Study on Air Traffic Controller (ATCO) and Engineering Staff (ATSEP) social issues and working conditions

Final Report

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Abstract

Over the past decade, the social issues and working conditions of Air Traffic Controller (ATCO) and Engineering Staff (ATSEP) in the Air Traffic Management industry (ATM) have been affected by growing air traffic. This study provides a clear landscape of current and future social issues and working conditions of ATCOs and ATSEPs in the EU Member States. It consisted of three separate tasks.

The **first task** (included in the interim report) showed the convergence of operational performance of the Air Navigation Service Providers (ANSPs) over Europe. However, the ANSPs relied on different operational practices to achieve these results. To understand what drove these diverging practices, we concluded **a second task** (the case studies) comparing the changes in social issues and working conditions in five ANSPs, and assessing the driving forces that caused changes in these conditions. Different organisational practices, other social dialogue models and institutional context (national rules, national supervisory authorities) helped explain the divergences.

The **third task** focused on understanding how ATCOs and ATSEPs expected future social and working conditions to change. We organised a set of scenario workshops to discuss with different stakeholders in the ANSPs three futures with varying degrees of EU-harmonisation and air travel growth. ATCOs thought that their future work would not be significantly different from today. ATSEPs, on the other hand, saw essential changes in technology and organisational practices. Even so, their future working conditions would be affected by technology, new traffic demands and changing social relations. To deal with these factors, the workshops' participants identified separate mitigating measures to reduce possible impacts. These core mitigating measures are mainly more training and flexible working times, which ANSPs should negotiate with the staff organisations and trade unions. The workshop participants suggested 23 examples of mitigating measures.

The future of ATM is currently rather unclear, given the continuing impact of the Covid-19 pandemic. Further growth in air traffic seems the most probable scenario, but to what degree? ATCOs and ATSEPs have been instrumental in the past decade to deliver the substantial economic development of the ATM industry. Their continued support remains essential for future growth. ANSPs need to learn from the diverging practices and understand what can help them and their ATCOs and ATSEPs. They should have that discussion in the forum offered to them by DG-MOVE.

Executive summary

This study on Air Traffic Controller (ATCO) and Engineering Staff (ATSEP) social issues and working conditions was commissioned by DG MOVE under the Service Contract MOVE/E3/SER/2019-431/S12.813754. The study has been carried out by the research organisations TNO and NLR.

Purpose and scope of the study

Over the past decade, the social issues and working conditions of ATCOs and ATSEPs in the Air Traffic Management industry (ATM) have been affected by the air traffic growth. This study aims to provide a landscape of these current and future social and human issues and working conditions in some EU Member States (Air Navigation Service Providers - ANSPs).

The study aimed at the following outcomes:

- To develop a shared understanding of the situation concerning the currently most critical social issues and working conditions in European ANSPs and how they may change in the future for ATCOs and ATSEPs in the ATM-industry, and
- To define a set of mitigating measures discussed with and assessed by stakeholders that can be taken at regional, national and European levels to mitigate the human and social issues.

The study started in October 2019 in a context in which the work for Air Traffic Management (ATM) personnel had become increasingly seasonal and more demanding due to increasing demand for their services and due to an ever-increasing amount of fluctuating traffic. Required individual competence of ATM personnel was also expected to change more often than before throughout their careers. In March 2020, the Covid-19 pandemic hit Europe, and it changed the discussion on the future of ATM-personnel. The belief among stakeholders in the sector remained that the Covid-19 pandemic will prove to be a temporary dip in the ATM-industry activities. In the future, important decisions by the industry are still needed on how to better manage social and human issues and working conditions of ATM-personnel.

The European Commission (DG MOVE) intends to use the study results to facilitate the stakeholders' development and implementation of a roadmap for addressing the 'human and social dimension' within the Digital Single European Sky.

Interpretation framework and methodology

The study was designed so that three consecutive tasks (A, B, C) could deliver the answers to the study's aims. Task A presented an overview of the ATM industry's changing demands and impacts on human and social issues. This input helped to feed the content of the interviews for the case studies in Task B. The final step was to integrate the outcomes of tasks A and B into the scenario workshops (Task C).

These three tasks were guided by an interpretation framework that helped understand how the main human and social issues were impacted by changes in the ATM-industry and how several measures could mitigate these changes. This framework represented a system's view of organisations. Actions in organisations were seen as a comprehensive set to maintain an organisation's functioning on the longer term. As indicated for the ATM-industry, the increasing number of flights and EU-harmonisation require the ANSPs to take mitigating measures to deal with changing work demands. Our focus was on the following seven mitigating measures: licensing and inter-ANSP mobility; training; recruitment and selection; social dialogue; intra-ANSP mobility; pensioning systems and retirement policies; working time and rosters. Chapter 2 explains the framework.

The conclusions and recommendations in this report are built on the following research strategy:

- Task A: Mapping through desk research and interviews what the impact is of contextual drivers (e.g. air traffic congestion, technology) on staff, employment and working conditions;
- Task B: Conducting case studies in five Air Navigation Service Providers (ANSPs) to identify current human and social issues of ATCOs and ATSEPs (Task B);
- Task C: Developing future scenarios for further investigating these issues and defining a set of mitigating measures for dealing with those issues (Task C).

Task A: Contextual drivers

The working conditions of ATCOs and ATSEPs in Europe were, up to the Covid-19 pandemic, characterised by increasing job demands and limited staff availability. These impacts were due to continuing traffic growth and variability of traffic on the one hand and difficulty in delivering the necessary ATM capacity in line with the traffic fluctuations. In the Interim Report, we identified the different practices the ANSPs had developed over time to deal with these social issues and working conditions. ATM capacity is determined by structural elements such as the airspace architecture and the availability of ATCO resources (*e.g. working time, skills, occupational mobility, and available technology to handle larger traffic volumes, etc.*). The effort from ATCOs and ATSEPs was instrumental for the ANSPs to deal with the demands. Although in-depth operational research was not within the scope of this study, it was necessary to collect data on staffing issues/shortages, employment structure (*gender, age, qualification*) as part of the analysis of staff working conditions (*including analysis of ageing staff, level of automation etc.*). This part of the study helped identify the questions for the case study research (Task B) and the discussion on future scenarios (Task C).

Task B: Current social and human issues for ATCOs and ATSEPs in five ANSPs and measures to mitigate impacts

Chapter 3 shows the mitigating measures taken by five ANSPs over the last ten years to address the impact of airspace congestion and high staffing requirements.

ANSPs needed to address changes in staff level and composition. However, their policies to address the increasing demands have been different.

- Staff levels of the ANSPs seemed to have hardly changed over the last ten years, despite fluctuations in traffic volumes, even if the workload of ATCOs and ATSEPs generally has increased over the period. During the economic crisis of 2010-2014, ANSPs could not expand their staff because of the austerity context and the resulting limited resources. An (unintended side-) effect of these policies was strong ageing of the workforce, both for ATCOs and ATSEPs.
- The five ANSPs differed significantly in the way they dealt with the various demands on personnel. Even though in the outcomes (*tariffs and other performance indicators*) the ANSPs were converging, the ANSPs continued to choose different mitigating measures to solve the staffing and organisational bottlenecks. Their policies were different; in the discussions with the ANSPs about the future, they stressed different options. The continuing divergence could be attributed to various factors, such as other social dialogue models, different organisational practices, lack of information about alternatives, and different institutional contexts.

To mitigate the strain on ATCOs and ATSEPs, ANSPs mainly focused on working time and rostering, increasing pensioning ages, and more social dialogue to guide the

changes. Different models could explain differences in selecting mitigating measures to deploy ATCOs and ATSEPs and differences in how the licence system worked in practice.

- For ATCOs, the debate seemed to be whether ATCOs should keep a comprehensive set of tasks (*e.g., integration of executive and planning tasks in one function, holding multiple ratings, controlling many sectors*), or whether the ATCO function should be split up into a limited number of highly specialised tasks and several less complex tasks. These less complex tasks could be executed by support or assistant functions. Each of these different models requires different training, selection requirements, competence policies and organisational practices. In this core discussion, ANSPs were still weighing their options for making the right choices.
- For ATSEPs, the ANSPs followed different paths to mitigate the changing demands, but the differences in measures are less pronounced than for ATCOs. There was extra pressure to reduce the number of ATSEPs and engineers to make processes more efficient. Simultaneously, the ANSPs were struggling to master the technological shift to using more digital technologies while maintaining legacy systems. Keeping up the competencies remained a critical challenge with the ANSPs working to develop new training methods. The focus of the job content discussion was only to a degree similar to the ATCO-discussion. Here too, ANSPs make different choices (*more integration versus more division of tasks*). With the technological challenges, we would have expected growth in the number of ATSEP-engineers, but these numbers declined, and the number of technicians remained stable.
- The room to select mitigating measures also depended on how the licence for ATCOs and ATSEPs worked in the ANSPs. Discussions focused, among other things, on what the regulator (National Supervisory Authority) allowed and what the ANSPs themselves considered necessary in the licensing system. Some ANSPs indicated that their NSA interpreted the licence rules more strictly than other national regulators did. An example was how the competence of ATCOs could be evaluated. Some regulators obliged ANSPs to do this each year; in others, the evaluation spanned three years. ANSPs indicated that they did not see a level playing field in how they operated.

Task C: The future of work of ATCOs and ATSEPs and mitigating measures to support the required change

Chapter 4 summarises the results from three scenario workshops, discussing three different scenarios (A, B and C). The participants discussed which elements in the work of ATCOs and ATSEPs would be most affected by various degrees of EU-harmonisation and increase in traffic complexity. Scenario A consisted of a high degree of EU-harmonisation and a substantial increase in traffic complexity. Scenarios B and C would be lower degrees of these dimensions. Figure A visualises the two axes of EU-harmonisation and traffic complexity, and which scenarios have been selected for the workshop discussion.

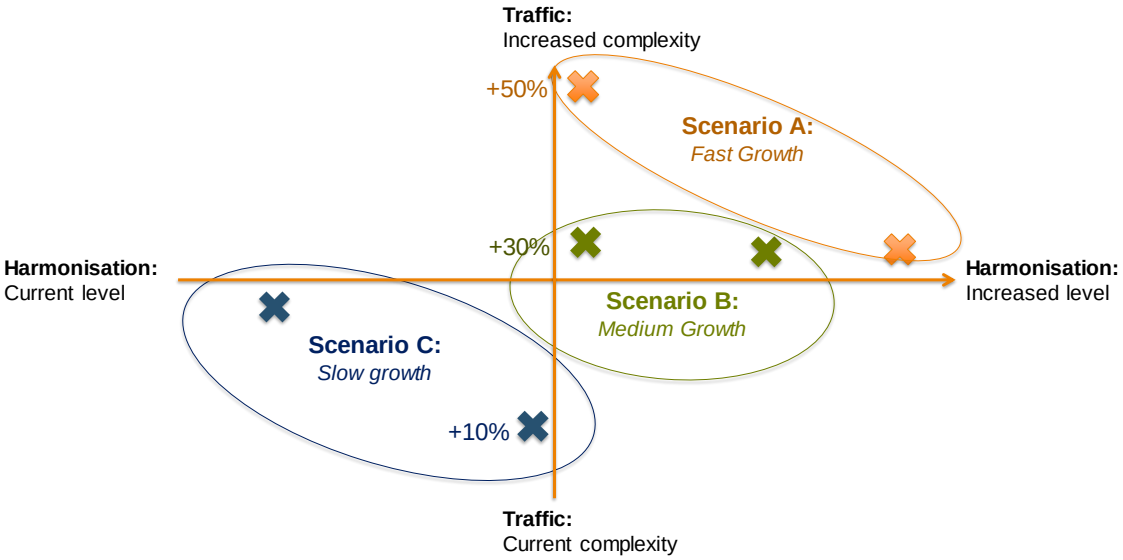

Figure A. Three possible scenarios (+10 – 30 – 50% = 10 – 30 – 50% rise in traffic complexity compared to Q4 2019).

The participants also needed to consider which mitigating measures would be needed to deal with future impacts. For the final selection of measures, we relied on the rankings provided by the participants.

- The participants in the workshops prioritised and elaborated each of the seven mitigating measures. In the various workshops, training, social dialogue and recruitment/selection were prioritised as the most critical mitigating measures within the future scenarios. Licences and retirement rules ended up at the bottom of the rankings in the majority of the workshops. These results implied that participants thought sufficient staff and personnel's continuous development were crucial in all future scenarios. Coordination between all social partners was necessary to advance these changes further.
- The participants did not make much distinction between the three different scenarios in prioritising the various mitigating measures. Scenario C, in which low growth was projected, was seen as a continuation of the current situation. In general, the participants considered each of the particular mitigating measures applicable in each future scenario. In other words, some mitigating measures required more attention than others in the future, whatever this future may bring.

Chapter 4 provides in table 2 an overview of 23 examples of what workshop participants thought needed to change in the seven mitigating measures. The table also shows which mitigating effect was expected. The measures should benefit the ANSPs as well as the staff.

TNO/NLR suggestions for possible next steps

In the final Chapter, TNO/NLR provides some afterthoughts and suggestions for possible next steps based on both the study results and our meta-observations during the interviews and workshops.

1. It may be useful to make the mitigating measures (table 2) available to a broader audience in the ATM sector. By **sharing information**, the ANSPs can improve ATCOs' and ATSEPs' work situation and thus their performance.

2. There is a strong belief in the ATM industry's technological potential. ATCOs and ATSEPs reminded us that the promises are hard to materialise. In practice, ATCOs and ATSEPs experience technology as a continuous delay of implementation processes and a

cause for increasing their work complexity. ATCOs and ATSEPs do not have a negative attitude towards technology but indicate that human and social issues should be better integrated into this thinking. Next to introducing a **'human-centric'** perspective on technology, there should be attention on a **'socio-centric' perspective on technology**. Currently, an impact assessment of each significant technology investment is done from the former perspective. A '**socio-centric' perspective** includes a weighing of the social interests that are affected by the change.

3. ANSPs pointed out that **cultural differences** make it difficult for them to adopt some mitigating measures that proved useful elsewhere. The cultural differences could be seen between countries, between regions in the same country and even between different professions within the same organisation. It may be interesting to evaluate if and how these cultural differences ought to be reduced, or perhaps exploited more to the benefit of all. EASA already discusses such differences with ANSPs. They should be engaged in future discussions.

4. ATSEPs indicated that they do not see their **interests sufficiently reflected** in the European level talks. Next to ATSEPs and ATCOs, no other staff groups were studied. It may be beneficial to verify if other staff groups share this feeling of being neglected at the European level.

5. **Data on human and social issues are not easily retrievable**. For some questions (e.g. working times), the current study was unable to formulate conclusive answers. More and better data is needed to explain the remaining differences. Engagement of the **Performance Review Commission** (PRC) and/or the Performance Review Board (PRB) is needed to improve the data availability and data quality.

6. For further research on human and social issues, close cooperation with the ANSPs and their staff is important. EASA and the PRC should have a role in such research. The study also revealed **sensitivities** among the ANSPs, ATCOs and ATSEPs (and their representatives) **about sharing information**. Any further discussion about human and social issues ought to take those sensitivities into account.

7. Due to the limited availability of public data on human and social issues, follow-up research will have to rely on various sources. This study consists of a **combination of methods**. This combination (desk research, interviews, scenario workshops) may well be suitable for follow-up research.

8. Table 2 provides an overview of a list of topics that merit more research. From a general point of view, three topics remain underdeveloped in this study: the impact of different **organisational practices**; what **flexibility** in shift systems and other organisational arrangements mean and how it benefits or costs ANSPs and the occupational groups; which mitigation measures are most appropriate under **which circumstances.** Understanding these circumstances could help develop the mechanisms in which ANSPs cooperate to find best practices.

Sommaire exécutif

Cette étude sur les questions sociales et les conditions de travail des contrôleurs aériens (ATCO) et du personnel technique (ATSEP) a été commandée par la DG MOVE dans le cadre du contrat de service MOVE/E3/SER/2019-431/S12.813754. L'étude a été réalisée par les centres de recherche TNO et NLR.

Objectif et portée de l'étude

Au cours de la dernière décennie, les questions sociales et les conditions de travail des ATCO et des ATSEP dans le secteur de la gestion du trafic aérien (ATM) ont été affectées par la croissance du trafic aérien. Cette étude vise à fournir un panorama de ces questions sociales et humaines et des conditions de travail actuelles et futures dans certains fournisseurs de services de navigation aérienne (ANSP) européens.

L'étude vise les résultats suivants :

- Développer une compréhension commune de la situation concernant les questions sociales et les conditions de travail les plus critiques actuellement dans les ANSP européens et comment elles peuvent changer dans le futur pour les ATCO et les ATSEP dans l'industrie de l'ATM, et
- Définir un ensemble de mesures d'atténuation (mitigating measures) discutées avec les parties prenantes et évaluées par celles-ci, qui peuvent être prises aux niveaux régional, national et européen pour atténuer les problèmes humains et sociaux.

L'étude a débuté en octobre 2019 dans un contexte où le travail du personnel de la gestion du trafic aérien (ATM) était devenu de plus en plus saisonnier et plus exigeant en raison de la demande croissante de ses services et d'un volume de trafic fluctuant toujours plus important. Les compétences individuelles requises du personnel de l'ATM devaient également changer plus souvent qu'auparavant tout au long de la carrière. En mars 2020, la pandémie de Covid-19 a frappé l'Europe, et elle a changé le débat sur l'avenir du personnel de l'ATM. Les acteurs du secteur restaient convaincus que la pandémie de Covid-19 se traduirait par une baisse temporaire des activités de l'industrie de l'ATM. Dans le futur, d'importantes décisions devront encore être prises par le secteur sur la manière de gérer les questions sociales et humaines et les conditions de travail du personnel ATM.

La Commission européenne (DG MOVE) a l'intention d'utiliser les résultats de l'étude pour faciliter l'élaboration et la mise en œuvre par les parties prenantes d'une feuille de route pour aborder la "dimension humaine et sociale" dans le cadre du Digital Single European Sky.

Cadre d'interprétation et méthodologie

L'étude a été conçue de manière à ce que trois tâches consécutives (A, B, C) puissent apporter les réponses aux objectifs de l'étude. La tâche A présentait un aperçu de l'évolution des demandes du secteur de la gestion du trafic aérien et de son impact sur les questions humaines et sociales. Cette contribution a permis d'alimenter le contenu des entretiens pour les études de cas de la tâche B. L'étape finale a consisté à intégrer les résultats des tâches A et B dans les ***scenario workshops*** (tâche C).

Ces trois tâches ont été guidées par un cadre d'interprétation qui a permis de comprendre comment les principaux problèmes humains et sociaux ont été influencés par les changements dans l'industrie de la gestion du trafic aérien et comment plusieurs mesures ont pu atténuer ces changements. Ce cadre représentait une vision systémique des organisations. Les actions dans les organisations étaient considérées comme un

ensemble complet visant à maintenir le fonctionnement d'une organisation sur le long terme. Comme indiqué pour le secteur de la gestion du trafic aérien, le nombre croissant de vols et l'harmonisation au niveau de l'UE obligent les prestataires de services de navigation aérienne à prendre des mesures d'atténuation pour faire face à l'évolution des exigences professionnelles. Nous nous sommes concentrés sur les sept mesures d'atténuation suivantes : licences et mobilité inter-ANSP ; formation ; recrutement et sélection ; dialogue social ; mobilité intra-ANSP ; systèmes de pension et politiques de retraite ; temps de travail et tableaux de service. Le chapitre 2 explique le cadre de travail.

Les conclusions et recommandations de ce rapport s'appuient sur la stratégie de recherche suivante:

- Tâche A : Cartographier, par le biais de recherches documentaires et d'entretiens, l'impact des facteurs contextuels (par exemple, la congestion du trafic aérien, la technologie) sur le personnel, l'emploi et les conditions de travail ;
- Tâche B : Réalisation d'études de cas dans cinq fournisseurs de services de navigation aérienne (ANSP) afin d'identifier les problèmes humains et sociaux actuels des ATCO et des ATSEP (Tâche B) ;
- Tâche C : Développer des scénarios futurs pour approfondir ces questions et définir un ensemble de mesures d'atténuation pour traiter ces questions (Tâche C).

Tâche A : Facteurs contextuels

Les conditions de travail des ATCO et des ATSEP en Europe étaient, jusqu'à la pandémie de Covid-19, caractérisées par des exigences professionnelles croissantes et une disponibilité limitée du personnel. Ces répercussions étaient dues à la croissance continue du trafic et à sa variabilité, d'une part, et à la difficulté de fournir la capacité ATM nécessaire en fonction des fluctuations du trafic, d'autre part. Dans le rapport intérimaire, nous avons identifié les différentes pratiques que les ANSP avaient développées au fil du temps pour faire face à ces problèmes sociaux et à ces conditions de travail. La capacité de l'ATM est déterminée par des éléments structurels tels que l'architecture de l'espace aérien et la disponibilité des ressources de l'ATCO (par exemple, le temps de travail, les compétences, la mobilité professionnelle et la technologie disponible pour traiter des volumes de trafic plus importants, etc.). Les efforts des ATCO et des ATSEP ont permis aux ANSP de répondre à ces demandes. Bien qu'une recherche opérationnelle approfondie n'ait pas fait partie du champ d'application de cette étude, il a été nécessaire de recueillir des données sur les problèmes/pénuries de personnel, la structure de l'emploi (sexe, âge, qualification) dans le cadre de l'analyse des conditions de travail du personnel (y compris l'analyse du vieillissement du personnel, le niveau d'automatisation, etc.). Cette partie de l'étude a permis d'identifier les questions pour la recherche sur les études de cas (tâche B) et la discussion sur les scénarios futurs (tâche C).

Tâche B : Questions sociales et humaines actuelles pour les ATCO et les ATSEP dans cinq ANSP et mesures pour atténuer les impacts

Le chapitre 3 présente les mesures d'atténuation prises par cinq ANSP au cours des dix dernières années pour faire face à l'impact de la congestion de l'espace aérien et aux besoins élevés en personnel.

