not be used together in the estimation. Therefore, it was decided to work with the passengers carried.

At first sight, the estimation results seem relevant with the coefficient for the constant and the passengers carried turning out to be significant at 1% and 5% respectively. However, the actual and fitted values showed that the fit of the estimation is less than optimal. In 2001 and 2004 the model overestimates the actual employment in AT&A while the employment is underestimated in 2002, 2003, 2005 and 2006.

The difference between the estimation and the actual values could come from the fact that often the AT&A companies are not flexible enough to quickly adapt the employment in the companies. Labour regulations often ask for some month of notice before an employee can be let go. This is why the estimation of the employment in AT&A was also made including as independent variable the passengers that were carried of the year before. The second ordinary least squares (OLS) regression also suggests significant coefficients.

Unfortunately for 2001, 2002 and 2003 the values were still over- or underestimated. It seems that the overall AT&A industry was still hiring people in 2002, while the number of passengers decreased. Therefore it was decided to discard the estimations. To produce more reliable estimations, more data and longer data series concerning the employment in the AT&A is necessary, especially when the estimation outcome is intended for forecasting.

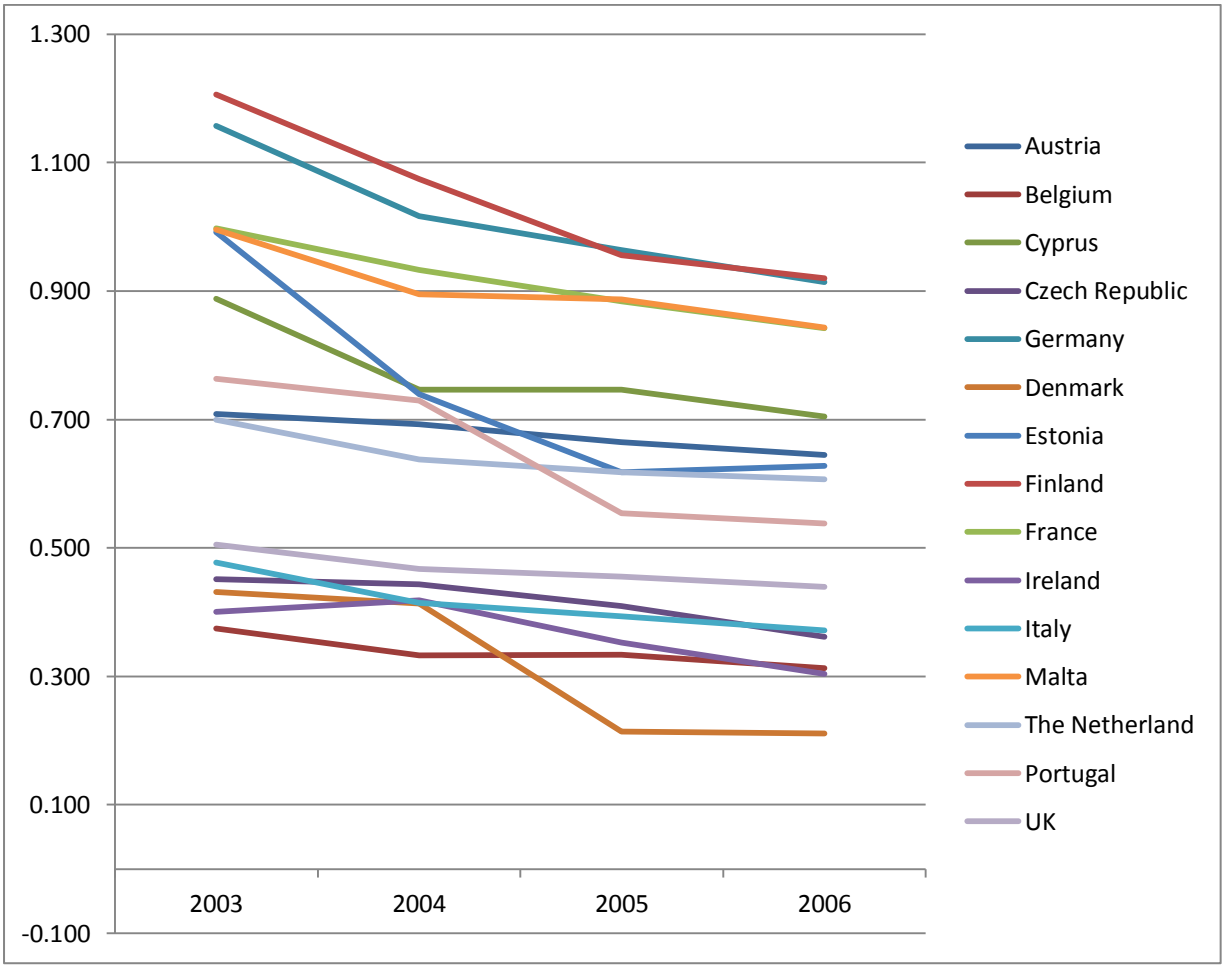
As the aim of the task 7.1. is to obtain an idea about the European demand in employment in AT&A and not only in Germany the estimation on an European level was attempted. This was done also in view of more reliable results.

Unfortunately not enough data for a longer time period could be found for all European countries. However, some data could be found for the following countries: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Malta, Netherlands, Portugal, and the UK. The data include the employment at the airports of the specific countries (booz&co, 2009), the airlines (booz&co, 2009), the Air Naviation Service Providers (booz&co, 2009), the registered carrier departures (World Bank), the passengers and freight on board (Eurostat). The passengers carried and the freight carried which was available for Germany, was not available for all countries in this analysis.

Similar to the estimations for Germany correlations between the independent variables were found which is why the estimations were carried out with the passengers on board.

The estimation was first made with common coefficients, which means that the data for the different countries were pooled. However, the results of the estimation were again not reliable as there are too many differences between countries. Therefore a country specific panel estimation was attempted for which, however, too few data (i.e. not enough years) was available to give reliable results.

Therefore it was decided to work with ratios of employees per thousand passengers on board. For the different countries all ratios show a decreasing trend between 2003 and 2006 (see Figure 11). The reason for a change in ratio can be due to for example technological advances with which the industry relies less on manpower. Secondly a trend can be seen that passengers are required to do more and more tasks themselves, such as checking in, so the airports and airlines can cut back on employment. The highest ratios between the passengers on board and the employment can be seen in Finland and in Germany with ratios around 0.915 in 2006. The lowest ratios on the other hand are shown for Denmark with a ratio of around 0.2 employees per 1000 passengers on board.



Source: own composition

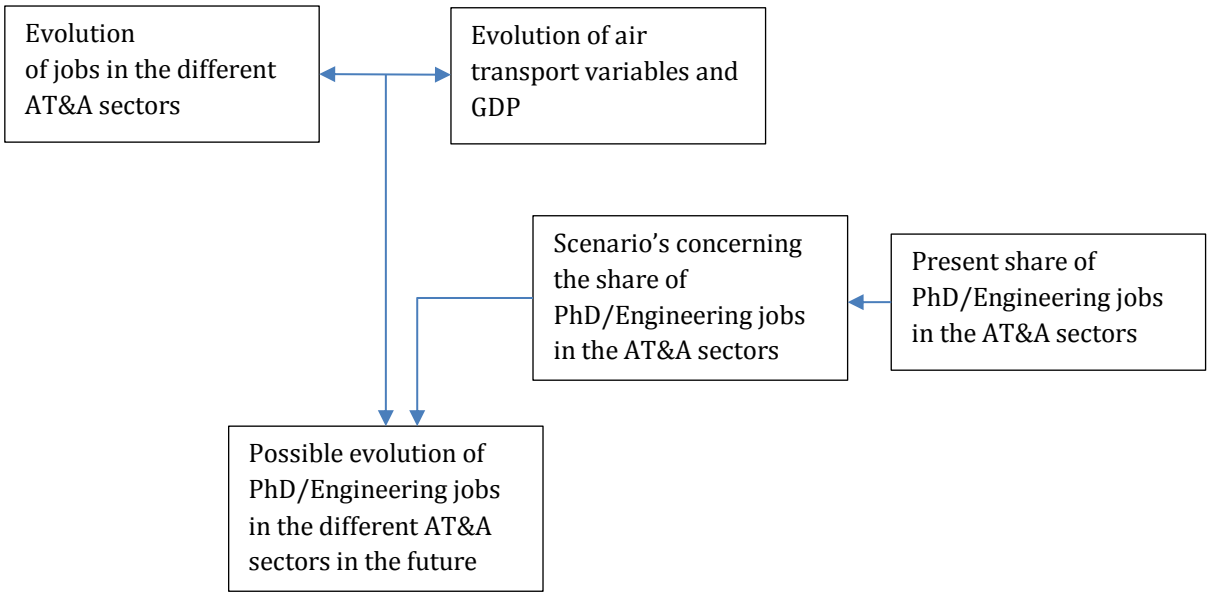
Figure 11 - Employment in the AT&A sector per 1000 passengers on board (selected European countries)

However, in terms of forecasting, it is not clear which ratio to use as the ratio vary quite considerably between the different European countries (see Figure 11) and an average ratio can only be a proxy. Furthermore, it is not clear how this ratio will develop in the future. Due to those reasons, also this method of estimating the employment need was discarded and the decision made to focus on disaggregate estimations for the demand for the employment at airports, airlines, ANSPs and in the civil aeronautics sector separately.

4.3 Data and Method

The relationship between the evolution of jobs in air transport and aeronautics and the evolution of air transport can be taken as basis for the estimation of the general development of jobs in the air transport and aeronautics sector (see Figure 12). Furthermore, the future need of

engineering jobs can then be calculated using the share of PhD/Engineering jobs in the different AT&A sectors.



Source: own composition

Figure 12 - Estimating the possible evolution of PhD/Engineering jobs in the different AT&A sectors

To estimate the future employment at airports, airlines, the aeronautics sector and at ANSP's, existing data from previous years needs to be collected. However, as mentioned earlier the public domain does not offer reliable data for employment in the different sectors for a longer time period (>10 year old). Moreover, it does not suffice to rely on fact that the historic trend in employment will simply proceed in the future. Also other variables, such as GDP and future air transport demand, can affect the future employment in the different sectors. Therefore, these variables were also taken into account when estimating the future employment in the air transport and aeronautics sector.

For all estimations data of the GDP, freight tonne-kilometre (FTK) and revenue passengerkilometre (RPK) were used based on expert analysis and consensus in the project team. Data for the GDP in Euro per capita in Europe could be retrieved from Eurostat (2013). For the FTK and RPK, in the end, data of IATA was used. Data for FTK and RPK on European level was not found for a sufficient long time period (data was only available from 2006). However, when calculating the share of the European FTK and RPK in worldwide traffic, it could be seen that this stays approximately the same with the available data. This is why the worldwide numbers could be used as proxy.

Movements of aircraft in Europe were used for the estimation for the airline sector, the airport sector and ANSP's, again based on expert analysis and consensus in the project team. The average daily movements used in the estimations are based on booz&Co (2009, p.6) and Eurocontrol data (Eurocontrol, 2013).

Furthermore, data for the orders and deliveries of aircraft were used for the estimation of the development of employment in aeronautics. Those data was retrieved from Boeing (2013) and Airbus (2013) as they are the largest civil aircraft manufactures in the world.

Concerning employment, data was needed for the amount of employed people at airports, airlines, the aeronautics sector and at ANSP's. For the direct employment at airports, data from booz&Co (p.49) and Eurostat country data were used. To fill the gaps in the database, numbers were estimated by using the average growth in the previous and/or last year. The latter was validated by analysing statistics of the direct employment at airports in Europe from ACI. Regarding employment in airlines, estimations for Europe were based on data from booz&Co (p. 27) and IATA (for 2008-2011). Data for the employment in the European (military and civil) aeronautics sector was taken from ASD for Europe. To calculate the share of the employment in civil aeronautics, the share of civil employment in Germany (Bundesverband der Deutschen Luft- und Raumfahrtindustrie e.V., 2012) and the share of incoming orders of the European civil aeronautics sector (ASD, 2012) were used as a proxy. Eurocontrol ACE benchmarking reports were used to calculate the employment in ANSP's. This data was completed by estimations for Poland for 2001 since data for this year was not available in the Eurocontrol benchmarking reports.

