International Civil Aviation Organization

Twenty Fourth Meeting of the Communications/ Navigation and Surveillance Sub-group (CNS SG/24) of APANPIRG

Web-conference, 30 November – 4 December 2020

Agenda Item 10: Human Factors and Air Traffic Safety Electronics Personnel (ATSEPs) related training

10.1 Review outcomes of small working group study on human factor issues of ATSEP

REVIEW OUTCOMES OF SMALL WORKING GROUP STUDY ON HUMAN FACTOR ISSUES OF ATSEP

(Presented by International Federation of Air Traffic Safety Electronics Association (IFATSEA))

SUMMARY

IFATSEA has initiated the study with the following objectives;

- To study the human factor issues of ATSEP on their working environment
- Identify the significant factors that add stress and fatigue and affect their safety job performance.
- To understand the stress and fatigue levels of ATSEP and for resolving potential risks to ANS
- Identify the significant counter measures
- Identify the means for improving the safety culture and professional engagement

The study found that the human performance management maturity levels of ANSPs w.r.t ATSEP are in the very early stages and there are scopes for improvements.

1. INTRODUCTION

1.1 IFATSEA, had elaborated the factors that cause the human factor issues to the ATSEP and the possible impacts on safety and efficiency in airports operations and air navigation services in the paper CNS SG/23 – WP/19 Agenda Item 9, “Factors adding stress and fatigue to ATSEP and the need for a study”

1.2 References were drawn from existing best practices, and correlated the human factor issues of ATSEP, including stress and fatigue, and the outcome of the study is presented in this CNS SG/24 meeting with recommendations and further scope of work for the discussion.

1.3 Due to various constraints including Covid-19, the phases as per initial plan got delayed and couldn't be completed. So, went for the revised strategies and plans with different phases.

1.4 However, all the revised phases were executed and the study was conducted globally, by involving ATSEP from at least 40 states on each phase.

1.5 The "Learning from the bottom" approach was adopted so that the entire spectrum of issues from different workplaces are captured.

1.6 The following process / stages were followed for the study; Literature research, personal interaction, Open-ended online survey, grouping of the factors, Closed-ended online survey and data processing and validation of countermeasures assumed in the early stages of the study.

1.7 ICAO's Human factors training manual is taken as a fundamental reference and SHELL model and REASON's model were taken for presenting the study to all participants. However, PEAR model and DIRTY DOZEN models were referred for further analysis of the inputs received.

1.8 As discussed in the CNS SG/23 the key references were taken from the links shared in the report of the meeting CNS SG/23 from the public domain of FAA and CANSO. In addition to these documents, documents from EASA / EUROCONTROL and other international organizations were referred.

1.9 The detailed study report is given as attachment and only key points, recommendation and further scope of the study are given in this WP.

2. DISCUSSION

Interactions with ATSEP

2.1 Interactive sessions on different slots were arranged at three major airports of India, namely Mumbai, Bengaluru and Kolkata. The key objectives set for the interactive sessions were to enable the ATSEP, to list the factors that add stress and fatigue by themselves, arrange them in the order of severity, identify whether it's an internal issue or an external issue and finally to suggest counter measure to mitigate the issues

2.2 Based on the time availability, one or more rounds of choices were given to the participants and they were insisted to come out with a new factor that was not listed earlier by them.

2.3 When time permitted, they have been asked to arrange the factors in the order of severity, identify whether it's an internal issue or external issue and finally to suggest counter measure to mitigate the issues as per the objectives.

2.4 Whenever a new group was called for different session, they were not shown any factors listed by the earlier group so that we could find out the common issues among groups irrespective of the airports and units they serve.

2.5 These initial interactions have confirmed that there are issues that need to be addressed scientifically as early as possible.

Open-ended online survey

2.6 After seeing the response from a limited group of ATSEP from India, IFATSEA decided to extend the similar interaction to different parts of the world.