Les ANSP ont dû faire face à des changements dans le niveau et la composition de leurs effectifs. Toutefois, leurs politiques pour faire face aux demandes croissantes ont été différentes.

- Les niveaux de personnel des ANSP semblent avoir à peine changé au cours des dix dernières années, même si la charge de travail des ATCO et des ATSEP a

considérablement augmenté. Pendant la crise économique de 2010-2014, les ANSP n'ont pas pu augmenter leurs effectifs en raison du contexte d'austérité et des ressources limitées qui en ont résulté. Ces politiques ont eu pour effet (secondaire involontaire) un fort vieillissement de la main-d'œuvre, tant pour les ATCO que pour les ATSEP.

- Les cinq ANSP différaient sensiblement dans la manière dont ils traitaient les diverses demandes de personnel. Même si les résultats (tarifs et autres indicateurs de performance) des ANSP convergeaient, ceux-ci ont continué à choisir différentes mesures d'atténuation pour résoudre les goulets d'étranglement (**bottlenecks**) en matière de personnel et d'organisation. Leurs politiques étaient différentes ; lors des discussions avec les ANSP sur l'avenir, ils ont mis l'accent sur différentes options. La divergence persistante peut être attribuée à divers facteurs, tels que d'autres modèles de dialogue social, des pratiques organisationnelles différentes, le manque d'informations sur les alternatives et des contextes institutionnels différents.

Pour atténuer la pression sur les ATCO et les ATSEP, les ANSP se sont principalement concentrés sur les horaires de travail, l'augmentation de l'âge de la retraite et le renforcement du dialogue social pour guider les changements. Différents modèles pourraient expliquer les différences dans le choix des mesures d'atténuation pour déployer les ATCO et les ATSEP et les différences dans la façon dont le système de licence fonctionne en pratique.

- Pour les ATCO, le débat semblait être de savoir si les ATCO devaient conserver un ensemble complet de tâches (par exemple, l'intégration des tâches de direction et de planification dans une seule fonction, la détention de **multiple ratings**, le contrôle de nombreux secteurs), ou si la fonction d'ATCO devait être divisée en un nombre limité de tâches hautement spécialisées et plusieurs tâches moins complexes. Ces tâches moins complexes pourraient être exécutées par des fonctions de soutien ou d'assistance. Chacun de ces différents modèles nécessite une formation, des exigences de sélection, des politiques de compétence et des pratiques organisationnelles différentes. Dans cette discussion fondamentale, les ANSP étaient encore en train de peser leurs options pour faire les bons choix.
- Pour les ATSEP, les ANSP ont suivi des voies différentes pour atténuer les demandes changeantes, mais les différences de mesures sont moins prononcées que pour les ATCO. Une pression supplémentaire a été exercée pour réduire le nombre d'ATSEP et d'ingénieurs afin de rendre les processus plus efficaces. Parallèlement, les ANSP s'efforçaient de maîtriser le changement technologique vers l'utilisation de technologies plus numériques et le maintien des systèmes existants. Le maintien des compétences reste un défi majeur, les ANSP s'efforçant de développer de nouvelles méthodes de formation. La discussion sur le contenu des emplois n'a été que dans une certaine mesure similaire à celle de l'ATCO. Ici aussi, les ANSP font des choix différents (plus d'intégration par rapport à une plus grande division des tâches). Avec les défis technologiques, on aurait pu s'attendre à une augmentation du nombre d'ingénieurs ATSEP, mais ce nombre a diminué et le nombre de techniciens est resté stable.
- La marge de manœuvre pour choisir les mesures d'atténuation dépendait également de la manière dont la licence des ATCO et des ATSEP fonctionnait dans les ANSP. Les discussions ont porté, entre autres, sur ce que le régulateur (**National Supervisory Authority ; NSA**) autorisait et sur ce que les ANSP eux-mêmes considéraient comme nécessaire dans le système de licence. Certains ANSP ont indiqué que leur NSA interprétait les règles de licence de manière plus stricte que d'autres régulateurs nationaux. Un exemple est la manière dont la compétence des ATCOs peut être évaluée. Certains régulateurs ont obligé les

ANSP à le faire chaque année ; dans d'autres, l'évaluation s'est étendue sur trois ans. Les ANSP ont indiqué qu'ils ne voyaient pas de règles du jeu équitables (**level playing field**) dans leur mode de fonctionnement.

Tâche C : Le futur du travail des ATCO et des ATSEP et les mesures d'atténuation pour soutenir le changement requis

Le chapitre 4 résume les résultats de trois ateliers de scénarios. Les participants ont discuté des éléments du travail des ATCO et des ATSEP qui seraient les plus affectés par les divers degrés d'harmonisation européenne et l'augmentation de la complexité du trafic. Le scénario A consistait en un degré élevé d'harmonisation au niveau de l'UE et une forte augmentation substantielle de la complexité du trafic. Les scénarios B et C seraient des degrés inférieurs de ces dimensions. La figure A visualise les deux axes de l'harmonisation européenne et de la complexité du trafic, et les scénarios qui ont été sélectionnés pour la discussion au workshop.

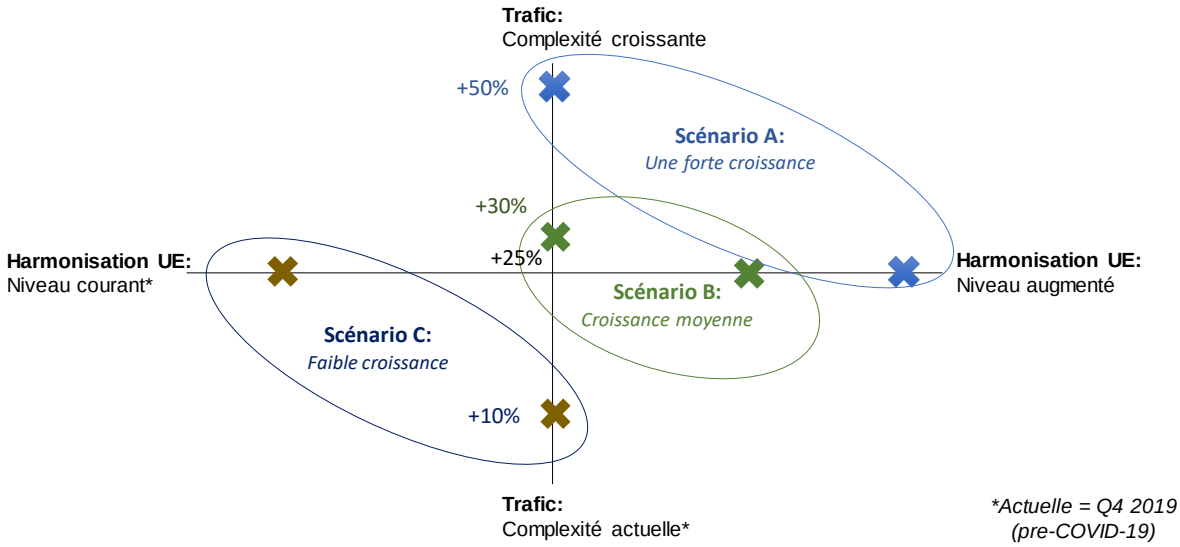

Figure A. Trois scénarios possibles (+10 - 30 - 50% = 10 - 30 - 50% d'augmentation de la complexité du trafic par rapport au T4 2019).

Les participants devaient également examiner quelles mesures d'atténuation seraient nécessaires pour faire face aux impacts futurs. Pour la sélection finale des mesures, nous nous sommes appuyés sur les priorités qui nous ont été données par les participants.

- Les participants aux workshops ont établi des priorités et élaboré chacune des sept mesures d'atténuation. Dans les différents workshops, la formation, le dialogue social et le recrutement/la sélection ont été considérés comme les mesures d'atténuation les plus critiques dans les scénarios futurs. Les licences et les règles de retraite se sont retrouvées en bas du classement dans la majorité des workshops. Ces résultats impliquent que les participants pensent qu'un personnel suffisant et le développement continu du personnel sont cruciaux dans tous les scénarios futurs. Une coordination entre tous les partenaires sociaux était nécessaire pour faire avancer ces changements.
- Les participants n'ont pas fait beaucoup de distinction entre les trois scénarios différents pour établir les priorités des différentes mesures d'atténuation. Le scénario C, dans lequel une faible croissance était prévue, a été considéré comme une continuation des problèmes actuels. La situation actuelle ne changerait pas grand-chose. En général, les participants ont examiné chacune des mesures d'atténuation particulières applicables dans chacun des scénarios futurs. En

d'autres termes, certaines mesures d'atténuation nécessitaient plus d'attention que d'autres dans le futur, quel que soit ce futur.

Le chapitre 4 donne dans le tableau 2 un aperçu de 23 exemples de ce que les participants aux workshops ont jugé nécessaire de changer dans les sept mesures d'atténuation. Le tableau montre également quel effet d'atténuation était attendu. Les mesures devraient profiter aux ANSP en tant que personnel.

Suggestions de TNO/NLR pour les prochaines étapes éventuelles

Dans le dernier chapitre, TNO/NLR fournit quelques réflexions et suggestions pour les prochaines étapes possibles, basées à la fois sur les résultats de l'étude et sur nos méta-observations au cours des entretiens et des workshops.

1. Il peut être utile de mettre les mesures d'atténuation (tableau 2) à la disposition d'un public plus large dans le secteur de la gestion du trafic aérien. En **partageant les informations**, les ANSP peuvent améliorer la situation de travail des ATCO et des ATSEP et donc leurs performances.

2. Il existe une forte croyance dans le potentiel technologique de l'industrie de l'ATM. Les ATCO et les ATSEP nous ont rappelé que les promesses sont difficiles à concrétiser. Dans la pratique, les ATCO et les ATSEP vivent la technologie comme un retard continu des processus de mise en œuvre et une cause d'augmentation de la complexité de leur travail. Les ATCO et les ATSEP n'ont pas une attitude négative envers la technologie mais indiquent que les questions humaines et sociales devraient être mieux intégrées dans cette réflexion sur la technologie. Outre l'introduction **d'une perspective "centrée sur l'homme (human-centric)"** sur la technologie, il faudrait également s'intéresser à **une perspective "sociocentrique (socio-centric)" sur la technologie**. Actuellement, une évaluation de l'impact de chaque investissement technologique important est effectuée selon la première perspective. Une perspective "sociocentrique" comprend une évaluation des intérêts sociaux qui sont affectés par le changement.

3. Les ANSP ont souligné que les **différences culturelles** font qu'il leur est difficile d'adopter certaines mesures d'atténuation qui se sont avérées utiles ailleurs. Les différences culturelles peuvent être observées entre les pays, entre les régions d'un même pays et même entre différentes professions au sein d'une même organisation. Il pourrait être intéressant d'évaluer si et comment ces différences culturelles devraient être réduites, ou peut-être exploitées davantage au profit de tous. **L'EASA** discute déjà de ces différences avec les ANSP et devrait être engagés dans de futures discussions.

4. Les ATSEP ont indiqué qu'ils ne voient pas leurs **intérêts suffisamment pris en compte** dans les discussions au niveau européen. Outre les ATSEP et les ATCO, aucun autre groupe de personnel n'a été étudié. Il peut être utile de vérifier si ce sentiment d'être négligé au niveau européen est partagé par d'autres groupes de personnel.

5. **Les données sur les questions humaines et sociales ne sont pas facilement accessibles**. En conséquence, pour certaines questions (par exemple, le temps de travail), la présente étude n'a pas pu formuler de réponses concluantes. Des données plus nombreuses et de meilleure qualité sont nécessaires pour expliquer les différences qui subsistent. L'engagement de la **Performance Review Commission** (PRC) et/ou du Performance Review Board (PRB) est nécessaire pour améliorer la disponibilité et la qualité des données.

6. Pour la poursuite des recherches sur les questions humaines et sociales, une coopération étroite avec les ANSP et leur personnel est importante. L'EASA et la PRC devraient avoir un rôle dans ces recherches. L'étude a également révélé des **sensibilités** parmi les ANSP, les ATCO et les ATSEP (et leurs représentants) **concernant le partage**

des informations. Toute discussion ultérieure sur les questions humaines et sociales devrait tenir compte de ces sensibilités.

7. En raison de la disponibilité limitée des données publiques sur les questions humaines et sociales, les recherches de suivi devront s'appuyer sur une combinaison de sources. Cette étude consiste en **une combinaison de méthodes**. Cette combinaison (recherche documentaire, entretiens, workshops de scénarios) pourrait bien convenir à la recherche de suivi.

8. Le tableau 2 donne un aperçu d'une liste de sujets qui méritent une recherche plus approfondie. D'un point de vue général, trois sujets restent sous-développés dans cette étude : l'impact des différentes **pratiques organisationnelles** ; ce que signifie la **flexibilité des systèmes** de changement et autres dispositions organisationnelles et comment elle profite ou coûte aux ANSP et aux groupes professionnels ; quelles mesures d'atténuation sont les plus appropriées dans **quelles circonstances**. La compréhension de ces circonstances pourrait être utile pour développer les mécanismes dans lesquels les ANSP coopèrent pour trouver ensemble les meilleures pratiques.

Abbreviations

- ACC = Area Control Centre
- ACE = ATM Cost-Effectiveness report (EUROCONTROL)
- ANSP = Air Navigation Service Provider
- APP = Approach Control Unit
- ATCO = Air Traffic Controller
- ATM = Air Traffic Management
- AIS = Aeronautical Information Services
- ATSEP = Air Traffic Safety Electronics Personnel
- CLA = Collective Labour Agreement
- DFS = Deutsche Flugsicherung GmbH, Germany
- DSNA = Direction des services de la navigation aérienne, France
- EGHD = Expert Group on the Human Dimension of the Single European Sky
- ENAIRE = Air Navigation Serice Provider of Spain
- FIS = Flight Information Service
- LFV = Luftfartsverket, Sweden
- MET = Aeronautical Meteorology
- NLR = Koninklijke Nederlands Lucht- en Ruimtevaartcentrum (Royal Netherlands Aerospace Centre)
- NSA = National Supervisory Authorities
- OJT = On the Job Training
- RP = Reference Period
- RTO = Remote Tower Operations
- TWR = Tower Control Unit
- SES = Single European Sky
- SESAR = Single European Sky ATM Research
- SESAR DM = Single European Sky ATM (Air Traffic Management) Research) Deployment Manager
- SESAR JU = Single European Sky ATM (Air Traffic Management) Research) Joint Undertaking
- SMC = System – Monitoring – Control
- TNO = Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek (Netherlands Organisation for Applied Scientific Research)

1. Introduction

a. The goal of the study

This Final Report documents a study on the future social issues and working conditions of Air Traffic Controllers (ATCO) and Safety Electronics Personnel (ATSEP) in the Air Traffic Management industry (ATM). It provides a landscape of current social issues and working conditions of ATCO and ATSEP in some EU Member States (ANSPs) and describes a set of mitigating measures to prepare for the future. The conclusions and recommendations in this report are built on the following research strategy:

- Mapping through desk research and interviews what the impact is of contextual drivers (e.g. traffic congestion, technology) on staff, employment and working conditions (Task A);
- Conducting case studies in five Air Navigation Service Providers (ANSPs) to identify current human and social issues of ATCOs and ATSEPs (Task B);
- Developing future scenarios for further investigating these issues and defining a set of mitigating measures for dealing with those issues (Task C).

Appendix 1 provides an overview of the (numerical) evolution of the ATCO and ATSEP. The accompanying excel-file shows how the workforce in EU-ANSPs developed itself since 2007. Task C presents three scenarios of staffing for the future.

The study started in October 2019 in a context in which the work for Air Traffic Management (ATM) personnel had become increasingly seasonal and more demanding due to increasing demand for their services and due to an ever-increasing amount of traffic, which furthermore fluctuates more strongly over the year. Required individual competence of ATM personnel (ATCO, ATSEP) was also expected to change more often than before over the course of their careers. This context was taken as a baseline for the study. Possible consequences of the Covid-19 pandemic are included in the scenarios (Task C). The study was aiming for the following:

- To develop a shared understanding of the situation concerning the currently most critical social issues and working conditions in European ANSPs and how they may change in the future for ATCOs and ATSEPs in the ATM-industry, and
- To define a set of mitigating measures discussed with and assessed by stakeholders that can be taken at regional, national and European levels to mitigate the human and social issues[1].

The belief among stakeholders in the ATM-sector was that the Covid-19 pandemic would prove to be a temporary dip in the economic situation of the ATM-industry. The sector still has to make crucial decisions for the future on how to manage social issues and working conditions of ATM-personnel more effectively. The European Commission (DG MOVE) intends to make the study results available as input for a roadmap for addressing the 'human and social dimension' within the Digital Single European Sky.

b. Structure of the report

The structure of the remainder of this report is as follows.

[1] In March 2020, the Covid-19 pandemic hit Europe and it changed the context for discussing the future of ATM-personnel. The pandemic complicated the finalisation of the project, but with the help of ATCOs, ATSEPs and other staff from ANSPs, the objectives of the project have been reached by performing online interviews and online workshops instead of on-site as originally planned.

- **Chapter 2** describes the interpretation framework and the methodology used in this study.
- **Chapters 3 and 4** present the main results of the study:
    - First, we describe the 'landscape' of current social issues and working conditions in five Air Navigation Service Providers (ANSPs). We do this by explaining contextual elements for ATCOs and ATSEPs, and then by providing insight in the mitigating measures that these ANSPs have taken in the past decade to deal with the increasing amount of air traffic and the new policy environment;
    - Second, the future of ATCOs' and ATSEPs' social issues and working conditions is described. The results are based on the outcomes of five case studies and on the results of a set of workshops that have been conducted with ATCOs, ATSEPs and other personnel from the ANSPs.
- **Chapter 5** contains the conclusions and recommendations of the study.
- Next to these core results, we provide a set of appendices, files and reports for the different goals of the project:
    - Appendix 1: an overview of the contents of a data file with the most recent data on the workforce (ATCO, ATSEP and other categories) of the ATM-industry;
    - Appendix 2: an overview of the scenarios for the future, as has been used in the workshops;
    - Appendix 3: the Task B-report with the results from the comparative analysis of the five case studies.
    - Appendix 4: the Task C-report with the results from the workshops;

Findings of all stakeholder consultation activities in November 2019 to March 2020 are integrated into the Interim Report[2]. This Interim Report includes statistical analyses, validation of results, and other information on the interpretation framework's identified topics.

c. Recognition

We take the opportunity to thank all the ATCOs, ATSEPs, managers, all other ANSP-personnel and other interviewees who helped us with the research. We also thank the Steering Group and DG MOVE for their support during the project and the reports' finalisation. This report has been improved with the final remarks by the Steering Group.

[2] Dhondt, S. (2020) Interim Report - Study on Air Traffic Controller (ATCO) and Engineering Staff (ATSEP) social issues and working conditions. Leiden: TNO/NLR.

2. Interpretation framework and methodology of the project

a. Interpretation framework

The study project is guided by an **interpretation framework** that helps understand how the main human and social issues are impacted by changes in the ATM-industry and how several measures can mitigate these changes. This framework represents a **system's view** of organisations. This view means that actions in organisations are seen as a comprehensive set to maintain the functioning of an organisation on the longer term. As indicated for the ATM-industry, the increasing number of flights and EU-harmonisation require the ANSPs to take mitigating measures to deal with changing work demands. For the interpretation of the results, this framework is used. Chapter 3 develops a further understanding of how ANSPs **in the past** have tried to mitigate the demands (Interim report – Task A; Case study report – Task A). Chapter 4 summarises what personnel of ANSPs see as the main mitigating measures **in the future** (Workshop report – Task C; partly also Task B). This interpretation framework contains the following **components**: the organisation as a system, the environmental constraints, the impact on staff, and the mitigating measures to deal with changing demands. A full description of this framework is included in Task C-report.

Organisations can be represented by a set of people in positions and roles divided over age groups (or age cohorts). This typically would lead to a trapezium-representation of an organisation, but in the ATM-industry, most ANSPs have age groups in their personnel towards the higher end, 40 to 60 years of age. This age structure allows us to represent **ANPS as hexagonal figures**. Within these organisations, the study is focused on what happens to the actual staffing levels, the composition of the staff, the work content of personnel and the complexity of this work content. In this system's perspective, the organisations react to external pressures or **changing demands**. In the ATM-industry, three main demands are 1) market pressures (increasing number of flights; variability in demand for ATM-services), 2) harmonisation demands, and 3) technological change. This second demand is specific for the ATM-industry. In this sense, ANSPs in Europe have agreed to follow European agreements or organisations (Single European Sky policy; EUROCONTROL; etc.). The ATM-industry is a highly regulated market, also meant to 'contain' ANSPs operating as local monopolies. Next to EU-regulation, national regulations also restrict specific policies in ANSPs. ANSPs need to **deploy a set of measures** to mitigate these changing demands.

Figure 1 summarises these ideas. The **left side** of figure 1 shows how the environment (market demands, harmonisation of rules and technological change) affects the work content, work complexity, staff composition and staff levels of ANSPs. The **right side** figure represents the organisation of an ANSP and shows mitigating measures considered in this study:

- Recruitment and selection (including direct entries)
- Training (initial training, recurrence training etc.)
- Working time and rostering
- Licensing and inter-ANSP mobility
- Social dialogue
- Pensioning situation and retirement rules
- Mobility measures (and internal promotion)

Table 1 explains these mitigating measures. This set of mitigating measures is not a complete set of measures that an organisation can select. It is a selection, decided upon after discussions with DG MOVE and the Steering Group at the project's onset. The figure summarises the overall study design. ANSPs as organisations respond to the impacts on staff and work with mitigating measures. Effects on staffing levels in the ANSPs, the

composition of the staff, the work content of personnel and the complexity of this work content will be considered at the level of the occupational groups of ATCOs, ATSEPs and OTHERs.