To forecast the future employment in the different sectors, MatLab and Excel were used to relate the employment with the different variables mentioned above such as GDP, FTK, RPK etc. (see Figure 10). First, the data was normalized to eliminate the effects of the magnitude of the absolute values. Thereafter, the ordinary least square linear regression method is applied to estimate the coefficients of the independent variables (GDP, FTK, RPK etc.). Here, the independent variables were assumed to have a linear additive (instead of a multiplicative) effect on the dependent variable (employment). This assumption was made as the European air transport market behaves as a mature market, small changes will have a small result. In the equation relating employment to the different independent variables, a constant factor was not included as this would presume that there is an inheritor organic growth in employment, even without growth in the independent variables.

After estimating the coefficients for the different independent variables, an average European growth of employment was calculated for the different sectors, by feeding the linear additive relations with its sector specific coefficients with experts forecasted growth data. Table 9 shows

the forecasted growth data for the independent variables. When more detailed yearly growth data was available (as for example for GDP) or could be estimated, then the latter was used in the calculation of the employment.

Table 9 - Forecasted growth data for the independent variables

Independent variable	**Average growth (until)**	**Source**
Deliveries	1.05% (2020)	Airbus, Global Market Forecast 2012-2031
RPK	4.10% (2031)	Airbus, Global Market Forecast 2012-2031
FTK	4.80% (2031)	Airbus, Global Market Forecast 2012-2031
Movements	3.00% (2019)	EUROCONTROL Seven-Year IFR Flight Movements and Service units Forecast 2013-2019
GDP	2.05% (2017)	International Monetary Fund, World Economic Outlook Database, October 2012

Source: own composition

4.4 Estimation results for the airport sector

To estimate the future employment in the airport sector, FTK and RPK growth data were used in the specific segment linear additive model. During the estimation process, it was seen that other variables such as GDP and movements proved to be insignificant[7] or their coefficient equalled zero.

To calculate the overall growth in airport employment, the following equation was estimated:

$$\Delta E_{airp} = 0.8691\ \Delta FTK + 0.3897\ \Delta RPK$$

Where: ΔE_{airp} = growth in employment in the airport sector

ΔFTK = yearly growth in freight tonne-kilometres

ΔRPK = yearly growth in passenger tonne-kilometres

With an R^2 of 0.66 and RPK and FTK significant at a 5% level.

[7] A coefficient was assumed to be significant if at least significant at a 10% level.

It can be seen that the explanatory value of the model is relatively low as the R^2 is quite low. This can be attributed to the lack of qualitative time-series data, especially for the employment at airports.

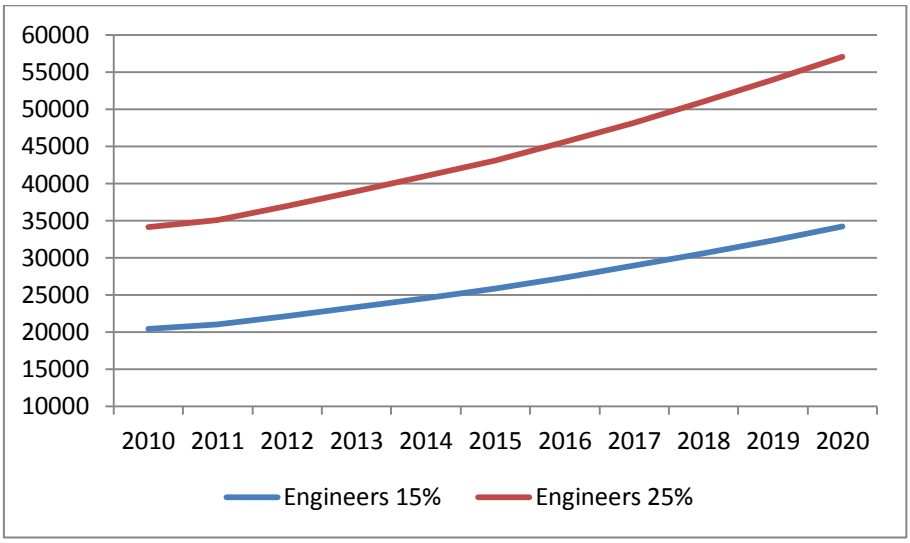
It can be seen that the growth in FTK and RPK have an impact on the employment at airports. That the growth in FTKs have higher impact than the growth in RPKs can be due to the relatively lack of long time-series with which the estimation could be carried out.

Table 10 shows the growth of employment in the airport sector until 2020. Also the development of engineers in the airport sector is shown (see Figure 13). Based on information from the surveys, a share of 15-25% of engineers in the airport sector can be assumed. The calculations show that the need for engineers working at airports can be assumed to grow from between 20,464 and 34,107 in 2010 to between 34,230 and 57050 in 2020, with an average yearly growth of 5.3%.

Table 10 - Employment at airports 2010-2020 (estimations 2010-2020)

	General	Engineers 15%	Engineers 25%
2010	136,427	20,464	34,107
2011	140,238	21,036	35,059
2012	147,813	22,172	36,953
2013	155,924	23,389	38,981
2014	163,944	24,592	40,986
2015	172,377	25,857	43,094
2016	182,323	27,348	45,581
2017	192,842	28,926	48,210
2018	203,968	30,595	50,992
2019	215,735	32,360	53,934
2020	228,182	34,227	57,046

Source: own composition



Source: own composition

Figure 13 - Employment of engineers at airports 2010-2020 (estimations 2010-2020)

4.5 Estimation results for the airline sector

To estimate the future employment in the airline sector, FTK and movement growth data was used. During the estimation process it was seen that other variables such as GDP and RPK proved to be insignificant or their coefficient to be zero.

To calculate the overall growth in employment at airports, the following equation was estimated:

$$\Delta E_{airl} = 0.2297\, \Delta FTK + 0.3152\, \Delta Mov$$

Where: ΔE_{airl} = growth in employment in the airline sector

ΔFTK = yearly growth in freight tonne-kilometres

ΔMov = yearly growth in movements

With an R^2 of 0.69 and FTK and average daily movements significant at a 1% level.

Also here the R^2 is relatively low, which can be attributed to the lack of reliable time-series data especially for the airline employment.

It can be seen that the growth in FTK and movements have an impact on the employment at airlines. The important RPK key performance indicator seems to be highly correlated with movements and is therefore not significant.

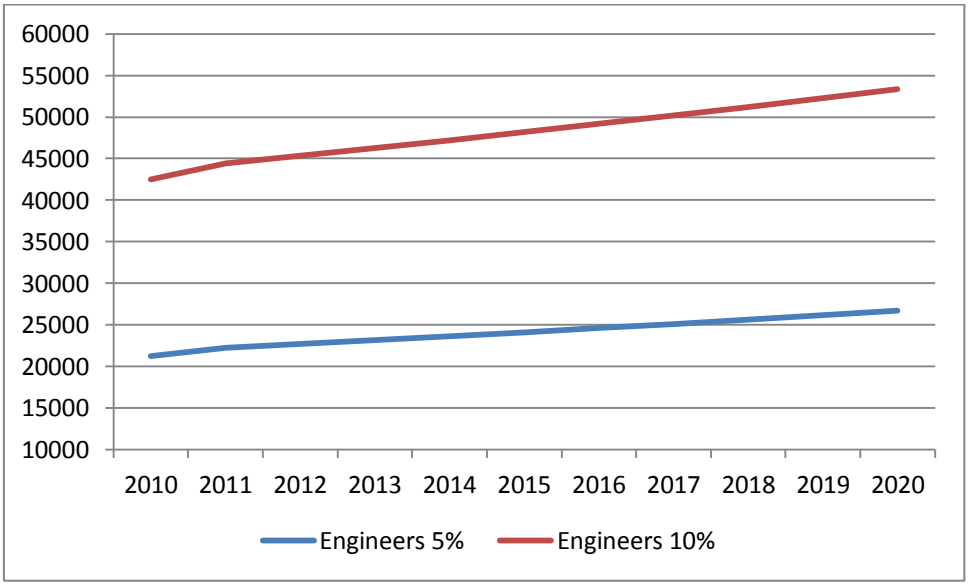
Table 11 shows the growth of employment in the airline sector until 2020. Also the development of engineers in the airline sector is shown (see Figure 14). Based on information from the surveys a share of 5-10% of engineers in the airline sector can be assumed.

The calculations show that the need for engineers working at airlines can be assumed to grow from between 21,229 and 42,458 in 2010 to between 26,670 and 53,330 in 2020, with an average yearly growth of 2.3 %.

Table 11 - Employment at airlines 2010-2020 (estimations 2012-2020)

	General	Engineers 5%	Engineers 10%
2010	424,582	21,229	42,458
2011	444,377	22,219	44,438
2012	453,479	22,674	45,348
2013	462,767	23,138	46,277
2014	472,245	23,612	47,224
2015	481,917	24,096	48,192
2016	491,787	24,589	49,179
2017	501,860	25,093	50,186
2018	512,139	25,607	51,214
2019	522,628	26,131	52,263
2020	533,333	26,667	53,333

Source: own composition



Source: own composition

Figure 14 - Employment of engineers at airports 2010-2020 (estimations 2012-2020)

4.6 Estimation results for the aeronautics sector (civil)

To estimate the future employment in the aeronautics sector, growth data about deliveries, GDP and passenger tonne-kilometres was used. During the estimation process it was seen that other variables such as FTK and movements proved to be insignificant or their coefficient to be zero.

To calculate the overall growth in employment in the aeronautics sector, the following equation was estimated:

$$\Delta E_{aero} = 0.2034\, \Delta Del + 0.6860\, \Delta GDP$$

Where: ΔE_{aero} = growth in employment in the aeronautics sector

ΔDel = yearly growth in deliveries

ΔGDP = yearly growth in GDP

With an R^2 of 0.97 and the growth in deliveries and GDP significant at a 10% level.

In contrast to the other estimations has the estimation for the employment in the civil aeronautics sector more explanatory value with a high R^2 of 0.97. This could point to the good quality of the used data from ASD for the employment in the aeronautics sector.

It can be seen that next to the growth in GDP, the growth in deliveries, but not the orders, has an impact on the employment in the aeronautical sector. The orders turned out not to be significant. This can be explained with the fact that orders can apply to aircraft which are delivered a number of years from now and of which the production does not start right away.

