D.3.1. FIRST GUIDELINES GENERATED (M12- SEPT 2023)

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Abstract	This document proposes a first set of recommendations to cover the gaps identified during WP1 and WP2, with respect to the demand and supply of ADS.
Keywords	Skills, HEI, academia, demand, roles, framework, Artificial Intelligence, Business Intelligence, Data Science, Cybersecurity, IoT, Quantum, Cloud, Edge

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EXECUTIVE SUMMARY

The aim of the Work Package 3 in LEADS is to define recommendations to cover the ADS demand-supply gap identified in the previous data analysis and stakeholder engagement.

This document, D3.1 contains the results of the work conducted by WP3 during its first period (March 2022-September 2023). This work effort includes the development of three workshops aimed to address specific scenarios which emerged from the results of Market demand data.

These workshops also considered the context in which ICT education and training is provided in the EU.

The deliverable contains a detailed description of the methodology used to gather the expected recommendations through the engagement of relevant stakeholders. Workshops have been chosen as the qualitative data collection methodology.

Two qualitative data analysis techniques, thematic analysis and content analysis have been used to elicit each workshop's recommendations and synthetise all of them, respectively. In summary, more than twenty recommendations for training providers (higher education institutions, and vocational training), industry and policy makers have been generated. Those mostly cover aspects like the best way to increase the pool of potential ADS workforce, how to identify the ADS content to be provided, and the most efficient way to offer that content and how to train and retain the best ADS trainers.

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ABBREVIATIONS

ADS	Advanced Digital Skills
AI	Artificial Intelligence
AIOTI	Alliance for the Internet of Things Innovation
BDVA	Big Data Value Association
BI	Business Intelligence
CAGR	Compound Annual Growth Rate
CATI	Computer-Assisted Telephone Interview
CISO	Chief Information Security Officer
EC	European Commission
ECF	e-Competence Framework
EU	European Union
GPU	Graphics Processing Units
HPC	High Performance Computing
ICT	Information and Communication Technologies
IoT	Internet of Things
IT	Information Technologies
JU	Joint Undertaking
ML	Machine Learning
MS	Member State
MSP	Managed Service Provider
NICE	National Initiative for Cybersecurity Education
NVME	Non-Volatile Memory Express
OECD	Organisation for Economic Cooperation and Development
SCM	Storage Class Memory
SDS	Software Defined Storage
SSDs	Solid State Driven
USD	US Dollar
WP	Work Package
5G	Fifth Generation

1 INTRODUCTION

The Leading Advanced Digital Skills (LEADS) project is responsible for identifying the future Advanced Digital Skills (ADS) demands across Europe and the actions required to support the Digital Decade targets of over 20 million ICT specialists.

The active and effective role of the different educational bodies is crucial to training in digital skills. It can stimulate productivity and improve well-being, as it can empower people to decide what they want to learn, where and when they want to work, and how they get involved in society (OECD, 2019)[1]. In this context, education is a major piece in the supply ecosystem. Education and training is to be considered from different perspectives, higher education and vocational training for the new workforce, as well as re-skilling and up-skilling for the existing workforce.

1.1 WP3 and Deliverable 3.1. Purpose

The aim of LEADS WP3 is to develop a set of flexible guidelines and recommendations that help to address the different challenges identified in WP1 and WP2. These aims include addressing the current and growing demand of ADS, and to respectively identify and detail the expected ADS demand-supply gap. The generation of these guidelines requires the engagement of the different stakeholders involved in the ADS provision, higher education institutions (HEI), vocational training providers, industry, and policy makers. The result of this engagement is not only to provide guidelines and validation, but also to promote and increase awareness in the ICT community on the need to take an active role on the process of ADS talent development. In this sense, WP3 results will also be disseminated and validated with the SPECIALISED projects[2] through WP4 which acts as bridge to other relevant initiatives in the ADS community. Figure 1 presents an overview of the LEADS work packages, grouped according to their main objective in the project. As can be seen, WP3 is part of the ecosystem engagement block of the project, built over the knowledge generation WPs (WP1 and WP2).
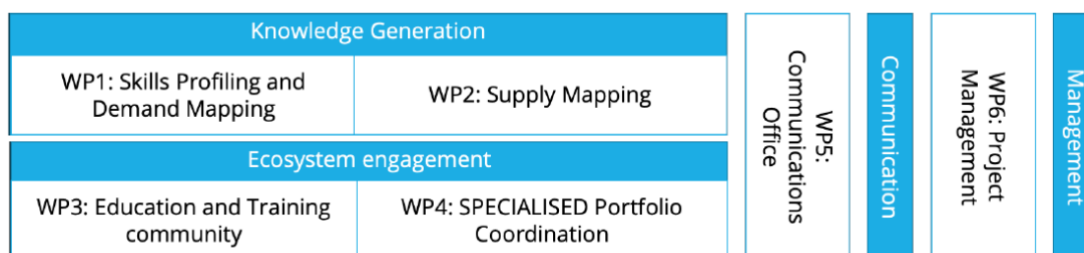
Figure 1 LEADS Work packages

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[1] OECD (2019). OECD Skills Outlook 2019. OECD. https://doi.org/10.1787/df80bc12-en

[2] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/digital-2021-skills-01-specialised;callCode=null;freeTextSearchKeyword=digital-2021-skills;matchWholeText=true;typeCodes=0,1,2,8;statusCodes=31094501,3109450

WP3 runs from March 2023 to February 2024. A series of customised events has been organised to capture inputs from stakeholders on the challenges for ADS talent development and acquisition, success stories, recommendations, and to disseminate the insights. The organization of the different workshops in WP3 is framed by the educational and training context of ICT in the EU. This context defines the setting in which ADS knowledge is delivered in higher education, vocational training and within companies. Additionally, the work that has taken place in previous LEADS WPs, will motivate the specific topic of each workshop and the outcomes to be gathered. More specifically, Figure 2 represents the overall approach followed in WP3. The outcome of each workshop will be represented as a set of recommendations, which will be synthetized together to produce the final WP3 recommendations and guidelines. These guidelines will facilitate organisations and education providers to fill the advanced digital skills needed in this rapidly changing technology environment.
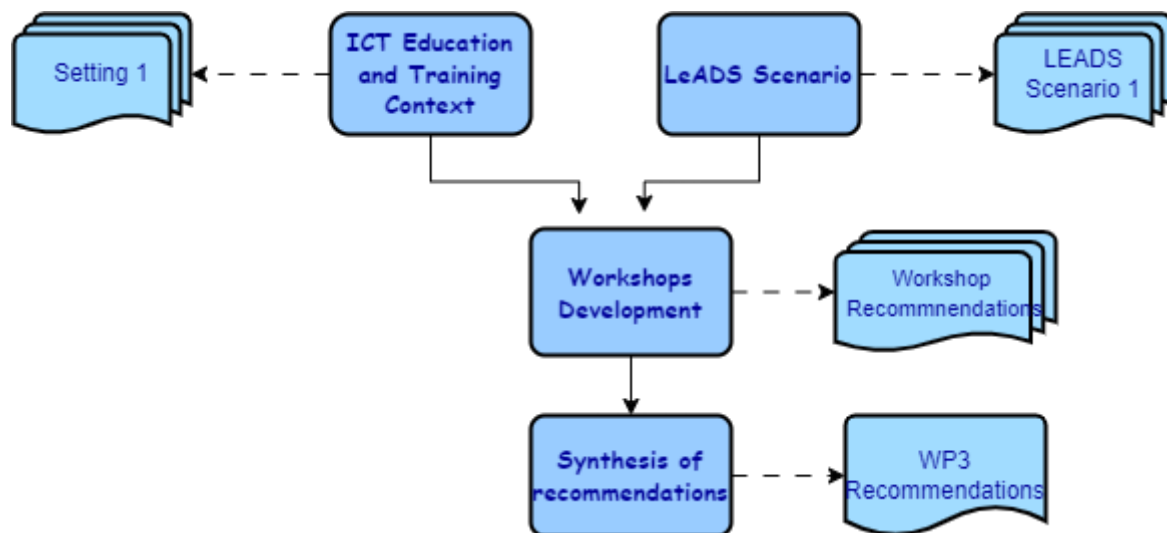
Figure 2 Overall approach followed in WP3

WP3 will provide two deliverables. D3.1. "First guidelines generated" reports the results of the interactive workshops, held during the first period of WP3 (from October 2023 to August 2023), under Task 3.1. Education & Training. The workshops generated during this period have been motivated by the results of WP1 regarding the ADS categorization (D1.1 and D1.2), and demand and forecast of ADS (D1.3). The first results of WP2 on the supply and gap analysis provided by June 2023 (D2.1) mainly focused on the data analysis methodology, while the detailed results of the gap analysis are provided in D.2.2 (September 2023).

The first recommendations in D3.1 as well as the final results of the gap analysis provided in D2.2 will motivate and guide the new events organized by WP3 during its second period (from October 2023 to February 2024). The overall results of WP3 will be reported in the final deliverable D.3.2. 'Final Guidelines Report' as result of Task 3.2. Recommendations & Guidelines.

D3.1. is structured around several sections. Section 2 contains a brief overview of the recent ICT training process in the EU in order to contextualize and understand the setting in which the ADS talent provision is delivered. As mentioned, this context needs to be considered when defining the recommendations to cover the ADS demand-supply gap. Section 3 presents the

scenario gathered from WP1 results, which provide the foundation of the events run so far, in WP3. Section 4 details the methodology followed to get the recommendations and guidelines expected from WP3. In this section we discuss the selection of workshops to obtain input and feedback from the engaged community in an interactive and dynamic way, as well as, introduce the qualitative analysis and synthesis approaches used to extract the final recommendations. Then, Sections 5, 6 and 7, detail each of the workshops developed in the first period of WP3, while Section 8 presents the results of the synthesis of the previous workshops' recommendations. Finally, Section 9 contains the conclusions of this deliverable.

1.2 Target Audience

This deliverable provides several recommendations. The major actors involved are trainers with special focus on academia, industry participants responsible for human resources and IT managers as well as policy makers. Regarding academia, the results of this deliverable can be particularly useful for educational IT programmes managers as the recommendations can be directly implemented at programme level. Academics responsible for ADS content can also obtain interesting and practical suggestions in order to improve the learning process of course content.

Even when the events organized during the first period of WP3 are not directly related to vocational training, some interesting recommendations have been produced from the discussion with the stakeholders engaged in this period. So, VET providers can also get interesting input from this deliverable.

The IT industry can benefit from the recommendations too, as they are concerned with skilling, up-skilling and re-skilling of the IT workforce. This deliverable will also help IT industry managers to better face the ADS talent acquisition challenges and to improve this important process.

Finally, some of the recommendations obtained are directly related to policy makers. Overall, the different recommendations will be helpful to make informed decisions about the definition of strategic agendas for education policies, to modify and create agility in the educational processes and accreditation bodies, as well as to allocate funding and resources.

2 CONTEXT OF ICT TRAINING

This section provides data on the ICT education and learning context in the European Union (EU) over the last decades of the 20th century and the beginning of the 21st century. This data is relevant for building different strategies and recommendations generated in WP3 in order to address the existing ADS demand-supply gap.

Section 2.1 delves into the state of ICT students and graduates in Europe. It highlights the remarkable growth of the ICT field and the rapid absorption of ICT graduates by the job market. Additionally, the section explores the significant growth of short-cycle tertiary ICT education, which is experiencing the fastest rate of expansion.

Section 2.2 discusses the educational role of industries, with a specific focus on upskilling and reskilling initiatives in ICT technologies. The analysis reveals that companies from various sectors are actively involved in these activities, with ICT companies leading the way. Furthermore, the section highlights the relationship between the company size and its investment in training.

Finally, section 2.3 presents a summary of the previous setting to create context for the work and recommendations generated in this WP.

2.1 Overview of Current State of ICT Education in Europe

This section presents current statistics on tertiary education[3] in the EU. Figure 3 reflects the number of students who finished their programmes by 2021 within tertiary education in Europe according to Eurostat. Figure 4 distils those numbers by major program categories, in absolute numbers and percentages. Hereby one can see that in 2021, the European University system faced the challenge of addressing the demands of the rapidly evolving ICT job market. In response, said system provided only 181,960 graduates in this field, accounting for 4.2% of overall graduate population. Meanwhile, 0.7% received short-cycle education, 2.2% earned bachelor's degrees, 1.3% completed master's programmes and 0.1% attained doctoral degrees.