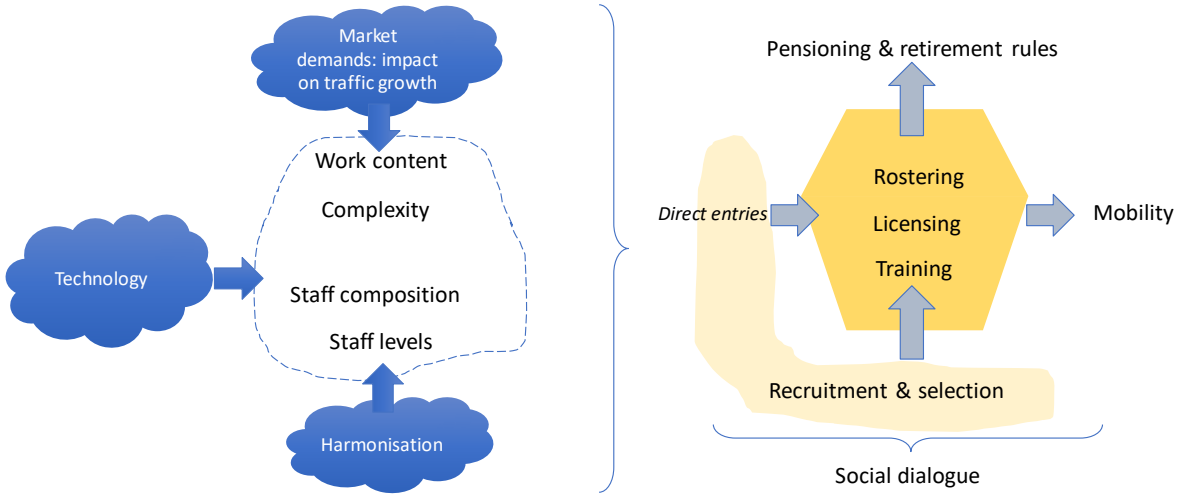

Figure 1. Mitigating measures to deal with impacts on occupational groups

Table 1. Overview of (1) expected changes in work content and staffing and (2) corresponding mitigating measures that can help ANSPs to deal with the demands of future scenarios

Topic	Explanation
Changes in work content and staffing ('social issues')	
Work content, division of tasks	Work content within occupations can change in the future. Tasks can shift between occupations. Different operating models of ANSPs can impact work content. Task division between ATCO/ATSEP and other occupations can change. The managerial structure in the OPS- and TECH-room can change.
Work complexity	Work content can become more complex. The demands to maintain competence can change.
Staff composition	Each of the occupational groups can show shifting staff composition. Changes can be affected by changes in gender balance, age composition and changing educational levels.
Staffing level, staff availability	Staffing levels can change because of productivity changes by existing staff shortages. For non-ATCO-groups, outsourcing is also a relevant category.
Mitigating measures	
Licensing	EASA regulations govern ATCO and ATSEP' tasks and competencies. ANSPs cannot change licensing rules, but they can see to what degree the work organisation can make the best use of the rules. Changes in societal practices (for example the growth of part-time work) may affect the licence.
Recruitment & selection	ANSPs can react to the changing demand for personnel by recruiting new staff, developing new selection criteria. ANSP can try to find more direct entries or stimulate the exchange of personnel with other ANSPs. HR-systems and Collective Labour Agreements may guide the way recruitment and selection are made.
Training	ANSPs can decide differently on how to use basic training, unit training, recurrent training, and on-the-job training (OJT) and OJT-trainers (OJT).

Mobility (within-job mobility; within organisation mobility)	ANSPs can use internal mobility measures to fill-up internal vacancies. Promotion and career development can be used to motivate personnel.
Working times, rosters	Roster system, overtime practice and holiday planning are measures to deal with fluctuations in demand. The use of these systems can be bound to strict rules.
Pensioning system	Long-term development of personnel in ANSPs can be managed by changing the pensioning age or developing new (pre-)retirement systems.
Social dialogue	Changes in most of the listed measures require negotiation with staff organisations or trade unions. The procedures to discuss such changes can be flexible to quite strict. The relationships between social partners can influence how decisions are made in the ANSPs.

b. Methodology

This section presents the **overall methodology** for the whole study. Chapters 3 and 5 clarify the particular methods for tasks B and C. Figure 2 shows the different steps taken in the entire study.

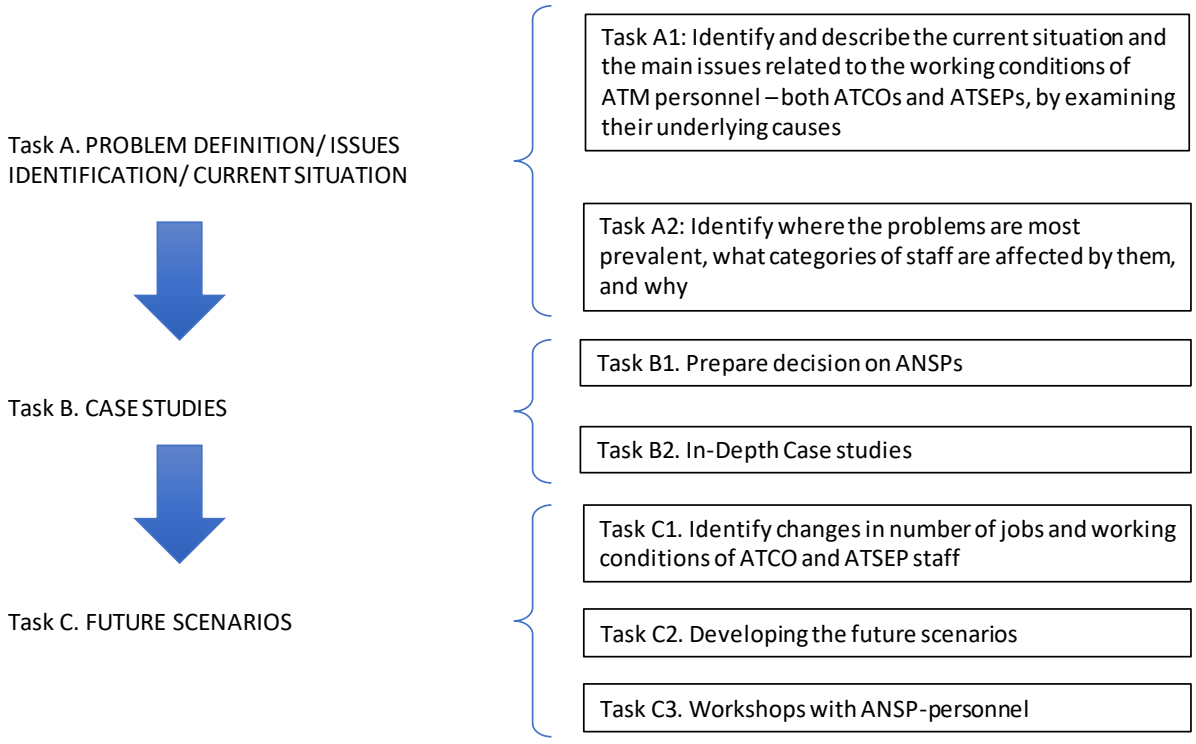

Figure 2.. Tasks and steps taken in the study

The study was designed so that the strongly interrelated three tasks (A, B, C) delivered the answers to the study's aims. Task A presented an overview of the ATM industry's changing demands and impacts on human and social issues. This input helped to feed the content of the interviews for the case studies in Task B. The final step was to integrate the outcomes of tasks A and B into the scenario workshops (Task C).

Task A: Desk research and interviews with stakeholders/experts. The research in Task A consisted of desk research, interviews, analysis and reporting. The desk research helped develop an overview of the ATM industry discussions on human and social issues.

Under the guidance of the Steering Group, an interview plan was developed. The interviews provided more in-depth information on the leading causes and explanations of ATM-working conditions concerning technological innovations and traffic complexity, and other capacity issues, from a European-wide perspective. The interviews dealt with insights, overviews and opinions of stakeholders in the field. They assessed the state of affairs in the ATM sector, which has been used as a reference point for the case studies of subsequent Task B.

Task B: Case studies. Task B described the operational perspective of five different ANSPs on several elements of the human and social dimension. The case studies sought to provide information on the impact of the changing demands such as traffic growth and new technology on ANSP staffing and work (e.g. complexity of work content). Particularly relevant for the project was that the selected ANSPs were those that had invested strongly into new technology and new organisational practices, or were ANSPs considering such investments. Those ANSPs were seen as closest to the technological frontier in the ATM-industry. These cases could offer the most relevant insight into what the changes in the ANSPs meant for the ATCOs and ATSEPs. The comparison between these innovative ANSPs helped to understand the extent to which the ANSPs converged or diverged in their decisions. The ANSPs all experienced the same changing demands and needed to react accordingly. Because this study focuses on these innovation leaders, the study is by no means representative for all ANSPs. The cases are, however, very indicative of the options that ANSPs have. The methodology is further described in Chapter 3.

Task C: Workshops. Task C aimed to gain insight into the future changes for work, work complexity, staffing levels and staff composition in ATM-industry, and second to understand how future changes could be ‘managed’ or ‘mitigated’. A set of workshops was designed in which participants from the ANSPs were engaged to develop their responses to questions from the research team and then discuss in separate groups what these futures for ATCOs and ATSEPs could be.

A scenario approach was used to guide the discussion among the workshop participants. The ATM sector's three future scenarios were defined, offering *distinctive pictures of foreseeable human dimension futures* for the oncoming 15+ years, with 2035 as their focal point. The scenarios, which have been developed in close collaboration with ATM stakeholders, were *explorative*: logically interrelated, consistent and credible narratives about how the future could unfold. In dealing with the human dimension's impact, specific attention was paid to assessing the importance of the seven mitigating measures listed in table 1.

The participants in the workshops were guided to develop a consensus on these futures. If a consensus was not possible, arguments for possible disagreement were collected. In Chapter 4, the six-step approach to achieve this convergence among participants is documented. The case studies were planned to finish quite early in the project and be used as background material for the workshop participants. Due to the Covid-19 pandemic, several case studies were only completed at the start of the workshops. The workshop participants could only use summary tables from the case studies to inform themselves about the ANSP practices.

Final report. The results from Tasks B and C are summarised and integrated into this final report.

3. Comparison of practices in five ANSPs in period 2010-18 (Task B)

a. Introduction

This Chapter provides a comparative overview of five case studies. The overview results in a clear landscape of current human and social issues dealt with by ANSPs in five EU Member States. The first focus is on the **impacts** of changing demands on social issues and working conditions of ATCOs and ATSEPs. The second focus is to initially assess to what degree the ANSPs converge in **mitigating** these impacts on ATCOs and ATSEPs and secondly, to understand **why** ANSPs selected these mitigating measures. The convergence (divergence) question is relevant because the ANSPs were all confronted with the same trends (increasing air travel, harmonisation of rules in Europe**,** comparable technological change environment) and operational demands (declining route charges). In reducing the route charges, some converging in mitigating measures could be expected. Possible **explanations** for converging or diverging policies were differences in ANSP-size, different organisational practices, different relationships between social partners; and other policy objectives. Mainly factors under direct ANSP control are reviewed (PRU, 2020, p. 3). The convergence question gives us possible explanations for the arguments developed by ATCOs and ATSEPs in the workshop part of the study.

b. Methodology case studies

The methodology of the case studies was developed to collect a **broad set of interviews** in five ANSPs and develop an insight into the current (2019-2020) human and social issues, the changes over the past decade and the measures designed during that period to mitigate possible impacts on employees and working conditions.

Initially, the ANSPs invited were: DFS (Germany), skyguide (Switzerland), HungaroControl (Hungary), DSNA (France) and ENAIRE (Spain). Unfortunately, due to the Covid-19 pandemic, HungaroControl did not have ten persons available in the planned timeframe, and therefore they were replaced by LFV (Sweden).

The original plan was to visit the **five different ANSPs** and have two-day long interviews with ten different persons at each ANSP. Only in two cases, face to face interviews could be applied due to the Covid-19 pandemic. In the remaining ANSPs, only online interviews were allowed. Each interview was prepared using EUROCONTROL's ATM Cost-Effectiveness (ACE) reports and annual reports of each ANSP, both with data over the past ten years.

Much effort was put in following a **careful and transparent procedure** for each of the ANSPs. Interviews were conducted with managers and several representatives of ATCO, ATSEP and other professional groups. Each interviewee received a personal report that could be checked. The reports were integrated into an ANSP-report, provided to our contact persons for validation purposes. These reports are not public but have been used for the overall Task B-report.

The interviews were planned with personnel from headquarters and a local unit (ACC/APP/TWR). For each ANSP, the following representatives were interviewed:

- COO/Director operations
- HR director /Training director
- Director systems
- Manager strategy/innovation department

- Trade union, staff organisation
- Unit Manager(s)
- Local training manager (new personnel, operational personnel)
- Rostering manager/coordinator
- Manager ATSEP group
- Project leader/manager of an implementation project in technological innovation in ATM
- Two ATCOs and two ATSEPs per ANSP

c. The changing demands for ANSPs in the period 2010-2018 …

The five ANSPs for this comparison are **DFS, DSNA, ENAIRE, LFV and skyguide**. These ANSPs are different in size and manage airspaces with varying degrees of complexity. They have other operational models and work in different institutional contexts. Some are part of the public administration, and others are independent (State-controlled) service providers. Their organisational positions have not changed dramatically in the past decade, even though some liberalisation did affect the ANSPs in part of their functioning. The ANSPs have experienced the same changing demands.

The first important changing demand has been an **increase in the demand for air traffic management services**. The large increase in the number of flights and variability in service demands has been substantial in the observed period 2010 - 2018. The five ANSPs have seen the number of flights in their airspaces grow with 12 to 26%. Seasonal variations show jumps in the number of flights between 10 to 50% in some of the ANSPs. Even if the number of flights might not have grown substantially in some ANSPs, the airlines carried bigger and heavier loads.

The **innovation context** has been quite the same for the five ANSPs. The investments by all ANSPs have grown over time, but mainly after 2017 (EUROCONTROL, 2019). The investment possibilities of the ANSPs were strongly different. All ANSPs participated in the SESAR-research programme with different interests. **Different technology strategies** were explained in the interviews, but all ANSPs focused on the development of ADSPs, virtualisation and Remote Tower Operation. These technologies are far from being implemented and have hardly affected the work of ATCOs and ATSEPs in the observed period. In the past decade, the focus of the ANSPs has mainly been on the replacement of ageing ATM-systems, supporting ATCOs with different kinds of tools (e.g. 4D-trajectory planning), the implementation of new communication and navigation tools, and other new infrastructure. There has been some experimentation with new **operational concepts** (e.g. performance-based navigation, new tools for separation management, departure and surface management concepts, sequencing of aircraft etc.). In most of these changes, the common denominator has been the further digitalisation of processes, tools, and tasks, with digital technologies pushing out older analogue systems. However, in 2010-18, there does not seem to be one major technology replacing all former technologies while providing a new context. Instead, technological change has been relatively small and only contributed marginally to the sector's productivity rise (EUROCONTROL, 2017). The five ANSPs did not see significant improvements in their operations. Still, in comparison to other ANSPs in Europe, these ANSPs can be seen as **innovation leaders**.

The **harmonisation of practices** in the ATM-industry has led to more changes in the ANSPs than technology has done. The demands brought by the Single European Sky, i.e.

the Reference Period 1 and Reference Period 2 context, have been substantial. All ANSPs have tried to make their performance more efficient, in some cases allowing to reduce route charges for the airlines substantially. In the period 2015-19, en-route charges have dropped 14% in the ANSPs under study. The variation between route charges across ANSPs and the annual traffic delays has been reduced. However, since 2017 these delays were rising again in some ANSPs.

d. … driving diverging mitigating measures with ATCOs

Different impacts on staff and work. Figure 3 shows the impacts of the changing demands on staffing levels, staff composition, work content and work complexity for 2010-2018.

ATCO 2010-18

Staff levels	Change in staffing levels varied between -13% and +8%. Shortage of ATCO-staff was 8% on average in 2018.
Staff composition	22-33% of ATCO were women. 12-35% of ATCO were 50 years of age or older. Contractual arrangements with ATCOs have remained stable. Civil-military ATCOs relations were different between ANSPs, but remained unchanged at the ANSP-level.
Work content	ATCOs were supported by 1 to 2 support staff on average, but support is declining. The proportion of ATCOs in ACCs vs ATCOs in TWR/APPs remained stable. Change in productivity levels (number of flights/ATCO) varied between -2% to +29%.
Work complexity	Work complexity increased because of more rules and technology.

Figure 3. Summary of impacts on staff levels and work of ATCOs in the period 2010-2018

In the period 2010-18, for the most part, staffing issues, work content, and work complexity developed differently between ANSPs. **Staff composition of ATCOs has remained relatively stable over time.** The percentage of women remained between 22 to 37% in the ANSPs, and the number of ATCOs being 50 years or older kept on growing over time in all ANSPs. The contractual situation of ATCOs, the models of civil-military collaboration and even the distribution of ATCOs, split up in two function types, - ACC versus TWR/APP -, have not changed dramatically in the ANSPs, with the differences between ANSPs remaining relatively stable. Only in one ANSP, outsourcing of ATCO-staff increased as a consequence of the liberalisation of services in their country.

Shortage of ATCO-staff and complexity of work show comparable developments in all ANSPs. The number of supporting personnel (ATSEP, AIS, FIS, Flight Data) per ATCO declined over time.

The **staffing levels for ATCOs showed diverging developments**, with some ANSPs showing a substantial decline in the number of ATCOs and others up to 8% growth. Productivity performances (number of ATM-services per ATCO) diverged strongly over time.

Overall, the changing demands have led **to intense pressure on the remaining ATCO-staff** in the ANSPs. Next to increasing complexity of the work, mainly caused by new procedures and new tasks, ATCO-staff needed to deal with more ATM-services and traffic growth. In this period, work intensification was a given. New technology was introduced

primarily to reduce work complexity, but this did not sufficiently counterbalance the increasing demands. ANSPs were confronted with a growing shortage in staff and little perspective that these high job demands would be alleviated on the short or medium term. ANSPs did not find extra capacity in ATCOs (for example direct entries). The increasing percentage of ATCOs of 50 years and older implied that only focusing on replacing these cohorts would probably not be sufficient to alleviate these job demands. Eventually, in the coming years, more ATCOs would be needed than the numbers of retiring ATCOs.

Strong divergence in mitigating measures. What were the primary measures the ANSPs developed and deployed in this period to mitigate these changing demands? Figure 4 summarises the main mitigating measures using the interpretation framework of this study. The font size of letters in the figure in the middle shows the most important measures. These were working time and rosters, social dialogue, pensioning situation and retirement rules, and training. The text boxes explain for each mitigating measure what was converging between the ANSPs, which measures were continuing to be different between ANSPs and which new divergences have arisen.

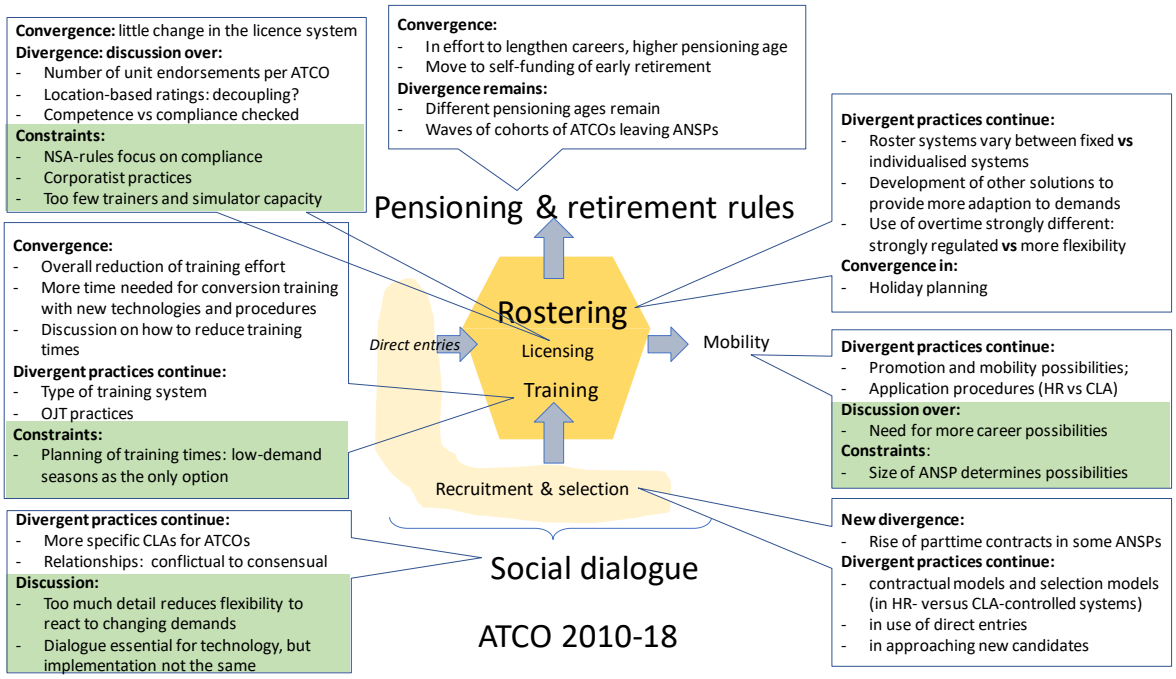

Figure 4. Overview of mitigating measures to support ATCOs in period 2010-18: convergence and divergence between ANSPs, constraints and discussions within ANSPs

Depending on the mitigation measure, constraints could be identified that did not allow the ANSPs to be as flexible as they may have wished to be. In some ANSPs, the local regulator's focus (NSA: National Supervisory Authorities) on compliance rather than on competence worked as a constraint. In other ANSPs, investment possibilities were too limited. Corporatist practices and too little available training capacity (in time, in personnel, in systems), were also listed as constraints. For some measures, the ANSPs identified issues that merited more discussion within the ANSP. For example, too detailed Collective Labour Agreements (CLAs) might have limited the possibilities of ANSPs to react more flexibly to the changing demands. These constraints are strongly different between the ANSPs.