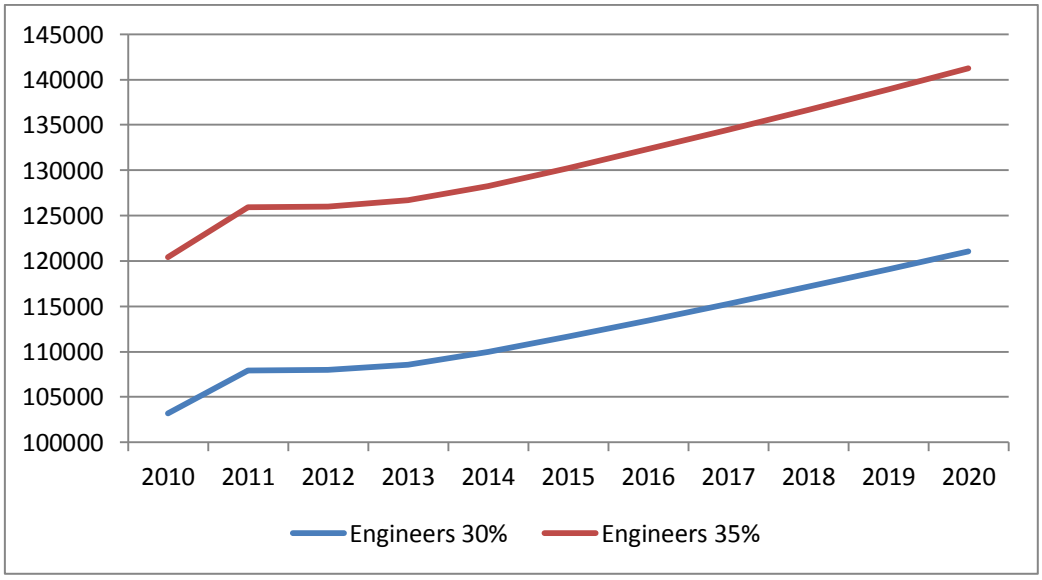
Table 12 - Employment in the civil aeronautics sector 2010-2020 (estimations 2012-2020)

	General	Engineers 30%	Engineers 35%
2010	344,025	103,208	120,409
2011	359,700	107,910	125,895
2012	359,957	107,987	125,985
2013	361,941	108,582	126,679
2014	366,523	109,957	128,283
2015	372,118	111,635	130,241
2016	378,072	113,422	132,325
2017	384,209	115,263	134,473
2018	390,501	117,150	136,675
2019	396,953	119,086	138,933
2020	403,569	121,071	141,249

Source: own composition

Table 12 shows the growth of employment in the aeronautics sector until 2020. Also the development of engineers in the aeronautics sector is shown. Based on information from ASD, a

share of 30-35% of engineers in the aeronautics sector can be assumed. It can be seen that the employment of engineers in the civil aeronautics sector growth from between 103,208 and 120,409 in 2010 to between 121,071 and 141,249 in 2020, with an average yearly growth of 1.6%.



Source: own composition

Figure 15 - Employment of engineers in the civil aeronautics sector 2010-2020 (estimations 2012-2020)

4.7 Estimation results for the ANSPs

To estimate the future employment in the ANSP sector, data about the average daily movements were used. During the estimation process it was seen that other variables such as GDP, FTK and RPK proved to be insignificant or their coefficients to be zero.

To calculate the overall growth in employment of the ANSPs, the following equation was estimated:

$$\Delta E_{ANSP} = 1.0494\, \Delta Mov$$

Where: ΔE_{ANSP} = growth in employment in the ANSP sector

ΔMov = yearly growth in movements

With an R^2 of 0.66 and the growth in movements significant at a 10% level.

It can be seen that the growth of movements has a very high impact on the employment at ANSPs. This high impact is far from surprising as the work at ANSP's depend mostly on the

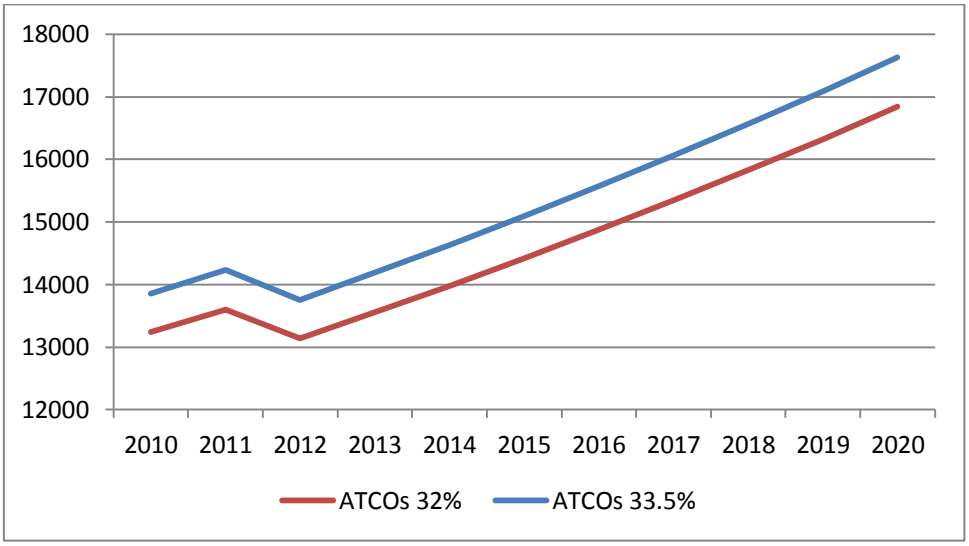
movements of aircraft. However, as with the estimations of the employment at airports and airlines, the R^2 and therefore explanatory value proved to be quite low.

Table 13 shows the growth in employment in the ANSP sector until 2020. Also the development of Air Traffic Control Operators (ATCOs) is shown (see Figure 16). Based on information from various Eurocontrol ACE benchmarking reports a share of 32-33.5% of ATCOs in the ANSP overall employment can be assumed. It can be seen that the employment of ATCOs at ANSPs grows from between 13,236 and 13,857 to between 16,839 and 17,628, with an average yearly growth of 2.4%. This average yearly growth can be considered quite reasonable. This knowing that the worldwide growth of controllers was forecasted by ICAO between 2010 and 2030 to be 3.7% and keeping in mind that the European market is a mature market.

Table 13 - Employment at ANSPs 2010-2020 (estimations 2011-2020)

	General	ATCOs 32%	ATCOs 33.5%
2010	41,363	13,236	13,857
2011	42,500	13,600	14,238
2012	41,064	13,141	13,756
2013	42,357	13,554	14,190
2014	43,690	13,981	14,636
2015	45,066	14,421	15,097
2016	46,485	14,875	15,572
2017	47,948	15,343	16,063
2018	49,458	15,826	16,568
2019	51,015	16,325	17,090
2020	52,621	16,839	17,628

Source: own composition



Source: own composition

Figure 16 - Employment of engineers at ANSPs 2010-2020 (estimations 2011-2020)

Comparing the estimates with the regional forecast of ICAO concerning the need for ATCOs it can be seen that ICAO forecasts a higher need for ATCOs in Europe. (ICAO, 2011b) In 2030 they estimate a need of 32,616 ATCOs in Europe. The reasons why this forecast deviates from our estimates are threefold. First, another geographical scale was used. Our estimation looked at ATCOs in the EU while ICAO looked at the European level, and therefore the base of the estimation differs. Second, another methodology was used in the estimation. While the forecast of ICAO is based on a ratio of 370 movements/ATCO for the final estimation next to the development of aircraft movements, our methodology is based on historical data. Based on those data, the relationship between the development in the number of employees at ANSPs and the development of aircraft movements were determined and projected into the future. Third, the time horizon of the ICAO study was set on 2030 while our study focusses on estimations to 2020. Furthermore, it should be mentioned that the forecast is based on present trends, not incorporating disruptions or increase in efficiency due to for example SESAR.

5 Assessment of the Attractiveness Levels

5.1 Introduction

5.1.1 Research on Attractiveness Level

The research topic on the underlying factors driving a person to choose a particular job position has received a great deal of attention over the past decades. Consequently, it is not surprising the amount of available literature (e.g.: books, papers, reports, etc. – Chapman et al., 2005[8]). We may essentially divide the available literature in two major groups, accordingly with its main purpose, as follows: i) to improve the accuracy of the recruitment process and ii) to improve the retaining rate of the best employees. The first group is the most aligned with the purpose of the current WP – WP 7 – and overall with EDUCAIR project.

Derek Chapman and his colleagues (2005) undertook a major review on the available literature concerning applicants' attraction to organisation and job choice factors. They clustered the available literature into five broad groups, accordingly with the nature of the variables – or predictors – used to explain an applicant's attraction, as follows:

- **Job and Organisational Characteristics** – this cluster is grounded in the objective factor theory (Behling et al., 1968). They claim that the applicant bases his/her decision upon a set of objective variables that characterise both the job and the company.
    - Variable concerning the job properties, include:
        - salary and other benefits,
        - security
        - roles and functions
        - working hours (flexibility)
    - Variable concerning the company, include:
        - path carrier development
        - opportunities for learning
        - working environment,
        - location
        - familiarity (having freight or relatives already working in there).
        - company's image and reputation
        - company's size

[8] Chapman, D., Uggerslev, K., Carrol, S., Piasentin, K., Jones, D. (2005) Applicant Attraction to Organizations and Job Choice: A Meta-Analytic Review of the Correlates of Recruiting Outcomes, Journal of Applied Psychology, 2005, Vol. 90, No. 5, 928–944

- **Recruiter Characteristics and Recruitment Process –** this subset of literature suggests that applicants often face the problem of lacking information about the job attributes, which prevents them of comparing the available offers and necessarily take a good decision. Instead, they build their perception about the job attributes, and consequently choose an offer, during the recruitment process and upon contact with the recruiter. This subset is based on the critical contact theory (Behling et al., 1968). Variables concerning this predictor include:
    - Friendliness and competence of the recruiter
    - Trustworthiness of the process
    - Procedural justice
    - Treatment and Consistency
- **Perceived fit -** this cluster defends that the applicant will choose the offer that better fits with his/her own needs and values – i.e. subjective factors and appraisal. The fundamental belief is that a person selects the environment that fulfils – i.e. fits – his/her needs. Translating this assumption into the workplace domain, we have that an applicant chooses the company whose characteristics are better aligned with his/her personal characteristics. The applicant starts by assessing the characteristics of the job, the organisation and, even, the recruitment process. Follows, a process of interaction between these characteristics and his/her own objectives, expectations, ambitions, etc. This process of interaction will identify the adjustment and the friction points resulting in a perceived fit. The job offer yields higher fitness would be chosen (Kristof, 1996). Variables concerning this predictor include:
    - Person – Company fit
    - Person – job fit
    - Person – recruiter fit
- **Perceived alternatives –** in face of multiple employment opportunities, applicants may disperse their energy over multiple channels, leading to a reduction of the focus and attention on each individual offer. This implicitly has a negative impact on the attractiveness of each specific offer (Bauer et al., 1998).
- **Hiring expectancies –** grounded in the expectancy theory (Vroom, 1966) this cluster suggests that there is a positive correlation between the applicants' expectancy and the respective attraction for applicants. The applicants' expectancy can be measured in several ways. The most common is the likelihood of being offered a position in the company.

Although the actual influence of each abovementioned variable varies among applicants and jobs offers, they offer an interesting starting point for pinpointing the attractiveness variables and

the reason leading graduates not following a carriers in AT&A. In any case, we may identify those that typically play a stronger role in the job choice process. Undoubtedly both the predictors characteristics of the job and of the company were influential in the applicant's choice. This evidences that the brand image of the company in the market and society is likely to influence as much as the actual characteristics of the job itself. Indeed, the creation of what researchers call of *organisational attractiveness* is seemed crucial to the success of the recruitment. Organisational attractiveness can be defined as the "applicant's willingness to pursue jobs and to accept job offers in an organisation" (Tsai and Yang, 2010[9]). In this sense, the company's brand image plays an important role in the level of attractiveness. In turn, the main pillars of a company's image are the: product or products, social and environmental responsibility and credibility. Another key predictor is the *perceptions of fit.* More and more, it has been recognised as one of the strongest ones to explain an applicant's attitudes and attractiveness behaviour. The perception of fit can be decomposed in several domain, accordingly with the objects being fit, as such we may identify: person-job fit, person-vocation fit, person-person fit, person-group fit or person-organisation fit. For many years, companies have adopted a work oriented analyses that favoured the recruitment of people based on their knowledge, skills and abilities to performing a given role or task. It was concluded that such approach led to low levels of fit, along the various dimensions, resulting in lower levels of job satisfaction and abandonment. A better way to attract better applicant and retain the best employees is by improving and ensuring a high level of fit with the person (in a first stage as applicant and later on as employee). Companies must thus look for applicants that, besides knowledge, skills or abilities, should exhibit personalities, beliefs and values that are aligned their culture, norms and values. This evidences that to attract the best people to the offer – that is maximisation of the fit – companies should engage in individual recruitment processes rather than general or broad recruitment processes.