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[3] *Tertiary education, provided by universities and other tertiary educational institutions, follows secondary schooling, and covers levels 5–8 of the international standard classification of education* (International Standard Classification of Education, 2023. Retrieved from: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=International_Standard_Classification_of_Education_(ISCED))
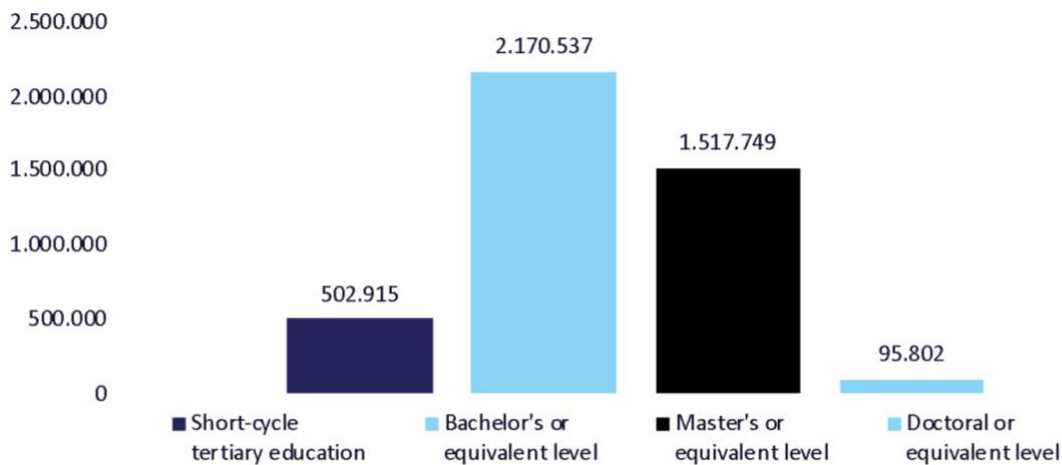
Figure 3 2021 Graduates in absolute number by education level [Source: Eurostat EDUC_UOE_GRAD02]

2021 Graduates in percentages from the total by education level, programme orientation, sex and field of education [Source: Eurostat EDUC_UOE_GRAD02]

ISCED11 (Labels)	Short-cycle tertiary education	Bachelor's or equivalent level	Master's or equivalent level	Doctoral or equivalent level	Total
Business, administration and law	4.0%	12.6%	9.0%	0.2%	25.7%
Engineering, manufacturing and construction	2.4%	7.1%	5.1%	0.4%	14.9%
Health and welfare	1.6%	6.5%	5.3%	0.5%	14.0%
Arts and humanities	0.6%	5.6%	3.1%	0.2%	9.5%
Social sciences, journalism and information	0.1%	5.4%	3.8%	0.2%	9.5%
Education	0.4%	4.8%	3.7%	0.1%	9.0%
Natural sciences, mathematics and statistics	0.3%	3.0%	2.6%	0.5%	6.4%
Services	1.4%	2.7%	0.9%	0.0%	5.0%
Information and Communication Technologies	0.7%	2.2%	1.3%	0.1%	**4.2%**
Agriculture, forestry, fisheries and veterinary	0.3%	0.8%	0.6%	0.1%	1.8%
TOTAL	11.7%	50.6%	35.4%	2.2%	100.0%

Figure 4 2021 Percentages of graduates in the EU by programme category

For the particular case of ICT graduates, Figure 5 showcases their evolution and trend during the period 2014-2021 (per year and accumulated). As illustrated in Figure 5, there is a clear correlation between the rising production of ICT graduates and their concurrent integration into the job market, as depicted in Figure 6.
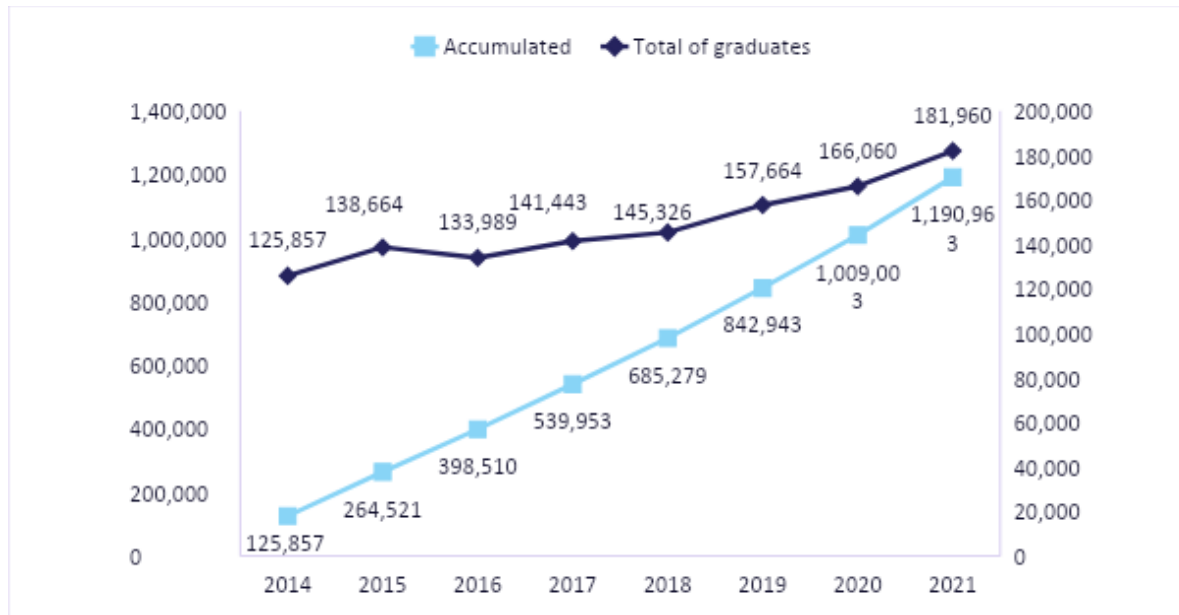
Figure 5 2014-2021 ICT TERTIARY Graduates [Source: Eurostat EDUC_UOE_GRAD02]
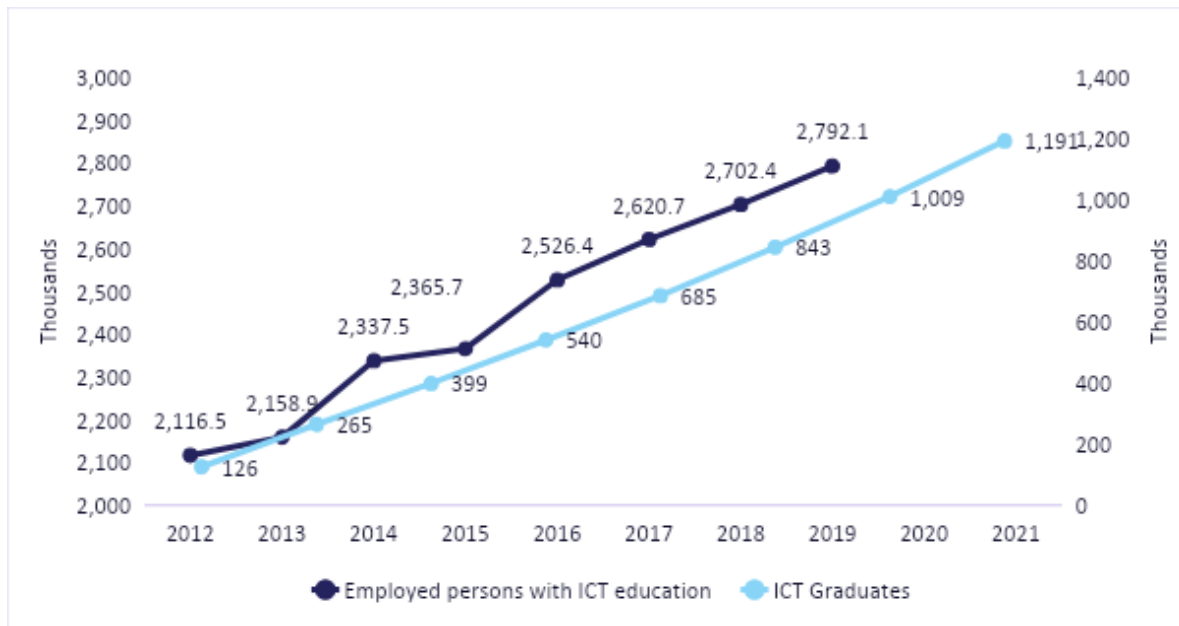
Figure 6 Employed persons with ICT education [Source: Eurostat ISOC_SKI_ITSEX] vs Accumulated ICT Graduates from fig. 8

Drawing from across the previous Eurostat dataset, the annual growth rates and long-term growth of ICT education participation by level and format is provided in Figure 7 between 2015 and 2023.

Evolution of the growth rate of ICT short-cycle tertiary education	Evolution of the rate of growing of ICT Bachelor's or equivalent level
Evolution of the rate of growing of ICT Master's or equivalent level	Evolution of the rate of growing of ICT Doctoral or equivalent level
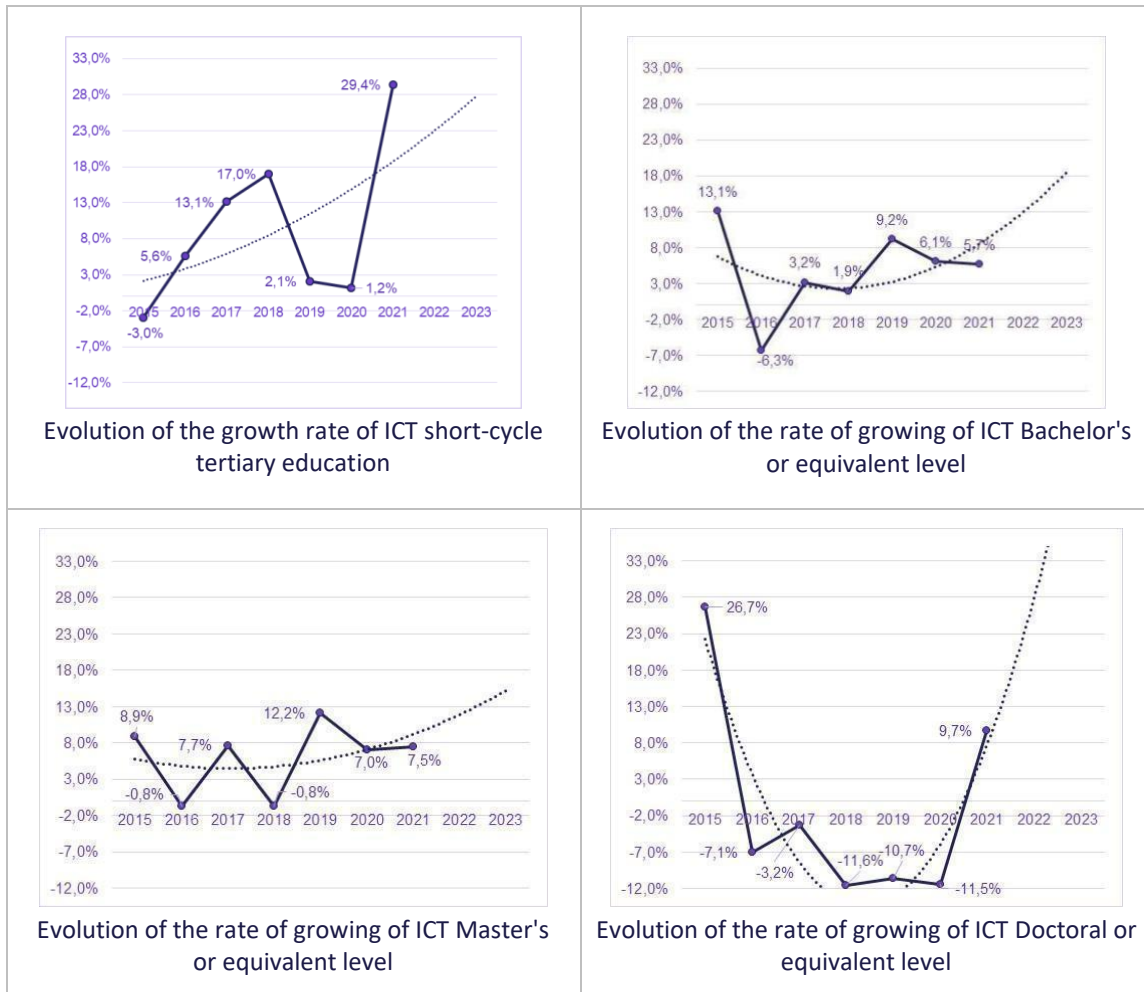
Figure 7 Evolution of the rate of growth of ICT education

It appears that individuals who possess either a bachelor's or a master's degree exhibit comparable growth rates within the ICT sector, with increases of 5.7% and 7.5% respectively, in the year of 2021. In contrast, respondents holding a short-cycle tertiary education qualification have demonstrated the most substantial growth rate, experiencing a remarkable surge of 29.4% during the same period.

2.2 The Role of Education in Industries

Universities are not the only actor providing ICT education, with industries themselves also offering education opportunities. Figure 8 shows the percentage of companies involved in ICT upskilling[4] and re-skilling[5] in different sectors. We see that all industrial sectors have a number of upskilling and re-skilling activities. It is interesting to note that the ICT sector has a higher percentage of companies involved in upskilling than in re-skilling, while in other sectors the

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[4] Field "Enterprise provided training to ICT/IT specialists to develop their ICT skills" in the Eurostat data