Several of these mitigating measures are discussed in more detail:

- The main area of experimentation in the past decade to deal with changing demands has been *working times and rosters*. ANSPs have tried a whole set of working time measures (**overtime, new shifts, individualised approaches**) to allow the capacity of ATCOs fluctuating more in line with demands (e.g. Summer traffic versus Winter traffic). Requirements in CLAs and health regulations were seen as severe limits to the flexibility that ANSPs would like to have. For example, in most ANSPs, ATCOs needed to compensate for any overtime they may have been asked to do in a limited time frame.
- *Social dialogue* was seen **as essential** for a successful introduction of new technologies and organisational change. In all ANSPs, agreements with representatives have been important for allowing staff levels to follow demand. In some of the ANSPs, the relationships between staffing group representatives and management have remained **quite conflictual** over the whole period. For example, this has impeded flexible responses to the requests made by ATCOs for more support and more flexible working times. No progress was possible to change such rules in the interest of ATCOs.
- The next primary measure that has been deployed to mitigate the demands on ATCOs has been changing the *pensioning age of ATCOs*. The actual pensioning age of ATCOs in the ANSPs in this study varies between 56 and 65 years. The objective was to make ATCOs work longer, or at least to let ATCOs choose other career paths once they have reached the age of fifty. This solution created extra capacity for the ANSPs. The hesitation of ANSPs was to what **maximum age** the ATCOs could perform the required tasks. Much thought has gone into thinking of alternative careers for ATCOs, but none of those ideas got implemented.
- *Training* has always been an essential measure for ANSPs to deal with changing demands. However, most ANSPs had significantly **cut back their training effort** in 2010-18, some even entirely abolishing the training department. The increasing seasonal demands reduced the options for refresher and continuation training. With increasing demands from new procedures and new technologies, ANSPs could not train ATCOs extra for being able to deal with these changes optimally. More practical issues also limited this measure's impact, such as **insufficient trainers and reduced simulator capacity**. Collective Labour Agreements did not always allow much flexibility in training methods or flexible allocation of ATCOs.

The remaining measures have only been used in some of the ANSPs:

- *Licensing and inter-ANSP-mobility* did not provide ANSPs with many possibilities to deal with staffing challenges for ATCOs. The comparison showed that ANSPs explored new venues to alleviate work (for example, less location-dependency (sector) in the licence). Still, ANSPs thought they were **restricted by their local regulator** (NSA) to apply licence rules as they understood these. For example, when monitoring the competencies of ATCOs, NSAs were seen to stress compliance with the rules rather than actual competence of ATCOs. ATCOs needed to keep proving their number of working hours at the control position.
- *Recruitment and selection* have been of limited value in the past decade to alleviate the problems of ATCOs. Most ANSPs had **limited possibilities** to increase the number of candidates in the recruitment and selection process. The introduction of **parttime contracts** has forced ANSPs to recruit more personnel. The recruitment and selection **methods** have changed only marginally, not much improving the low success rates at the recruiting phase and the pass rates in the training phase. There are generally not many initiatives to recruit more **direct entries** or other talents outside the operations rooms. The number of direct entries has remained limited to a handful for all ANSPs in the observed period.

- *Mobility* of ATCOs within an ANSP has also not been the core mitigating measure for ANSPs. In some of the ANSPs, mobility had unintended impacts. If an ATCO-position became free in a location, this could lead to up to four ATCOs moving their position and requiring long training efforts to learn to manage new airspaces. The explanation is that if a position becomes vacant in a central location, then this position must be filled with a candidate from a peripheral location. This replacement creates another vacancy, and this needs to be completed in the same way, eventually leading to up to four ATCOs that need training. **Smaller ANSPs** did not have the option to offer mobility or promotion as a motivational instrument for ATCOs.

Core focus of the ATCOs. In the past decade, the overall picture is that ANSPs have mainly focused on alleviating the high strain put on ATCOs, primarily by looking at working time and rostering, changed pensioning ages, and social dialogue to guide the changes. The ANSPs have all developed their own set of mitigating measures, that over time have **not converged**. Also, the already existing differences in measures have remained as they were at the beginning of 2010. With common external demands, the ANSPs have looked at different mitigating measures. The explanations offered for these diverging approaches were the (perceived) **inflexible agreements** (CLAs) between management and ATCO-representatives, the few **financial possibilities** to invest in new ATM-systems or supporting technologies for ATCOs, but also the **overestimation of the possibilities of new technologies** would offer to help ATCOs. The main differences in organisational practices (integrated models versus specialised ATCO-models) have persisted over time. The austerity measures from national governments did not allow to develop alternative approaches to manage personnel demands.

e. … and leading to more different tactics for ATSEPs

Different models, same impacts on staff and work. Figure 5 summarises the impacts of the changing demands on staffing levels, staff composition, work content and work complexity of ATSEPs for 2010-2018. It is important to note that the ATSEP definition covers two groups in the ANSPs: **technical personnel** responsible for the operational performance and **engineers** responsible for planning, innovation and development. Engineers are not always ATSEPs. ATSEP is used for both groups unless otherwise indicated.

ATSEP 2010-18

Staff levels	Staffing levels show decrease in engineers of -20% to -15% and change in levels of operational maintenance between -2% to +29%. Staff levels varied from small shortages to continued surpluses in ATSEPs.
Staff composition	22-35% of ATSEP were women. 24-40% of ATSEP were 50 years of age or older. Contractual and outsourcing arrangements with ATSEP have remained stable. Outsourcing practices are quite different between ANSPs.
Work content	Operational maintenance has become more important; the share of engineers has been declining. Operational models are different, with two alternatives as dominant: integration vs specialisation. Change in productivity levels (number of flights/ATSEP) varied between -7% to +35%.
Work complexity	Complexity has increased because of increase in digitalisation, cyber security, AI. Complexity has increased because of maintaining legacy systems. Complexity has decreased because of the availability of more support technology, standardising of components, uniform equipment, service level agreements, specialisation.

Figure 5. Summary of impacts on staff levels and work of ATSEPS in the period 2010-2018

In the period 2010-18, the **impacts** on staffing and work of ATSEP in general in the five ANSPs were **quite comparable**, even if the general practices at the start of 2010 between the ANSPs were quite different. Either ANSPs operated within the civil service of a country, and then there existed limits on outsourcing and deployment of workers. Or they were independent operators, and then management had more options in using different contracts or methods to optimise the organisation of work. All ANSPs saw a **decline in the number of ATSEPs**, and for that matter also in other ATM-support tasks such as FIS, Flight Data and AIS. Given the technological shifts that the ANSPs have experienced during this period, an expectation was that ANSPs would see a rise in engineering tasks. The figures, however, showed a continuing **shift towards more operational maintenance** in the ANSPs. At the end of the past decade, ANSPs only experienced small shortages in ATSEPs and engineers, and even needed to reduce the numbers even further.

The ATSEP group's staff composition has remained **relatively stable** over time with still a minority of women in these technical functions. A large part of the ATSEPs is well over 50 years of age, making it clear that the ANSPs will experience a significant outflow of personnel and experience in the second part of the 2020s. If the Collective Labour Agreements allowed, then the ANSPs used different outsourcing practices, but the amount of information collected about these practices remained quite limited during the study.

The **work content** of ATSEP and engineers has been shifting. More and more, the technical personnel needed to **understand the digital technologies** driving the systems. This shift in work content did not lead to a change in the ATSEP competencies' composition, mainly because the remaining legacy systems required the older competencies to keep the systems operational. The ANSPs expected that the need for operational maintenance would reduce over time. In the figures, this development was not visible. Instead, figures for operational maintenance remained relatively stable, but there was an apparent decline in demand for engineers. ANSPs operated **different models of ATSEP-specialisms**. In one model, ATSEPs were expected to master all engineering

and maintenance domains covering the ATM industry. In other words, ATSEP started specialising from the start of their careers, with little allowances to master several technical systems. Within the ANSPs, these **organisational models have persisted over time**, with no visible changes. Job demands have not diminished over the past decade with the ATSEPs needing to have a daily presence in the ANSP to keep the legacy and new systems operational. Even if in the ANSPs, there was a discussion to move from an 'in-safe mode' approach to ATSEPs that were 'on-call'; in practice, the ATSEPs needed to continue working in shift systems to guarantee interventions to maintain continuity. The different positions in the TECH-room also required to be covered by more than one person, creating **necessary redundancy**. With the increasing number of flights and services, the productivity levels of ATSEP have risen considerably; even if the daily operations did not seem to have changed much. The regulation change introduced in the **EASA 2017/373** regulation, mainly reduced ATSEP tasks. Not all ANSPs have changed their internal regulations to accommodate these changes.

Work complexity of ATSEPs has shown conflicting trends with no clear direction of the changes. On the one side, the **complexity of the ATSEP-task has increased**, due to the introduction of more and more digital technologies, cybersecurity requirements and Artificial Intelligence (AI). These technologies are still in the introduction phase but require the technical personnel to master new expertise. Not all technicians were able to make this shift, given that there remained a critical need to **maintain the legacy systems**. This last fact rendered the technicians and engineers' working situation **more complicated** because it remained unclear how fast these legacy systems will be phased out. On the other side, digital technologies allowed to **simplify major tasks**. Further standardisation of components, uniformisation of equipment, and the development of service level agreements between the different parts of the organisations have reduced the complexity of the ATSEPs' and engineers' work.

The overall picture was a situation of **stable practices**, mainly explained by the need to further rationalise operations under the austerity policies and maintain operation under the changing demands on the ANSPs. As with the ATCOs, there was little time to change the approaches in the ANSPs, which explains why different practices have not converged.

More alignment in mitigating measures. In contrast to the ATCOs, the ANSPs have been more aligned in the measures they have used to mitigate the changing demands of ATSEPs. Figure 6 shows that the ANSPs have used working time and rosters, training, and pensioning situation and retirement rules to adapt. The text boxes explain for each mitigating measure what was converging between the ANSPs, which measures were continuing to be different between ANSPs and which new divergences have arisen.

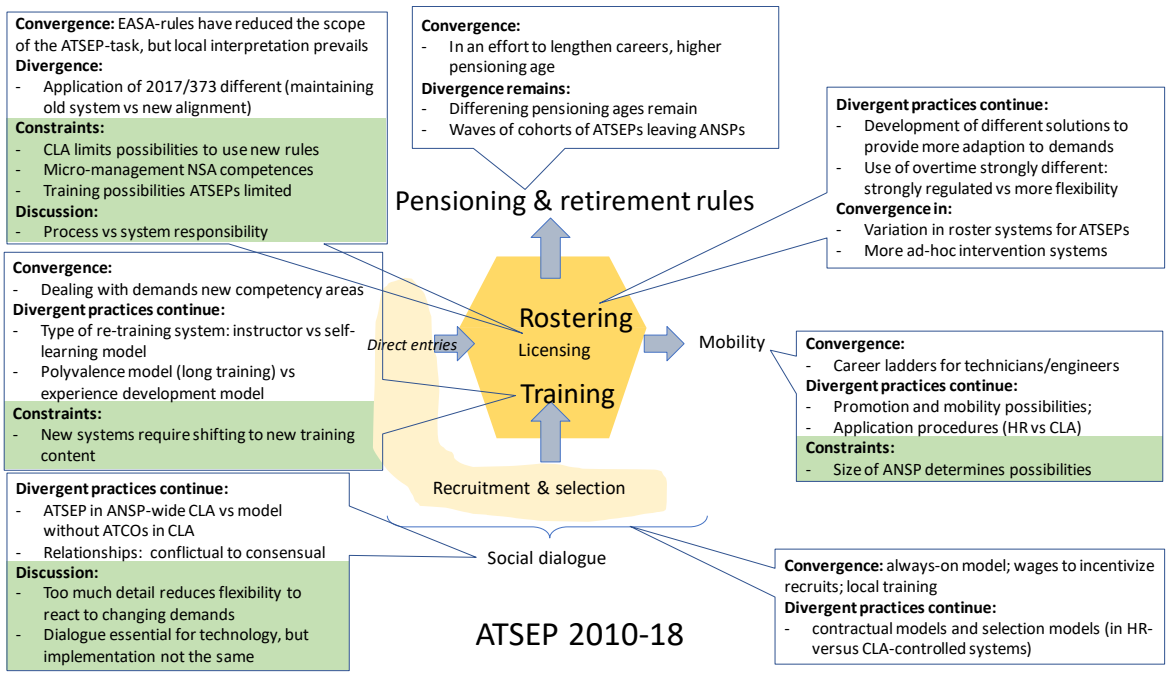

Figure 6. Overview of mitigating measures to support ATSEPs in period 2010-18: convergence and divergence between ANSPs, constraints and discussions within ANSPs

Many **constraints** that ANSPs experienced when managing the ATCOs issues could also be identified for the ATSEPs. The **licence model** is very different between ATCOs and ATSEPs. ATSEPs are being treated as 'regular' staff. Much in the differences in applying the licence rules between ANSPs relied on how the ANSP and the local regulator (NSA) cooperated. In some ANSPs, the stress on compliance and micro-management of the NSA limited the possibilities of the ANSPs to adapt to the ATSEPs'-work. As with the ATCOs, **other constraints** have been valid for the ATSEPs: too limited investment possibilities, corporatist practices in ANSPs and limited capacity available for training (in time, in personnel, in systems).

Several of these mitigating measures are discussed in more detail:

- As with the ATCOs, the central area of experimentation in the past decade to deal with changing demands has been *working times and rosters*. In comparison to ATCOs, the ATSEPs already had more possibilities to swap shifts and arrange their holidays as they needed, as long as they abided by the required resting times. New technologies changed the need from working with a scheduled maintenance framework for hardware to more **ad hoc intervention** due to the new technologies combined with the ageing legacy technologies. The primary measure of ANSPs to deal with these changing demands was to use on-call systems and overtime. CLAs regulated how these exceptions were allowed to be used. New technologies increased the need for **continuous ATSEP support** to deal with ad-hoc system problems, rather than scheduled hardware maintenance as in the past.
- *Social dialogue* was recognised as an essential means to channel the necessary changes. All depended on the relationships between management and the staff representatives. As with ATCOs, not in all ANSPs have the relationships been consensual over this period. The focus in many discussions has mainly been on working time and rosters.

- The ATSEPs have also been confronted with **increasing pensioning age** and retirement rules changes, mainly due to national discussions about ageing populations, pensioning costs and austerity. Lengthening the careers of ATSEPs was a complicated matter, mostly because the elder ATSEPs did not master the new technologies. Still, at the same time, they were needed to maintain the legacy systems for which new talent was not schooled. Between the ANSPs, there were differences in *retirement ages for ATSEPs*, but these age levels fall in line with the practices in the national context.
- *Training* has been an essential measure for ANSPs to mitigate the changing demands, mainly in the competence area. As for the ATCOs, most ANSPs have significantly **cut back their training effort**. The ATSEPs were not that constrained in their training effort by the air traffic demand as ATCOs were, but they were limited by the training constraints that existed because of the need of ANSPs to prioritise the ATCO-training. For the ATSEPs, the effort was to update the new digital technologies' competenc**ies**, next to the fact that they needed to stay current on all the existing and new machines. Depending on how the ANSP functioned, training was either only provided at the **start of the ATSEP-career**, or otherwise a model in which competencies could be developed **over time**. To deal with the shortage in training capacity and new technologies' requirements, some ANSPs invested in shifting the (re)training effort to a **self-learning model** with support of digital tools.

The remaining measures have only been used in some of the ANSPs:

- *Licensing and inter-ANSP-mobility* saw a substantial change with the introduction of the EASA 2017/373 regulation. Within the regulations, the ANSPs have developed together with their NSA their **application of ATSEP-rules**. Examples are: the number of SMC-ATSEP in the central technical office (TECH-room); how on-call was regulated; purchasing rules (*as public services, the obligation was always to have public tenders which lead to a more diversified technical base than strived for*); but also the obligation from the NSA to manage the ATSEP-competence at the level of each specific machine. ANSPs differed in promoting **polyvalence models** (ATSEP and engineers need to master all domains) or more **specialised models** (limiting the area of responsibility of an ATSEP). The ANSPs indicated that they saw no room in the licence system to deal with their staff's changing demands.
- *Recruitment and selection* have not been the centre of attention in the past decade, mainly because the policy of the ANSPs has been to reduce the number of ATSEPs and engineers. ANSPs have been able to use **temporary contracts** for recruits, sometimes at the detriment of the ANSP. Promising talent could not be engaged because of the recruiting constraints the ANSPs had. The recruitment and selection **methods** have changed only marginally, even if the ANSPs found themselves more and more competing with major engineering sectors in their labour markets. For example, the highly regulated environment discouraged young IT professionals from applying for positions. The ANSPs did indicate that for attracting specialists, they did need to offer **higher wages**. This option was only possible in those ANSPs working outside the civil service model.
- *Mobility measures* (internal promotion) were not a measure that ANSPs used to mitigate changing demands. The size of the ANSP determined if such possibilities were available at all. In larger ANSPs, application for a job and competency of the ATSEP remained the core criteria to make promotion. With the reduction in the number of ATSEP-positions, mobility of ATSEP has been limited.

Core focus of the ATSEPs. For the ATSEPs, the **overall picture is different from that of the ATCOs**. ANSPs have mainly focused on reducing the number of ATSEPs and engineers to make processes more efficient. They all struggled to juggle the technological shift to more digital technologies and at the same time, maintain legacy systems. Keeping up the competencies remained a critical challenge with the ANSPs working to develop new training methods. The ANSPs followed different paths to mitigate the changing demands, but the differences are less pronounced than ATCOs. The **explanations offered** to select the mitigating measures were much in line between ANSPs, from dealing with the austerity context that limited the number of investment possibilities to follow the CLAs and NSA's guidance rules. Another main difference in the development of measures was the model used for organising work. On the one end, the polyvalence model was used (requiring long training times, and continuous investment into keeping competency current). At the other end, the specialisation model allowed competency in each of the competence areas (Communication, Navigation, Surveillance, Data processing, SMC) to be developed over time.

4. Scenario-workshops: understanding possible ATM-futures (Task C)

a. Introduction

This Chapter reflects on the outcomes of the workshops with ATCOs, ATSEPs and other personnel of ANSPs. Appendix 3 includes more detail on the outcomes themselves. The participants in the workshops assessed what impact the three future scenarios would have on work and staffing levels, and discussed with each other how to mitigate these impacts. The three scenarios for the coming 15 years as developed in the project were:

- Scenario A depicts a high-tech, **fast-growth scenario**, calling for sustained developments in technology and accelerated EU harmonisation concerning ATM policy, rules and regulations.
- Scenario B (**medium growth**) depicts a situation where the sector still experiences traffic growth but slower than in previous decades. Traffic volumes and complexity will be moderate, in particular, because of changing societal contexts and demand, and consequently new EU/worldwide environmental regulations (e.g. EU Green Deal). In this scenario, it is also assumed that aviation stakeholders continue to progress with further EU harmonisation because of unlocking the Single European Sky ambitions' potential in response to sustained worldwide competition.
- Scenario C is a **slow-growth scenario**. The combined result of a longer-lasting impact of the Covid-19 pandemic, economic stagnation in Europe and more substantial EU/Worldwide environmental constraints on civil aviation. Technological investments stay behind, and national strategies for cost optimisation dominate.

Figure 7 shows these three scenarios with three ovals on the two axes representing the driving forces for the scenarios, traffic complexity and EU-harmonisation. The scenario choices and narratives were selected based on an expert judgement and collected evidence during our case studies (Task B).

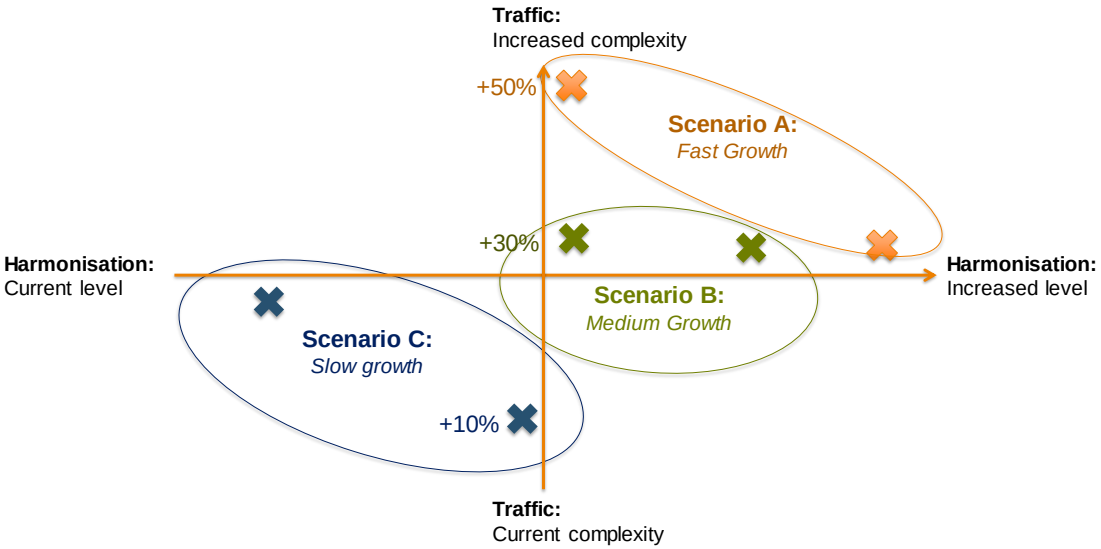

Figure 7. Three possible scenarios (+10 – 30 – 50% = 10 – 30 – 50% rise in traffic complexity compared to Q4 2019).

In the previous Chapter, we looked into the convergence and divergence in practices of ANSPs over the past decade. We integrated information from management, employee representatives, ATCOs and ATSEPs. The workshops' participants, also from these ANSPs-groups, could take notice of the case study comparison and reflected on what

their ANSPs would need, given the increasing future demands on their professions as described in the three scenarios. They could initially reflect on it in a survey to be maximally prepared for further discussion in the subsequent workshops. ATCOs needed to answer what they thought the possible future impacts on ATCOs would be and how these impacts should be mitigated. Their answers will be compared to the outcomes of Chapter 3. The same analysis will be repeated for the ATSEPs.