A key point is the understanding of an applicant's process of job choice. Notwithstanding the amount of research, there is yet no consensus about the actual structure of the process. In this report we adopted an approach based on the concept of decision funnel with three steps and four different sets of alternatives (Trommsdorff, 2002[10], Shocker et al., 1991[11]). The following scheme (Figure 17) translates the conceptual idea of the job choice process.

[9] Tsai, W-C., Yang, W-F. (2010) Does Image Matter to Different Job Applicants? The influences of corporate image and applicant individual differences on organizational attractiveness, International Journal of Selection and Assessment, Volume 18 Number 1 March 2010
[10] TROMMSDORFF, V. (2002): Konsumentenverhalten, 4. Ed. Stuttgart.

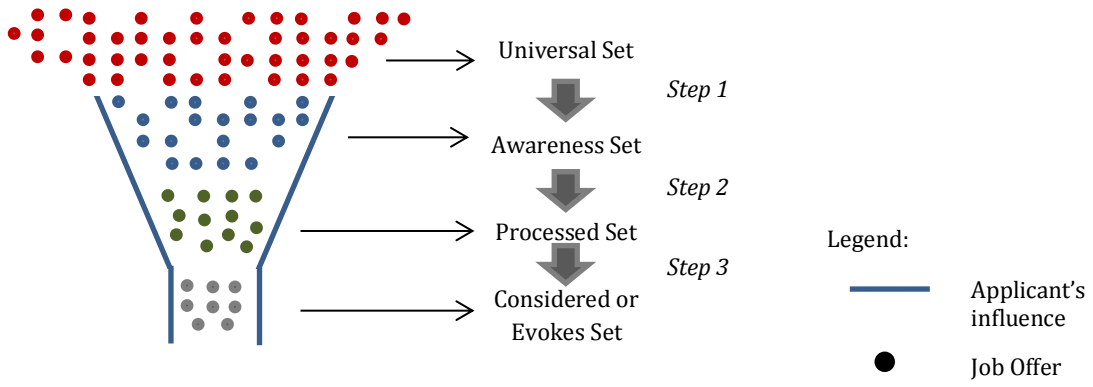


Figure 17 – Applicant's job choice process

The set of all offers available in the market forms the **Universal Set.** The applicant however may not know (and, most times, does not know) about of all available offers; instead he/she is only aware of a partial set. This partial set forms the **Awareness Set**. The actual size of the Awareness Set depends on both the applicant and the company. In what concerns the former, the amount of aware job depends on his/her curiosity and resources (time, money, etc.) to look for the jobs. In what concerns the latter, the amount of aware jobs depends on the resources (marketing campaigns, participation in info or job fairs, etc.) deployed by the companies to disseminate its job offers.

The applicant may not necessarily collect information about all the known job offers. He/she may discard non-fit companies or jobs offers that imply a change in location. Therefore the applicant will only evaluate (that is, gather information and evaluate the possibility of applying) a reduced set of job offers. This set is designated as **Processed Set.**

The applicant evolves then to a stage in which more and detailed information is collected about the job offer and company. Here again, only a smaller amount of job offers are likely to be selected for application. The applicant may conclude that he/she does not fit into the job, the offer requires other competences or skills than his/hers, or the job is simply not attractive. This reduced set forms the **Considered or Evoked Set** and represents the set of job offers found attractive to be applied by the applicant.

The applicant's job choice process can thus be summarised through a set of 3 steps of which 2 steps involved decision making (Steps 2 and Step 3) and 1 step – Step 1 – depends on the searching and dissemination efforts.

[11] SHOCKER, A.D., BEN-AKIVA, M., BOCCARA, B., and NEDUNGADI, P. (1991): Consideration Set Influences on Consumer Decision-Making and Choice: Isues, Models and Suggestions. Marketing Letters, 2:3 (1991), S. 181-197.

5.1.2 Current Situation in Air Transport and Aeronautics Sectors

Labour markets worldwide are undergoing unprecedented evolutions. Over the last decades, Globalisation and other phenomena opened first ever opportunities for people to freely (or with low barriers) move across regions and Countries. Naturally, in parallel, employees' mobility is raising not only at geographical level but also across industries or markets. While some decades ago, to seek job in an entirely different industry was uncommon, nowadays it is a daily business and often stimulated and sought for industries as a way to acquire new skills and abilities. If this creates new opportunities for recruitment, it also creates major and new problems for companies to retain their best employees.

In human capital intensive industries, like in the AT&A, it has long been recognised that employees' knowledge, skills or abilities are fundamental for sustaining the long term sustainability of a company. Indeed, the competitive edge of AT&A industries heavily relies on their ability to attract and retain the best applicants. However, this is becoming increasingly difficult and some authors classify as "war for talent" (Axelrod, 2001 – see 18329851.pdf) the current dynamics and evolutions occurring in the labour markets.

Although this problem has emerged and grown in parallel with Globalisation, this phenomenon was not the root of the problem but simply an enabler for an already existence but latent one. The progressive freedom in moving linked to an economy-driven Society drove employees to seek better opportunities resulting in a growing mobility.

The AT&A sectors have undergone profound changes over the last couples of decades. In addition to the European Union liberalisation in the nineties and many others around the world, there were many other factors impacting the sectors, including: a growing environmental awareness, which put the industry under a major pressure and forced the industry to reduce its carbon footprint and emissions; a growing demand for air transport services, which is requiring further supply from an industry that is often working at its full capacity; a progressive increase in fuel costs; or significant technological progresses, that over the last years produced major solutions and advancements for the industry. It is within this whirlpool of constant change that AT&T companies operate and compete. Necessarily, such evolutions have brought more or less changes into the required competences of the work force. Recently, H. Deconinck (2011)[12] elaborated some of the industrial needs and requirements in aeronautics:

- Fuel efficiency (CO2), reduction of noise emission, reduction of NOX;

[12] Decononck, H. (2011) Trends in Educational Activities and Tools for Aeronautics the example of the von Karman Institute, Aerodays 2011, 6th European Aeronautics Days, Madrid, March 30 – April 1, 2011

- New materials for light weighted aircrafts;
- Innovative aircraft configurations (flying wing, etc.);
- Innovative engines (contra-rotating propeller, etc.);
- Flow control (laminar wing …), MEMS, morphing;
- Shortening in the design cycle of new aircraft, engines, etc.;

In the Air Transport sector, the implementation of the Single European Sky by 2020 is expected to radically change the paradigm of planning, organising and managing the Air Traffic. Currently, SESAR, the technological research program of the Single European Sky initiative is conducting wide scale research projects to create the necessary technological and knowledge for the correct deployment of the initiative. It is therefore natural to anticipate significant changes in the required competences, as well as, the creation of new ones.

AT&A sectors have been suffering from this growing problem and progressively industries are reporting the difficulty in attracting sufficiently skilled employees. The reasons for such problem have already been identified and are well documented elsewhere (Deconinck, 2011, Favennec, 2011[13]). We summarise here the main identified problems:

P1: Progressive loss of interest in scientific or technical carriers

Traditionally, scientific and technical carriers ranked among the most reputed and socially relevant ones. However, along the years, they have progressively been replaced by others more fashionable (and eventually well paid). Among these, we include: financing and banking, management and entrepreneurship, marketing or public relationships, etc.

Rewards (promotions, salaries, societal relevancy, etc.) in the scientific and technical carriers appear (if any at all) after a long time of dedication and investment; whereas in the new fashionable carriers, it is believed to appear after almost immediately and with lower investments. Consequently, when making the trade-offs between carriers, the rewards of a scientific or technical carrier are not worth the required investment.

P2: Progressive loss of prestige of the Air Transport and Aeronautic Sectors

Air Transport and Aeronautics, in the broad sense, have always captured the interest of people, in general, and youth, in particular. The opportunity to work with a flying machine or in a related sector was often the main driver to apply for a job in this area. However, such glamour has somewhat faded over time. Endogenous and exogenous reasons may be identified. The massification of air transport contributed to the reduction of the mystic. Also, many other industries have been much more pro-active in attracting youth, like for

[13] Favennec (2011) How to get the right aerospace engineers of the future, Eurocopter, Aerodays 2011, 6th European Aeronautics Days, Madrid, March 30 – April 1, 2011

example: car makers. A this reason is linked with the previous problem and it is related with a change in society's view on the technical related jobs (and inherently, in the AT&A sectors).

P3: Progressive reduction of students' interest for mathematics, physics and other sciences

A change in students' perception about educational needs in mathematics, physics and other sciences is underway over the last decades. Nowadays, students no longer look to these disciplines with awe and eagerness to learn. Indeed, they label them as unattractive, difficult, boredom and with low connection to reality. Also, they do not see them as necessary requisite to get a gob job in the future. Instead, they are favouring other disciplines, often related with the development of soft-skills. These disciplines are often advertised as fundamental for getting the job.

No longer, the promising students are those with better grades in mathematics, physics, chemistry and other science; but, in areas related with management, entrepreneurship, marketing, etc.

P4: Technical carrier is inferior to management carrier

Although promotions and progression do occur in both technical and management tracks, in many companies, the top positions (and, consequently, the higher salaries, benefits and recognition) are restricted to those in the management carrier. There is therefore a major incentive for employees and applicants to move towards this track.

P5: Job in AT&A still has a strong "male" image

A well-known term trend is the growth of female students in many high-educational courses, particularly, in those traditionally disciples always controlled by male students, notably: engineering and physics. However, such evolution was not necessarily mirrored by a change in AT&A companies' recruitment strategies and even job conditions. Arguably, the strategies for adverting and attracting female applicants are different from those used in attracting male applicants. Furthermore, men favour different job factors than female women, which must be taken into account by the companies. On the other hand, the fact of jobs in AT&A remaining labelled as male jobs may be a factor leading female students pursuing other courses and female applicant to look elsewhere.

P6: Educational paradigm has changed favouring the teaching of soft-skills in detriment of hard-skills

The spread of Globalisation has led to the emergence of new business and educational paradigms, largely based on the concepts of networking and chains, and

(multidisciplinary) teams. In parallel, we witnessed in many prominent management schools the emergence of novel educational paradigms, often largely based in the development of soft-skills (precisely to educate students working in the Globalised world and teams). Progressively, this trend was adopted by other schools and universities. Although the relevancy of soft-skills cannot be challenged, the problem occurs when the teaching of hard-skills is reduced to a point that students lack the competencies to work in scientific or technical areas. This trend also occurred to more or less degree in engineering schools leading to a progressive reduction of knowledge on central areas for AT&A. The direct consequence was the reduction of interest of students in these industries.

P7: Reduction of systems engineering-related courses

The development of industry and labour market has favoured the specialisation of employees. In paralleled many engineering-related courses were structured in silos with low (if any) interaction among them. This has created a bread of knowledgeable engineers in a given area, but with little understanding outside their area. If this is positive in certain business sectors, the same does not occur in AT&A, in which employees are erquired to have a systems' view and knowledge of the entire productive process. This may be leading specialised applicants to look elsewhere.

The impact of each problem in the level of attractiveness varies in nature and reach. Recalling the job choice process discussed in the previous Section and schematised in the Figure 17, we can now identify the step (or steps) impacted by each problem. Figure 18 links the problems with the steps.