[5] Field "Enterprise provided training to other persons employed to develop their ICT skills" in the Eurostat data

case is opposite. This is not surprising as the ICT sector tends to have more ICT professionals already hired in their organizations than other sectors.
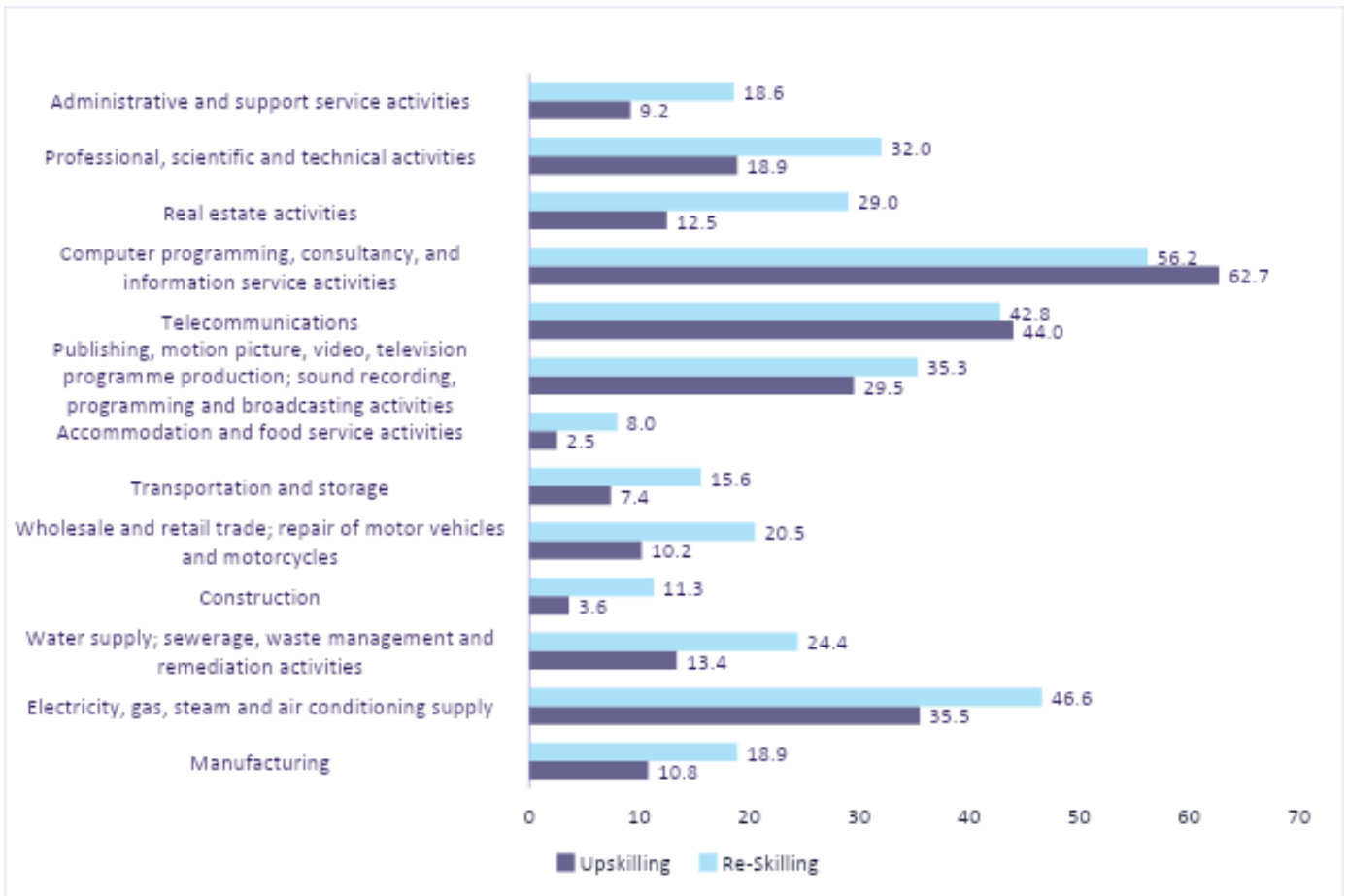
Figure 8 2022 Percentage of Enterprises that provided training to develop/upgrade ICT skills of their personnel by NACE Rev.2 activity [Source: Eurostat ISOC_SKE_ITTN2]

Figure 9 shows the percentages of organizations that provided ICT training to their employees broken down by size: small (10-49 persons employed), medium (50-249) and large (250 or more). As expected, the percentage of companies involved in upskilling and re-skilling activities grows as size increases. It is also worth noting the percentage of small companies that are also involved in those activities, as this represents a big investment for such companies.
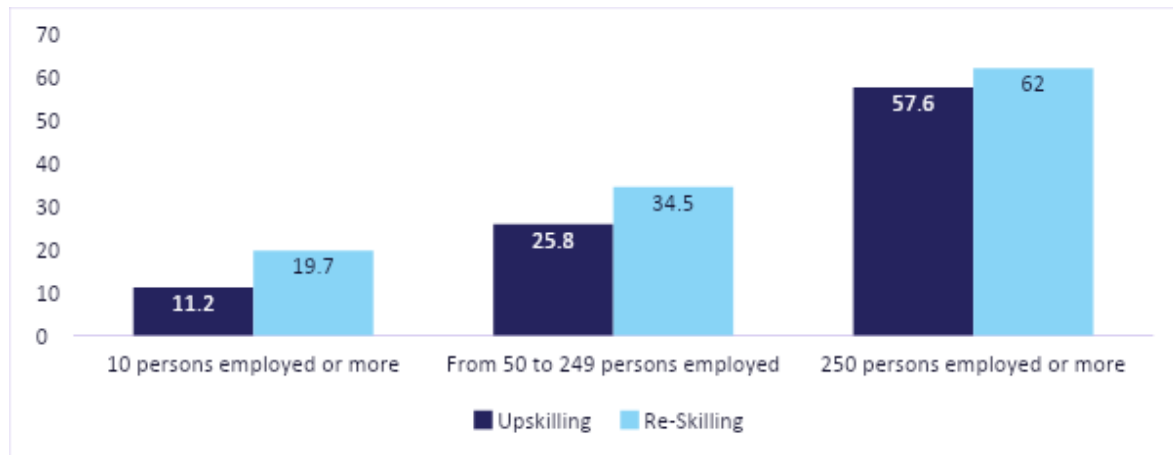
Figure 9 Percentage of enterprises that provided training to develop/upgrade ICT skills of their personnel by size class of enterprise [ISOC_SKE_ITTS]

2.3 Summary of the Recent ICT Education and Learning Process in EU

Overall, this section has presented a very brief overview of the ICT education and learning setting in the EU in order to understand the context. We now synthetize in what follows, this context through a set items, referred as ST(X).

- ST1: Although ICT graduates currently make up only 4.2% of the total, universities are experiencing a consistent increase in the production of ICT graduates, with an accelerating growth rate each year.

- ST2: All the ICT graduates produced are immediately absorbed by the industry.

- ST3: Companies across all sectors are engaged in ICT upskilling and reskilling initiatives for their employees. ICT companies are particularly proactive in this regard, and the larger the size of the company, the more likely is the provision of upskilling and re-skilling ICT education for their employees.

- ST4: There is a growing acceleration for the short-cycle tertiary education in the last few years.

As mentioned, these facts contextualize the setting in which the recommendations will be extracted.

3   LEADS SCENARIOS ADDRESSED

Once the educational context has been analysed and main facts have been extracted, in this section we will analyse the results that have arose from WP2 and WP1 up to June 2023 that set up what we have called the LEADS scenarios.

Below we summarize such scenarios.

- **There is an expected relevant growth in the demand of the ADS represented in the LEADS framework (LEADS1)**. D1.2.[6] has forecasted the future demand for ADS in the market (2027) with respect to the demand based on data from 2022, providing a general overview of the growth in the demand of the skills represented in the LEADS framework. Those skills related to AI and data analysis are the ones with the most prominent demand growth, followed by cloud. In particular, the expected demand of AI and Data skills is to be multiplied by four, while Cloud skills are expected to grow three-fold.

- **There is a need for alignment of academic curricula with industry needs (LEADS2).** The survey presented in D1.3.[7], which consulted more than 800 organizations, highlighted the need to adapt university curricula to create ADS talent as a critical factor to cover the future demand for ADS talent in organizations; the lack of academic qualifications was identified as one of main difficulties to cover the ADS talent needs.

- **Hiring ADS talent is a challenging and difficult process not only for ICT organizations but also non ICT domains (LEADS3)**. D1.3. also showed that hiring new professionals is the most used approach to cover the digital skills needed. However, the hiring situation for digital skills recruitment presents a challenge for organisations, not only exclusive of ICT areas but also non-ICT areas, for example in supply chain, operations, marketing and HR. In considering the ICT hiring challenge, the survey provided valuable insights into why hiring for digital skills is difficult. Salary expectation is not the main factor both professional and academic lack of qualifications, are the main reasons for the lack of applications.

- **European SMEs are faced with particular challenges, they are not executing successfully their digital strategies compared to peers in their industry and they do not have a clear view of which skills** they **will need to proceed (LEADS4**). The survey considered the special case of SMEs, showing that the smaller the organisation, the more the respondents feel they are lagging behind, in terms of their digital maturity when compared with colleagues in bigger companies. This influences their ability to attract the hard-to-come-by digital talent, creating a negative cycle for talent attraction. D3.1. also showed that SMEs are also more unsure of the skills they will need to execute a digital strategy than big companies.

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[6] D2.1 Programme and Course Analysis and Mapping
[7] D1.3. Final ADS Demand and Forecast Report

4 WP3 METHODOLOGICAL APPROACH

4.1 Data collection technique

As already mentioned, the aim of WP3 is to obtain different recommendations in order to address the ADS supply-demand gap, and the associated challenges. For that aim the engagement of the different stakeholders which have a major role in the ADS process (Figure 10) is essential.
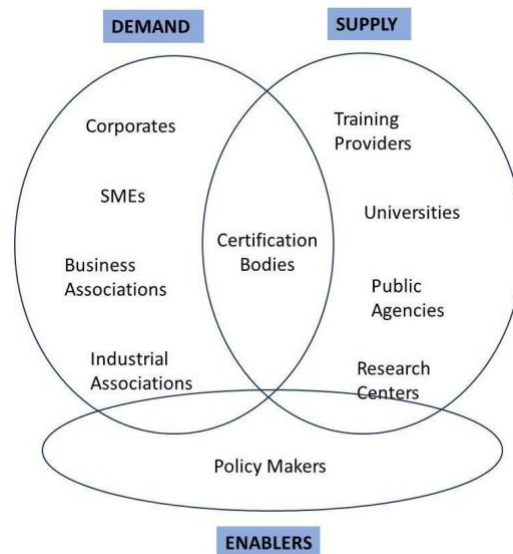
Figure 10 Major stakeholders involved in the ADS demand-supply process

It is also essential to create a forum that encourages dynamic communication and discussion allowing LEADS partners to obtain, refine and validate recommendations and guidelines. This is essential for enabling the identification and creating proposals for filling the gaps. To this end, we have used **workshops** as the primary data collection tool, over other qualitative data collection tools like interviews, observations or content analysis. Workshops have several advantages, all of them of outmost importance for the aim of WP3:

- **Active Participation:** Unlike passive methods like surveys or interviews, workshops require attendees to engage directly with the material and with each other. This can lead to richer and more detailed information.

- **Collaboration and Knowledge Sharing:** Workshops provide a platform for brainstorming, sharing ideas, and gaining insights from diverse perspectives. This collaborative environment can lead to a more comprehensive understanding of the topic at hand.

- **Real-time Feedback:** Participants can ask questions, seek clarification, and provide immediate input, which can lead to clearer and more accurate information collection.

- **Problem Solving:** Workshops enable participants to work together to identify challenges, generate solutions, and make informed decisions based on the information collected.

- **Customization:** Workshops can be designed to target the exact information you need to collect, making them highly adaptable to different situations.

- **Engagement and Motivation:** Participants are actively involved, which can boost their interest and motivation to contribute meaningfully.

- **Builds Relationships:** Workshops can foster a sense of community and teamwork. This can be especially valuable in situations where ongoing collaboration is essential.

- **Qualitative Insights:** Workshops excel at capturing qualitative data, including personal experiences, opinions, and emotions. This depth of insight can be challenging to obtain through other methods.

4.2   Methodology

The development of each WP3 workshop follows the stages described in Figure 11. This figure shows the activities to be performed to develop and derive insights from each of the workshops.
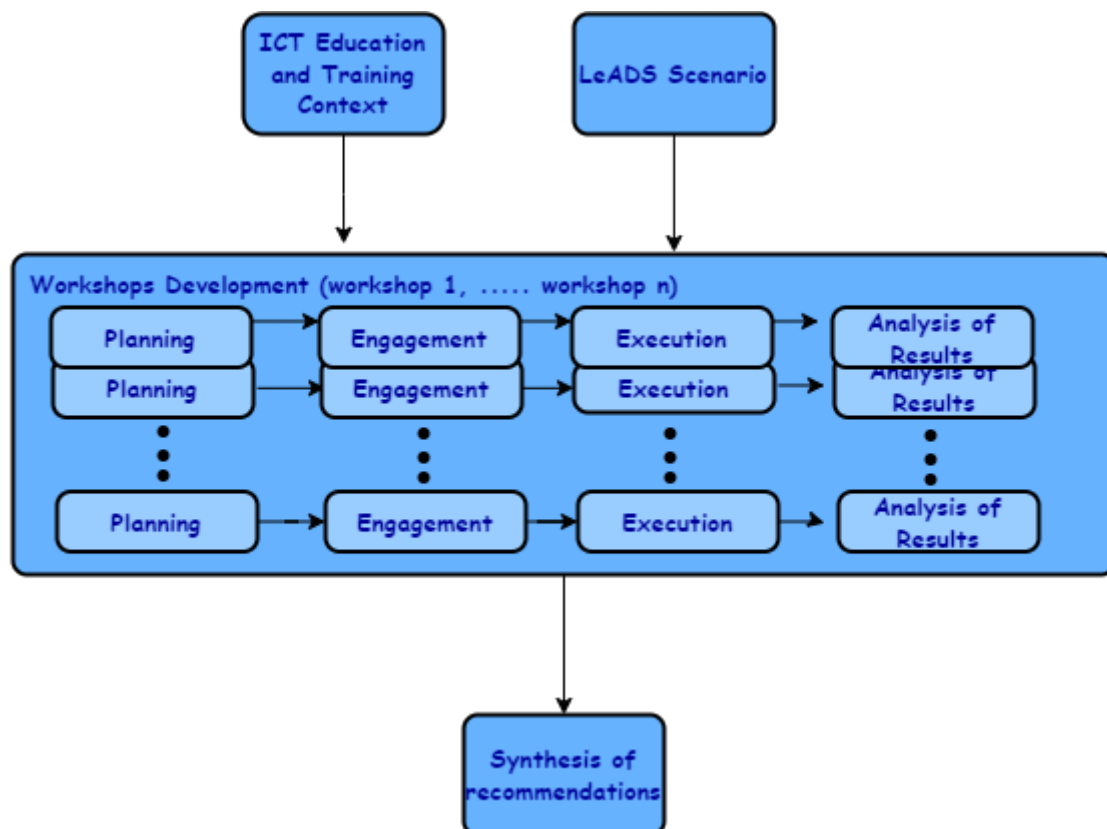
Figure 11 LEADS workshops development flow chart

In the following sections we will explain in detail the activities of each task.