Chapter 4 is structured similarly as Chapter 3, with first reporting on how workshop participants understood the three scenarios' changes in work. Next, we describe the mitigating measures the participants considered crucial to deal with these three scenarios' challenges. At the end of the Chapter, we summarise the main lessons from the workshops. Before presenting all results, we describe the workshop methodology.

b. Methodology of the Workshops

The workshops in this Task C first aimed to gain insight into the future changes for work, work complexity, staffing levels and staff composition in the ATM-industry, and subsequently to understand how future changes could be 'managed' or possible impacts 'mitigated'. The participants of the five ANSPs from Task B were invited to a series of **three sets of workshops** (1. kick-off; 2. scenario workshops for respectively ATCOs, ATSEPs, and OTHERs; 3. final workshop). A stepwise approach was used to inform and discuss with participants, starting with Task B's results and with information about three future scenarios. A **six-step approach** was designed to help the participants first develop their ideas (divergence phase) via a survey, and second to let them discuss the results among peers in workshops and come to a consensus. If an agreement was not possible, we collected arguments on a possible disagreement between participants. Figure 8 shows this divergence-convergence approach using several feedback-moments to help the participants clarify any divergence that would exist.

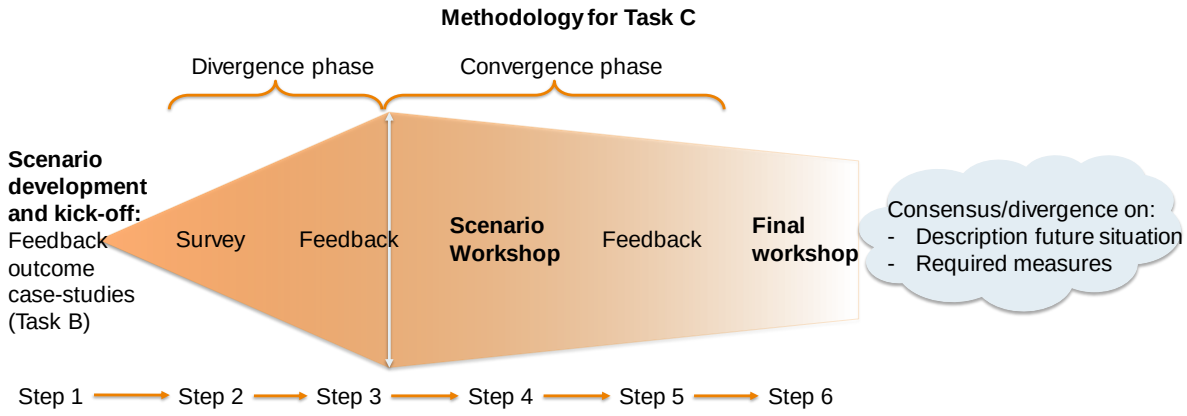

Figure 8. The stepwise approach used by TNO/NLR

In total, 42 ATCOs, ATSEP and other ATM-personnel participated in some way in the workshops or survey.

c. The future of ATCO work: more of the same?

i. Changes in future ATCO-work content and staffing levels

ATCOs took notice of the future scenarios but did **not expect a revolutionary change** in their work. **Scenario C (low growth)** was seen as much in line with the current state of affairs in the ATM-industry and should therefore deliver comparable work to before the Covid-19 pandemic. The ATCOs expected that staffing problems in this scenario would continue if the large cohorts of retiring ATCOs, were not sufficiently replaced.

In **scenarios A (high growth) and B (medium growth**), **work content will change and become more complex**. ATCOs considered the current staffing levels as a minimum to manage the airspace, regardless of the future scenario. Any increased growth in air traffic would require more ATCO-staff. If staff levels did not change, ATCOs expected a further **intensification** of their work due to insufficient numbers of staff and significant changes in their work. New technologies would change their work. Staff shortages will remain a constant factor in these two scenarios because the existing staff imbalances would not disappear.

The higher degree of automation in scenario A will probably require that ATCOs develop substantial, **different competencies**. The question was if the technology that was foreseen for the future would be available to support ATCOs. From their experience with technology, they did **not expect dramatic changes** in technology support. Their opinion was that if any future technology needed to be introduced, this would need to be a technology that **enhances their capabilities**. Technology should not be there to eliminate the ATCO position.

The ATCOs expected that the **average age of the ATCOs would reduce** over time, the only visible change in staff composition. Younger ATCOs will replace ageing cohorts of ATCOs. For the **current disbalance between man-women**, the workshop participants did not expect any changes. The profession would remain male-dominated. Gender biases in the recruiting process would persist, and the limited financial possibilities of the ANSPs would restrict investments in changing recruitment practices. The ANSPs seem to need more encouragement and incentives via EU or national policies to become more diverse.

If the future situation of ATCOs is **compared to 2010-18**, the **intensification of work** will continue. ATCOs had seen that productivity improvements in the past decade were achieved by pushing ATCOs to do more. They saw scenarios A and B mostly as a continuation of this period. Technology would be helpful in the future, but not sufficiently beneficial to reduce their job demands. The complexity of work would increase compared to the past. In Chapter 3, changes were related to the organisational model that ANSPs used for ATCOs. Even with different organisational models, ATCOs did not expect that there would be much difference between those that were working in more integrated job profiles and those that worked in more specialised job profiles.

In the discussion, the ATCOs suggested how to increase the **opportunities that future technologies would offer**. ATCOs needed to be informed and trained to use these opportunities. Training required to be attuned to the capabilities of the different age groups.

ii. Mitigating changes in future ATCO-work content and staffing levels

The ATCOs prioritised *training, social dialogue,* and *working time and rostering* as the main mitigating measures to deal with job intensification, increasing work complexity and staffing changes. Compared to the past, there is less stress on changing *recruitment and*

selection, *pensioning and retirement rules*, or *licensing and intra-ANSP mobility*. *Internal mobility* of ATCOs was not seen as a solution to evolving demands and would not be mitigating in the future. The **focus on training is a significant change with the past**.

The following two figures summarise the results from the workshop with the ATCOs. The letters' size in the figures shows the importance attached by the participants to the mitigating measure.

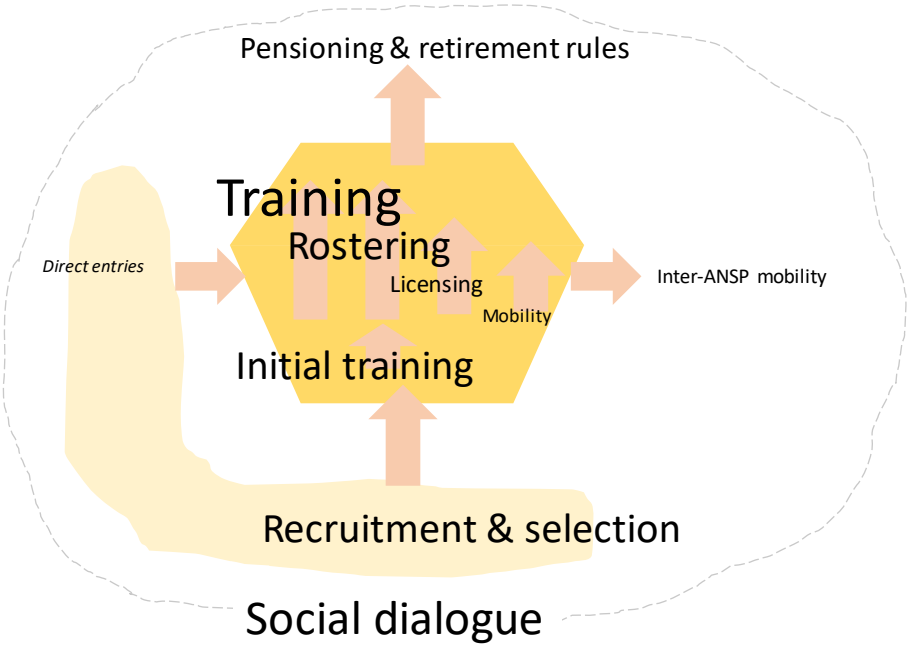

Figure 9. Importance of the mitigation measures as discussed by the ATCOs (the bigger the size of the letters, the greater the importance of the mitigating measure)

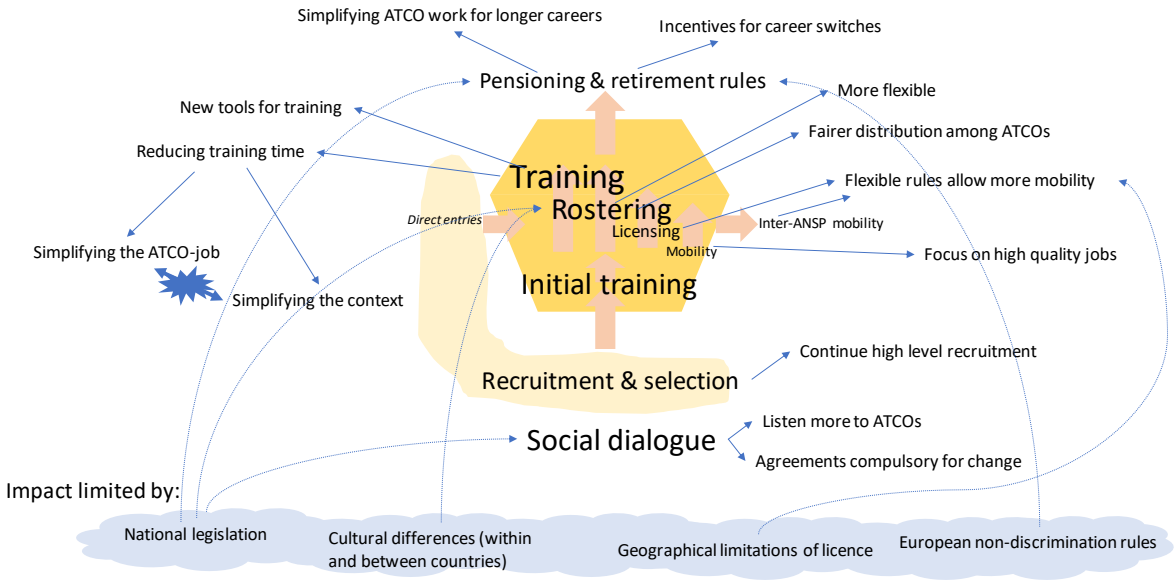

Figure 10. Connecting the mitigation measures discussed by the ATCOs: what should change and what limits the impact of these mitigation measures?

The ATCOs clarified which measures would help to mitigate the demands the future scenarios would bring:

- *Training:* the ATCOs will be helped by **new supporting tools** (4D-trajectory planning, planning and prediction tools, alerting systems, new tools for separation management, departure and surface management concepts, sequencing of aircraft, tools to improve training efficiency etc.) that will be available in the future. New tools help to make work less complicated, and this may have a positive influence on training outcomes. **New training technology** could help future training, particularly by allowing to make greater use of simulators to save OJT time (e.g. more systematic training of more complex situations, automated measures). The effort should continue to **reduce the length of training time**, both in initial training and during an ATCO's career. It is still unclear what the impact would be of job simplification versus keeping jobs complex. This different direction (simplification vs complex jobs) would be a subject for further discussion.
- *Working time and rosters:* the effort should be focused on making ATCOs' **working hours and rosters more flexible** and distributing the demands of irregular working times in a **fairer way** among ATCOs. There would also be a need to change such working time rules in CLAs in a more flexible and **agile** way. These changes should mainly be discussed at the national level, not at the EU level. One such discussion should be on the **maximum number of working hours** for an ATCO. The exchange of experience across ANSPs in Europe between ANSPs would remain essential to achieving these changes.
- *Social dialogue*: any future change will only be possible if current practices of social dialogue change. Employers should **listen better to ATCOs** and should be prepared to make **binding agreements** also at the EU-level. The discussion must focus on these changing practices within national contexts. Another topic discussed between participants was to clarify what the EU-level debate brings to the national levels. It should be **more precise** what topics are at the EU-level and what at the national level.

The other measures would not be that helpful for the changes foreseen in the three scenarios:

- *Recruitment and selection*: ANSPs will mainly be confronted with a changing context that will require new recruitment and selection measures. Increasing environmental demands will change the need for air traffic; the Covid-19 pandemic reduces the current demand for services. The discussion should focus on how to deal with these changes and ensure that **recruiting a sufficient number** of candidates will be maintained. **Recruitment and selection rules should be more harmonised** across the EU. Harmonisation could support better support candidates making the **right career choices.**
- *Pensioning situation and retirement rules*: further changes in pensioning and retirement regulations are not likely to be embraced by the ATCOs. ATCOs stressed the **age limits for performing ATCO-work**. If longer careers were the aim, then jobs need to be simplified, for instance, by offering more straightforward tasks at the end of a career or motivate ATCOs to take other jobs. A European solution is not considered likely, but a European discussion is needed because the (EU) non-discrimination rules force the issue on ATCOs (can you force ATCOs to retire?).
- *Licensing & Inter-ANSP mobility, Mobility measures (internal promotion)*: as in the past, ATCOs keep putting the **content of work** above internal mobility systems (careers). They will remain interested in high-quality jobs, rather than in more promotion possibilities. The current **licensing** systems would be **future proof**,

even if there is some disagreement about the need for more simplification of licensing or more specialisation between ATCO jobs. EASA should have a central role in this simplification task. One element that should change is the requirement to fulfil a certain number of **OJT hours in training**. This requirement limits the possibility to use simulator training hours instead.

iii. ANSPs should benefit from an ATCO-centric perspective

The ATCOs saw their work **continued to be challenged by intense demands** on ATCO-staff. Technology may render work more complex, and more recruits can help cover higher staffing levels. These measures do not require a change in policies, but an **engagement by the ANSPs** to attract, select and train a sufficient number of new personnel. The main difference with the past is that in the future ANSPs should focus more on investing in the training and development of the ATCOs. If sufficient training would be provided to ATCOs to deal with the technologies and work complexity, ANSPs could build policies relying on the functional flexibility of the ATCOs. The ATCOs saw themselves as the primary resource for ANSPs, and they merit **more training investment**. For this investment, ATCOs are prepared to negotiate a more flexible working time and roster solutions.

d. The future of ATSEP work is dealing with complex technology

i. Changes in future ATSEP-work content and staffing levels

The overall assessment of the scenarios by the ATSEPs revealed several **contrasting insights** with the ATCOs.

ANSPs will still need the ATSEP in all three scenarios. The licence system regulates ATSEP competence, and ANSPs will require persons to perform this task. It might be that these tasks are conducted by outsourced specialists or by ANSP-personnel. **Outsourcing was not seen as a threat to the ATSEP**: outsourcing is already a common practice. ANSPs already have to deal with shifting tasks between themselves and suppliers. The future might change the place where ATSEPs work, but, according to the workshop participants, the ATSEPs did not have a problem whether they should perform the task for an ANSP or a supplier. The only objection ATSEPs had was that ANSP might be buying in services from companies that did not **abide by the 2017-373 regulation**. ATSEP were concerned by this possible development, not only for their own jobs but also because ANSPs might lose grip on the staff's knowledge and experience levels who work on the ANSP-systems. Future research should focus on this.

The increased traffic complexity in scenarios A and B will impact **complexity in work**. **A lot will depend on the availability of new technology and the amount of maintenance that legacy systems require.** If this need should remain high, legacy expertise will be required. However, most staff planning in ANSP is based on phasing out technology and expertise, and experience has shown that ATSEP needs to manage varied knowledge situations. The reality of ATM safety requirements (and stringent procurement systems) means that ANSPs have to live and work side by side with different generations of technical systems. **Personnel planning and deployment** must be geared to the presence of different generations of knowledge.

ATSEP expected the future still to be a combined technology situation. The ANSPs will need to secure the right expertise in the future. They will need to decide whether they should strengthen relationships with **external (engineering) suppliers** or **start recruiting**

new generations of engineers and technicians to support the planned significant technological changes.

Connected to this development is the probable **shift from maintenance tasks to engineering**. If new digital technology prevails, then fewer maintenance technicians are needed. Digital technology is much more reliable than current (analogue) technologies and requires less technical support. Tasks will shift to engineering, both ATSEP and non-ATSEP engineering. These changes need to be monitored and discussed because of their impact on three topics: the general division of labour in the ATSEPs, the difference in skills, and training. In comparison to the 2010-18 period, this shift from maintenance to engineering would be a significant change. In the past decade, operational maintenance had become more critical in comparison to engineering.

Another impact on the complexity of works was that ATSEP expected that new technology would centralise **many ATSEP tasks and** roles. The ADSP revolution would allow concentrating all monitoring tasks to one TECH-room. Centralisation means fewer technical rooms and probably fewer ATSEPs. What is unclear is what this would mean for the content of the future ATSEP-work.

ATSEPs expected that the growth scenarios would **not lead to staff shortages**. The past decade has seen a gradual reduction of engineering and stable staff numbers for operational maintenance. What happened in the ANSPs is not completely clear; the primary indication was that many engineering tasks were outsourced to engineering companies or other suppliers. The discussion among ATSEPs seemed to indicate that future technology will be so good that **operational maintenance will become less critical**. At the same time, this future technology will become so complicated that **more engineering expertise** would be needed. These expectations should be checked.

As with ATCOs, the most crucial future change in staff composition will be technicians and engineers' gradual ageing. The ageing cohorts will leave the ANSPs in the next 5 to 10 years. The ATSEP role will remain **dominated by men**. Again, as with the ATCOs, only overall societal changes could force ANSPs to change their recruiting policies drastically.

There was less consensus between workshop participants **on organisational issues**. The future might require different organisational models for the use of technical/engineering knowledge, and the differences between these models need to be better understood. As EUROCONTROL (PRC, 2017) has already indicated, there is a need to know why these different approaches exist and which other models would help the ANSPs. **ATSEP did not agree** on which model would prevail: the integrated model of expertise (the all-around ATSEP) or the model of specialised ATSEP (covering parts of the ATSEP-requirements).

ii. How do we interpret the ATSEPs' future vision?

The main impacts on ATSEPs in the future will be on the **expertise side** and shifts in **staff composition**. ATSEPs insisted on developing new measures for *Training, Social dialogue* and *Recruitment & Selection* to mitigate these impacts. The other measures are merely necessary mitigating measures in specific future scenarios. ATSEPs insisted that they, as an occupational group, should be further 'developed' as a primary resource for the ANSPs. However, ATSEPs have a different perspective in this investment in comparison to the ATCOs: here, the ATSEPs expect that in the future they will need new skill sets, which require other training and trainers. The current trainers are specialised in the knowledge of the past. *Social dialogue* is seen as an essential means to achieve the changes as it is with the ATCOs. *Recruitment and selection* are focused on dealing with the current shortages in personnel, and this would require creating a pool of ATSEPs.

The next two figures summarise the results from the ATSEP-workshop.

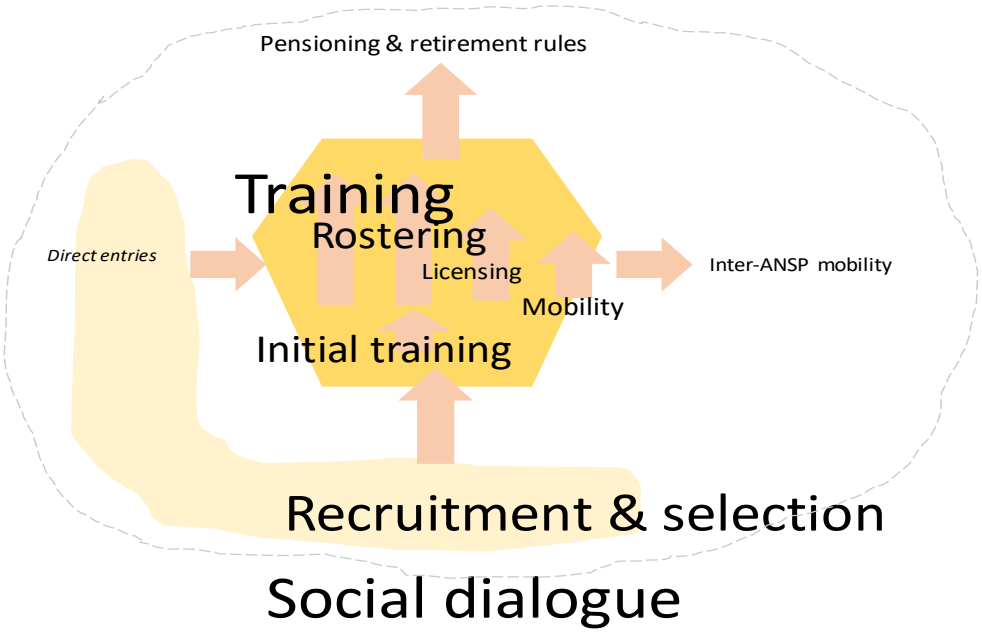

Figure 11. Importance of the mitigation measures as discussed by the ATSEPs (the bigger the size of the letters, the greater the importance of the mitigating measure)

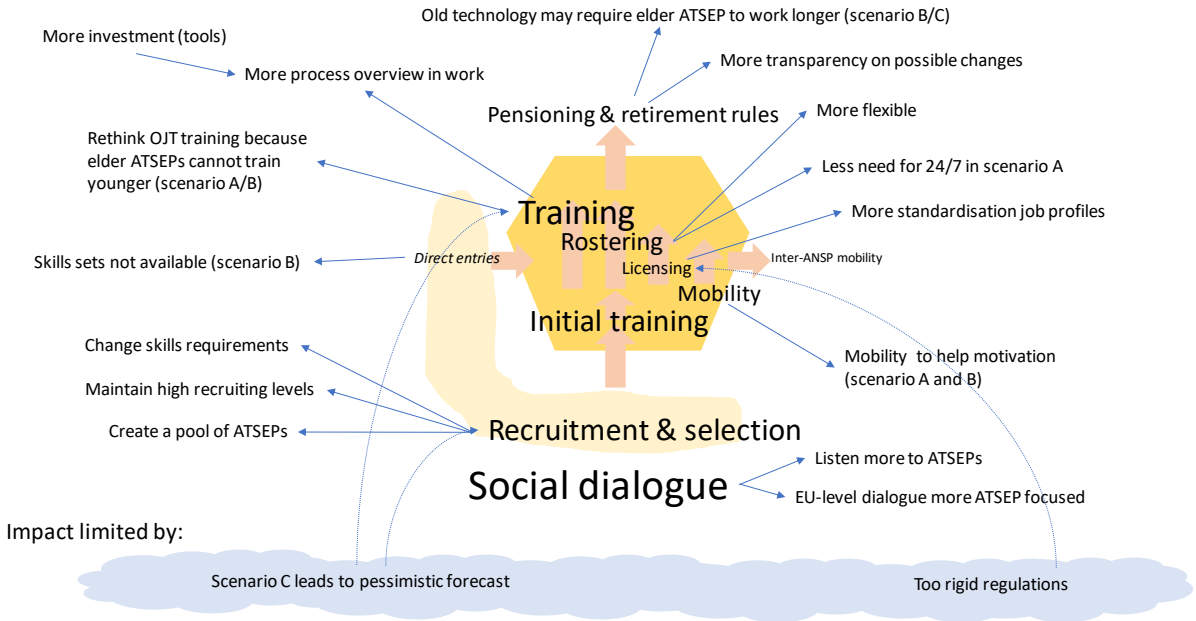

Figure 12. Connecting the mitigation measures discussed by the ATSEPs: what should change and what limits the impact of these mitigation measures?