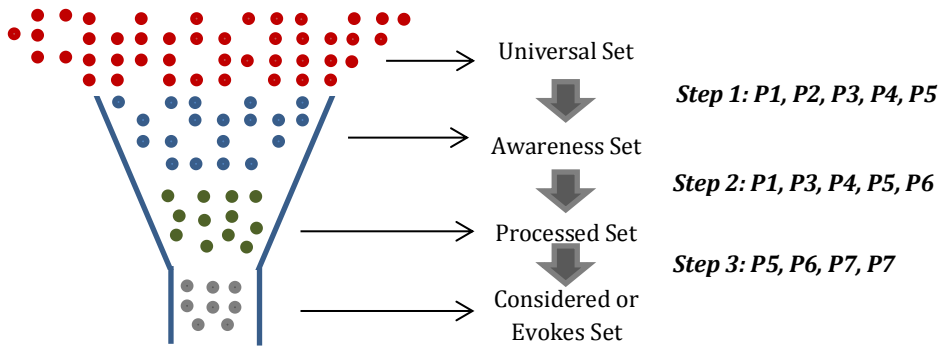


Figure 18 – Impact of the problems with the steps of the job choice problem

The *Progressive loss of interest in scientific or technical carriers* (Problem 1) has an earlier influence in the job choice process and, thus, in the level of attractiveness. The point is that if students do not even think in getting a scientific degree they will hardly become acquainted with jobs in the domain of AT&A (Step 1) or will immediately discarded them (Step 2). The *Progressive loss of prestige of the Air Transport and Aeronautic Sectors* (Problem 2) is another problem with the same level of impact. If AT&A sectors fail to get known to students and applicants, they will simply not search for jobs (Step 1). AT&T sectors need to adopt a pro-active positioning in order to stand above the crowd and flag themselves out. The *progressive reduction of students' interest for mathematics, physics and other sciences* (Problem 3) has a similar effect, since may lead them to divert to other domains and necessarily exclude them from searching (Step 1) and working (Step 2) in AT&A sectors.

By the same token, the fact of a *Technical carrier is inferior to management carrier* (Problem 4) may divert students from pursuing educational (Step 1) and later on a carrier (Step 2) in AT&A afraid of being relegated to inferior job positions.

The next problem related with the fact that *Job in AT&A still has a strong "male" image* (Problem 5) has a much wider impact since it influences the ability of AT&A sectors to attract female applicants. The problem starts at school level with female students discarding the idea of getting a degree in engineering simply because AT&A is not for hers. The first impact is when they graduate, AT&A sectors will not be scanned (Step 1). Even if they get an engineering degree, female applicants may discard right way AT&A job offers afraid of inadequate conditions or simply thinking that it is not a job for them (Step 2). Finally, is the AT&A companies do not offer adequate conditions for female workers, including equal opportunities, they may simple not consider such offers for application (Step 3). Therefore, this problems has a profound impact in the level of attractiveness of AT&A companies.

The fact of *Educational paradigm has changed favouring the teaching of soft-skills in detriment of hard-skills* (Problem 6) and the *Reduction of systems engineering-related courses* (Problem 7) may lead applicants to not process AT&A jobs offers (Step 2) afraid of not having enough competences, or simply discarded them upon reading the actual requirements (Step 3).

5.2 Results of the Surveys and Interviews

As explained in Section 3, three Surveys were conducted to assess the attractiveness level. Each survey targeted a specific group, namely:

- *Graduates* of universities and colleges with engineering programs in AT&A *who are not working* in these sectors (WP7).

- Graduated *employees* working in the AT&A companies (WP6);
- *Students* of universities and colleges with programs in AT&A (WP4 and WP5);

In this section we present the results of the three surveys.

5.2.1 Survey to graduates who are not working in AT&A sectors

This survey has thus far yield a reduced amount of answers. Tracking former students revealed a difficult task. Over time, these graduates students loose most (if not all) ties with the AT&A fields (meaning: former professors, colleagues, university, associations, etc.). They do not update their contacts in the Alumni Associations or Universities' Students Office. In practical terms, the natural distributions channels (i.e: Alumni Associations, Universities and Associations) were of little use. Instead, we had to rely on the professional contact network of EDUCAIR partners (both with other professors, researchers and former students). The total amount of valid answers on the 15th March 2013 was of 16. Despite the number, it was still possible to draw interesting conclusions about the attractiveness of the AT&A sectors.

Section 3.3 provides a description about the structure of the survey. It is divided in seven parts as follows:

Part 1. General information about the respondent (Q1-Q4)
Part 2. Educational Background (Q5 – Q10)
Part 3. Attraction and Repulsion Factors in AT&A education (Q11-Q12 & Q19)
Part 4. Current Employment Status (Q13 – Q14)
Part 5. Working experience in AT&A sectors (Q15)
Part 6. Attraction and Repulsion Factors in AT&A sectors (Q16-Q19)
Part 7. Other Comments (Q20 – Q22)

Owing to the amount of received messages, we conducted a qualitative analysis. We will now present a table with the results for each part. The column headers display the Question Number and a brief description. The list of questions is presented in Annex I.

Table 14 - Part 1: General information about the respondent

# Respondent	Q1: Age	Q2: Nationality	Q3: English as 1st Language	Q4: Gender
1	29	French	No	Male
2	26	Portuguese	No	Male
3	39	Portuguese	No	Male
4	27	Malaysia	No	Male
5	25	Portuguese	No	Male

6	40	german	No	Male
7	56	Austrian	No	Male
8	38	Swedish	No	Male
9	31	Dutch	No	Male
10	35	British and Lebanese	No	Female
11	49	German	No	Male
12	34	Austria	Yes	Male
13	51	Czech	No	Male
14	63	german	No	Male
15	31	German	No	Male
16	25	Dutch	No	Female
17	29	portuguese	No	Male
18	27	Portuguese	No	Male
19	25	Indian	Yes	Male

Table 15 - Part 2: Educational Background (Q5 – Q10)

# Respondent	Q5: Educ. Backg.	Q6 & Q7: Grad. Maj.	Q8: AT&A Educ. Level	Q9: Influence of AT&A Educ. Level	Q10: Licenses
1	PhD	Materials engineering	PhD programe	Major	None
2	Master degree	Other Engineering, please specify below	A Master degree	Major	None
3	PhD	Aerospace engineering	PhD programe	Minor	None
4	Master degree	Mechanical engineering	Up to 1 year	Minor	None
6	Master degree	Aerospace engineering	A Master degree	Major	None
7	PhD	Information Systems & Computer engineering	Up to 1 year	Minor	None
8	Master degree	Business Economics	Vocational/Professional course	Minor	None
9	PhD	Other Engineering, please specify below	A post-graduate research/PhD program	Minor	None
10	Master degree	Aerospace engineering	A Master degree	Minor	None
11	Master degree	Other Engineering, please specify below	A Master degree	Major	None

12	Master degree	Aerospace engineering	A Master degree	Major	None
13	PhD	Information Systems & Computer engineering	A post-graduate research/PhD program	None	None
14	Master degree	Aerospace engineering	A Master degree	Major	None
15	PhD	Other Engineering, please specify below	Vocational/Professional course	Major	None
16	Bachelor degree	Aerospace engineering	A Bachelor degree	Major	Flight Operations Officer license
17	Bachelor degree	Management	A Bachelor degree	Major	None
18	Master degree	Civil engineering	Up to 1 semester	None	None
19	Master degree	Civil engineering	Up to 1 semester	Minor	None

Table 16 - Part 3: Attraction and Repulsion Factors in AT&A education (Q11-Q12 & Q19)

# Respondent	Q11: Attraction	Q12: Repulsion	Q19: Missing Educ.
1	-	-	-
2	-	-	-
3	Technology	Tactics	On job learning and training.
4	-	-	-
5	A Dream to Put Something Flying Creative	A need for more practical teaching than theoretical	-
6	-	-	-
7	Fascinated by aviation Interesting technology area with broad technical education	Boring and Unfair teachers	None
8	High tech industry	The fact that the air transport sector is so large and internationally interdependent makes change management (which I was studying) extremely cumbersome.	-
9	-	-	-
10	I was interested in pursuing a PHD in NPT (navigation, positioning and timing) but I couldn't secure a scholarship. Topic is attractive because it is highly transferable to other	Other areas that I found dull were ATC and ATM . Lots of boring theories , very little engagement with the core of the topic , no practical case studies were discussed in class(problem	Mathematical modeling for NPT . Overlapping between IT

	modes and disciplines, very dynamic and fun to work on.	solving) or the like.	
11	Interest in topic international working environment attractive projects attractive companies and payment	in my case : basic studies were in civil enegineering	Not applicable
12	-	-	-
13	-	-	-
14		-	-
15		-	-
16		-	-
17	money	-	-
18	-	-	-
19	My course content at masters in transport planning at school of planning and architecture, New Delhi	-	-

Table 17 - Part 4: Current Employment Status (Q13 – Q14)

# Respondent	Q13: Current Company	Q14: Country
1	-	-
2	-	-
3	Maintenance and operational Manager	Portugal
4	Phd researcher in Queen's University Belfast	UK at the moment
5	-	Portugal
6	-	-
7	Self-employed technology and innovation consultant.	Austria, Germany
8	System developer, SAAB	Sweden
9	-	-
10	I am a free lance financial consultant 03M Solutions limited	UK
11	Lead System Architect for Security solutions at EADS/Cassidian	Germany
12	Senior researcher / Lecturer	Austria
13	-	-
14	-	-
15	-	-
16	-	-
17	-	Portugal
18	Research in MIT-Portugal	Portugal
19	Urban transport planner institute of urban transport (India), New Delhi	India

Table 18 - Part 5: Working experience in AT&A sectors (Q15) and Part 6: Attraction and Repulsion Factors in AT&A sectors (Q16-Q19)

# Respondent	Q15: Work Exp. in AT&A	Q16: Repulsion	Q17: Attraction in current Job	Q18: Req. to move back to AT&A
1	-	-	-	-
2	-	-	-	-
3	Yes	Personal motives	Personal motives	Challenge
4	No	N/A	-	-
5	Yes	-	-	-
6	-	-	-	-
7	No	At the time finishing the aeronautical engineers school there was no job available in Austria.	Broadness of technology fields to be involved in developing R&D concepts.	An interesting job offering in the field of innovation (management).
8	No	Actually, my current work retains the opportunity to act in the aero-domain. It's just that I have no current project in the domain.	My perception of the employer as seriously wanting to address issues in my area of competence. Commitment.	-
9	-	-	-	-
10	No	I didn't get any support from the department at my college, the suggested topics were not for me. There wasn't enough education and support to pursue a career in the sector pr a PhD . Also from our visits to the airports and the little we saw, the jobs (ATControllers, or ATM) were extremely boring and the people looked super depressed. the talks very super boring. The technological side of the control tower was fascinating though and people looked more dynamic there.	The pay seems to be much lower in the Transport sector than the financial sector. Uni didnot help much in career guidance and the research dept were more interested in what topics they liked (SESAR) and not what the student wanted to do or work on.	Proper guidance , explanation, workshops. I also suggest that these companies can create a 2 year (plus or minus) program similar to those created by banks whereby they train and teach graduates with potential and then offer them careers after their graduation from the programs. These programs should be specific, intensive and concentrated whereby by the end of the program the graduate becomes specialized and can deliver much better results .
11	Yes	NA	Career issues and th	career progress

			ewish to do something new let to a change from mil. aircraft to systems business unit	interesting project/programme interesting site/town/country
12	No	-	-	-
13	-	-	-	-
14	-	-	-	-
15	-		-	-
16	-	-	-	-
17	No	-	-	-
18	No	Lack of technical knowledge provided by courses in air transport.	Specific topic on which I did my master thesis.	Better salary
19	No	-	Urban transport planning helps to various jobs related to airport planing, transport engineering etc and there are less jobs which are specifically related to aerospace engineering in developing nations	-

5.2.2 Survey to graduated employees working in the AT&A companies

A full description of this survey can be found in the deliverable of WP6. In this delivery we describe only the results concerning the questions related with the attractiveness of the AT&A sectors. These questions are 46, 47, 53 and 54 (Figure 8). This survey has received far more answers than the previous one. On the 15th March 2013, a total of 153 valid surveys have been collected and analysed. Despite the larger amount, it is still not enough to conduct wide statistical analysis. Instead, we decided to follow a mix qualitative and quantitative approach.

Questions 46 and 47 aimed to collect information about the attractiveness of AT&A educational. Around 55 respondents described their factors. Questions 53 and 53 aimed to collect information about the attractiveness of AT&T working conditions. Around 60 respondents presented their perspective.