4.2.1 Workshop Planning

The planning of the workshop is essential to develop a successful event. Several activities are involved in this process which are represented in Figure 12.

Figure 12 Activities involved in the Planning stage of each WP3 workshop

This figure represents planning activities in a sequential order although some of them can be executed in parallel.

- Identification of the workshop **motivation**: The rationale of each workshop should be based on the contextualization of ICT education and training presented in Section 2 as well as the scenarios produced by previous LEADS results (Section 3).

- Selection of the **top leading question**: Each question must clearly define the top-level question that will lead the workshop development, and that ideally should be answered by the recommendations gathered from the workshop.

- Assignment of a **responsible partner**. One partner is assigned as responsible for the development of each workshop. The partner background and its relation to the top leading question are the main criteria to motivate this assignment.

- Identification of the **expected outcome.** According to the top leading question and the responsible partner background a specific expected outcome has to be detailed for each workshop. This outcome guides the workshop structure and the discussion to be held with the workshop attendees.

- Definition of the workshop **format**. Both online and physical workshops will be delivered. The time stipulated for each workshop will also depend on the format. In some cases, this length will be externally imposed, for example when the workshop is organized in the context of community events with fixed slots.

- Selection of **speakers**. The top leading questions and expected outcome will lead the speakers selection, identifying the specific segment of each workshop speaker (e.g., policymakers, industry professionals, community members, academics).

- Selection of the **audience.** With the exception of a concluding workshop that will be organized to validate and disseminate the final recommendations gathered from WP3, the rest of WP3 workshops are designed to engage very specific members of the community who can provide high-quality contributions. As with speakers, the corresponding target audience will be identified among the corresponding segments.

4.2.2 Workshop Engagement

Engaging with the community and disseminating the workshop to attract the desired audience is a critical part of the methodology for organizing and running workshops. Activities related to the creation of a communication strategy as well as related to the preparation of the workshop will be held.

4.2.3 Workshops Execution

This task involves running the workshop according to the plan and using the materials and facilities developed during the engagement activity. Especially relevant in this phase is capturing the discussion, insights, and main outcomes of the event, so they can be later analysed to generate the expected outcome.

4.2.4 Workshops Analysis of Results

The results of the discussion produced in each workshop need to be analysed to develop the specific recommendations that contribute to answering the corresponding top level question. The analysis process is described in Figure 13. A qualitative analysis process will be conducted on the results of the discussion held during the event. In particular **thematic analysis** guided by open codes[8],[9] and themes will be used to generate a set of recommendations organized according to the main actor involved in each, even when other actors might be needed to implement them. These actors are education providers, mainly universities and VET, providers; demand providers generally represented by industry; and education enablers represented by policy makers (see Figure 10).
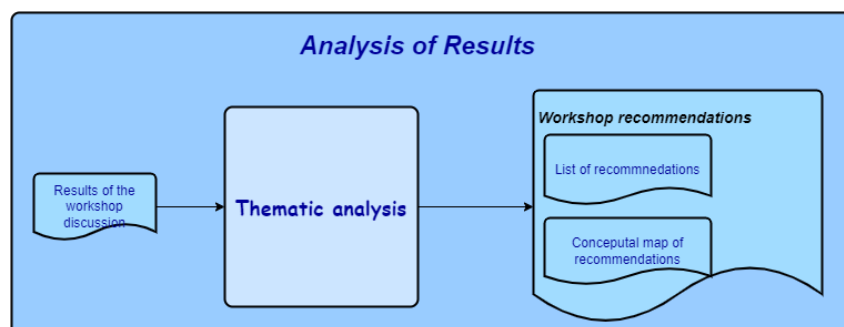
Figure 13 Analysis of results of each workshop

This thematic analysis will provide two types of results:

1. A **recommendations list** organized in table form providing for each major actor the recommendations with the title and a brief description (see Table 1). This thematic analysis process will be achieved by the workshop responsible, and the results will be validated at least with another partner attending the workshop.

Main Actor	Recommendation	Description
Higher education providers	**Recommendation X**	Description of recommendation
	…	…

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[8] D.S. Cruzes and T. Dyba, "Recommended Steps for Thematic Synthesis in Software Engineering," 2011 Int. Symp. Empir. Softw. Eng. Meas., no. 7491, pp. 275–284, 2011.
[9] D.S. Cruzes, T. Dybå, P. Runeson, and M. Höst, "Case studies synthesis: a thematic, cross-case, and narrative synthesis worked example," Empir. Softw. Eng., vol. 20, no. 6, pp. 1634–1665, 2015

VET provider	**Recommendation Y**	Description of recommendation
	…	…
Policy maker	**Recommendation Z**	Description of recommendation
	…	…
Industry	**Recommendation T**	Description of recommendation
	…	…

Table 1 Format for recommendations list of each workshop

2. A **conceptual map of recommendations** will be produced, grouping them into themes and identifying relations among them. This conceptual map creates a global view of the whole discussion and also the outcomes derived from each workshop. The qualitative analysis tool Atlas.ti[10] will be used during this process. Different colors will identify the main actor involved in the recommendations (green for education providers, orange for policy makers and blue for industry). This activity will be held by UPM for all workshops. This will allow homogenization of the conceptual maps generated and will also validate the results of the thematic analysis performed in each workshop. In case of workshops, in which UPM is the responsible partner, a different UPM representative will work on the recommendations produced and on the conceptual map generated and its corresponding discussion. These results will be later shared with the workshop responsible partner for validation.

4.3 Recommendations Synthesis

A synthesis of the different recommendations coming from the individual workshops will be produced providing a holistic view of all workshops, and mapping such recommendations to the different workshops from which they originated. For that aim **inductive content analysis[11]** will be used to group the different recommendations under a particular categorization according to their main aim, and to produce a consolidated list. This categorization will be defined as a consequence of the synthesis process, following the inductive process. The result of this process will be shared and validated by all WP3 partners involved in the participation of any of the workshops, either as responsible partners or attendees.

D.3.1. contains the recommendations resulting from the synthesis of the workshops developed so far in WP3, while D.3.2. will synthesize these recommendations along with the new one generated in the second part of WP3.

The following sections report the specific details of the workshops held to date in WP3. They focus on the planning, execution and analysis of results phases, as engagement activities were very similar in the different workshops and were carried out seamlessly.

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[10] https://atlasti.com/

[11] J. F. DeFranco, P. A. Laplante, A content analysis process for qualitative software engineering research, Innovations in Systems and Software Engineering (2017) 1–13

5 WORKSHOP 1. BEST PRACTICES FOR ALIGNING HIGHER EDUCATION CURRICULA TO ADS DYNAMIC DEMAND

5.1 Scope

Section 3 discussed several scenarios that motivate the organization of the workshops held so far in WP3. In general, the expected growth in the demand of the ADS technologies (LEADS1) forms the background of each of the events in WP3. Additionally, the first workshop in WP3, 'Best practices for aligning higher education curricula with dynamic demand" is motivated by the need of universities to incorporate the ADS knowledge demanded by industry represented in Section 3 (LEADS2). It should be noted that this need is crucial, as the production of ICT graduates is experiencing a consistent increase as discussed in Section 2 when reviewing the setting of ICT education in the EU (ST1). Therefore, the proper training of such graduates will be essential to cover in an efficient way the growing ADS demand, even having in mind that industry immediately absorbs all the ICT graduates that emerge. (ST2).

The incorporation of ADS knowledge in curricula implies that universities need to create new specialised programs covering ADS knowledge, or to adapt their existing programmes with ADS knowledge. Both situations denote the need to modify the IT programmes strategy and curricula. However, formal education is often limited by specific legal and bureaucratic restrictions that slow down the quick adaptation of its programmes. The LEADS top level question that drives this first workshop is shown in Figure 14.

To answer this question the workshop was organized to address the following content:

- Problems that the lack of updated ADS creates for industry in the context of inadequate supply of employees with ADS skills.

- Position of formal education providers regarding the inclusion of ADS in their programmes. This includes the cons, pros, barriers and understanding the difficulties faced by third level education when trying to integrate ADS into their programme offerings.

- Insights into how HEI can integrate the needs of industry specialized skills in the design of their programs.

This process aimed to get the corresponding workshop expected outcome (which is also shown in figure 22) by trying to identify some tentative solutions for introducing agility into the HEI curricula. The responsibility of this workshop was assigned to the WP3 academic partners responsible for Task 3.1. and WP3, respectively, that is TCD and UPM.
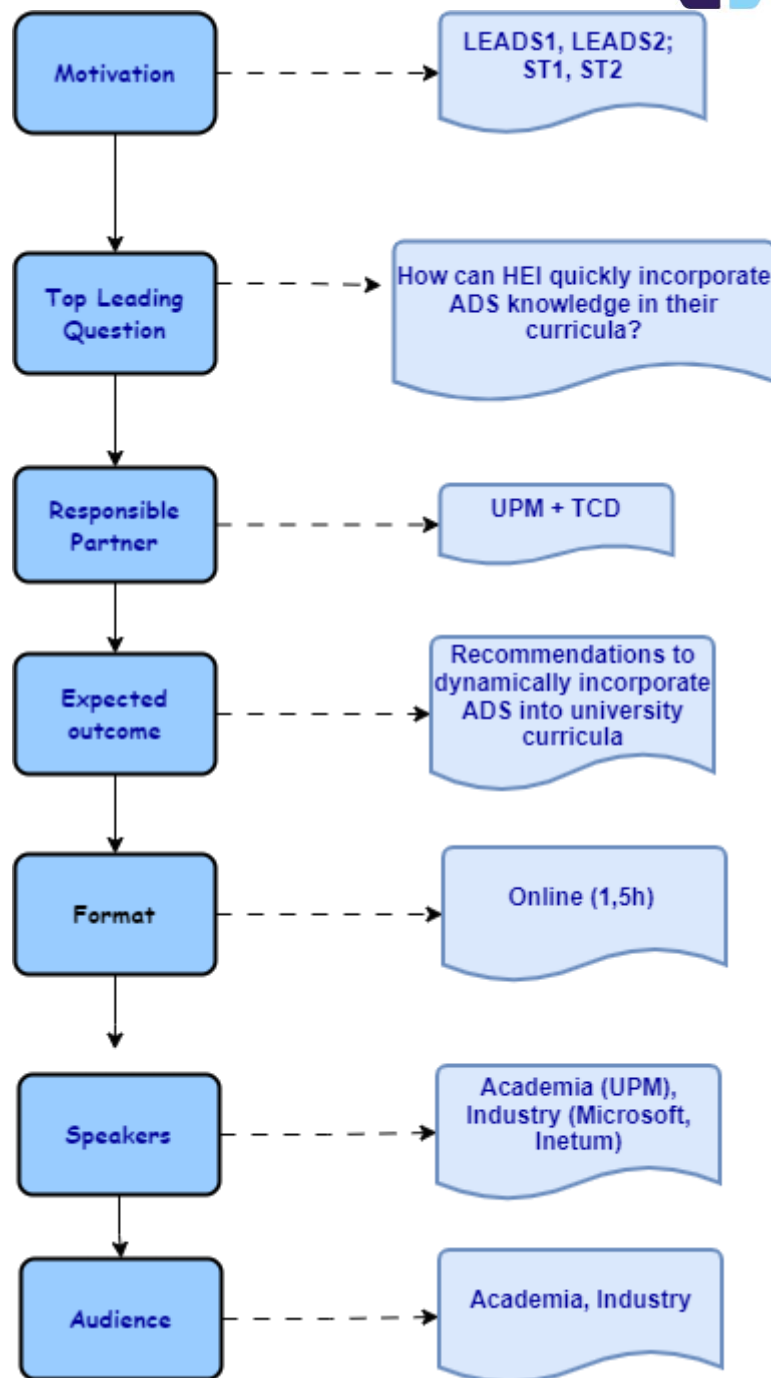
Figure 14 Planning of the first workshop in WP3

The workshop was mainly aimed at HEI, although the participation of industry was also relevant (in fact, as discussed later, two of the three invited speakers are from the industrial sector). Finally, the workshop was defined as an online event, as it was organized at the very beginning of the project, with a short duration (1,5 hour) and with potential speakers from different locations. The event was planned for March 27, 2023.

To motivate discussion, the three speakers that were invited to the workshop covering the main stakeholders, i.e. academia and industry. Academia has a major role in these workshops, however the collaboration with industry is a must in the process of integrating new knowledge

into curricula. Annex A provides a detailed description of each of the speakers invited for the workshop. Below we list their names and most relevant background.

- Gonzalo Gómez-Lardies, INETUM. Gonzalo has seventeen years of professional experience in corporate strategy, consulting, and business development, all from a technological perspective. He also has experience in academia as he is responsible of a postgraduate ICT course in a private university.

- Kieran Mc Corry, MICROSOFT. National Technology Officer in Ireland. He belongs to several industry boards and government forums, focused on technology skills development and strategic planning.

- Prof. Dr. Juan José Moreno-Navarro, UPM. Full professor in the Computer Science department at the UPM. He has extensively worked in policy creation from 2008 in the Ministry of Science and Innovation, Ministry of Education, and as vice-rector of digitalisation, and Academic Planning and doctorate studies at the UPM.

5.2 Workshop Execution

Around 30 participants, mainly from academia participated in the event. The agenda is shown in Table 2. There were no significant changes regarding planning. A very dynamic and fruitful discussion was held among the speakers as well as the audience. The workshop was recorded with the acknowledgement of all participants to enable the corresponding analysis of the results.