2.7 To simulate the exact actions that were done during the personal interactive sessions, online participants were asked to go through the video presentations before answering the questions. And they were asked to list at least three significant factors and maximum of eight factors.

2.8 Online participants were asked more information than what was asked in the interactive session for using these data for further study at a later stage.

2.9 Only inputs received on selected questions from 289 forms were taken for the analysis as they were meeting the objectives of the study. 1400+ statements received from these 289 participants. While processing all the statements reference materials from ICAO, FAA, CANSO and EASA were considered.

2.10 The discrete statements were combined scientifically for easy reference and for further study into eight groups of statements. 1. Knowledge, Skills, Attitude, Competency and technology optimization, 2. Workload management, 3. Procedures, Information, Tools and Practices, 4. Duty time limitation – Shift (day/night/late), 5. Stress, Fatigue, Pressure, Time pressure and deadlines, 6. Lack of knowledge, communication, teamwork and leadership, 7. Selection, HR and other policies, 8. Workspace facilities / environment.

2.11 Having taken a wide range of input and categorized into eight groups, the following could be concluded. ATSEP human factor issues are universal in nature. Irrespective of the maturity levels of ANSPs in the human performance management w.r.t to the ATCOs, the maturity levels of human performance management system w.r.t ATSEP were low and mostly it is in the initiating stage only. Analysis was done based on PEAR model and for error issues Dirty Dozen was also applied

2.12 Each significant factor was analyzed in various angles and probable counter measures were identified. It was decided to go for a closed-ended survey with all counter measures into the questionnaire and reach once again all ATSEP for participating in the online survey.

Closed-ended online survey

2.13 ATSEP are provided with options from which they choose a response. Most of the questions were based on the significant factors and their counter measures.

2.14 It was decided to measure the safety culture, human performance management maturity levels and competency development framework within the organization.

2.15 Since we wanted more than those who have participated in the open-ended survey and to engage more ATSEP for validating the counter measures, the questionnaire was translated into Arabic, French, Japanese and Persian languages in addition to English version.

2.16 Most of the initial counter measures have been validated by ATSEP. At the end of this stage almost all the significant stress factors and their counter measures were matched and validated.

Global webinars on human factors of ATSEP

2.17 In addition to the interactions and online surveys, two global webinars were also conducted for deliberating some of the human factor issues and to discuss the benefits of addressing the human factor issues.

2.18 The first webinar was deliberated on high performing team. And the second one was on ANSPs resilience levels and their relationships with the competencies of ATSEP. During the second webinar, through a short duration polling, once again some of the factors and counter measures were taken up with the global ATSEP for their inputs.

Recommendations

2.19 After the entire process that we have discussed above, final consolidated counter measures and significant factors were listed as recommendations in the Chapter 10 of the study report.

2.20 Most important measures that ANSP need to take on priority are listed in the conclusion chapter and the same points are repeated here below.

2.21 Clear job description, roles, responsibilities and deployment as per DOC 10057 so that core competency is developed and retained and safety performance is assured. Defining accountabilities as per seniority with clear demarcation on technical as well as managerial aspects to avoid ambiguities.

2.22 Rationalizing existing human resources to carry the existing safety tasks and for developing necessary KSA and competency with job rotation. Regular recruitment in phased manner to supplement retirement and also for augmenting the new additional facilities.

2.23 Scientific resource allocations as per the number of complex systems and number of simultaneous tasks assigned to particular team. Structured workload distribution with reward and punishment mechanism for safe and non-safe performance, so that undue overload of work is prevented.

2.24 Implementation of all the phases of CBT/A as per DOC 9868 and DOC 10057 based on the roles and responsibilities of ATSEP and competency requirements. Augmentation of training infrastructures for required KSA and competency development in line with the successive induction of technologies.

2.25 Scientific shift duty duration and pattern with breaks in shifts and weekly clear OFFs for managing the fatigue and sleep management. Flexible working hours to general maintenance and project teams, after long work hours without break at remote sites either due to late hour calls, breakdown maintenance, VVIP movements and on installation activities.