5.2.2.1 Attractiveness factors in AT&A education

In Q46, respondents were invited *to specify and rank the determinant factor have led them to choose the course in AT&A.* Despite being an open question, there was a clear converge of the answers around three 3 main topics. As such, we created four groups of answers, concerning the 3 topics plus one containing other factors, as follows:

- Employment related factors;
- Carrier development related factors;
- Fascination of AT&A sectors related factors.

1. **Employment related factors**

   These factors refer to the positive perception of AT&A sectors in the employees, while students, about the employment and employability perspectives. The answers evidence students' strong belief (and awareness) on availability of job opportunities in the AT&A among students. But, perhaps most relevant, they demonstrate that students' understanding (and awareness) about the richness and diversity of working options in these sectors. Some of the answers received are quoted below:

   - *very good employment prospects*
   - *aeronautics offers good jobs opportunities*
   - *a lot of fields to work*
   - *specialized engineering with high employability factor*
   - *promise of a challenging job after graduating*

2. **Carrier Development related factors**

   These factors refer to the attractive conditions that a job in AT&A is expected to offer, from the perspective of a student. These can in turn be split in two sub-groups: one related with the permanent challenges of AT&A and the other about the broad and diverse options for working (both in terms of geography as well as in terms of roles).

   In what concerns, the challenges of AT&A sectors, the received quotes were as follows:

   - *high degree of technical challenge, complexity, continually being pushed*
   - *challenging tasks*
   - *there is always something new and it is widely open*
   - *dealing with a broad range of topics*
   - *worldwide industry*
   - *The fact of being a growing Sector both in dimension and challenges.*
   - *way of doing business in aviation industry!*
   - *highly determined and organized society with the great ratio of freedom.*
   - *Science in a top level, high tech*

3. **Fascination of AT&A sectors related factors**

   This third group of attraction factors are related with the very nature of the AT&A industries and the inherent fascination that has driven many people over the years.

Invariantly, one of the factors presented by the respondents was related with this factor. The most relevant quotations are listed below:

- *aircrafts' mystery*
- *the passion for aviation and everything related with it*
- *general interest in aircraft*
- *the most determining factor was my interest in airplanes.*
- *affiliation to space*
- *interest in aeronautics*
- *personal attraction*
- *interest to know how fly*
- *passionate about aircraft and flight*
- *personal knowledge and passion*
- *air transport engineers can contribute to improving air transport passenger mobility (on ground (airports) or in the air).*
- *aerospace domain is my passion since the my childhood.*
- *I love aircraft*

4. **Other factors.**

The last group gather other attractiveness factors that do not fit in the previous ones. One pointed out by several respondents was the fact of AT&A education implying considerable knowledge in maths and physic. Other respondents indicated the advantage of using AT&A graduation to get a job in a different field. A third group of respondents claimed that AT&A education would prepare them in many relevant areas, besides aviation or aeronautics.

5.2.2.2 Repulsion factors in AT&A education

Perhaps as important as the attraction factors, the repulsion factor evidence the drawbacks and flaws of AT&A education and that may be causing students to divert towards other fields. The purpose of Q47 was precisely to obtain the factors that the employees enjoyed the least while students and that could have led them to withdraw.

Again the answers were focussed on a small set of topics. Such coherence gives confidence on the results and denotes the existence of problems transversal to the AT&S educational sector. Three types of main problems were documented, including:

1. Cumbersome regulatory and legal framework
2. Heavy theoretical with unperceived connection with real practice
3. Reduced amount of practical working hours.

1. **Cumbersome legal framework**

   Many respondents claimed the regulatory and legal framework was quite difficult and lengthy. The burden to acquire the duly certifications was also considered considerable and excessive. Some of the answers are quoted below:

   - *high level of bureaucracy*
   - *bureaucratic works*
   - *highly regulated*
   - *certification and related "administrative burden"*

2. **Heavy theoretical with unperceived connection with real practice**

   The second problem identified by most respondents was related with the actual curricula and teaching methods. Respondents do not complain about the amount of taught theory, but only from the lack of a clear relationship with the real practice. In other words, the teaching was too abstract not in line with the needs of the industry. As a consequence, respondents claimed that the teaching was misaligned with the needs of the industry. Some of the answers are quoted below:

   - *the course is very focused on theory and not what is actually done in aviation world;*
   - *course content too abstract/theoretical;*
   - *too theoretical, far from the real industry needs;*
   - *too much theoric, away from the airlines real needs.*
   - *most specific aerospace classes were too theoretical and had little to no relevance when considering what is done at industry level;*
   - *unpreparation of the faculty professors regarding the current technology;*
   - *the lack of industry inputs to the academy and academic outputs to the industry*
   - *very few pratical stuff;*
   - *lack of applicability of the studies taken;*
   - *too technical (and for 90% of the people useless) preparation.*

3. **Reduced amount of practical working hours.**

   The problem reported in final group is in line with the previous one and it is perhaps its root. Respondents claimed for a low amount of practical studies and insufficient connection with the industry. Naturally, this resulted in the problem reported in the

previous group, about a disconnection between what is taught in the classroom and what is required by the industry. Quotes of the respondents are listed below:

- *lack of "hands-on"/concrete working material.*
- *lack of hands on subject*
- *lack of practices or relations with entities within the sector to be ready to work in the real world;*
- *lack of internship and on-job training opportunities in air transport or aeronautics companies during the course of my studies.*

5.2.2.3 Attractiveness factors of AT&A job

In Q53, respondents were invited *to specify and rank the factors that they valuate the most in the AT&A industry – attractiveness factors – and that could incentivize others to pursue a similar carrier.* This was an open-question, in which respondents were free to leave their ideas and thoughts. Despite the variety of answers, again they all cluster around a small number of ideas, in this case we were able to identify three main attractiveness clusters:

1. Professional prestige and recognition;
2. Working conditions and benefits;
3. Challenging working;

1. Professional prestige and recognition

AT&A industry still remains a substantial amount of their prestige and this is notorious in the respondents. Many of factors reported a pride and respect earned by working in these sectors. Likewise, the answers evidence that employees share a feeling of belonging to something worth and the belief of contributing to a bigger cause. Some of the answers are quoted below:

- *to work in the field (aerospace);*
- *the possibility to participate in the development of the future aviation system at a time of intense change in the domain;*
- *my work is valued;*
- *my work helps improving efficiency in my department;*
- *my superior relies on me and values my work;*
- *flexibility potential for self-fulfilment.*

2. Working conditions and benefits

In parallel with the prestige of the industry, the above-average working conditions and benefits were also repeatedly reported by the respondents as a key attractiveness factor. In addition to the benefits, AT&A sectors offer their employees good working conditions, in an international environment with multidisciplinary teams. In addition, employees have the opportunity to work an ever-evolving business activity. Some of the answers are quoted below:

- *organization and work conditions;*
- *interest for people and organization;*
- *the job stability and very good atmosphere amongst colleagues;*
- *relevance for the company-development influence remuneration;*
- *autonomy;*
- *the people who work with me*
- *stability,*
- *income*
- *a profession as well as a hobby, job flexibility, work-Life balance, relatively high income*
- *Good team play of multi-disciplinary researchers*
- *family friendliness of employer*
- *interesting work colleagues*

3. Challenging working conditions

The final group of attractiveness factors is related with the ever-changing ever-evolving nature of AT&A business and the direct consequence of employee being constantly changing and facing new challenges. This lack of routines, or at least the change in the job activities was a factor often repeated in the surveys. Employees are faced with evolving working conditions which was reported as very positive. In addition, the international nature of the AT&A industries was considered positive, since it entails working in an multinational and multidisciplinary teams. Linked to this is the opportunity to work in different regions. Some of the answers are quoted below:

- *influence major technical and infrastructure investment decisions;*
- *the opportunity to develop real projects and real demonstration of technologies.*
- *the need of rapid response and multi-discipline projects.*
- *high Technology environment.*
- *innovation*
- *challenging environment*

- *innovation management,*
- *freedom in research job.*
- *to be in the R&D area where things evolve and change.*
- *job that you can have in almost any point in the globe.*
- *creativity diversity of addressed problems*
- *multidisciplinary work*
- *international working environment*
- *range of different subjects/stakeholders*
- *I have to deal with and constant learning it requires.*
- *the diversity of tasks that need to be addressed and solved*
- *creativity.*
- *variety of jobs ranging from concept work to programming*
- *every day is different than the previous one.*
- *to be part of an international team*
- *big company with big projects.*

5.2.2.4 Repulsion factors of AT&A job

The final question concerning the attractiveness on AT&A jobs was placed in Q54, in which respondents were invited *to specify and rank the factors that they valuate the least in the AT&A industry – repulsion factors – and that could lead others to avoid this industry.* Like in all the other questions, respondents were free to leave their ideas and thoughts. Interestingly, the problems put forward are rather identical to the previous ones, but now seen from a negative perspective. However, conversely to the answers in previous question, the reported problems were too firm specific (for example one answer was "*lack of coaching from current boss and no team work spirit*") and, therefore, cannot be considered representative of the industry. Arguably, many companies in AT&A may have poor management or working conditions but that does not mean that cannot be generalised to the whole industry. The direct conclusion is that some respondents used the survey to convey their discomfort instead of looking. In any case, some answers do provide valuable information to understand some transversal problems and therefore may represent repulsion factors. The valuable answers were all around the same problem that is related with the lack of appropriate competences in many employees. As a consequence, they perform poorly leading to multiple problems, such as: underperformance, bad working environment or lack of empowerment. This reported problem may also reveal a lack of suitable education in this domain and may represent a tip of an iceberg. A most revealing answer of this problem is the following one: "*young engineers failing to present recommendations and judgements rather than data generated by a computer output".*

5.2.3 Survey to students of universities and colleges with programs in AT&A

The last survey used to provide inputs to assess the attractiveness of AT&A sectors was conducted to current students enrolled in AT&A courses/programmes. The full description of the survey can be found in the deliverables of WP4 and WP5. Similarly to the previous sections, in this delivery we only describe the results concerning the questions relate with the attractiveness of the AT&A sectors. These questions are the 12 and 13 (Figure 8). This survey has received far more answers than the previous ones. On the 15th March 2013, a total of 409 valid surveys have been collected and analysed. Despite the larger amount, it is still not enough to conduct wide statistical analysis. As such, we decided to follow a mix qualitative and quantitative approach.

Questions 12 and 13 aimed to collect information about the attractiveness and repulsion, respectively, of AT&A educational and working context. Around 80 respondents described their factors.

5.2.3.1 Attractiveness factors in AT&A education

In Q12, students were invited *to specify the attractiveness factors of the course (i.e., the determinant factors for choosing your course).* Despite the +76 open answers, there was a clear convergence around three focal ideas. Indeed, the convergence was so vivid that students, regardless being in different countries often used a similar wording. Interestingly, all the three attractiveness factors coincides with the factors listed in Section 5.1. The attractiveness factors of AT&A are:

- Fascination of AT&A sectors.
- Challenging work, technological and innovation driven;
- Employment and working benefits and benefits;

1. **Fascination of AT&A sectors**

   The vast majority of students indicated a more or less interest by airships, aeronautics or aerospace as a key reason to engage in the course. One of the students wrote that "since I was 16 years old that I wanted to choose this course". Indeed, as already mentioned in Section 5.1, the fascination around AT&A industries is a key factor in the attractiveness of the sector. Some of the answers received are quoted below:

   - *I was always attracted by air transport industry*
   - *exciting and interesting field of study*
   - *curiosity and fascination of aeronautical and astrophysical phenomena*
   - *being space related*

- *for me it's like the space, and the excellence of the course between others.*
- *I like everything related with space, technology and innovation*

2. **Challenging work, technological and innovation driven**

   The second most often refereed attractiveness factor was the perception of a work in AT&A being challenging and demanding. Clearly, students have built an idea about a job in AT&A industry. The job certainly is always changing, in line with the technological developments and new demands, above-average demanding, in terms of required cognitive capabilities and knowledge, and challenging. Some of the answers received are quoted below:

   - *complexity*
   - *challenging and modern*
   - *Many real complex problems.*
   - *Ability to learn about a demanding sector and broad technical skills*

3. **Employment and working conditions and benefits**

   The last attractiveness sector is related with the high levels of employability of the AT&A sectors and the (well) above average working conditions and benefits. As often as not, students indicated the high availability of jobs in the AT&S sectors, the perspectives of having a good working carrier and development and, in parallel, the expectation of a well paid job (and other benefits). Some of the answers received are quoted below:

   - *good chances of having a high salary*
   - *job availability*
   - *employment rate*
   - *employability.*
   - *job opportunities in aerospace Career*

5.2.3.2 Repulsion factors in AT&A education

In Q13, students were invited *to specify the repulsion factors of the course (i.e., the determinant factors which could discourage someone from choosing your course).* The amount of answers was slightly fewer than in the previous one, in a total 65. This may denote a students' satisfaction towards the programmes. This is more evident when some of the students answered having no repulsion factor on the course. The answers could be grouped around three main topics,

although not necessarily representing repulsion factors but simply negative (or nor positive) characteristics of the programme, being:

- Above-average difficulty and lengthy of the programme;
- Excessive theoretical contexts;
- Insufficient emphasis on practice.