TIME	ITEM	LEAD
13:00	Welcome	Ernestina Menasalvas (UPM)
13:05	LEADS context	Brendan Rowan (BLU)
13:15	An overview of ADS	Leonardo Freiras (IDC)
13:25	Round Table	Speakers
13:55	Discussion	Audience
14:00	Wrap-up	Ernestina Menasalvas (UPM)

Table 2 Workshop 1 agenda

5.3 Analysis of Workshop Results

The workshop discussion was transcribed by UPM and as mentioned in Section 4, a thematic analysis process from this transcription was held. From this process, different kinds of recommendation were generated according to its main actor, HEI, VET, policy makers and industry. Therefore, even when the main focus of the event was HEI, recommendations for other stakeholders implicated in the ADS demand-supply process were also identified. The resulting recommendations are summarized in Table 3.

Main Actor	Recommendation	Description

Higher education providers	Develop a university strategy	HEIs must strategically design their research, technology transfer, and industrial cooperation to cover a significant number of emerging topics and be prepared for adequate course offerings.
	Provide formal and non-formal training on ADS	The European Higher Education Space (aka Bologna reform) designs general bachelor's degrees and specialised master's degrees to include advanced skills. Therefore, in order to implement a course in some of the advanced skills, the two possible mechanisms are either a formal Masters programme or a non-formal course. Both have pros and cons.
	Use mechanisms that allow agile changes in the curricula	Formal degrees are less agile in reacting to changes. It can be improved by adequate use of optional subjects, seminars, and broader subjects. The course organization might also be reconsidered (weekend courses, afternoon courses, hybrid/blended courses, courses in cooperation with companies, research institutions, other universities, vocational education centers)
	Prepare the university offer for a life-long learning process	Universities must not only focus on young students, but also accompany them throughout their careers, which, in many cases, implies a deep transformation.
	Promote training the trainers	There is a real lack of ADS trainers in the university. Incentives for professors deeply involved in research and training in ADS could be an option.
	Promote STEM areas	Additional efforts should be made for programmes and campaigns to attract more students to IT topics, especially women. These actions should not be restricted to bachelor students, covering from primary school to vocational training.
VET	Increase the agility of VET processes	Most job needs can and must be covered for vocational training. Some additional efforts must be done at this step in VET education that shares many barriers with universities (lack of agility, bureaucracy, difficulty in finding adequate staff, etc.) even with less autonomy than HEI.
Policy Makers	Improve the agility of the curricula accreditation process	Accreditation agencies are playing a significant role in ensuring the quality of university degrees. Unfortunately, they are a bottleneck for the agile creation or updating of degrees.

	Improve the agility of the teacher's accreditation process	Accreditation agencies and governing rules need to be more flexible in the requirements and certification process of teaching staff because experts (whenever they come) are always welcome.
	Adapt the hiring process	It should be easier for universities to create specific positions prioritizing the hiring of experts in advanced areas where there is not enough internal expertise. Universities should be allowed to create some specific positions for these new needs, with experts either from industry or from other foreign HEIs.
	Promote inter-university graduate and post-graduate official degrees.	There is no mandatory requirement for a particular University to cover in-depth all emerging topics and instead, collaboration should be promoted between HEI's to ensure adequate coverage in a particular area, taking advantage of the expertise of all universities in the area. European programmes could help in this task.
	Promote training through official or well recognized training providers.	Isolated online courses are not a global solution, due to the disconnection from other subjects, lack of confidence and practical components, quality assurance, etc. However, for specific situations particular courses could be provided through official programmes or micro-credentials.
	Promote the generation of a body of knowledge of successful practices.	Cooperate with existing institutions and associations for extending best practices (e.g., European Association of Universities, Informatics Europe, Industrial associations, etc.).
Industry	Create a skills strategic plan	Promote the creation of a strategic plan with future requirements for recruitment and for upskilling. This plan should not only be useful for industry purposes but could guide training providers in their own strategic plans.
	Consider hiring graduate students in other areas than Computer Science.	Due to the lack of a workforce for specific technical jobs, the industry might consider hiring and training other professionals with specific characteristics and soft skills.

Table 3 Recommendations collected from the first WP3 workshop

A conceptual map of these recommendations was also generated using Atlas.ti as mentioned in Section 4. Figure 15 shows the recommendation map obtained from Workshop 1. Different colours have been used to identify the main actor involved in the recommendations, even

when other actors will be needed to implement them. Those colors are green for education providers, orange for policy makers and blue for industry.

One of the main issues that came up during the workshop was the need to define a **strategy for universities to cooperate with industry for training**. Industries need a strategic plan with future requirements for recruitment and upskilling. From the HEI point of view, a strategy is crucial in the definition of knowledge and course content and structure, as well as to define the educational model to be provided, which should include both formal and non-formal training. The educational model of each university should take into account that the university should be prepared to **offer a lifelong learning process**. The strategic plan for HEI will drive the different polices to **train the trainers**. As it was discussed during the workshop, there is also an important lack of trainers with enough expertise in ADS. In this sense, special efforts should be put on policies that motivate academics to re-skill themselves, for example by motivating and rewarding academics who participate in ADS R+D initiatives.

Having a relevant pool of entry students in ADS-related programmes is also a need. For this aim, the **promotion of STEM areas** needs to be addressed. Even when this promotion can be done through the universities, it would be desirable that more general and broad policies should be defined at different levels (national, EU).

The Bologna reform[12] grants universities academic freedom and institutional autonomy with the conditions of accountability, transparency, and quality assurance. Accreditation agencies are playing a significant role in this process, so they are responsible for ensuring the quality of university degrees. In general, they should help assess the adequacy of degree content and skills with society's needs. However, sometimes they are a bottleneck for the agile creation or updating of degrees. Therefore, a general recommendation was made to policy makers to improve the **agility of accreditation protocols.** These accreditation protocols are related to both the accreditation of programmes and the accreditation of teachers. In the first case, a suggestion that came out during the workshop was that, in general, accreditation agencies could be more confident in highly reputable universities. Regarding the accreditation of teachers, rules need to be more flexible regarding teaching staff requirements, allowing experts from different backgrounds to have the corresponding certification. The policies defined by the accreditation process for academic staff will condition the **hiring policies in HEI**. This will need to include the provision of different profiles allowing to incorporate and update ADS knowledge into the academia.

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[12] https://www.ehea.info/
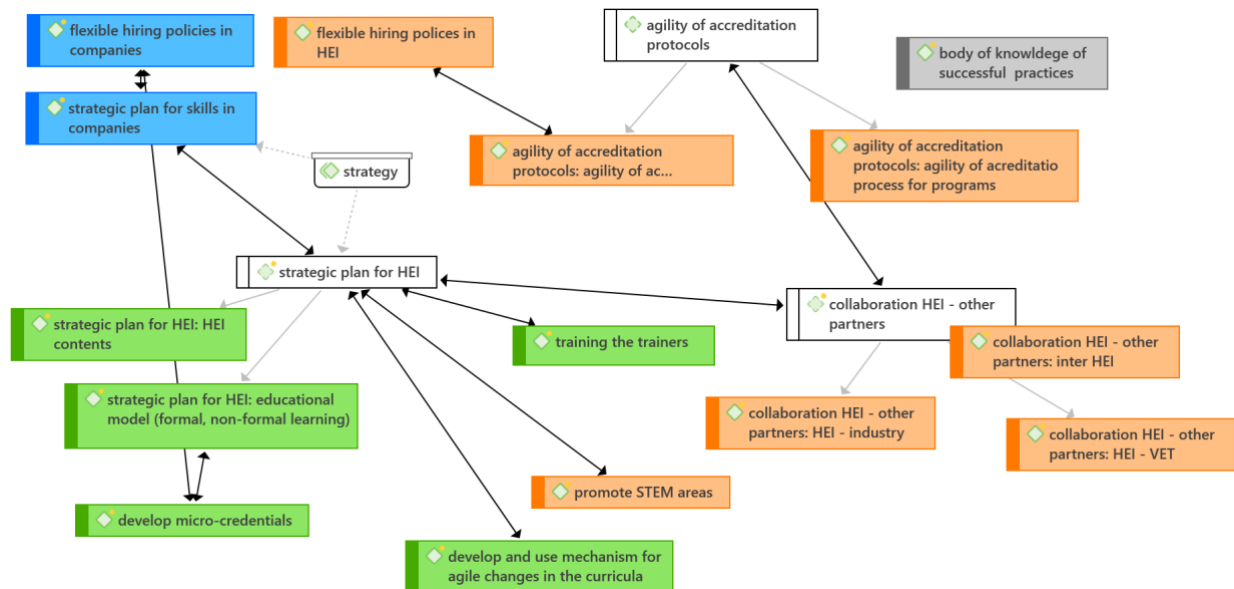
Figure 15 Conceptual Map of recommendations from the first WP3 workshop

Collaboration is another concept that has been mentioned in different recommendations. In this sense, this collaboration is related to three different perspectives. Collaboration inter-HEI has been suggested to complement expertise and talent among different institutions (for example, through European programmes). Collaboration with VET providers has also emerged as a way to provide specific knowledge in university courses. Finally, collaboration with industry, for example with part-time instructors or case studies can provide relevant, updated, and close to market knowledge which would be of interest to students. Even when this collaboration materializes at university level, high level policies at national and EU level are needed to promote and provide a regulatory framework.

Finally, it is important to mention the relevance of the creation of a **body of knowledge of good practices,** which can be defined and shared in different contexts (e.g., European Association of Universities, Informatics Europe, Industrial associations, etc.). In this case, this recommendation can be applied at any level, so we have not assigned it to any primary actor (grey background color).

6   WORKSHOP 2. MEETING THE FUTURE TALENT CHALLENGES OF ADVANCED DIGITAL SKILLS NEEDS IN ORGANISATIONS

6.1 Scope

The second workshop developed, focuses on industry acquisition of ADS talent. Having in mind the expected growth of ADS demand, represented in Section 3 as LEADS1, the scenario of industry talent acquisition is summarized also in Section 3 by LEADS3 describing several relevant challenges that industry faces when trying to cover their ADS needs. Even when as stated in Section 2, industry incorporates all the graduates produced (ST2), this process is not straightforward and presents relevant limitations that would be essential to further develop. In this context the second workshop was designed with the top leading question shown in Figure 16.

The expected outcome from this workshop is therefore to identify potential recommendations that help industry to improve their ADS acquisition process. For that aim, the workshop was planned to be structured according to the following steps:

1. To share data currently collated by LEADS WP1.
2. To develop an understanding of the challenges of filling the ADS talent pipeline needs in organisations.
3. To discuss potential solutions for addressing those challenges.

The workshop was held with a duration of 2 hours in a roundtable format to elicit maximum discussions and debate and was planned for May 4th, 2023.

The goal of this session was to engage with leaders who are at the coalface of attracting ADS talent and who have a high demand for talent in their area. Therefore, the invitees were from industry backgrounds, industry bodies and research bodies operating at the intersection of industry and academia. The invitees also represented a variety of functions, reflecting the extent of the challenge facing the entire organization.
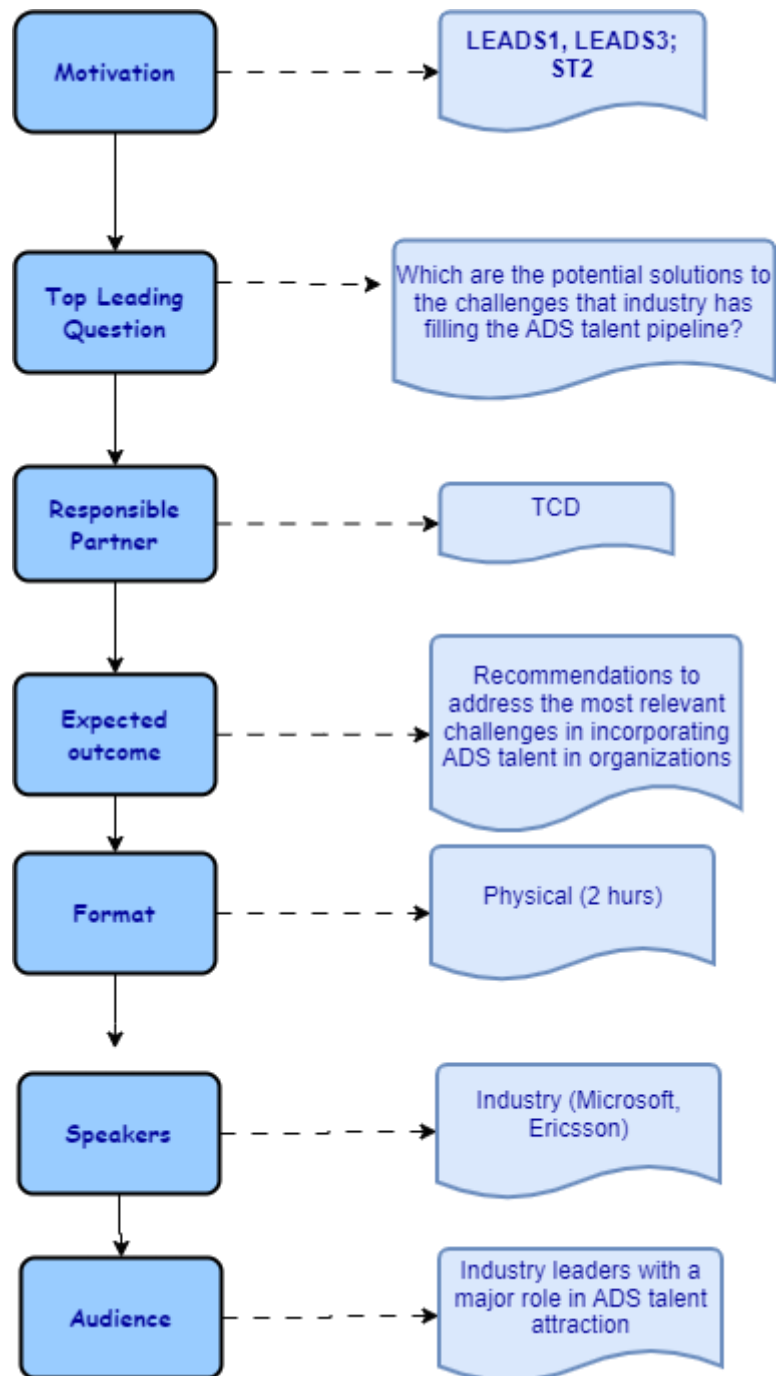
Figure 16 Planning results for the second workshop in WP3

Additionally, and to motivate the debate and discussion, two industry speakers were invited to present their experience in the acquisition of ADS talent:

- Fiona Williams from Ericsson. She has over 30 years of experience and is the Research Director of Ericsson, based in Germany. She initiates and LEADS large-scale collaborative programmes and projects in the national and European context.
- Kieran Mc Corry, MICROSOFT. National Technology Officer in Ireland. He belongs to several industry boards and government forums, focused on technology skills development and strategic planning.