2.26 Procurement policies by keeping long term safety objectives above cost of acquisition, for suiting the quick induction of the best available latest technologies and for best contract support after the acquisition. Service life expansion of old and obsolete equipment based on spare support contract and on the availability of optimum number of competent ATSEP on old technology.

Further scope of work

2.27 WG and CNS /SG 24 meeting may decide whether to extend the study to all APAC states or to review and enhance the chapter 7 and chapter 10 collectively in the coming days. Then we can proceed for a voluntary check in the APAC states on finding the maturity levels. IFATSEA is willing to contribute either way.

2.28 IFATSEA proposes to make a detailed human factor regional guidance material for the self-evaluation by states w.r.t ATSEP job profile and working environment. This regional guidance material shall enable the states to bench mark themselves and attain higher level of maturity in assuring the human performance.

2.29 Though there are several manuals and guidance materials available, IFATSEA, APAC would like to prepare a human factor training material for ATSEP, for the benefit of the regional ATSEP and ANSPs.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) Discuss on the study, study's recommendation and on further scope of work proposed by IFATSEA

b) Recommend and invite more volunteers on proceeding with the further stages.

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<table>
<tr><td colspan="3">Draft Conclusion/Conclusion/Decision XX/XX - REVIEW OUTCOMES OF SMALL WORKING GROUP STUDY ON HUMAN FACTOR ISSUES OF ATSEP</td></tr>
<tr><td colspan="2">What: The states are urged to utilize the recommendations made out of the study for their self-evaluation and for necessary pro-active measures. States are also urged to join the WG for finding the left-out gaps and in preparing the regional human factor guidance material.</td><td>Expected impact:
☐Political / Global
☐Inter-regional
☐Economic
☐Environmental
☐Ops/Technical</td></tr>
<tr><td>Why: To encourage initiating the human performance management in practice and continue the improvements</td><td colspan="2">Follow-up: ☐Required from States</td></tr>
<tr><td>When: 4-Dec-20</td><td colspan="2">Status: Draft to be adopted by PIRG</td></tr>
<tr><td colspan="3">Who: ☒Sub groups ☐APAC States ☐ICAO APAC RO ☐ICAO HQ ☐Other: XXXX</td></tr>
</table>

Enclosed: Attachment – Detailed study report "Factors adding stress and fatigue to ATSEP" Study to address the Human factors of ATSEP

Note: RAW data are not enclosed as it runs over 1000 pages of PDF document.

APAC

Factors adding stress and fatigue to ATSEP

Study to address the

Human factors of ATSEP

2019-2020

APAC

Factors adding stress and fatigue to ATSEP

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Abstract

To cope up with the new technologies and safety levels, ANSPs need to match modernization plans with human performance management of their key workforce i.e. ATSEP. To ensure the required level of human performance to assure safety, it is essential to understand the factors adding stress and fatigue in the present scenario. On understanding the factors and their effective counter measures, ANSPs can plan a human performance management system that can assure continues performance improvement w.r.t ATSEP.

The purpose of this study is to understand the abilities and limitations of Air Traffic Safety Electronics Personal (ATSEP) in their working environment. The study has focused on their roles, responsibilities, deployment, duty pattern, requirement of knowledge, skills, attitude, competency, training, and resources.

With the rich research literatures and best practices available in the civil aviation, this study assessed the present level ANSPs maturity levels in terms of human performance management pertaining to ATSEP.