The following narrative supports the figure:

- *Training:* ATSEPs expected to learn new skills, mainly consisting **more of a process overview** in their work. ATSEPs need to have a general overview of what is happening in systems' interaction, rather than only mastering a part of the machines. Achieving this process overview requires **more investment** in training and different types of training (e.g., AR/VR, remote training) in the future. The shift

in skills needed also requires new trainers. Current ATSEP-trainers will not be able to provide **On-the-Job training** mainly because the required skillsets are new for them too. The medium growth scenario will be most challenging for ANSPs because they will need to maintain and train new and old skillsets. These skillsets will not easily found among the current staff.

- *Social dialogue* will remain quite crucial in the future. There might also be a need for social dialogue **at the EU level**, but this should be more focused on relevant measures that are important to the ATSEPs.
- *Working time and rosters:* as with the ATCOs, working hours and rosters should become **more flexible**. Working time should be used to let the capacity of services follow demand. The discussion itself about adapting these rules should **become more agile**. ATSEP expected that technology would be so good that the shift work might disappear for standard working weeks in the high growth scenario. The need for on-duty service would remain essentially the same in the other two scenarios.
- *Mobility measures (internal promotion):* the current ATSEP-licence dictates what the ATSEP function may do. The fact that persons are connected to specific machines works as a **barrier to** mobility between tasks and jobs. Several changes will be needed to take these barriers away. More **harmonisation of systems** could allow changing positions and locations. **Standardisation** in job profiles will be required for mobility. **Career mobility** will help ATSEPs continue their career in the ANSP and not seek opportunities outside the ATM-industry. However, such a change is also a double-edged sword. At the same time, the new background and digital skills ATSEP will require to have, will make them move more easily between companies or sectors. Mobility within a job can help maintain interest and **motivation** for the job.
- *Recruiting and selection:* ANSPs should create a **pool** of extra trained ATSEP, which will require ANSPs to maintain high levels of recruiting and selection. In the new scenarios, **skill profiles of ATSEP will be different (more digital skills), and this requires ANSPs to change their recruiting strategies.** High growth in the future requires other background and abilities of ATSEP. Low growth will reduce staff even more, also reducing the need for attention to this recruitment and selection.
- *Pensioning situation and retirement rules:* ATSEPs expected more changes here but find them only acceptable if the discussion about possible changes is conducted transparent**ly.** Low growth scenarios may confront ANSPs with the need to recruit or retain "**elder" technicians to maintain the systems. However, the consequence is that these technicians may be required to stay longer than the official retirement age**.
- *Licensing & Inter-ANSP mobility:* More mobility of ATSEPs between ANSPs may be possible in scenarios A and B, but full standardisation seems difficult for the maintenance at the **functional level**. For the **non-functional layers** (infrastructure, IT services), standardisation seems easier to realise depending on whether if they are considered as ATSEP related tasks.

iii. Balancing the demands of the licence and new technologies

The ATSEP saw the changing technological context as their primary future challenge. They will be ‘squeezed’ between the requirements of the ATSEP-licence and this technological change in their work. The licence requirement (mainly machine-oriented) focused the ATSEPs on a limited number of existing machines and processes. New

technologies will require entirely different expertise for which they needed a substantial time to retrain. This training time was not sufficiently available to them. Of course, recruiting new specialists could be an option for ANSPs. For the ANSPs, the issue would be how to deal with this changing environment in which new machines enter, but at the same time, older devices needed to remain operational. ANSPs will need to manage this paradoxical situation with technology and competencies if a safe condition is maintained. **In the workshops, ATSEPs stressed the need for more training and training support.** Another idea was to create pools of ATSEPs for the ANSPs to respond quickly to maintenance needs. This suggestion for an ATSEP-pool is costly. The ATSEPs were quite realistic of the changes needed in working time and rosters. They suggested discussing more flexible set-ups of these systems. One hope the ATSEPs communicated was that the working week in the ATSEP-position could become a standard week without shifts. The ATSEPs expected that the newest technologies could become extraordinarily reliable and sufficiently redundant that only an on-call system for the ATSEPs would be required.

For all these ideas, the ATSEPs insisted on having a trustworthy social dialogue. The ATSEPs indicated that such a social dialogue might also exist at the EU-level, but the current discussion's benefits were not clear. They thought ATSEPs were not well represented at that level. As with the ATCOs, the whole debate was partly clouded by the different operational models that ANSPs used to deploy ATSEPs. Some ANSPs used a strong division of tasks among ATSEP to reduce training requirements. Other ANSPs used integrated models in which ATSEPs had extensive training in all technology areas that the ATM-industry needed. Future discussions will need to consider this input.

e. Overview of measures and expected benefits

The set of scenario workshops' objective was to develop the main issues for the 'human and social dimension' in the Air Traffic Management sector. The ATCOs, ATSEPs, and OTHERs have provided a list of 36 mitigating measures for further discussion. Some of these measures show overlap and can be merged. Table 2 shows an overview of 23 measures the workshop participants proposed. For each of the measures, the table explains its content and which mitigating impact is targeted.

Table 2. Summary table of 23 measures that the ATCOs, ATSEPs and the OTHERs proposed to mitigate the changing demands in the sector (white background = relevant for ATCO and ATSEP; blue = ATCO; yellow = ATSEP)

Training
On-the-Job Training and Simulator training: ANSPs need to make better use of simulator training. To maintain a licence, an ATCO has to show sufficient on-the-job training hours. Currently, simulator training hours are not counted for this competency requirement. This topic would help ANSPs to have more flexibility in organising training for the ATCOs. EASA should be engaged in this discussion. **Mitigating impact:** OJT puts a heavy burden on the organisation and ATCO. Simulator training can alleviate this. The quality of competence development should stay at the same level.
Professionalisation of trainers and training function. Currently, ANSPs rely on experienced ATCOs to support on-the-job training or training supervision. This task merits more professionalisation. Training professionals can help ANSPs in the development of a better training function. **Mitigating impact:** Professional trainers have access to more effective training methods. This change reduces the need to use specialised ATCOs for a non-ATCO task and will reduce the number of recruits who drop-out.
EU-level training infrastructure. The training infrastructure is an essential investment for ANSPs. In the past, ANSPs have tried to save costs by scaling back this infrastructure. More support for an EU-level training infrastructure could be a solution for ANSPs. There needs to be a better understanding of the obstacles and opportunities for such an infrastructure. **Mitigating impact:** ANSPs can reduce training costs. Competence development can be standardised.
Self-learning training system. New ATSEP training systems can help ATSEPs to maintain and develop their skills. Developing new competencies or even keeping up with the technological development is crucial for ATSEPs. More research is needed to understand the benefits of alternative training methods. Self-learning seems a critical venue to develop competencies. Self-learning promises more opportunities for scaling-up training opportunities. Sharing these experiences between ANSPs is in the interest of all ANSPs. **Mitigating impact:** ANSPs can reduce training costs. ATSEPs can develop new expertise more quickly or maintain existing expertise more easily.
Recruitment and selection
Reducing drop-out and improving pass rates. Current recruiting levels for new ATCOs remain low. Candidates' chances of passing the initial selection and their pass rates during the basic training are considered too low. ANSPs are developing each their methods to reduce drop-out and improve pass rates. The gender impact of measures and methods need to be considered. There is a clear need to share such experiences. **Mitigating impact:** More supply of ATCO-talent helps ANSPs to respond more quickly to changing demands.
Sharing experience of the effectiveness of recruitment and selection strategies. There is one platform in Europe to exchange experiences with the selection of new ATCOs (FEAST). This platform could have a broader scope. Sharing experiences allows ANSPs to improve their recruiting and prevents competition on new talent. **Mitigating impact:** More supply of ATCO-talent helps ANSPs to respond more quickly to changing demands.
Offer more opportunities to talent interested in ATM-positions. The major ANSPs have more candidates applying for training positions than they need. ATCO-positions are denied to strong candidates. Referrals from other ANSPs could profit the receiving ANSPs. If ANSPs could implement such an exchange, the whole sector and the candidates themselves can benefit. Here lies an opportunity for EU initiatives. **Mitigating impact:** More supply of ATCO-talent helps ANSPs to respond more quickly to changing demands. It reduces recruiting costs for ANSPs.
Create a European market for ATSEPs. The technical and engineering expertise in the ATM-industry mainly stays confined to the national borders. ANSPs are experiencing a vital brain drain towards other technical and engineering companies. To maintain expertise in the ATM-industry, ANSPs need to invest more to create opportunities for ATSEPs in neighbouring countries. The sector should reduce limitations in the licence system to allow more direct entries. **Mitigating impact:** Expertise of ATSEPs can be better maintained.
ANSPs need to manage multi-generational ATSEP-workforce. In the past, ANSPs had ATSEPs that mainly managed one type of technology. Nowadays, ANSPs need to make sure that they have the expertise to maintain 'older technology' and new technology at the same time. For the older technology, the labour market does not offer any technical or maintenance expertise. And ANSPs need to attract at the same time new expertise to deal with the latest digital technologies. HR-systems (personnel planning and deployment) are not always geared to the presence of different generations of knowledge in one company. New policies need to be developed. **Mitigating impact:** Expertise of ATSEPs can be better maintained.
Social dialogue
Change and social dialogue. The ATM industry is in continuous evolution. To support agile adaptation, the ANSPs need to embrace social dialogue as an essential tool. The degree to which social dialogue plays this role is underestimated. **Mitigating impact:** More information on this measure helps to create more understanding of and support for the role

of social dialogue and help the agile change of the ANSPs.
Agile model of social dialogue. Current Collective Labour Agreements (CLAs) regulate relations between management and employees, based on an assessment of the past. The issue is that for each new demand, CLAs are hard to change. The sector could profit from having an approach that is more flexible in dealing with contemporary issues. Such an agile model should be developed. **Mitigating impact:** An agile social dialogue model reduces overhead to achieve changes in contracts and agreements.
Assessing the impact of the newest technologies. ATCOs and ATSEPs are affected by new technologies. Discussions on new technologies are not well organised, or at least the support for such investments could be more robust. It would be helpful for both groups to rely on a methodology to assess new technologies from their perspectives and know-how to discuss possible management changes with these technologies. **Mitigating impact:** Technological change can be accelerated, and working situations can improve accordingly.
Benefits of the specialisation and integration ATCO model. ANSPs use different models for the description of the ATCO-position. An analysis of the impact of these two models does not exist. The two models impact recruiting, training and development of talent. They also affect the operational management and future development of technologies. These challenges need to be listed. **Mitigating impact:** Choices for one or the other model have profound consequences. An informed discussion helps to make better and more supported choices.
ATSEP representation at the EU-level. ATSEPs feel that the current discussion at the EU level on ATSEP does not give sufficient attention to their issues and interests. An assessment is needed to what degree these interests are covered and what could help to improve their representation. **Mitigating impact:** Better representation allows more support and buy-in from ATSEPs for EU-level decision making.
Working time and rosters
Information on the impacts of shift systems on the flexibility of ANSPs. There is a robust understanding of how shift systems work and what they have as an impact on the health and performance of ATCOs. Less is known on the operational implications of alternative shift systems. **Mitigating impact:** More attuned choices for a shift system will also be better supported.
Comparison of fixed versus individual shift systems. There is a need for more understanding of the operational effects of both types of shift systems. Different approaches to shift systems promise other things for organisations and their individual staff members. This understanding could help ANSPs make their choices. **Mitigating impact:** More attuned choices for a shift system will also be better supported.
ATSEP and standard working weeks. The high growth scenario would allow for the use of more reliable technology. ANSPs could reduce the intervention need from ATSEPs. This change is a future possibility. Such an opportunity should be underpinned with an impact assessment with more insight into the safe operation. **Mitigating impact:** The reduction of the burden of the shift system has positive health impacts for ATSEPs. It makes the job more attractive to other engineering or technical personnel.
Internal mobility
Motivating factors in ATCO work. ATCOs are more motivated by the content of their work than by the prospect of making promotion. A broader assessment of the motivating factors in ATCOs work deserves more investigation. This outcome underpins different policies towards ATCOs. **Mitigating impact:** More attuned HR-measures and -policy will be more supported by ATCOs.
Pensioning situation and retirement rules
Balance job security and longer careers. ATCOs can offer support to ANSPs after their career in the working position. They need to adapt to other tasks by taking up such tasks earlier in their career. Job security can be a means for ANSPs to motivate ATCOs to start redeveloping their career path and working longer. **Mitigating impact:** Longer careers of ATCOs help reduce costs. ATCOs who start earlier with a second career have more time to develop substantial expertise in news tasks. Such a change also allows reducing the health impacts of long ATCO careers.
Age sensitive policies. ATSEPs are much more confronted with the fast change in competence areas during their career. Not all ATSEP can and should redevelop their competencies. ANSPs need to develop in cooperation with ATSEPs age-sensitive policies to make the best use of the available competence, expertise and motivation. **Mitigating impact:** ANSPs will be able to maintain competencies. ATSEPs can choose which type of competencies they want to develop or maintain.
Licence, inter-ANSP mobility
Overview of different application of EASA-regulations/licence. ANSPs indicate that there are differences in the application or interpretation of the EASA-regulations. EASA-regulations do not cause these differences. An overview of such local means of compliance does not exist and would help to understand how the application of the regulations can be made more harmonised. EASA could provide an overview of such different applications of licence rules. **Mitigating impact:** Harmonised application of regulations allows more mobility between ANSPs. Having harmonised

regulations allow more standardisation of technology requirements.
Future technology capabilities and licence restrictions. Technology allows for new management concepts. To implement such new concepts, any conditions that restrict the licence should be clear. The example is sector-less (location-independent) control. The current licence requires sector-specific expertise. **Mitigating impact:** If ANSPs want to use technology to react flexibly to changes, then the licence should not be a barrier for change. Prospective analysis can identify possible obstacles.
Cooperation for changing regulations and licences. Changing the regulations can create a level-playing field that allows ANSPs to compete in ATSEP-tasks. Such an intention may help to lower costs, but ANSPs or ATSEPs will not support it. The strategy should be to cooperate between ANSPs to improve the regulations and licences. **Mitigating impact:** The ATSEP licence needs to stay future-proof. Cooperation allows ANSPs to exchange how to improve operations. Information may not be shared if the environment is one of competition.

In the previous sections of this Chapter, we have indicated how ATCOs and ATSEPs stressed different mitigating measures. We have also discussed how the selection of these future measures reflected the two groups' experience with the changes in the past decade. In selecting the measures, it is interesting to understand which future benefits the ATCOs, ATSEPs and OTHERs stressed **for the ANSPs** and **the ATM-staff**. The following figures summarise these benefits.

Benefits at the organisational level

Reduce training and other costs	• General training costs can be reduced. • Costs connected to organisational restructuring can be reduced. • Pensioning costs can be reduced.
Maintain or increase the capacity of ATCOs	• Maintain or increase ATCO-capacity. • More supply of ATCO-talent helps ANSPs to respond more quickly to changing demands.
Increase support for innovation and new technology	• Technological change can be accelerated. • Barriers for technology in the licence can be reduced. • Harmonised regulations allow more standardisation of technology requirements.
Better Informed choices about organisational models	• Overview is possible of the consequences of choices about organisational models. • Cooperation model allows the sharing of information. • More understanding of and support for the role of social dialogue help an agile change of the ANSPs.

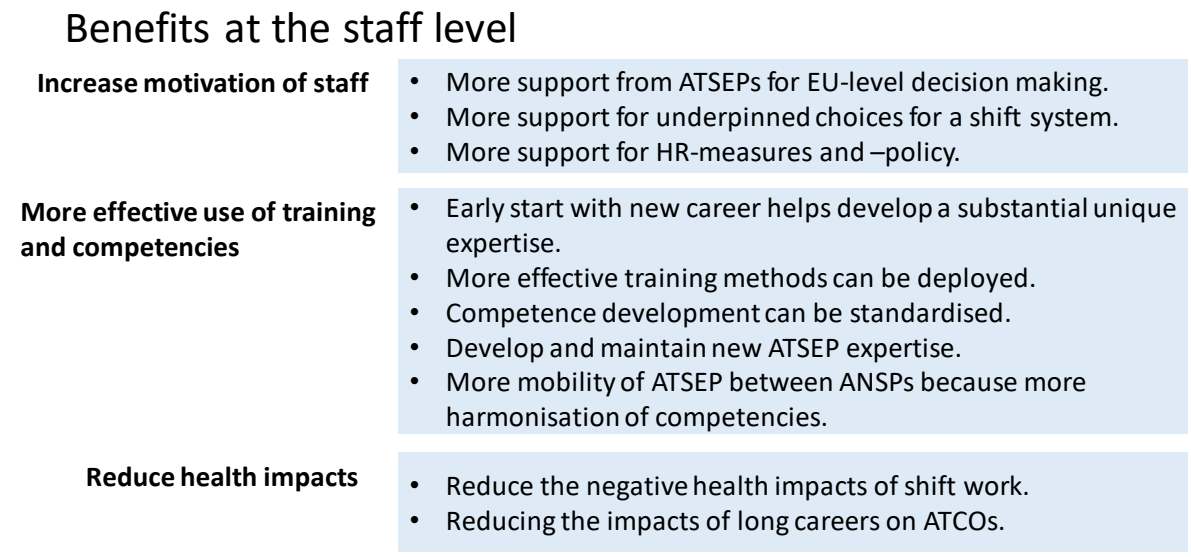

Figure 13. Overview of the benefits the workshop participants saw in the change of the mitigating measures for the future scenarios

5. Conclusions

The **goal of this study** is to provide:

- a common understanding of the current situation concerning the most critical social issues and working conditions in European ANSPs and how they probably are going to change in the future for ATCOs and ATSEPs in the ATM-industry, and
- a set of mitigating measures discussed with and assessed by stakeholders that can be taken at regional, national and European levels to improve the overall situation based on future scenarios.

The **study's outcome** will contribute to the European Commission's effort to address identified social issues and working conditions. The study proposes solutions at the European level for both the actual situation and future evolution of the ATM sector, as they were proposed by the participants from the ATM-industry. The European Commission (DG MOVE) intends to make the study results available as input for a roadmap for addressing the 'human and social dimension' within the Digital Single European Sky.

First of all, the process and methodology of the study have led to an important observation. **There is a need among stakeholders in the sector to share information about the human and social dimension and discuss them**. The ANSPs are national monopolies and operate in line with European agreements to reduce costs for airspace users as much as possible. This report shows that a targeted approach, in which the ANSPs and the various professional communities work together, can benefit this goal. The European Commission might stimulate this approach of collaboration. A constructive debate between ANSPs, ATCOs and ATSEPs is possible and can be channelled. The method used to involve the participants in workshops, and provide continuous feedback on what the researchers do and think, helps bring a discussion to a successful conclusion.

Chapter 3 provides the answer to the first part of the first objective of this study. This Chapter shows **the mitigating measures taken by five ANSPs over the last ten years to address the impact of airspace congestion and high staffing requirements**. The analysis of these mitigating measures allows the following conclusions:

- During **2010-2018**, nearly all ANSPs have suspended recruiting new ATCOs and they also reduced staff levels for ATSEPs. Despite fluctuations and an overall increase in air traffic, the staff composition seems to have hardly changed over the last ten years, and this seems to be the effect of the savings the ANSPs had to make especially during the economic crisis ('austerity measures') and of the resulting limited resources of the ANSPs. The unintended effect of this 'staff freeze' is strong ageing of the workforce.
- ANSPs showed **significant differences in mitigating measures** they selected for ATCOS and ATSEPs to channel external pressure from high traffic demands. Even though in the outcomes (decreasing route charges and improving other performance indicators), the ANSPs were moving towards each other, the ANSPs continued to choose different mitigating measures to solve the bottlenecks. Not only the policies were different, but the workshop discussions also showed that different options were available and selected for the future for each ANSP. The continuing **divergence can be attributed** to various factors such as local relations between employees and management; lack of information about alternatives; and local interpretations of common European rules.
- Further performance improvement of the sector, which does not always have to be linked to more cost-cutting but could also be achieved with more **sharing of 'best**

practices', depends on obtaining more access to better information and a greater willingness to share details on mitigating measures and their effectiveness.