6.2 Workshop Execution

The workshop was run as planned according to the agenda shown in Table 4. A range of industries were represented by senior managers with operational and functional responsibility in the areas of technology, talent acquisition, innovation and strategy. Figure 17 illustrates the diversity and range of participants present, 38 in total. The event led by TCD and was facilitated by UPM and BLU.

TIME	ITEM	LEAD
10:00	Welcome	Laurent Muzellec (TCD)
10:05	Key data on Advanced Digital Skills demand predictions	Brendan Rowan (BLU)
10:15	Panel Discussion	Speakers
10:35	Round Table Breakout 1: Identification of challenges facing industry in ADS talent acquisition and retention	Na Fu (TCD)
10:55	Plenary	Audience
11:10	Round Table Breakout 2: Identifying solutions to top 3 ADS talent challenges	Na Fu (TCD)
11:30	Plenary	Audience
11:40	Clossing	Laurent Muzellec (TCD)

Table 4 Workshop 2 agenda

Figure 17 Second workshop participants

After the speaker presentations, the workshop participants worked in roundtables to identify the most relevant challenges in ADS talent acquisition and potential solutions. A plenary discussion was then held. Scribes were assigned to each table to take notes of the discussion, while TCD representatives also took the corresponding notes on the overall event execution.

6.3 Analysis of Workshop Results

The thematic analysis results of the workshop results arose with the recommendations detailed in Table 5.

Figure 18 represents a conceptual map of such recommendations. In general, it is important to highlight, that Workshop 2 participants focused on the importance of primary and post-primary education in filling the gap of ADS talent in industry.

Main Actor	Recommendation	Description
Higher education providers	Teacher Education Curricula to include ADS content	Teacher education curricula in all third level institutions (providers of teacher training across primary and secondary levels) should include a learning stream related to ADS. In this way, teachers can develop competence and confidence in ADS and can encourage interest in students.
	Integrating industry into Education	Education must keep up with industry needs. More interaction between education and industry is needed. At third level, this needs to be supported by more Adjunct Professors that can bring industry into the classrooms. Universities should create strategic relations with employers in order to create enduring relationships.
	Micro-credentials and fast-paced learning	More emphasis is needed on micro-credentials as a route to acquiring knowledge. Universities and third-party providers can address this gap, and industry is receptive to this as a route to increasing skilled people for employment.
Policy Makers	Increased Education on STEM topics	Primary and post-primary schools are key players in the development of ADS. There is a need for more focus on curriculum creation to ensure that young people are exposed to STEM skills earlier in the education cycle and in a way that encourages interest and ethical use of new channels of technology. Policy makers need to incorporate this dimension into their curriculum and one suggestion was to create STEM internships within companies for teachers to help create awareness.
	Examine the curricula and skill areas addressed in specific Career Guidance teaching qualifications.	Industry representatives perceived a gap in the knowledge of teaching staff who specialized in career guidance at post primary level. There is a need for career guidance qualifications for teachers to be integrated in a structured way with developments in ADS. Doing so will ensure that they are providing the necessary guidance to students. They need to have current knowledge on the new roles that are emerging in organisations and they need to understand the pace of change.
	Ongoing update of education of school leaders and teachers in the primary and post primary school system	In-service courses are common methods for providing professional development for primary and secondary-level teaching, it is recommended that these ongoing professional development opportunities include regular knowledge updates of digital and ADS topics. Faculty providing in-service development should include industry leaders.
	Creation of a digital passport	Similar to the the International Computer **Driving Licence** (**ICDL**). It was suggested that a 'Digital passport' be created to provide a route to increase the general level of digital skills across Europe. This could be

		subsidised and similar to the ECDL offered to students at post-primary level as an accredited qualification.
Vocational Education	Vocational Education Training - Increase in provision of this training as part of an apprenticeship model	The role of apprenticeships was discussed as a credible alternative to traditional routes (i.e. Universities). The concept of real-time learning in-company, combined with a structured pathway was seen as a real alternative to traditional University education. Creating more VET options can increase the prestige of vocational education and create more diverse routes to entry.
Industry	Creating visible role models "Can't see it, can't be it" -	Engaging with schools and implementing mentoring, and providing role models can help address some of the aforementioned issues identified in 'challenges'. Several participants noted that these types of initiatives tend to energise students and help them realise and understand the pathways to a career in technology-related fields. These initiatives can imbue students with confidence, understand the environment, break down social barriers and 'widen the lens'.
	Companies need to create more agile diverse pathways for talent development and acquisition	Industry participants were very concerned about the lack of diversity in the acquisition of ADS talent. In order to fill the necessary pipeline, it was suggested that talent is sourced from (a) wider socio-economic groups for example creating scholarships or internships for those in disadvantaged areas (b) encouraging the recruitment of neuro diverse candidates (c) targeting school leavers and providing credible career development routes (d) within companies create 'crash courses' in digital skill development to enthuse employees to follow new career paths.
	Gender issues still need to be addressed and maintained as a high priority	Participants in this workshop were concerned that there was still a low participation of women in STEM and consequently in leadership roles within organisations. Therefore, industry must continue to support initiatives to encourage female participation in STEM, through supporting targeted scholarships in third level, in-company mentoring, and providing upskilling within organisations to female workforce.

Table 5 Recommendations gathered from the second WP3 workshop

This issue was addressed from different perspectives. On the one hand, the role of teachers in these levels of the education. It was discussed the need to **provide ADS knowledge in the HEI programmes that train primary and post-primary teachers**, so they are able to guide and encourage students in ADS knowledge. Additionally, **career guidance teachers** have an essential role in guiding students in their HEI paths and therefore the formers **need to have enough and updated knowledge about ADS** and new roles that are created to guide future students.

On the other hand, the **promotion of STEM areas** was a critical point from which several specific suggestions were provided. The participants considered it essential to increase the

motivation and interest of young people in STEM and ICT areas, so they can take in their future ICT related studies and therefore get ADS to cover the future gap. **Creating role models in STEM** was suggested as it can help to provide concrete and real examples of STEM roles and profiles, these can motivate younger children to opt for this field. The **inclusion of specific STEM contents in the curricula of primary and post-primary schools** can also motivate students and develop their interests in the corresponding discipline. The creation of specific **conversion courses** at different levels (school level so young people can move from one learning path to another, as well as, in the companies) could also play a role in providing generalists with an opportunity to move into digitally focused areas. STEM areas can also be promoted indirectly through the creation of a **wider offer of VET courses**.
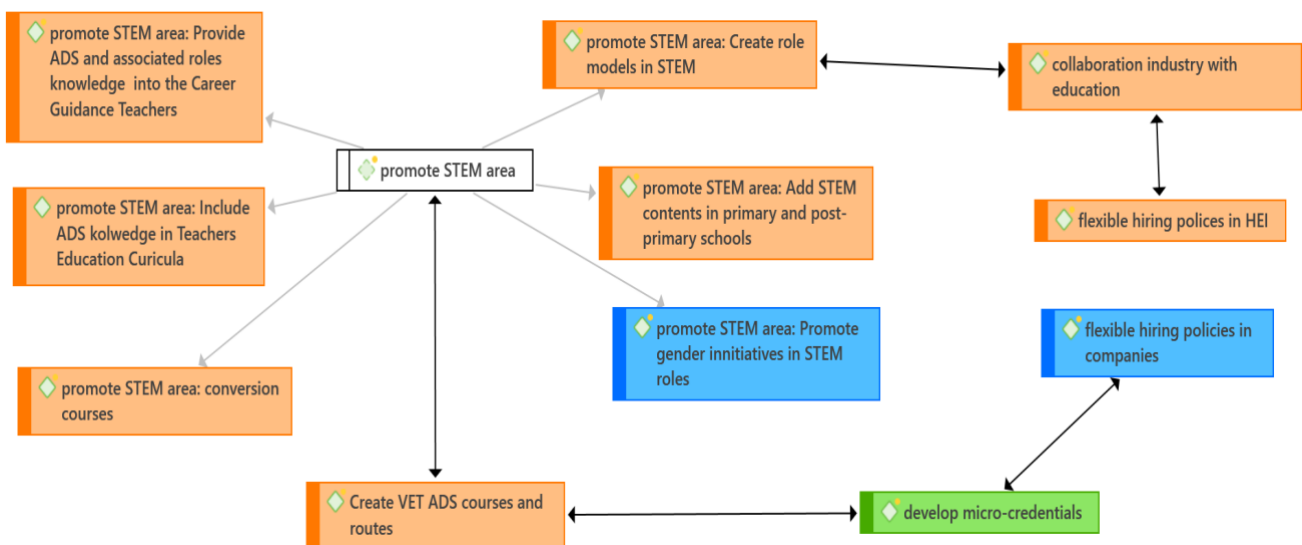

Figure 18 Conceptual map of recommendations from the second WP3 workshop

Finally, the gender issue was discussed, highlighting the low participation of females in STEM and consequently in leadership roles within organisations. It was suggested that **industry should support initiatives to encourage female participation in STEM**, for example, through supporting targeted scholarships in third level, in-company mentoring, or providing upskilling within organisations for the female workforce.

The need for industry to have **a flexible hiring policy** was suggested. In particular,, industry participants were concerned about the lack of diversity in the acquisition of ADS talent, and therefore different sources of talent were suggested, like including different socio-economic groups creating scholarships or internships for those from disadvantaged areas; encouraging the recruitment of neuro-diverse candidates, targeting school leavers and providing credible career development routes; and within companies creating 'crash courses' in digital skill development to enthuse employees to follow new career paths, developing a focus on re-purposing the skillset of existing employees and reskilling them. In this sense the use of **micro-credentials** was considered very useful, for example to support on the job training and to support upskilling or new hiring, and as an opportunity to enrich VET education being offered.

As in Workshop 1, the topic of **collaboration** emerged. However, in this case, it was considered from a wider perspective, addressing all levels of education, primary and secondary school, and university. In the case of university, it was related to the need of having **flexible hiring**

polices to hire adjunct instructors with industrial expertise. At school levels, the collaboration was related to the creation of role models in STEM to be presented to young students.

7 WORKSHOP 3. ADVANCED DIGITAL SKILLS IN DATA AND AI: CURRENT DEMAND, FORECASTED SCENARIOS AND EXPECTED GAP

7.1 Scope

Section 3 has discussed the scenario identified by LEADS related to the specific problems faced by SMEs regarding digital maturity and lack of identification of the ADS demand (LEADS4). As mentioned, this scenario creates a negative cycle for talent attraction; therefore, complemented with the expected growth of ADS demands (LEADS1), in particular in the area of AI and Data, motivates the organization of the third workshop of WP3. "Advanced Digital Skills in Data and AI: current demand, forecasted scenarios and expected gap".

As in the previous workshops, the immediate introduction of ICT graduates into the market, referred in Section 2 as ST2, is particularly relevant in this workshop as small companies have to compete with corporates for talent. The active role of industry in upskilling and reskilling, and the investment in these activities depending on the organization size, represented as ST3 in Section 2, is also relevant for this workshop, as preconditions to the possible solutions to be provided in the SME context.

Figure 19 summarizes the results of the planning process of this workshop, which was structured around three blocks:

1. Presentation of the data currently collated by LEADS WP1.
2. Identification of the challenges of filling the ADS talent pipeline needs in SMEs.
3. To discuss potential solutions for addressing those challenges.

The workshop was planned to be held physically in Luleå during the Data Week[13], the spring gathering of the European Big Data and Data Driven AI research and innovation communities, organized by the Big Data Value Association (BDVA) and the EUHubs4Data project in collaboration with the Research Institutes of Sweden (RISE) and it was scheduled for one hour on June 14, 2023. The workshop was aimed to share the main LEADS results and to engage with the specialised community, in particular SMEs attending the event to discuss possible solutions to address their difficulties to hire, re-skill and up-skill ADS talent. UPM and BLU took the responsibility of this workshop.