1. **Above-average difficulty and lengthy of the programme**

   Two factors that were consistently presented side by side were the inherent difficulty and the lengthy of the programme. Some of the quotes are:

   - *the difficulty of the subjects*
   - *being so difficult and having so few chairs about space*
   - *very extend course, and also a bit difficult*
   - *time to devote to the study*
   - *it is a very demanding course.*
   - *the length of the education, currently 4 years.*
   - *the amount of work during the 5 years.*

   Bearing in mind the underlying knowledge (in terms of math or physics) behind many of the disciplines, we can easily understand why students label the programmes as being rather demanding. We cannot however say that this is necessarily a repulsion factor; instead, we see it more as a complain about the (excessive) amount of contents lectured in the period of classes (see next factor). Indeed, we can hardly conceive these students (that had previously pointed out precisely the challenging nature of the discipline as a key attractiveness factor) accepting seeing their programme reduced in its contents; neither see the industry accepting being deprived from valuable human resources.

2. **Excessive theoretical contexts**

   This second factor is intrinsically related with the previous one and with the following one (see next factor). Along with the difficulty of the subjects, students also mentioned that excessive theoretical contents. They acknowledged intellectual interest, but questioned the practical usefulness of such knowledge, in particular, how it could be used in a working context. Necessarily, without a stimulus or motive (i.e. not seeing the (practical) utility of such contents), a feeling of frustration can build up within students and the sensation of difficulty will naturally emerge. Some of the quotes are listed below:

   - *too much theory and less practice;*
   - *too narrowly focussed;*

- *extensive theoretical component;*
- *much theory;*
- *The course itself has a high emphasis on theory and low emphasis on practice;*
- *with the current industry technology;*
- *to have some parts that is more to memorize than to work;*

3. **Insufficient emphasis on practice**

   The last factor is again directly linked with the previous ones and it is related with the insufficient practical component of the programmes. Many students reported that their courses have few hands-on work components. Consequently, they often miss understanding the applicability of their knowledge. Also, of high relevancy is the fact of some students reporting a teaching gap in terms of technology and practice. That is, the contents of the lectures, concerning technological issues or practical aspects, are outdated (or simply do not report the latest developments), which creates a feeling of disappointment in the students. Some of the quotes are listed below:

   - *not enough focus on the practical side;*
   - *very poor relation with the industry, poor organization of some subjects and lack of a more practical approach;.*
   - *low contact with industry;*
   - *a lot of knowledge is very interesting but the chance is big that you will never use it in your carrier.*

5.3 Discussion of Results

Notwithstanding our best dissemination efforts, some of the surveys got a low rate of answers, namely the one targeting the graduates who are not working in AT&A sectors. Several reasons may be pointed out.

Firstly, people are less and less willing to participate in this kind of activities. This is the natural outcome of the progressive growth of web-based surveys made by the most diverse entities and with the most diverse purpose. In order to minimise the risk of flooding people with e-mail messages concerning EDUCAIR surveys, we have segmented our mailing lists accordingly with the type of surveys. Consequently, each person has in principle only received one tailored e-mail. We have done several waves of calls, but always following this principle. Naturally, we informed respondents about the other surveys and invite them to distribute among their contacts.

Secondly, our surveys targeted a very specific segment of the employees and students; therefore, we could never expect a large amount of surveys. This specificity raised a third limitation that

was reaching the right audience. Students or companies are fairly easy to pinpoint. The universities, colleges or research centres with interest in AT&A sectors are well known of EDUCAIR's partners (besides a web based search yields a large amount of them). The response behaviour has however been rather different; while students (and researchers) have fairly answered our call; professors, lectures and so (universities and research centres) have not. This denotes a higher willingness of the former in relation to the latters. Naturally, we may argue that students have more free time, although this is hardly a reason since most students reported having no spare time.

Conversely, employees and other graduated revealed being rather difficult. Companies did not show major willingness to distribute the survey among their workers. Furthermore, although we could retrieve the companies' contacts that do not necessarily mean access to the employees contacts. Consequently, we had to rely on the willingness of the human resources, marketing or other department to distribute internally. In addition, we also used our own network of contacts to reach the employees and it is our understanding that this solution was far more effective than the previous one.

Finally, the group that revealed being most difficult to be contacted was the former graduates in AT&A. The point is that most of these students lose (or broke) all the links with the AT&A sectors when they moved to another field of work. Universities' alumni databases revealed of little use as contacts were often outdated. They are also outside the network of contacts of the AT&A Associations or Alumni Associations (most likely, they are not enrolled in other associations). Consequently, we could not rely on these networks of contacts because. Also, because their current fields of work are not known and since we had very limited resources, to do a call embracing all fields of work was not feasible.

Looking now into the repulsion factors on AT&A education, we can conclude for a strong consistency of the results within and between each set of surveys (that is: students and employees). As explained in each section – Section 5.2.2.2 and Section 5.2.3.2 – the respondents focussed on a reduced set of negative aspect of educational system. More interestingly though is the similitude between the employees and students' answers – there is almost a complete overlapping.

The employees focussed around the main repulsion factors being: *cumbersome regulatory and legal framework*, *heavy theoretical with unperceived connection with real practice*, and *reduced amount of practical working hours*. In turn, the students answered an: *above-average difficulty*

and lengthy of the programme, *excessive theoretical contexts*, and *insufficient emphasis on practice*. The employees and students coincide in the two last topics.

Starting with the different topics, employees reported difficulties to obtain the necessary legal certificates to work in some AT&A jobs. It is natural students not reporting this problem, since it is very specific and only emerges when graduates apply for it. Certificates are provided by either national or international bodies. The process appears to be lengthy and involving a considerable amount of bureaucracy. Bearing in mind that a considerable amount of job, in AT&A industry, requires a valid licence (see Deliverable of WP3 for further information), this factor is indeed relevant and should be investigated. On the other hand, this problem only seems to emerge after graduation, as students did not report it (and many of them mentioned having the intention of applying for a job that required a licence, such as: traffic operator, or aircraft maintenance). Although, thus far, this problem has been limited, and therefore could not be considered as a potential factor contributing to reducing attractiveness, it should be tackled as soon as possible in order to avoid possible contagious to students.

Looking now to the students' survey, they reported as problem an excessive difficulty of the course. As already discussed in the previous section, this is not necessarily a repulsion factor, since we can hardly conceive students wishing an easy and simple programme. Furthermore, AT&A domain requires a deep knowledge on certain fundamental fields, such as: mathematics, or physics, or applied fields, such as: mechanics, fluids, materials, etc. Naturally, the contents are demanding and lengthy and, naturally, only above average students may be able to pursue such studies. For this reason, it is perfectly understandable to see labelled the programs as difficulty. However, we must not confuse impossibility with difficulty. That is, the topics must be feasible to teach and learn within to the available lecturing and studying times, even requiring major efforts and commitment by the students. Otherwise, the program is not difficult but impossible. The students fell frustrated, since they cannot cope with the requirements, with a subsequent loss of commitment and detachment from the programme. Notwithstanding this factor must not be ignored, principally, because it was consistently reported by students across the EU. This may evidence an underlying transversal problem he to EU's educational system. This problem is also intrinsically linked to the remaining two problems.

The remaining two factors were simultaneously reported in the students and employees' surveys. Such consistency reinforces the validity of the findings. Yet, perhaps, more importantly the surveys reveal that these repulsion factors occur for some time now, since employees have ended their studies some years ago. These two problems are more relevant when the employees pointed it out even after ending the programme and starting working. It is therefore relevant

now to end with this cycle so that the new generations of students could have a more positive view about AT&A education.

One repulsion factor is related with the excessive theoretical contents of the classes with apparently low connection with the practice. As already explained, AT&A programmes are likely to have a strong emphasis in fundamental and applied fields, particularly, in the first two years, which often do not have a direct translation into the real world. Nonetheless, these topics are vital for students fully understanding the lectures in the final years, which tend to have a stronger practical component. In addition, AT&A programmes are vast and often student end up working in a very specific job, doing specific tasks, which only required a few amount of the disciplines. In addition, both surveys reported that often lectures were outdated in relation to industry's practices, procedures or technological advancements. Consequently, the knowledge was not used besides reducing the students' learning interest.

The other repulsion factor is related with the insufficient practice and contact with industries. This factor is intrinsically related with the previous one but differs in nature. In the previous factor, the students and employees reported the inability to transform their theoretical knowledge into competences or tool to use at their work. This factor goes in another direction and reports that students pass too much time seated in the classroom and little time in industry context. Arguably, studying in an industry context could lead students to better understand how to deploy their theoretical knowledge and how to build tools for doing their job tasks. In any case, the bottom line is that AT&A programmes appear lacking enough contact with industry and the students feel it.

Finally, the surveys also provided insights on the attractiveness factors of AT&T sectors. Again we found a full alignment between students and employees' perspectives. Three main attractiveness factors could be identified, although eventually named differently by students or employees, being:

- Fascination of AT&A sectors.
- Challenging carrier development path;
- Employment and working benefits;

Foremost, AT&A sectors still remain all of its mysticism and glamour, at least for the respondents. Indeed, many respondents wrote being fascinated by airships, air transport or aeronautics, often since adolescence. Inevitably, there were drawn into an AT&A educational programme. In addition to awe, respondents often reported that a job in AT&A is respected and admired by others (including family and peers). A very revealing picture was by a Polish

employee that wrote that "aviation industry in Mielec is most distinguished in my town and in other towns in Poland".

A second attractiveness factors is related with the very nature of the job. Students repeatedly evidence a strong belief about the challenging and ever-changing jobs that lie ahead of them. And this belief was a strong reason for pursuing a carrier in AT&A industry. The employees corroborate such belief, as many of them mentioned as very positive the dynamic and evolving nature of AT&A industry. An employee provided a blunt example about such nature: "*yesterday we were sizing rotating parts of an aircraft engine and today we are involved in the design of a regional airport*". Also reported as positive was the fact of AT&A sectors often being at the forefront of technological development and pushing forward the limits of knowledge.

The final attractiveness factor was related with the high levels of employability and above-average working benefits. The students expect and the employees confirm that AT&A employers tend to offer attractive working conditions and benefits. Also often reported, by the employees, was an interesting carrier path development that an AT&A job has to offer. Finally, AT&A sectors exhibit high levels of employability, being therefore a good attractive for students.

In Section 5.1.2, we listed the trending factors in the origin of the progressive loss of students to AT&A educational programmes. Both the attractiveness and the repulsion factors match with those trending factors, contributing to their validation. The first conclusion is that the surveys contributed to validate and reinforce the importance of those factors in attracting people to AT&A educational programs. The second conclusion is that if the trends are accurate then they can actually be diverting people towards other programmes.