Several core discussions within the ATM-community lie underneath this divergence. These discussions resurfaced in Chapter 4:

- An initial critical core discussion is about the **content of the ATCO and ATSEP work**. **For ATCOs**, the debate seems to be whether ATCOs should keep a **comprehensive set of tasks** (e.g., integration of executive and planning tasks in one function, holding multiple ratings, controlling many sectors), or whether the ATCO function should be split up into a limited number of **highly specialised tasks** and several less complex tasks. These less complex tasks could be executed by support or assistant functions. More complex functions require more training, high selection requirements, and high and persistent competence levels. For less complex functions, training time can be reduced. The price paid for this latter option is that simple functions require a more complex organisation: more management layers, more specialists, less flexible working time systems, more rostering problems and thus a more complicated training organisation. If on the other side, the ATCO functions remain as complex as they mostly are, the organisation of the work and training is more straightforward. For example, less management is required. **ANSPs are still weighing their options for making the right choices in this core discussion**. **For ATSEPs**, the job content discussion is only to a degree similar to the ATCO-discussion: for ATSEP functions, distinctions have since long existed between technicians and engineers, and between different fields of expertise and the way to organise competencies. The latter difference refers to the possibility to allow ATSEPs to master all ATSEP-expertise (Communication, Navigation, Surveillance, Data processing, SMC) or only to enable ATSEPs to work with one or two expertise areas. Here too, **ANSPs make different choices** (more integration versus more division of tasks), sometimes depending on agreements made in Collective Labour Agreements. In the past decade, mainly the number of engineers has declined while the number of technicians has remained stable. This decline contrasts with the expectation that the future ATSEP will need to have an overview and in-depth knowledge, favouring a future of ATSEP-engineers.
- A final discussion that returned in many ANSPs, and caused divergence in selecting mitigating measures between ANSPs, is how the licence for ATCOs and ATSEPs is understood. Discussions focused, among other things, on **what the regulator (National Supervisory Authority) allows** and what the ANSPs themselves consider necessary in the licensing system. Some ANSPs indicated that their NSA interprets the licence rules more strictly than other national regulators do. An example is that the 2015/340-regulation[3] allows the competence of ATCOs to be checked once each three years. Local NSA rules oblige some ANSP to do this each year. ANSPs indicated that there is not yet a level playing field between ANSPs in how they operate.

Chapter 4 discusses the future of ATCO and ATSEP work. To outline this perspective, the ATCOs, ATSEPs and other staff from ATM have discussed the needs for change in seven mitigating measures (see table 1) in the context of three future ATM scenarios (Appendix 2):

- The participants in the workshops prioritised and elaborated seven mitigating measures. In the various workshops, *training*, *social dialogue* and

[3] Commission Regulation (EU) 2015/340 on air traffic controllers' licences and certificates

recruitment/selection have been prioritised as the most critical mitigating measures within the future scenarios. Licences and retirement rules ended up at the bottom of the rankings in the majority of the workshops. Even so, several proposals for future changes imply that licence rules would need to change. Engagement of EASA (and local NSAs) seems necessary in these changes. These results imply that participants thought **sufficient staff and personnel's continuous development** were crucial in all future scenarios. Coordination between all social partners was considered necessary to advance these changes further.

- The participants did **not make much distinction between the three different scenarios** in prioritising the various mitigating measures. Scenario C, in which low growth was projected, was seen as a continuation of the current situation. In general, the participants considered each of the particular mitigating measures applicable in each future scenario. In other words, some mitigating measures require more attention than others in the future, whatever this future may bring.
- Chapter 4 provides in table 2 an overview of the 23 core mitigating measures the workshop participants identified. The table also shows which mitigating effect is expected from the measures. The measures should benefit both the ANSPs and their staff.

6. TNO/NLR suggestions for possible next steps

The European Commission has offered to facilitate the development and implementation of a roadmap for the stakeholders' social and human dimension. This study is part of that facilitation process. In the previous chapters, results were presented as the workshop participants provided them. In this final Chapter, TNO/NLR provides some afterthoughts and suggestions for possible next steps based on both the study results and our meta-observations during the interviews and workshops.

1. It may be useful to make the mitigating measures (table 2) available to a broader audience in the ATM sector. By **sharing information**, the ANSPs can improve ATCOs' and ATSEPs' work situation and thus their performance. The list of benefits shown in figure 13 indicates that ATCOs and ATSEPs not only focus on their own specific interests but also on improving the sector in general.

2. In the discussions, we were reminded that the belief in the ATM industry's technological potential is great, but that according to ATCOs and ATSEPs the promises are hard to materialise. In practice, ATCOs and ATSEPs experience technology as a continuous delay of implementation processes and a cause for increasing the complexity of their work. ATCOs and ATSEPs do not have a negative attitude towards technology but indicate that human and social issues should be better integrated into this thinking about technology. Interesting work is already being done in the sector on introducing a **'human-centric'** perspective on technology (see European Aviation Artificial Intelligence High-Level Group, 2020). This 'human-centric' perspective could be broadened to a 'socio-centric' perspective (Müller, 2020). Currently, an impact assessment of each significant technology investment is done from the former perspective. The Expert Group on the Human Dimension of the Single European Sky (EGHD) currently discusses several impact assessments. A '**socio-centric' perspective** includes a weighing of the social interests that are affected by the change.

3. ANSPs pointed out that **cultural differences** make it difficult for them to adopt some mitigating measures that proved useful elsewhere. The cultural differences could be seen between countries, between regions in the same country and even between different professions within the same organisation. It may be interesting to evaluate if and how these cultural differences ought to be reduced, or perhaps exploited more to the benefit of all. An example is the application of the EASA-licence system. **EASA** already discusses such differences with ANSPs. They should be engaged in future discussions.

4. ATSEPs indicated that they do not see their **interests sufficiently reflected** in the talks at the European level. The voice of the ATCOs seems to sound much louder. Next to ATSEPs and ATCOs, no other staff groups were studied. It may be beneficial to verify if other staff groups share this feeling of being neglected at the European level.

5. **Data on human and social issues are not easily retrievable**. As a consequence for some questions, the current study was unable to formulate conclusive answers. An example is the number of working hours on an annual basis that an ATCO has available in a particular ANSP. The differences in actual hours are dramatically different between air navigation service providers. It is still unclear how these differences can be explained. These differences can only be understood if the EUROCONTROL-data (ACE data) are supplemented with input from ANSPs. Each future study will have to compare material from secondary sources, from interviews with the ANSPs and the ACE-reports. It is not yet possible to formulate a recommendation in this study on how to improve data quality, but follow-up research will have to focus on this. The **Performance Review Commission** (PRC) and/or the Performance Review Board (PRB) seem best positioned to take up such a role.

6. For further research on human and social issues, close cooperation with the ANSPs and their staff is important. EASA and the PRC should have a role. The study also revealed **sensitivities** among the ANSPs, ATCOs and ATSEPs (and their representatives) **about sharing information**. Any further discussion about human and social issues ought to take those sensitivities into account.

7. Due to the limited availability of public data on human and social issues, follow-up research will have to rely on various sources. This study consists of a **combination of methods**. This combination (desk research, interviews, scenario workshops) may well be suitable for follow-up research.

8. Table 2 provides an overview of a list of topics that merit more research. From a general point of view, three topics remain underdeveloped in this study. The first topic is the impact of different **organisational practices**. We have clarified how these practices impact mitigating measures. A broader comparison but also an assessment of the prevalence of these models is needed. The second topic is what **flexibility** in shift systems and other organisational arrangements mean and how it benefits or costs ANSPs and the occupational groups. The last topic is which mitigation measures are most appropriate under **which circumstances.** Understanding these circumstances could help develop the mechanisms in which ANSPs cooperate to find best practices.

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Appendixes

The Appendixes include additional data, information substantiating the study's findings, the main outputs of the consultation activities and field research, and the details of the assumptions supporting the proposed scenarios together with the corresponding sources. The following appendices are provided:

- Overview of the contents of the excel with the evolution of the number of ATCOs (and other material)
- Comparative tables case studies, scenario workshop and TNO/NLR evaluation
- Task B - The comparative case study report.
- Task C - Report on the scenario workshop

Appendix 1 – An overview of the evolution of the ATCO workforce since 2007

We have constructed an overview excel-file that provides data on the ATCO-workforce (and other groups) since 2005. This excel will be provided on request.

Appendix 2 – Background tables on ATCOs and ATSEPs: comparison of the situation in the five ANSPs and the workshop results

ATCO

Topic list study logic		Situation ATCOs in five ANSPs	Workshop results
Staffing level, staff availability	Productivity growth	12 to 26% growth in the number of flights over the past ten years; with variation in productivity development from -2% to +29%.	**ATCOs:** The ATCOs see shortages of staff in all future scenarios, mainly because of retiring cohorts of ATCOs and the need to secure minimum staff levels. Even the availability of new tools will not be able to counter these facts. In the scenario-specific comments, however, the picture emerges that staffing shortages are more significant in scenario A than in B and C. In scenario C, problems may arise as a result of the outdated technology with which ATCOs are expected to work. **OTHERS:** The participants see no real issues with staffing levels. The Covid-19 pandemic offers the opportunity to alleviate any shortages there may have been. Technology in future scenarios will also help to reduce staffing issues. **Perspective Human & Social Dimension (H&S Dim):** Productivity improvements (more capacity) over the past ten years have been achieved by keeping staff-levels constant with (nearly) no recruits. This model of 'increasing job demands' to improve productivity has its limits and does not guarantee productivity gains for future growth. Productivity growth needs to come from technological or organisational improvements (see work complexity: specialisation vs integration). The question from the ATCO-side is to see the current staffing levels as a minimum, whatever the future scenario may be. In high growth, more staff is likely needed.
	Staffing level	From -13% decline to + 8% increase in 2010-2018	
	Shortage in the current year	8% of total ATCOs on top of current capacity	
Staff composition, number of staff	Division within occupation	Further developments between ATCOs belonging to APP/TWR-ATCOs versus ACC-ATCOS; ANSP-specific. Not one tendency. Minimal possibilities for a shift of ATCOs between the type of position: minimal (retraining) of personnel from TWR to ACC centres.	**ATCOs:** The ATCOs do not foresee changes in diversity in staff in the three scenarios. **OTHERS:** The diversity issue is seen as disconnected from the three scenarios. The main driver for more diversity is seen as lying outside the ANSPs. **Perspective H&S Dim:** The main change in the future is the age distribution. The ageing cohorts will be leaving the ANSPs. No other changes are foreseen unless external forces drive the ANSPs to change their policies. The gender disbalance (fewer women in ATCO-positions) can only be explained by how the selection systems within the ANSPs work. More discussion and analysis are needed to understand why some countries do not see more women become ATCO. ANSPs can learn from their different practices.
	Gender balance	22-33% women (not increasing)	
	Age structure	12 to 41% over 50 years of age (all staff)	

Work content, division of tasks	Difference in tasks between functions	Difference between TWR/APP-ATCOs and ACC-ATCOs in all. Career models are different.	**ATCOs:** ATCO-support tools may be helpful for the ATCO in the future. The perspective needs to be that these new tools will not significantly impact the social issues connected to ATCO-work. Work content will change; demands will be higher in scenarios A and B. Probably, automated contexts (scenario A) will lead to substantially different competencies. Technology will be available, but no revolution in support of ATCOs is expected. **OTHERS:** The OTHER group see small changes in work content in scenario A. The future may be connected to significant technological changes; the OTHERs group does not expect significant changes within the occupations. **Perspective H&S Dim:** ANSPs have achieved productivity gains (capacity increase) with very different task division models. Specialized support tools are seen as an essential means to improve productivity. The discussion should be on the following topics: Firstly, more understanding is needed on these technological possibilities to use them and make sure that ATCOs use the opportunities offered to them (innovation adoption). Secondly, a separate issue is that use of (new) technology should be equal among different age groups, given that there may be age limits in conducting ATCO-work. There needs to be an understanding which (differential) training methods can support different age groups of ATCOs to use technological opportunities.
	Difference in ANSP operating models	From uniform model for all OPS-rooms in one ANSP to substantial variation in practices in the OPS room depending on location in an ANSP. However, ANSPs try to implement uniform practices as an effective strategy.	
	Difference in ATCO/ATSEP-practices according to location	From uniform model for all OPS-rooms in an ANSP to substantial variation in practices in the OPS room depending on location in an ANSP. However, ANSPs try to uniform practices as an effective strategy.	
	ATCOs other duties	Large variations between ANSPS (6-23% of ATCOs), but also fluctuating over time.	
	ATSEP/ATCO division	Between 55% to 85% ATSEP/ATCO. Staffing level of ATSEP not really a function of ATCOs. A low number of ATCOs is correlated to a high percentage of ATSEP. This number indicates that ANSPs use different organisational models to manage ATM.	
	Managing the OPS- or TECH-room	Different models applied: from self-management in OPS-room to centralised control in which head of OPS-room decides on splitting and merging of sectors to be controlled.	
	Future vision on roles	These visions vary from shared to conflicting views on the future. ATCOs can become monitors, but controlling tasks remain with technology mainly as a support tool. Different opinions 'on collaboration with other ANSPs' and 'increased efficiency' also play a role in the future ATM world. Some ANSPs are moving towards interoperability and sectorless flying. Sectorless flying in this instance means controlling a	

		varying geographical area.	
Work complexity	Competence maintenance	Competence is demonstrated by compliance with formal criteria: number of hours of training, medical test, number of hours on position. In some ANSPs, also by competence evaluation and collegial evaluation.	**ATCOs:** Underneath this consensus is a significant difference between those ATCOs that see simplifying the ATCO-profession as an option and those that do not see simplification as an option. The simplification option states that the ATCO-profession needs to be split-up in specialisms. The advantage lies in several topics for discussion: less complexity, less training required, easier recruiting and selection. The question is then how to tackle the licence issue. The ATCOs that do not see simplification as an option state that the discussion should not be on the licence, that cultural differences are so significant that a common opinion may be hard to achieve, and that keep a complex ATCO-function allows to simplify working time and shift systems, capacity management etc. **OTHERS:** Complexity levels increase in scenario A, remain similar to today in scenarios B and C. The participants were in general, not very optimistic about changes in occupations, mainly because occupations are different, and they find the sector traditionally slow to adopt change. **Perspective H&S Dim:** The main discussion in a longer-term perspective is about simplifying the ATCO-job through specialisation and/or reduction of the controlling scope (number of sectors) or keeping the complex work for the ATCO. Both options have an impact on many issues. The costs and benefits of both models need to be better understood.
	Development in complexity	Increase in new procedures and productivity improvements (additional tasks) have led to increased job complexity in recent years. New technology is being introduced primarily to reduce complexity while further increasing productivity.	
Licencing and mobility measures	As a barrier to adaptation	Mainly location-dependency (sector) and training for several sectors (training up to 10 sectors) as a constraint. Regulator (NSA) can stress compliance rather than competence. This is felt as a constraint. An insufficient number of trainers and simulator capacity reduces training adaptability. Corporatist practices ruling ATCOs are seen as a constraint. The variation between ANSPs on the number of unit endorsements that an ATCO can hold and flexibility in the working area. A uniform licensing/endorsement system would allow more flexibility between locations/units.	**ATCOs:** Licensing is seen as adequate, even if there is some dissensus about simplifying the licence or more specialisation between ATCO-jobs. **OTHERS:** Harmonisation of the licences is still a core debate that needs to be conducted. This debate's goal should be clear too: if the idea is inter-ANSP mobility to get more market pressure on ANSPs, this is not helpful. If it is needed for collaboration between ANSPs, it might be a profitable strategy. **Perspective H&S Dim:** There are several discussion about the licence of the ATCO. When it comes to the future, one argument is about how the national regulator interprets the licence. Is it correct that these differences exist? A second discussion is if the licence itself is not an issue: is it right that the current rules are 'fine'? A third discussion is to what degree new technology allows changes in the operation of ATCO. Is sector-less (location independent) controlling possible? These are already long debates, but still very inconclusive.
	As a driver for adaptation	A good relationship with the regulator as an enabler for change. Model stressing polyvalence and quick O-J-T supervision competence of	

		ATCO helps adaptation.	
	Contractual situation (flex-contracts; part-time work)	Some ANSPs see a sharp increase in part-time employees (up to 16%), while others have hardly any part-timers. Some countries have several ANSPs working under market conditions for TWR and Regional services.	
Social dialogue	Collective agreement approach	More and more separate collective agreement per groups (ATCOs vs other groups); different unions to deal with employer/managers. Too detailed arrangements block flexibility.	**ATCOs:** The futures changes are only possible if the current social dialogue practices change. The discussion should focus on these changes within the national contexts. In all scenarios, social dialogue is the means to allow the changes. This social dialogue needs to change if the ANSPs want to deal with all the scenarios. **OTHERS:** The main issue to improve in social dialogue is to clarify the unclear discussion context at the EU-level (who is doing what?) to better understand what should be discussed at the national and the EU-level and then to identify topics to discuss (strike regulation, one trade union, etc.). **Perspective H&S Dim:** Social dialogue is recognised as an instrument to achieve alignment in interests between employers and personnel. It helps to manage the long-term expectation of personnel. There was one suggestion that the EU could help to solve some local issues (strikes etc.). However, others did not expect such a role to be helpful, because interference at the EU-level may escalate existing tensions (e.g. the right to strike). More successful past efforts have been oriented at making issues more predictable (the guide for social dialogue). Discussion on future social dialogue ought to be focused on: how dialogue models can be developed to act more flexible to new demands from work (agile model of social dialogue); how to the impact of the newest technologies on employee interests should be evaluated.
	Relationship between social partners	Mainly location-dependency (sector) and training for several sectors (training up to 10 sectors) as a constraint. Regulator (NSA) can stress compliance rather than competence. This is felt as a constraint. An insufficient number of trainers and simulator capacity reduces training adaptability. Corporatist practices ruling ATCOs are seen as a constraint. The variation between ANSPs on the number of unit endorsements that an ATCO can hold, and therefore the flexibility in the working area. A uniform licensing/endorsement system would allow more flexibility between locations/units.	
Recruitment & selection	Model	Three models: a. 100% new recruits through initial and unit training; b. only selecting for unit training; c. mixed model of allowing external suppliers to provide training, next to own capacity for initial training. Training channel is the main entrance to new capacity, which requires long term planning to adjust internal capacity.	**ATCOs:** The question here is how to change recruitment and selection in a changing context? Environment rules will impact air traffic demand; the Covid-19 pandemic reduces the current demand for services. The discussion should be on how to deal with these changes and to ensure that recruitment continues. **OTHERS:** The changes in recruitment and selection are focused on more harmonisation in the EU. The fear is that not the right talent finds a place in the ANSP. What are ways to help candidates for positions make the best career investments? For some ANSPs, the discussion is how to make sure that new

	Improvement effort	Focus on shortening unit training; more individual student-centric approach, rather than class-based training model; efforts to enlarge a number of candidates to ab initio training and improve pass rates. New technology (new workplace, systems) is also seen as a method of attracting young talent.	candidates only access ATCO-positions through the training system. The changes in recruitment and selection should be focused on more harmonisation in the EU. If the selection requirements in the future are harmonised and (maybe) decreased, it will be easier to recruit a sufficient amount of qualified entries. A separate discussion that needs to be conducted is to make sure that candidates make right career investments and that ANSP-investment in (initial) training is optimised: should you only restrict entries to those coming through the 'strong selection system' or are more inroads into the ATM-careers helpful? **Perspective H&S Dim:** The current recruitment and selection system seems to work on the idea that the current high drop-out and low pass-rates are 'normal' for the ATM-industry. Should there not be more attention on how to reduce drop-out (FEAST-method) and improve the pass-rates? How to share more experiences to improve the R&S-performance of ANSPs? How to share information on talent between ANSPs? Offering more opportunities to candidates to work at other ANSPs is a win-win for candidate and ANSPs. EU initiatives can support this. Research may be needed to determine whether inter-ANSP mobility has an impact on the operation of the ANSPs.
	Role of HR/management in allocation of new personnel	Variation between HR-dominated system in which HR determines where the candidate will start unit training; models in which CLA (trade union/local rules) guide who can create a unit training.	
	Direct entries	Different models in which there is no reliance on direct entries to models where up to a third of personnel is an external direct entry. Direct entries may be allowed to the unit training.	
Training	Basic training	Not always provided by the ANSP. Some ANSPs reduced the inflow of trainees to increase the productivity of existing personnel.	**ATCOs:** The main discussion should be on the length of training times, as well in initial training as during the career of an ATCO. More research is needed into the impact of simplification of jobs versus keeping jobs complex and impacting other social dimension-topics. **OTHERS:** The discussion on changes in training focuses on how training technology can help future training, especially making more use of simulators to save OJT time (e.g. training more complex situations systematically, automated measures). Another issue is that the rules and requirements regulators on several hours OJT, limit the possibilities of ANSPs to use these changes. Adapting to future scenarios would be helped by these technologies. **Perspective H&S Dim:** The future focus should be on the length of training times. All the efforts of the past, the use of technologies is not creating significant breakthroughs to reduce these times. The following future discussion should be conducted: What is needed to align OJT training hours with Simulator training hours? SIM hours are cheaper and offer ANSPs more flexibility to deal with licence requirements. The
	Unit training	Training times can vary from 6 months (local TWR) to 3 years (ACC). Differences are in the role of HR or rather CLA (Trade Union) to channel candidates to the unit.	
	Recurrence training	Differences in the rhythm of training sequence to retain licence (from 1 year to 3-year cycle. NSA provides different compliance rules between ANSPs. ANSPs need a seasonal approach to offer retraining efforts depending on capacity demands: training planned in low-capacity moments. Capacity for retraining is not always available. Increased requirement for conversion training as more new technology, new procedures and recent airspace changes are	

		introduced.	ANSPs mainly see obstacles on the side of the local regulators who mainly control OJT hours.
	OJTI trainers	Different models: OJTI is a trainer position you need to apply for (talent based); to model in which all ATCOs are also OJTI.	• Can the training time shift to simulators? What is needed to do that? Can such training time be compared to OJT? • Does the specialisation model of ATCOs reduce or complicate training and training time? More research is needed on the impact of simplifying jobs versus keeping jobs complex, and on the effects on other social aspects. There is much debate on how training will change and how this will be influenced by different "forces" such as simplification, less OJT training, keeping jobs complex. All in all, training scenarios need to be prepared, but it is not clear for what change we need to prepare. • Does the professionalisation of the training function help the training effort? • What are possible factors that block further integration of training infrastructure? (marketisation of training is not sufficient to model, i.e. selling training capacity externally to maintain the infrastructure) Keeping a training infrastructure is a costly affair. More initiatives are needed to examine whether there are obstacles to the ANSPs working more together in basic training.
Mobility within an ANSP	Career model	All ANSPs provide a 'promotion ladder' into higher paid jobs. Depending on the size of the ANSP, promotion ladders require moving between locations. Smaller ANSPs only provide promotion within one area. Differing approach to mobility between ANSPs - some ANSPs want increased mobility, others do not see it, as necessary.	**ATCOs:** ATCOs put the content of work ahead of internal mobility systems (careers). **OTHERS:** The discussion here should focus on how harmonisation of systems and conditions can help to create conditions for (internal) mobility. The need for this is seen as limited. **Perspective H&S Dim:** The future discussion should be about appropriate ways to motivate the ATCO staff. Content of work is 60% of the motivation explanation, and promotion possibilities are less critical. Promotion possibilities as a motivational instrument are only available at bigger ANSPs. The question is if ATCOs see work content as an excellent motivating factor? What happens with a model of ATCOs with more specialistic tasks (and thus less variation in their job)?
	Promotion	Application for a new job is nearly everywhere the rule, but the difference lies in who decides who can apply: HR or Trade Unions (CLA-rules).	
Working times, rosters	Roster system	Variation between fixed rosters in shift systems, to individualised systems. Fixed systems are complex and very inflexible but build on fixed teams. Individualised rosters make teamwork less logical. ANSPs have different challenges with the seasonal variation in traffic (from little to substantial variability), and therefore variation in staff requirements. Flexible rostering (and holiday planning) is used to adjust	**ATCOs:** Working times and rosters of ATCOs need to become more flexible if the ANSPs want to deal with future scenarios. The discussions should remain at the national level, not at the EU-level. However, exchanging experiences is essential. **OTHERS:** There are many topics with rostering and working times that could be aligned in Europe. This alignment requires more discussion and possibly also more intervention at the EU-level (for example, maximum limits to working times). A separate issue is to achieve a more flexible (agile) approach to deal with the issues.