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[13] https://data-week.eu/
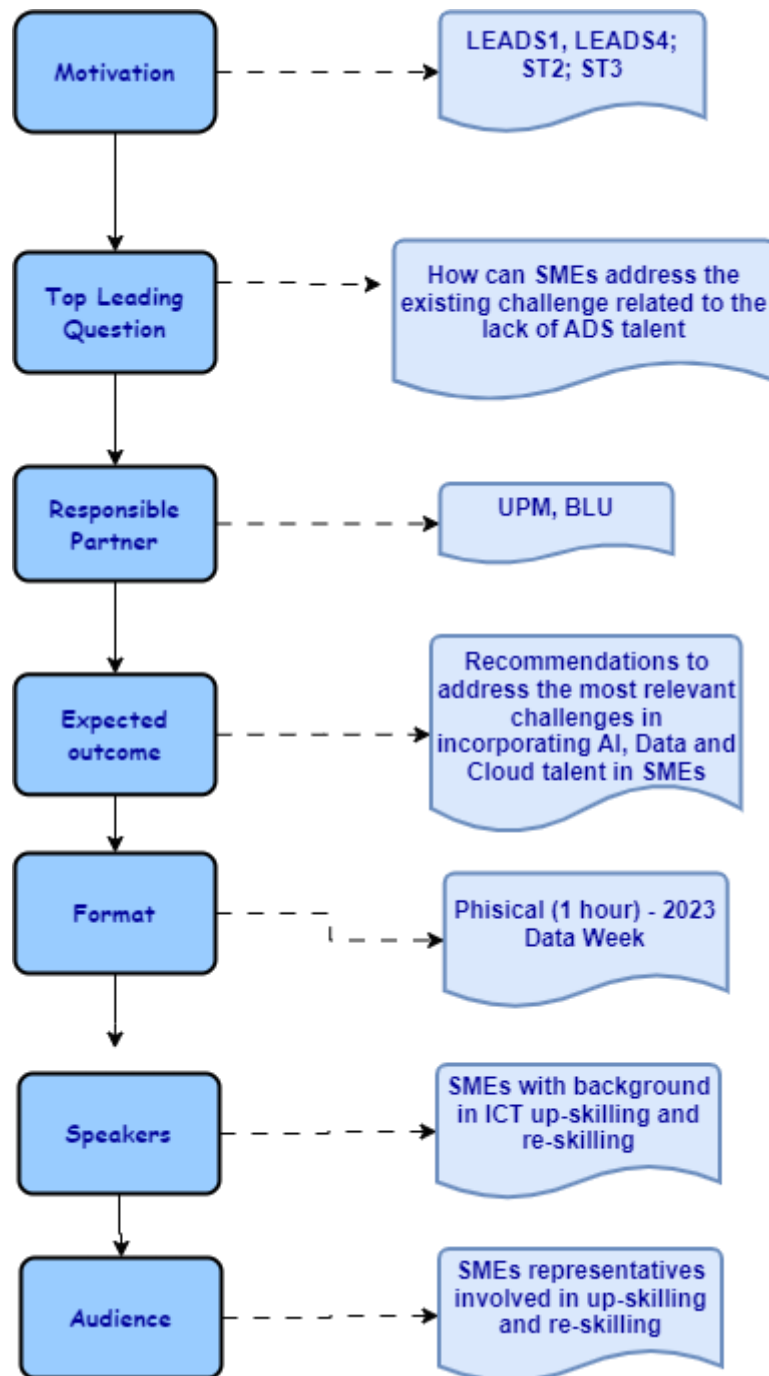
Figure 19 Planning for the third workshop in WP3

Three SMEs with specific programmes for up-skilling, were chosen to participate in the event as main speakers, describing their experiences and lessons learnt:

- HOLOS: With facilities in Portugal and Dubai, Holos's proves innovative products and services to improve access to information, support decisions and generate knowledge in the health domain. In particular they have an important area based on data exploitation and BI.

- LURTIS: SME working in UK and Spain, helping companies automate and optimize their tasks in the construction, engineering, health and finance sectors using AI solutions.

● PORINI SLR: Based in Italy, they are specialized in AI, BI and machine learning ERP solutions and consulting services specific to fashion, clothing, textiles and retail companies.

7.2 Workshop Execution

There were approximately 30 attendees from different backgrounds (industry and consulting), and a small representation from academia who attended to the workshop. However, even when the original aim of the workshop was to discuss and gather recommendations about how SMEs can address the existing challenge related to the lack of ADS talent, unexpected issues with the invited speakers and representatives of SMEs necessitated an adjustment from the initial aims of the discussion. A new focus related to the need for alignment of academic curricula with industry needs represented by LEADS2 was brought to the arena, in particular the discussion on the role of the different stakeholders in delivering the required ADS skills.

The workshop started with the presentation of the LEADS WP1 main results, and the presentation of the ADS formation strategy through customized programmes of one SME (PORINI). It continued with a discussion raised by the organizers (1) exploring the ultimate responsibility for providing the corresponding skills, (2) identifying the key stakeholders who should invest in their development, and (3) discussing how industry and universities can effectively collaborate to avoid outdated approaches. These were some of the questions that triggered the conversation between researchers, industry experts, policymakers, and practitioners during the LEADS workshop.

7.3 Analysis of Workshop Results

The thematic analysis process applied over the third workshop results generated a set of recommendations, having most of them policy makers as main actor. Table 6 summarizes such recommendations.

Target	Recommendation	Description
Policy Makers	**Develop financial and structural measures to address the shortage of trained academics**	Conduct an analysis of the impact of the ICT skilled labour shortage on university recruiting processes and develop measures to address it. Proposed measures may include European programmes that supplement government-provided salaries in each country or mobility programmes to facilitate the transfer of teachers from countries with a surplus to those with a greater shortage, and other relevant initiatives. These measures aim to mitigate the impact of the shortage and ensure a more balanced distribution of skilled ICT professionals across European universities.
	Use Entertainment Media to promote STEM knowledge	Create programmes at European level to promote STEM related Entertainment media, at the same level as it is currently promoting European cultural and linguistic diversity and heritage.
	Validate the effectiveness of EU initiatives promoting	Analyse the impact on universities of programmes like Erasmus Mundus, Digital Europe in terms of flow of new

	skilling and up-skilling collaboration programmes	students, funding and academic staff. This will provide understanding of the extent to which these programmes created a stable source of students for the university, for which the university is supported by state funding.
	Create a strategy for ICT and ADS re-skilling	Analyse firstly the industry demand for ICT re-skilling in all industry sectors under the Digital Transformation. Secondly, (and depending on the sector and students' backgrounds), design and create, with the industry, the standards for ICT re-skilling programmes, to guide and help governments and educational institutions to create a new offer of ICT re-skilling Masters.
	Create a strategy for short-cycle tertiary ICT programmes	Analyse the industry demand of skilled people at short-cycle level and with industry create industry standards for short-cycle tertiary ICT programmes. This information can be used to guide and help both governments and educational institutions to create a differentiated offer from the traditional Bachelor and Master programme.
	Provide financial support for ADS short-cycle tertiary and programmes and re-skilling Masters	The European Parliament should urge the national governments to allocate funds for universities that are targeted at the delivery of short-cycle tertiary ICT programmes and ICT Re-Skilling Masters. These funds should be additional to the funds currently devoted to skilling and up-skilling
	Promote "Centres for Professional Excellence"	Promote "Centres for Professional Excellence" as specialiced entities within universities or universities of applied science, solely dedicated to providing short-cycle tertiary ICT programmes and ICT re-skilling Masters, aligned closely with the rapidly evolving technology and labour market. They would serve as a catalyst to foster collaboration between universities and companies, enabling a focused and concerted effort to optimize and share resources. Its regulations, especially regarding the contracting, must have the same flexibility as a company, having most teachers an industrial background
Higher Education Providers	Develop new ADS HEI programmes combining existing courses	To collaborate on these masters, universities applied a simple approach. There is a general shortage of funding to create new ADS programmes at HEI. Instead of creating entirely new courses from scratch, which would require additional human resources that are already dedicated to existing degrees, opted to design the new master programmes by combining existing courses from other relevant master's degrees. Only a few new courses may need to be developed.

Table 6 Recommendations gathered from the third WP3 workshop

Figure 20 graphically summarizes the previous recommendations in a conceptual map. In order to cover the lack of ADS skills, it is important to promote STEM knowledge. An interesting and innovative suggestion regarding the use of **entertainment media to promote**

STEM knowledge was also shared based on the current promotion of European cultural and linguistic diversity and heritage. Even if there is enough critical mass of students to be enrolled in STEM programmes, we know that there is a shortage of academics properly trained. Industry and academia compete for these professionals and the position of academia is clearly in disadvantage from a financial point of view. Therefore, it is important to investigate this problem and provide **measures to mitigate the existing difference between industry and university** and make academia more attractive for good professionals. During the workshop a couple of measures were discussed (see Table 6). The lack of academics was also discussed regarding the need to provide specific programmes for skilling and up-skilling in ADS. One suggestion discussed was **the design of ADS programmes not from scratch** but by combining existing related courses already given. In that only a few new courses should be created enabling universities to introduce new masters' programmes without putting a strain on their limited resources.
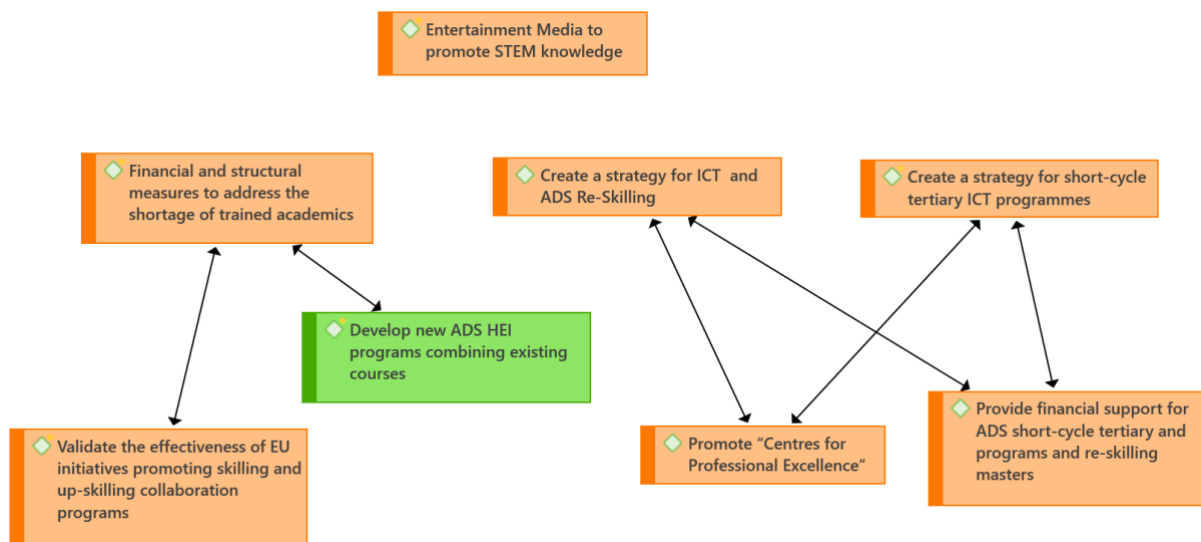

Figure 20 Conceptual map of recommendations from the third WP 3 workshop.

The need for financial support is important to cover the existing ADS gap. The EU already provides support for programmes like the Erasmus Mundus Joint Masters or the Digital Europe Programme. But there is a question regarding the survival of these initiatives because these funding programmes have a defined duration. It would be worth knowing what the surviving rate has been of the Erasmus Mundus Masters programmes since the beginning of the programme once the funding finished. That would give us a tip of to what extent these programmes achieve their goal. How many of them used that funding to seed a new master degree that is still receiving students once the funding ended, in sum, **information about the effectiveness of such EU initiatives**.

As discussed during the workshop (Annex C) re-skilling has become a fundamental activity to cover the ADS gap. On one hand, less than 5% of the graduates are in the ICT area so there is a big pool of graduates that might change their careers to the ICT sector (see Section 2). On the other hand, the interesting paradox for the ICT Education is that nobody seems to be in charge of providing the workforce for the lowest levels, those graduates from the short-cycle tertiary ICT programmes, and therefore what universities are providing is a rhombus shaped population of graduates, instead of a pyramid of skilled people. The definition of a **strategy**

for short-cycle tertiary ICT programmes is critical, and should be done jointly with industry to guide and help governments and educational institutions to create a differentiated offer from Bachelor and Master that cover the low level of the ICT pyramid. Similarly, the definition of a **strategy for ICT and ADS re-skilling,** with a detailed analysis of the training needs depending on backgrounds and target ADS knowledge, is a must to complement the existing traditional skilling and up-skilling offer.

However, delivering short-cycle tertiary ICT programmes and delivering ICT re-skilling Masters at universities would require a differentiated new academic staff with a different profile, and a new allocation of core budget for it. So, EU initiatives should be developed to urge the national governments to **allocate additional funds for universities especially devoted to short-cycle** tertiary ICT and ADS programmes and ICT re-skilling Masters.

Another initiative discussed for short-cycle tertiary education are the so called "Centres for Professional Excellence" to harmonize the collaboration between universities and companies providing short term tertiary programmes aligned with industry dynamic needs. These centers can allow universities to enrich their official programmes with elective courses and provide companies with early access for talent.

8 PRELIMINARY GUIDELINES

Different recommendations were presented in previous sections derived from each of the workshops developed so far in WP3. This section provides a holistic view of all of them in order to have a general snapshot of the guidelines generated so far in WP3. To do so, an inductive content analysis process has been applied as described in Section 4.2.4.

As results of this process, we observed that in general, from all the workshops emerges the idea of the need to develop a proper strategy aimed at four areas:

1. Attraction of more STEM and ICT students.
2. Identification of the proper ADS knowledge to be provided at the different levels of ADS education and training.
3. Definition the most adequate approaches to provide such knowledge.
4. Attraction and retention of adequate trainers.

Even when the different recommendations are closely related to each other, for clarification purposes we will show them grouped according to these four guiding lines. Additionally, we summarize a very specific set of recommendations that can be of interest for industry to have an active role in the ADS talent production process.

As a result of the analysis process, some of the recommendations keep their original names while others coming from different workshops have been unified under a common and representative title.