Just to finalise this section, we present an answer from an employee about the reasons underlying his choice for AT&A industry:

- *I wanted to be an astronaut.*
- *I liked engineering*
- *The ability of aircrafts to fly fascinated me*
- *The aeronautical field had a low unemployed percentage.*

We believe it provides a good example about the nature and type of answers.

6 Conclusions

Currently EU's AT&A sector faces a real risk of mismatch between the prospective employees' competences and the market's actual requirements (competences). And if such mismatch is not addressed, there is the danger of creating a significant competence gap that will inevitably affect the competitiveness and efficiency of the European AT&A sectors (Figure 2). EDUCAIR project aims to improve the match between needs in human resources, and the educational and training offer of engineers and researchers within the Europe Union for the horizon of 2020 in the domains of Air Transport and Aeronautics.

EDUCAIR project's rationale is built on the concept of competence gap. The overall concept presented in Figure 2 was further decoupled into its fundamental constituents – or agents – being: Companies, Employees, Universities and Students. A potential gap was identified between every pair of agents, leading to the identification of 4 potential gaps (Figure 4), being:

- **Gap 1** - Competence Gap - Gap between the competences that the employees need and the actual competences of the students (i.e. to what extend are the student's competences actually useful in their working daily activities?);
- **Gap 2** - Gap between the knowledge that the companies need and the actual competences of the employees (i.e. to what extend do the employees' competences actually fit in their companies' competences requirements?)
- **Gap 3** - Gap between the knowledge the universities generate and the actual competences of the students (i.e. is the knowledge generated in the research transferred in the courses?)
- **Gap 4** - Gap between the knowledge the companies need and the knowledge the universities have (i.e. is the universities' research and teaching activities of relevance for the companies?)

The recommendations will be elaborated upon the assessment of the competence gaps along the four dimensions. The present delivery presents the works developed in WP7 aimed to i) to determine the likely number of jobs in air transport and aeronautics in European Union, and ii) to assess the level of attractiveness of the air transport and aeronautics industries. The attractiveness level of the AT&A industries depends on the nature of each competence gap, mainly, Gap 1 and Gap 4.

The current WP7 was developed in parallel with three other WP, being: WP4, WP5 and WP6. Each of these WPs contributes to the assessment of one or two competence gaps as follows, as follows: Gap 1 (WP4), Gap 2(WP6), Gap 3(WP4, WP5) and Gap 4 (WP5).

A set of five surveys was launched aimed to gather the necessary information to assess the attractiveness levels and of the competence gaps. One survey was tailored for every agent, in a total of four, as follows:

1. **Companies** - professionals involved in the management and recruitment of new employees;
2. **Employees** - graduated employees working in the air transport and aeronautics companies. Graduation must be in Engineering (all levels of Bologna) or Management/ Business Economics/ Law/ Economics/ Public policy (3rd level of Bologna - holder of Phd).
3. **Universities** - heads of departments or full professors of universities and colleges with engineering programs involving air transport/ aeronautics and/or research and PhD programs in air transport/ aeronautics. Furthermore, also vocational and professional training institutions are addressed.
4. **Students** - students of universities and colleges with programs in air transport/aeronautics.
5. Graduates of universities and colleges with engineering programs involving air transport/ aeronautics (and/ or research and PhD programs in air transport/ aeronautics) WHO ARE NOT WORKING in the air transport/ aeronautics sector.

Figure 7 and Figure 8 present the various surveys, respective contents and their cross interactions. A fifth survey was designed and launched in parallel targeting those graduated students in AT&A but that have either not followed or abandoned a carriers in these sectors. The fact of these graduated students have decided working outside their educational area, reveals a lack of attractiveness of AT&A or, alternatively, a higher attractiveness of other working sectors. In any case, it is the AT&A that is losing competitive hedge. Thus, this people are the primary source of information to assess the (lack of) attractiveness of these sectors.

This WP has made use of three surveys – Survey 2, 3 and 5. Survey 2 and Survey 3 are described in detail in WP 6 (more information in the respective Deliverable). Survey 5 was structured in the following chapters:

1. General information about the respondent (Q1 – Q4)
2. Educational Background (Q5 – Q12)
3. Attraction and Repulsion Factors in AT&A education (Q11-Q12 & Q19)
4. Current Employment Status (Q13 – Q14)
5. Working experience in AT&A sectors (Q15)
6. Attraction and Repulsion Factors in AT&A sectors (Q16-Q19)
7. Other Comments (Q20 – Q22)

The questions relevant to evaluate the level of attractiveness in Survey 2 and Survey 3 are highlighted in Figure 8.

The surveys have produced a considerable amount of information, as follow:

- Survey 2 (employees) - 153
- Survey 4 (students) - 408
- Survey 5 - 16

Unfortunately, Survey number 5 only produced 16 answers, which is manifestly insufficient to reach conclusions. The remaining surveys produced an interesting amount of answers enough to produce valid conclusions.

The analysis to the Survey 2 and Survey 4 produced valuable insights into the current repulsion and attraction factors of AT&A jobs and education. The employees' answers focussed around three main repulsion factors as follows:

E1. *cumbersome regulatory and legal framework*,
E2. *heavy theoretical with unperceived connection with real practice*,
E3. *reduced amount of practical working hours*.

Whereas the students' answers allowed the identification of the following ones:

S1. *above-average difficulty and lengthy of the programme*,
S2. *excessive theoretical contexts*,
S3. *insufficient emphasis on practice*.

There is a clear overlap between employees and students' perception. The first repulsion factors point out by the employees can only be perceived when looking for a job. The other two are related with the current educational paradigm. Since we got answers from multiple EU member states we may conclude that the problem is transversal to the EU Universities.

Looking now into the attraction factors, we could identify an overlap between employees and students' perceptions. Although varying the description among respondents, three key attraction factors emerged from the analysis of the results, as follows:

4. Fascination of AT&A sectors.
5. Challenging carrier and development path;
6. Employment and working benefits.

Interestingly both employees and students agreed on the attraction factors. This denotes that the attraction factors have not been changing over time.

From the analysis of the surveys it was quite clear that, firstly, a key driver for pursuing education in AT&A was the students' enthusiasm and fascination by aviation and aeronautics. Indeed, both employees and students referred often and often that a fundamental reason for ever entering an aviation or aeronautics graduation was the enthusiasm or fascination for this industry, in particular, on airships or spaceships.

Secondly, employees' referred (and students' mentioned a strong belief) in the ever-changing and always-challenging nature of a job in AT&A. This perception was mentioned as an important attraction factor. Indeed, by its very technological nature and owing to the recent dynamics, AT&A offers a very challenging working environment. This is not expected to change in the near future, therefore, this attraction factor is not expected to fade out.

In addition, a job in AT&A still offers respect and admiration by Society and peers, and this is an important factor of attraction. An eventual degradation of the working conditions will erode such positive property, with negative consequences. The sources of respect were not easy to track, but apparently the following reasons are important contributors: difficult education track, denotes that only the most capable students are able to graduate, challenging and demanding working competences, denotes that only the most competence people can work in this environment, above-average salary (and other benefits), aviation and aeronautics' inherent fascination, and the strong technological nature of the industry, that contributes for an image of development and advancement. All of these factors were to some extend brought forward by the respondents.

Thirdly, AT&A companies offer (very) good working conditions and benefits. Again this was indicated by the employees and expressed by the students. The specificities, competence requirements or responsibilities of many tasks in aviation and aeronautics naturally results in job positions offering above average working conditions. It is the only companies have to attract and retain the best people for the job. With the current economic and financial turmoil, companies may feel the temptation (or be forced) to eliminate some of the benefits or bonuses, and eventually salaries. This poses a real threat into the attractiveness level of the AT&A companies, as graduates (and even employees) may be attracted to other industry sectors (for example: car automakers are increasingly looking for aeronautics engineers).

There is a perception in the EU about a steady decline in the level of attractiveness of AT&A industry over the last years. Several factors and trends were already identified as lying at the root of this problem, including:

P1. Progressive loss of interest in scientific or technical carriers
P2. Progressive loss of prestige of the Air Transport and Aeronautic Sectors
P3. Progressive reduction of students' interest for mathematics, physics and other sciences
P4. Technical carrier is inferior to management carrier
P5. Job in AT&A still has a strong "male" image
P6. Educational paradigm has changed favouring the teaching of soft-skills in detriment of hard-skills
P7. Reduction of systems engineering-related courses

Every and each trend is believed to contribute, to some extent, to the decay of the attractiveness level although the actual contribution (if any) is still to be demonstrated.

EUCAIR's surveys cannot provide evidence to support the existence of these trends, instead they can be used to infer about their relevancy and validity. We can use P5 as an example, only one respondent (out of several tens) pointed out that the reduced quantity of female students was as a negative factor; therefore, even if the trend P5 holds true, there is little evidence that it would have significant impact in the attractiveness level of AT&A.

From the surveys we can infer the following conclusions for each trend:

P1. Both employees and students referred that the technological nature of aviation and aeronautics was a relevant factor in their decision making process (Attractiveness factor 1 and 2);
P2. Attractiveness factor 1 provides string evidence towards the validity of this factor;
P3. It is indirectly supported by the surveys in the sense that some students referred that a reason to choose AT&A education was the emphasis in mathematics and analytical reasoning
P4. It is not supported by the surveys, as any employee mentioned a feeling of inferior by having a more technical job.
P5. Already explained above.
P6. Surveys do not provide definitive answer, but many students complain about the too heavy lectures on mathematics, physics and other analytical disciplines (repulsion factor E2). This repulsion factor may denote that the teaching of these disciplines has not been softened.
P7. The surveys cannot conclude anything towards this factor.

Before arriving at the estimations for the number of jobs in AT&A, different approaches were applied. First an attempt to the relationship between the development of employment and air transport was made using data on an aggregated level, which means for the AT&A sector in general. Here, estimations for Germany and different European countries were made. However, as the results did not turn out to be reliable, they were not discussed in detail.

Furthermore, disaggregate estimations for the demand for employment at airports, airlines, at ANSPs and the AT&A sector were carried out. As the results from those estimations proved to be more reliable, they are discussed more in detail.

For the forecast of the demand at airports, based on information from the surveys, a share of 15-25% of engineers in the airport sector could be assumed. The calculations then show that the need for engineers working at airports can be assumed to grow from between 20,464 and 34,107 in 2010 to between 34,230 and 57,050 in 2020, with an average yearly growth of 5.3%.

Concerning the airline sector, a share of 5-10% of engineers in the airline sector was assumed. The need for engineers working at airlines can therefore be assumed to grow from between 21229 and 42,458 in 2010 to between 26,670 and 53,330 in 2020, with an average yearly growth of 2.3 %.

For the civil aeronautics sector, it can be seen that the employment of engineers in the civil aeronautics sector growth from between 103,208 and 120,409 in 2010 to between 121,071 and 141,249 in 2020, with an average yearly growth of 1.6%. Here, a share of 30-35% of engineers in the aeronautics sector was assumed.

Based on information from various Eurocontrol ACE benchmarking reports a share of 32-33.5% of ATCOs in the ANSP overall employment can be assumed. Taking this assumption into account, it can be seen that the employment of ATCOs at ANSPs grows from between 13,236 and 13,857 to between 16,839 and 17,628, with an average yearly growth of 2.4%. As all forecasts also the forecast for the demand for ATCOs is based on present trends, therefore not incorporating disruptions or increase in efficiency due to for example SESAR.

The main difficulty with the estimations proved to be the lack of long reliable time-series data. Especially information about the historic development of employment in the whole AT&A sector was scarce. However, also in the separate sectors of airlines, airports, ANSPs and civil aeronautics sector data was difficult to find. Therefore, next to the results of the estimation, this task shows the need for more reliable data of the employment in the AT&A sector to analyse the development of the employment even more in detail and for a longer time period.

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8 Annex I: Education Survey - Graduates who are not working in the Air Transport and Aeronautics sectors

9 Annex II: Students Contacts List

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