		to fluctuations in demand.	Currently, the national discussions are focusing on solutions for past issues, not for future issues. **Perspective H&S Dim:** ANSPs have set up shift systems to deal with the local variation in capacity and ensure safety. The differences in tasks of ANSPs are so significant that a general solution for shift systems and flexibility are not obvious. These differences will not decrease in the future. However, the EU can provide for information sharing. In the fixed shift system, the ATCOs see too little allowances in changing shifts with colleagues (little flexibility to deal with personal issues). Medical arguments are used to limit flexibility. More flexibility could be possible, but the discussion about working times needs to find a method to respond more quickly. Future changes will require quicker reactions within working time systems. The human and social dimension question: are these differences between the fixed vs individual shift systems valid? Do they have a different impact on more flexible use of the time of ATCOs? And what are the possible implications for safety?
	Overtime practice	Weekly working can be strictly managed with agreements on maximum weekly working times (e.g. 32-43 hours) to models where employees can have more choices. The stricter the week, the fewer allowances are provided for overtime. The use of overtime is somewhat limited in the ANSPs. Working on odd moments is financially compensated. With ATSEP, on-call systems are allowed.	
	Holiday planning	Nearly always strictly organised, with a difference in no-allowance for holidays in peak seasons to other ANSPs with more possibilities.	
Pensioning situation	Pensioning age	Large differences going from 56 to 65 years. Early retirement is allowed with these age categories but requires self-funding. Most ANSPs are seeing pension ages rising, but possibilities for more increases are limited. Several ANSPs challenged by irregular recruiting in past periods leading to peaks of retirements.	**ATCOs:** Changes in the pensioning and retirement rules are not a topic that the ATCOs happily embrace. They see limits to the age of doing ATCO-work. Here possibilities for longer careers are connected to simplifying jobs, offering more straightforward jobs at the end of a career, or looking at the different regulations' incentive structure to take up other tasks. A European solution is not deemed possible, but a European discussion is needed because non-discrimination rules force the issue for ATCOs (can you force ATCOs into a pension?). **OTHERS:** The most relevant issue to be debated with pensioning regulations is how to lengthen the careers of ATM-personnel and keep those careers interesting. **Perspective H&S Dim:** The topic for discussion is how to lengthen the working career of the ATCO. Currently, some ANSPs allow the ATCO to leave in early retirement. More effort should be invested in the future in offering alternative careers. Given that the ATCO-job is demanding, more should be done to start earlier with alternative tasks. The discussion will have to focus on new careers for ATCOs after 50/55 years. In this respect, an exchange by ANSPs may be helpful: ATCOs should be given job security until (higher) retirement age in exchange for leaving the control position in time. Europe could facilitate those discussions on sharing experiences.
	System	Variation between company-based pension system and state pension systems.	

ATSEP

Topic list study logic		Situation ATSEPs in five ANSPs	Workshop results
Staffing level, staff availability	Productivity growth	Variation in productivity development from -2% to +29%.	**ATSEPs:** The ATSEPs see staff shortage levels remaining quite the same in the three scenarios, remaining quite similar to today. Much depends on the local situation (amount of ATSEPs retiring; on balance between ATSEP and engineers). **OTHERS:** These participants see no real issues with staffing levels. The Covid-19 pandemic offers the opportunity to alleviate any shortages there may have been. Technology in future scenarios will also help to reduce staffing issues. **Perspective H&S Dim:** Productivity improvements have been achieved by reducing staff-levels, mainly among engineers. In this situation, many tasks have been outsourced to technology firms or other suppliers. Operational maintenance has remained the same. The discussion among ATSEPs seems to say that technology will be so good that operational maintenance will become less critical. Because technology is becoming so complex, engineers are more in need. Can technology be the driver of productivity, or are we continuing on the path that each couple of years, the number of engineers/technicians is reduced? Further, thorough analysis of the different observations of ATSEPs and OTHERS on ATSEP-staffing levels is needed.
	Staffing level	Operational maintenance: between -7% to +35% Engineers (-15 to -20%)	
	Shortage in current year	From shortage in ATSEP to need to reduce the capacity of ATSEP further	
Staff composition, number of staff	Division within occupation	Share engineers in Technical support: 15 to 46% and declining over time	**ATSEPs:** There is no real consensus between the ATSEPs in which direction staff diversity will change. Most of them expect more diversity (younger, more women), but it depends on outside factors (non-ATM developments) too. In the scenarios, more change was seen in scenario A, less in B and C. **OTHERS:** The diversity issue is seen as disconnected from the three scenarios. The main driver for more diversity lies outside the ANSPs. **Perspective H&S Dim:** As with ATCOs, the main change in the future is technicians and engineers' gradual ageing. There has been a redistribution of tasks from engineers towards technicians. The ageing cohorts will be leaving the ANSPs in the coming 5 to 10 years. The question for ANSPs is if their relationship with outside support needs to be increased, or that new generations of engineers and technicians are recruited to support the significant technological change that is planned.
	Gender balance	22-33% women (not increasing)	
	Age structure	24 to 40% over 50 years (not such an impact as for ATCOs, because of higher pensioning age)	
Work content, division of	Difference in tasks between functions	Models vary from three to four levels of ATSEPs; division of tasks in terms of in-depth maintenance (level 3-4: engineers), and overview of technologies. In some outsourcing mainly of engineering (the	**ATSEPs:** Much depends on the extent to which (future) technology allows work to be simplified. Therefore, expectations are for an increase or decrease in complexity, depending on the conditions the ATSEPs sees. However, in the scenario-specific comments, the picture emerges that staffing shortages are more significant in scenario A than in B and C. In

tasks		reason for decline). Technicians: 80% of time repair tasks.	scenario C, problems may arise due to the old technology with which ATSEPs have to work. The scenarios A&B lead to more need for engineering tasks, scenario C more stress on maintenance of the technologies that will not change. **OTHERS:** The OTHER group see small changes in work content in scenario A. The future may be connected to significant technological changes; the OTHERs group do not expect to see significant changes within the occupations. **Perspective H&S Dim:** Three issues are essential for future discussion. Different organisational models of using technical/engineering knowledge are in use, and this needs to be better understood. As EUROCONTROL has already pointed out, there requires to be understanding why these different approaches are the case and how other models can help ANSPs. A vital context dimension is the availability of new technology. The critical issue is the number of legacy systems that require 'legacy' expertise. Most personnel planning is based on phasing out technology, but the experience learns that ANSPs need to manage mixed knowledge situations. How to do this? Experience does show to expect more centralisation of the ATSEP-tasks and roles.
	Difference in ANSP operating models	Variation in ATSEP working models, either entirely in-house staff, or for a part a sub-contract model with separate companies.	
	Difference in ATCO/ATSEP-practices according to location	Uniform models applied.	
	ATSEP/ATCO division	Between 55% to 85% ATSEP/ATCO. Staffing level of ATSEP not really a function of ATCOs. Between 16% to 92% AIS&-support/ATCO. Support is a function of the number of ATSEP. The low number of ATCOs is correlated to a high percentage of ATSEP and AIS&-support. This result indicates that ANSPs use different organisational models to manage ATM.	
	Managing the OPS- or TECH-room	Mainly centralised TECH-rooms.	
	Future vision on roles	Future: only SMC with vitality/business criticality level of the system will remain; CNS will remain. SMC as system specialists. ATCOs are becoming increasingly dependent on ATSEPs where technology increases. Systems become more complex (and more capable, from a technology perspective).	
Work complexity	Competence maintenance	Digitalisation of work changes work content to new competence areas (cyber, AI). ATCOs and ATSEPs will need to be more coordinated in the future, due to digitalisation of the tools and the job - especially during technology transition. This digitalisation affects the coordination (of tasks and duties) between ATCO and ATSEP	**ATSEPs:** Much depends on the extent to which (future) technology allows work to be simplified. Both expectations were expressed for an increase or decrease in complexity, depending on the conditions the ATSEPs see. However, in the scenario-specific comments, the picture emerges that staffing shortages are more significant in scenario A than in B and C. In scenario C, problems may arise as a result of the old technology with which ATSEPs

		when process chains/functional chains are involved.	have to work. The scenarios A&B lead to more need for engineering tasks, scenario C more stress on maintenance of the technologies that will not change. **OTHERS:** The OTHER group see small changes in work content in scenario A. The future may be connected to significant technological changes; the OTHERs group does not expect significant changes within the occupations. **Perspective H&S Dim:** Three issues are essential for future discussion: (1) different organisational models of using technical/engineering knowledge are in use, which needs to be better understood; (2) a vital context dimension is an availability of new technology; (3) and the critical issue is the number of legacy systems that require 'legacy' expertise. Most personnel planning is based on phasing out technology, but the experience learns that ANSPs need to manage mixed knowledge situations. How to do this? Experience does show to expect more centralisation of the ATSEP-tasks and roles.
	Development in complexity	Task complexity is being reduced (standardising components and replacement; uniform equipment), but at the same time, maintaining legacy systems enhances the complexity of technology setting. The increasing variety of technical systems increases complexity. Service Level-steering for service to ATCO reduces complexity. Specialisation helps reduce complexity, but again: different models applied. The expectation that 'in-safe mode' model of ATSEP can be changed to 'on-call' model.	
	Outsourcing	Some ANSPs use outsourcing, where permitted; depending on specific tasks. Future: outsourcing of machine-level repairs and interventions to suppliers; but in some ANSPs, outsourcing is not allowed by union rules, or technology support is being brought in-house.	
Licencing and mobility measures	As a barrier to adaptation	Local rules to comply limit flexibility (e.g. number of SMC in TECH room; on-call rules; maintaining old systems and ratings). Focus on process responsibility, rather than system responsibility, limits flexibility. The focus of NSA on training for too specific tools is a limitation. The priority of ATCOs on simulators limit ATSEP.	**ATSEPs:** Inter-ANSP mobility is not an issue for different future scenarios. *Scenario A and B:* Licensing: more mobility may be possible in cases A and B, but a complete standardisation seems complicated for the maintenance at the functional level. Standardisation seems more comfortable to achieve for the non-functional layers (infrastructure, IT services), depending on if they are considered as ATSEP or not. **OTHERS:** Harmonisation of the licences is still a core debate that needs to be conducted. This debate's goal should be clear too: if the idea is inter-ANSP mobility to get more market pressure on ANSPs, this is not helpful. If it is needed for collaboration between ANSPs, it might be a profitable strategy. **Perspective H&S Dim:** Even if the ATSEP-licence focuses on the competences to maintain tools, there seem to be several topics that make the application of the licence system inflexible. The future debate should be about aligning local applications and interpretations. What are the main differences? A next discussion is that if future changes are needed in licence and mobility, then the focus is on how these changes help collaboration, rather than marketisation of the ATSEP-tasks. This marketisation may be a result, but not the starting point.
	As a driver for adaptation	Polyvalence helps flexibility. Technology shift towards software rather than analogue machines allows flexibility. EASA-rules not seen as a barrier.	
	Contractual situation (flex-contracts; part-time work)	Some ANSPs see a sharp increase in part-time employees (up to 16%), while others have hardly any part-timers.	

Social dialogue	Collective agreement approach	More and more separate collective agreement per groups (ATCOs vs other groups); different unions to deal with employer/managers. Too detailed arrangements block flexibility.	**ATSEPs:** Social dialogue is quite essential for the future, and there is a need for a discussion on this topic in the future. There might also be a need for social dialogue at the EU level, but this should be more focused on relevant topics important to the ATSEPs. **OTHERS:** The issues to improve in social dialogue are the unclear discussion context at the EU-level (who is doing what?); to understand better what is at the national and the EU-level; and then to identify topics to discuss (strike regulation, one trade union). **Perspective H&S Dim:** For ATSEPs, the same discussion exists as for the ATCOs. The main difference is that the feeling exists (among ATSEPs) that the current EU-level discussion on ATSEP does not sufficiently direct their issues and interests. Social dialogue is essential but requires an assessment if the right EU-institutional framework is available for the ATSEPs.
	Relationship between social partners	Good relationships are seen as essential for necessary changes. Social dialogue is crucial to introducing new technologies, by all partners, but there are disagreement and variation in how that is achieved. But such social relationships are not equally good among all ANSPs.	
Recruitment & selection	Model	Flexible contract to test new candidates; training recruits to ATSEP-model; high wages to be able to recruit specialists on labour markets. Highly regulated environment discourages young IT professionals from applying.	**ATSEPs:** Create a pool of extra trained ATSEP (requiring keeping high levels of recruiting and selection). Change the skill requirements for ATSEP in the new scenarios. High growth in the future requires other background and skills of ATSEP. *Scenario A (high growth):* the background and skills required for ATSEP are entirely different from the current ones, and recruitment should change accordingly. *Scenario C:* Reduction of staff in pessimistic scenarios **OTHERS:** The changes in recruitment and selection are focused on more harmonisation in the EU. The fear is that not the right talent finds a place in the ANSPs. What are ways to help candidates for positions make the best career investments? For ANSPs, the discussion is how to limit the entrance to the jobs. The changes in recruitment and selection should be focused on more harmonisation in the EU. If the future selection requirements are harmonised and (maybe) decreased, it will be easier to recruit a sufficient number of qualified entries. A separate discussion that needs be conducted is to make sure that candidates make right career investments and that ANSP-investment in (initial) training is optimised: should you only restrict entries to those coming through the 'strong selection system' or are more inroads into the ATM-careers helpful? **Perspective H&S Dim:** The fear is that recruitment effort for ATSEPs will be reduced due to the Covid-19 pandemic. The debate should be on the future ATSEP, what kind of profiles are needed (see topics above)? Which division of tasks is required and what kind of impact does that have on R&S? What can be learned from other sectors?
	Improvement effort	High starting wages to attract talent (in past: deferred payment system). New technology (new workplace, systems) is also seen as a method of attracting young talent.	
	Role of HR/management in allocation of new personnel	Variation between HR-dominated system in which HR determines where the candidate will start unit training; models in which CLA (trade union/local rules) guide who can start a unit training.	
	Direct entries	Idem ATCO, only direct entries come from tech-firms in the region.	

Training	Basic training	Not at ANSPs: mainly recruited with technical expertise; unless national selection model of engineers.	**ATSEPs:** ATSEPs are expected to have to learn new skills which require more process overview. This new situation requires more investment in training and different types of training (e.g., AR/VR, remote training) in the future. *Scenario A and B:* current ATSEP will not be able to provide On-the-Job training on these new skills. *Scenario B:* According to the new skills required for ATSEP, a particular effort should be made, especially in case B where a more extensive set of skills is needed, not easy to find in the same personnel. *Scenario C:* Pressure on the reduction of training costs as well as the impossibility to travel for supplier training in most pessimistic scenarios **OTHERS:** The discussion on changes in training focuses on how training technology can help future training, especially making more use of simulators to save OJT time (e.g. training more complex situations systematically, automated measures). Another issue is that the rules and requirements regulators on the number of hours OJT, limit the possibilities of ANSPs to use these changes. Adapting to future scenarios would be helped by these technologies. **Perspective H&S Dim:** Future scenarios clarify that the SMC role of ATSEPs will eventually be more important than technical intervention in the systems (2nd, 3rd line maintenance). The process overview and rapid assessment require a shift in the ATSEP role and competences. This shift will also lead to a change in the type of training necessary for that role. OJT is then not an obvious training method. Changes are needed in the competence requirements. Which skills will be required, how to prepare for this? And how to shorten training times? What can ATSEPs learn themselves? More research is needed to understand alternative training methods.
	Unit training	Model varies: specialisation model versus the polyvalence model. Training times vary: new candidate can need up to 18 months of training. Training is done to deal with insufficient candidates on the labour market.	
	Recurrence training	Effort to shift training to self-learning model with digital tools. Increase in training requirements as new systems are introduced.	
	OJTI trainers		
Mobility within a job	Career model	Career models used.	**ATSEPs:** The current ATSEP-regulation limits what is possible in the ATSEP function. This regulation is a barrier to mobility. Standardisation in job profiles is needed for mobility. Career mobility helps ATSEPs stay in the ANSP. *Scenario A and B:* Mobility measures: the new background and skills required for ATSEP will mean that they will change between companies or sectors more efficiently. The mobility within a job may allow keeping interested and motivation for the job longer. **OTHERS:** The discussion here should focus on how harmonisation of systems and conditions can help to create conditions for (internal) mobility. The need for this is seen as
	Promotion	Competence requirements necessary for promotion; but also, performance outcomes.	

			limited. **Perspective H&S Dim:** There is as yet no European market for ATSEPs. ANSPs report that for engineers and technicians, they compete in their national markets. The work of the ANSPs is not always the top-of-the-bill for these groups. The question is if ANSPs suffer from this position. To what degree have ANSPs suffered from the impact of a 'draining' of their technicians and engineering corps, from external recruiting? Does this expertise-loss affect their safety performance? Do changes in the job profiles allow faster integration of new talent (see training)? ANSPs can learn from each other from the deployment of technicians and engineering models. Europe can carry out targeted studies on these differences. Mobility in itself should not be a central objective.
Working times, rosters	Roster system	Fixed system, with allowance for individual swapping, only according to rules (resting times)	**ATSEPs:** How to create and integrate more flexibility in working times and rosters, given future scenarios? *Scenario A (high growth):* management of services does not require a 24/7 service. As said before, this applies only if we consider only the personnel of the ANSP and not the contracted companies. *Scenario B and C:* the need for on-duty service will remain the same. **OTHERS:** There are many topics with rostering and working times that could be aligned in Europe. This alignment requires more discussion and possibly also more intervention at the EU-level (for example, maximum limits to working times). A separate issue is to achieve a more flexible (agile) approach to deal with the issues. Currently, the national discussions are focusing on solutions for past issues, not for future issues. **Perspective H&S Dim:** ATSEP-work is in general seen as less affected by traffic levels, so more possibilities are available for ATSEPs to plan their working times than ATCOs can. The main question is if, in the high growth scenario, the changing skills situation (more process skills) and improved more resilient technology will require different approaches to rosters and shift? What is needed to make a workweek of 8 hours and five days happen? More understanding is needed of the ATSEP deployment and competence requirements to enable safe operation within such models.
	Overtime practice	Variation with systems like ATCOs to on-call systems and more overtime. Increase in continuous ATSEP support requirement to deal with ad-hoc system problems, rather than scheduled maintenance of hardware.	
	Holiday planning	Shift: 2 days on (day-night); 3-4 days off.	
Pensioning	Pensioning age	Large differences going from 62 to 67 years. Early retirement is allowed with these age categories but requires self-funding. Most ANSPs are seeing	**ATSEPs:** If the future scenarios lead to changes in pensioning systems, then this requires

situation		pension ages increasing, but possibilities are becoming less. Several ANSPs challenged by uneven recruiting in past periods leading to peaks of retirements.	more transparency if such changes are to be introduced. *Scenario A and B:* Pensioning: In scenarios with growing complexity and uncertainty, this requires and adapting to changing situations in a way that is plannable, transparent and acceptable to the ATSEP. Only this will help the ANSP to deliver services efficiently. *Scenario B and C:* Pensioning: the need to recruit or keep "old" technicians may impact the retirement rules. **OTHERS:** For as far as there is an issue to be debated with pensioning regulations, it should be on how to lengthen ATM-personnel careers. **Perspective H&S Dim:** As with the ATCO, longer working careers are needed for ATSEPs. For the ATSEP, age-sensitive policies should be developed.
	System	Variation between company-based pension system and state pension systems.	

Appendix 3 – Task B – Report comparative analysis of the five case studies

Appendix 4 – Task C – Report with the results from the scenario-workshops

These scenarios have been included in the Scenario workshop report, and in the Guide for the workshop. In these reports, the methodology and the findings of all stakeholder consultation activities have been included.

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