Regarding STEM and ICT student attraction, as mentioned during the discussion of the first and second workshop, having a relevant pool of students potentially interested in ICT areas is essential to cover the expected gap regarding ADS. Workshop 1, Workshop 2 and Workshop 3 suggested interesting recommendations which are summarized in Table 7. The last column indicates from which workshop such recommendations come from. We will use the same color code as in previous sections to identify the main actor in each recommendation (orange - policy makers; blue - industry; green - education provider). We can see that while Workshop 1 provides a general recommendations to promote STEM areas, Workshop 2 and Workshop 3 go deeper in this topic suggesting more specific actions. In particular, the suggested policies addressed to the attraction of STEM students focus on primary and secondary education, and address specific actions to create awareness in those level teachers as well as actions to specifically motivate students.

About the identification of the knowledge to be provided, Workshop 1 proposed the need for industry to develop a strategic plan for defining their needs in terms of ADS, so this plan can also be used in the definition of the knowledge to be transferred by the training providers. This recommendation is included later, as it is specifically oriented to industry, however we consider relevant to mention it here as it is a relevant component to define the ADS knowledge to be taught by learning providers (Table 8). Notice that the first recommendation regarding the university strategy is also mentioned later but related to the approach to provide ADS knowledge. We have opted to keep the same name for this recommendation, as the university strategy should cover several issues.

Recommendation	Description	Contributing Workshop

Promote STEM areas (general recommendation)	Additional efforts should be made for programmes and campaigns to attract more students to IT topics, especially female students, covering from primary school to vocational training.	• Workshop 1
"Can't see it, can't be it" – creating visible role models	Implement mentoring, community building, internships and provide role models that help in the promotion of STEM roles. These initiatives can imbue students with confidence, understand the environment, break down social barriers and 'widen the lens'.	• Workshop 1 • Workshop 2
Ongoing update of education of school leaders and teachers in the primary and post primary school system	Use in-service courses for providing professional development for primary and secondary-level teaching, Faculty providing in-service development should include industry leaders.	• Workshop 1 • Workshop 2
Examine the curricula and skill areas addressed in specific Career Guidance teaching qualifications	Workshop participants perceived a gap in the knowledge of teaching staff who specialized in career guidance at post primary level. There is a need for career guidance qualifications for teachers to be integrated in a structured way with developments in ADS to ensure that they are providing the necessary guidance to students. They need to have current knowledge on the new roles that are emerging in organisations and they need to understand the pace of change.	• Workshop 1 • Workshop 2
Increased education on STEM topics	Primary and post-primary schools are key players in the development of ADS. There is a need for more focus on curriculum creation to ensure that young people are exposed to STEM skills earlier in the education cycle and in a way that encourages interest and ethical use of new channels of technology. One related suggestion was to create STEM internships within companies for teachers to help create awareness.	• Workshop1 • Workshop 2
Include ADS content in teachers' education curricula	Teacher education curricula in all third level institutions (providers of teacher training across primary and secondary levels) should include a learning stream related to ADS. In this way, teachers can develop competence and confidence in ADS and can encourage interest in students.	• Workshop 1 • Workshop 2
Use entertainment media to promote STEM knowledge	Create programmes at European level to promote STEM related entertainment media, at the same level as it is currently promoting European cultural and linguistic diversity and heritage.	• Workshop 1 • Workshop 3

Table 7 Preliminary recommendations for attracting STEM and ICT students

Recommendation	Description	Source
Develop a university strategy (contents)	HEIs must strategically design their research, technology transfer, and industrial cooperation to cover a significant number of emerging topics and be prepared for adequate course offer.	• Workshop 1

Table 8 Preliminary recommendations related to the ADS knowledge to be provided

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Regarding the approaches to provide such knowledge, we can distinguish different initiatives for skilling, up-skilling and re-skilling in ADS, which includes both VET education as well as official bachelor and master courses. They also include specific actions to make education and training more agile and close to industry ADS demands. These group of recommendations are summarized in Table 9.

Recommendation	Description	Source
Develop a university strategy (prepare the university offer for a life-long learning process including formal and training)	Universities must have a deep transformation in order to focus not only on skilling young students, but also accompany them along their careers for up-skilling and re-skilling. This transformation in many cases, implies combining traditional Bachelor and Masters programmes with other short-duration courses.	• Workshop 1 • Workshop 3
Promote inter-university graduate and post-graduate official degrees	There should exist collaboration between HEIs for ensuring adequate coverage in a particular area, taking advantage of the expertise of all universities in the area. European programmes could help in this task, although it is important to analyse the impact of EU investments in programmes like Erasmus Mundus and the like, to confirm that they are the seed for stable programmes.	• Workshop 1 • Workshop 3
Develop new ADS HEI programmes combining existing courses	Instead of creating entirely new courses from scratch, which would require additional human resources that are already dedicated to existing degrees, design new master programmes by combining existing courses from other relevant master's degrees. Only a few new courses may need to be developed from scratch.	• Workshop 3
Create a strategy for ICT and ADS re-skilling	Industry demand of ICT re-skilling, and in particular ADS re-skilling should be identified, and standards for ICT re-skilling programmes should be created with industry, to guide on the definition of new offer of ICT re-skilling masters.	• Workshop 3
Create a strategy for short-cycle tertiary ICT programmes	Increase the provision of vocational education analysing the industry demand of skilled people at short-cycle level, and with industry create industry standards for short-cycle tertiary ICT programmes. This information can be used to guide and help both governments and educational institutions to create a differentiated offer from the traditional Bachelor and Master programmes, providing a credible and valuable alternative for traditional routes (HEI)	• Workshop 1 • Workshop 3
Promote the use of micro-credentials and fast-paced learning	For specific situations particular courses could be provided through micro-credentials offered by well-known training providers as well as HEI. The recognition of such micro-credentials must be promoted.	• Workshop 1 • Workshop 2 • Workshop 3
Promote "Centres for Professional Excellence"	"Centres for Professional Excellence" can be considered as specialized entities within universities or universities of applied science, dedicated to	• Workshop 3

	providing short-cycle tertiary ICT programmes and ICT re-skilling masters. They would serve as a catalyst to foster collaboration between universities and companies, enabling a focused and concerted effort to optimize and share resources. Its regulations, especially regarding the contracting, must have the same flexibility as a company, having most teachers an industrial background.	
Use mechanisms that allow agile changes in the curricula	Formal degrees are less agile in reacting to changes. Use mechanisms like optional subjects, seminars, and broader subjects to include new demanded knowledge in formal education. Weekend courses, afternoon courses, hybrid/blended courses, courses in cooperation with companies, research institutions, other universities, vocational education centers are also options to be considered	• Workshop 1
Improve the agility of the curricula accreditation process	Study how to accelerate the work of accreditation agencies to avoid possible bottlenecks for the agile creation or updating of degrees.	• Workshop 1
Increase the agility of VET processes	Some additional efforts must be done in official VET education that shares many barriers with universities (lack of agility, bureaucracy, difficulty in finding adequate staff, etc.) even with less autonomy, to eliminate bottlenecks.	• Workshop 1

Table 9 Preliminary recommendations for identifying how to provide ADS knowledge

About the ADS trainers and how to attract and retain them, Workshop 1 and Workshop 3 generated some interesting recommendations summarized in Table 10.

Some specific recommendations for industries also arose from the workshops, mainly related to the need to have a skills strategic plan, make more flexible the talent acquisition process, and keep on working on gender issues. They are summarized in Table 11.

Recommendation	Description	Source
Adapt the HEI hiring process	It should be easier for universities to create specific positions prioritizing the hiring of experts in advanced areas where there is not enough internal expertise. Universities should be allowed to create some specific positions for these new needs, with experts either from industry or from other foreign HEIs, for example as adjunct professors. In the case of industry, universities should create strategic relations with industrial experts in order to create enduring relationships.	• Workshop 1 • Workshop 2
Develop financial and structural measures to address the shortage of trained academics	Implement measures to mitigate the impact of the shortage of ADS trainers and ensure a more balanced distribution of skilled ICT professionals across European universities. Example of measures can be European programmes that supplement	• Workshop 3

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	government-provided salaries in each country or mobility programmes to facilitate the transfer of teachers from countries with a surplus to those with a greater shortage.	
Promote training the trainers	Provide incentives for professors deeply involved in research and training in ADS (ECTS reduction, …).	• Workshop 1
Improve the agility of the teacher's accreditation process	Accreditation agencies and governing rules need to be more flexible in the requirements and certification process of teaching staff because experts (whenever they come) are always welcome.	• Workshop 1

Table 10 Preliminary recommendations regarding ADS trainers

Recommendation	Description	Source
Create a skills strategic plan	Promote the creation of a strategic plan with future requirements for recruitment and for upskilling. This plan should not only be useful for industry purposes but could guide training providers in their own strategic plans.	• Workshop 1
Companies need to create more agile diverse pathways for talent development and acquisition	Industry participants were very concerned about the lack of diversity in the acquisition of ADS talent. In order to fill the necessary pipeline it was suggested that talent is sourced from, (a) other areas than computer science; (b) wider socio-economic groups for example creating scholarships or internships for those in disadvantaged areas; (c) encouraging the recruitment of neuro diverse candidates; (d) targeting school leavers and providing credible career development routes; (e) within companies create 'crash courses' in digital skill development to enthuse employees to follow new career paths.	• Workshop 1 • Workshop 2
Gender issues still need to be addressed and maintained as a high priority	Industry must continue to support initiatives to encourage female participation in STEM, through supporting targeted scholarships in third level, in-company mentoring, and providing upskilling within organisations for the female workforce. The aim is to increase the participation of women in STEM and consequently in leadership roles within organisations.	• Workshop 2

Table 11 Preliminary recommendations for industry

Finally, we would like to mention one recommendation arisen from Workhop 1 that can be applied to any organization related to the generation of a body of knowledge of successful practices (Table 12).

Recommendation	Description	Source
Promote the generation of a body of knowledge of successful practices	Cooperate with existing institutions and associations for extending best practices (e.g., European Association of Universities, Informatics Europe, Industrial associations, etc.).	• Workshop 1

Table 12 General recommendation for all organizations involved in ADS acquisition and development

Notice that collaboration is in the background of most of the recommendations, collaboration inter HEI, industry-HEI, industry-VET, so even when they are represented in different tables, they are closely related.

9 CONCLUSIONS

This deliverable has shown the recommendations obtained so far from the workshops organized by WP3 during the first period (March 2022-September 2023) of the project. Workshops have been run taking as input the contextual situation and the results that have been already obtained by LEADS. In particular, we have identified very specific outcomes from WP1 which have driven and motivated the top leading questions of the three workshops developed in this period. The first workshop was specifically oriented to academia while the second workshop had as main actor the industrial sector. The third workshop explored the role of the different stakeholders in delivering the required ADS skills. Table 13 shows the scenarios planned and covered by each of the workshops, the top leading question and the setting defining the context that impact in the corresponding topic.

	LEADS Scenario		Top Leading Question		ICT education setting	
	Planned	Covered	Planned	Covered	Planned	Covered
Workshop 1	LEADS1 LEADS2	✓ ✓	How can HEI quickly incorporate ADS knowledge into their curricula?	✓	ST1 ST2	✓ ✓
Workshop 2	LEADS3	✓	Which are the potential solutions to the challenges that industry has filling the ADS talent pipeline?	✓	ST2	✓
Workshop 3	LEADS1 LEADS4	✓ LEADS2	How can SMEs address the existing challenges on the lack of ADS talent?	Which is the role of the different stakeholders in delivering the required ADS skills?	ST2 ST3	✓ ✓

Table 13 Overview of the workshops developed in the first period of WP3

As shown in Table 13 the scenario related to the limitations of European SMEs to execute successfully on their digital strategy (LEADS4) has not been addressed in this first period of WP3 due to unexpected issues during the third workshop execution. However this scenario will be considered during the second part of WP3. Similarly, the setting related to the growth of short-cycle tertiary education in the last years (ST4).

Different recommendations to address the identified scenarios described in the previous table have been provided through a detailed qualitative analysis and synthesis process. Those recommendations mostly address the attraction of STEM and ICT students, the identification of the proper ADS knowledge to be provided at the different education and training levels, some proposals for an efficient provision of such knowledge, as well as some recommendations to attract and retain the adequate trainers. One important outcome of this process is the identification of the relevance of a strategy for ADS talent provision at different levels and involving the different stakeholders in a coordinated way. The definition of this strategy requires that industry should be able to dynamically identify the skills needed, and

that training providers are able to quickly adapt their training offer to such needs (official programmes, vocational training options as well as the specific training provided by industry as part of their up-skill and re-skilling process). All this has important implications related to endowing the proper trainers or defining flexible policies in industry to motivate their employee's talent improvement. From the workshops also arose a recommendation to create a body of knowledge of successful practices, covering the different segments involved in the ADS skills talent pipeline (academia, industry and policy makers).

About the generalization of these recommendations for the European context, the recommendations gathered are the result of a consensual process, so they do not represent the individual opinions of the participants in the workshop but the results of the discussion held during the different workshops. Speakers and attendees of the workshops were selected to cover different geographical regions. Due to physical/schedule constraints however, in some workshops the representation was higher from the hosting country. As it can be observed in Section 8, the recommendations arisen from the different workshop reinforce each other, which confirms their validity in a wider context. On the other hand, WP3 plans a validation event that will be held at the end of WP3 covering the recommendations gathered during the whole workpackage, in which representatives of the different stakeholders involved in the ADS talent demand and supply process will be involved.

WP3 will work on the second half of the project on addressing other relevant scenarios (as well as the pending scenario LEADS4). Some top leading question that still need to be addressed are:

- How can HEI and VET training be integrated in order to provide flexible paths to navigate among them?

- How can industry, both corporates and SMEs, improve its ADS re-skilling and up-skilling process?

- How can the formal accreditation process in academy be streamlined to quickly incorporate changes in the curricula?

These and other questions will be carefully identified and addressed following the methodology described in this deliverable. The corresponding recommendations will be gathered and synthetized along with the recommendations generated in D.3.1 and a specific roadmap of recommendations will be produced addressing the ADS demand-supply identified in the project.