This study report consists of twelve chapters to suit for a non-ATSEP reader. However, **senior ATSEP and human factor experts can proceed to Chapter 10.**

1. Chapter-1 Introduces ATSEP and IFATSEA
2. Chapter-2 Recollects the human factors in aviation.
3. Chapter-3 Introduces objectives, initial methodologies and alternate strategies followed after Covid-19 for the completion of this study
4. Chapter-4 Lists the literature and policies that are referred during the study.
5. Chapter-5 Highlights the significant incidents or accidents or major traffic diversions happened due to ground CNS/ATM facilities.
6. Chapter-6 Presents the inputs received through personal interactive sessions.
7. Chapter-7 Presents the inputs received through open-ended online survey.
8. Chapter-8 Presents the inputs received through closed-ended online survey.
9. Chapter-9 Briefs about the discussions and deliberations done on two global webinars on the human factors of ATSEP.
10. **Chapter-10 Presents the recommendations**
11. Chapter-11 Presents the future scopes on the study
12. Chapter-12 Presents the conclusion and commitment of IFATSEA

The study found that the human performance management maturity levels of ANSPs w.r.t ATSEP are in the very early stages and there are scopes for improvements. This global study conducted through different stages of interactions with ATSEP from different parts of the world, found significant factors that add stress and fatigue and effective countermeasures. **ANSPs are requested to make use of this global study recommendations** and to assure the safety objectives and achieve the organizational resilience from unprecedented crisis.

Acknowledgement

I would like to express my sincere thanks to **Airports Authority of India (AAI),** for giving me a vast experience in vide range of facilities, airports, work environments, cultural experience, challenging tasks and for sponsoring Air Navigation Service Providers Management, Advanced Masters Course (**ANSPMAMC**) of **ENAC (Ecole Nationale de l'Aviation Civile).** Without these knowledge and experience, this work wouldn't have been possible.

I would like to express my sincere gratitude to **Mr. Pan Singh E D (O & M),** Airports Authority of India (AAI) and **Mr. S.K. Swami E D (CNS-P)**, AAI for their continuous moral support. They remained as great inspiration to pursue the study with hard work and dedication.

I owe my deepest gratitude to **Mr. Thorsten Wahe** President, IFATSEA for his support and commitment on this study.

I would like to thank all the **work group members** to have co-operated with IFATSEA, for completing the earlier phases of the study by IFATSEA with missed deadlines due to ongoing Covid-19 pandemic.

Besides, I would like to thank my colleagues **Mr. M. Gopalakrishna** and **Mr. N. Venugopal** for their continuous encouragement and support in carrying out these studies. Without their support and encouragement, this study would not have been possible.

I am indebted to **my colleagues from India**, who supported me for carrying out the group discussions. Their encouragement and feedback helped a lot in the study.

I would like to thank **all the ATSEP from over 50 states**, those who have responded to my online survey, polling and participated in the global webinars.

I thank **ICAO, FAA, CANSO, Eurocontrol**, and all the other international organization for keeping all valuable research works, policies, manuals, documents and advisories in the field of human factors in aviation in public domain for easy access and for global community benefits. I thank all social media tools and online meeting service providers, for making the entire interactive study possible even under Covid-19 pandemic.

Last but not the least; I would like to thank **my wife and my daughter** for supporting me all the while.

Senthilvel Balasubramanian
IFATSEA, Regional Director, Asia Pacific

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1. Introduction

1.1. Air Traffic Safety Electronics Personal (ATSEP)

The term Air Traffic Safety Electronic Personnel (ATSEP) has been invented to describe those technical specialists working to provide and support the electronics and software, which enable ATS systems to function. ATSEP comprise engineers, technicians, and computer hardware and software specialists who are responsible for the specification, procurement, installation, calibration, maintenance, testing and certification of ground electronic systems used to help control aircraft movements.

ATSEP may perform tasks on a wide variety of CNS/ATM systems and equipment requiring a wide range of competencies and expertise as well as knowledge and skills in electronics, computer sciences and network. In addition, ATSEP activities may be carried out from technician to high-level engineering. *Figure 1* illustrates the possible scope of ATSEP activities using as a basis the engineering lifecycle from system conception through design, operations and finally decommissioning.

In addition to technical activities, others may be added related to management, teaching or assessment, safety management, security management (e.g. networks) and quality management. Training programmes should be focused on the specific activities assigned to ATSEP within an ANSP. To ensure global standardization, DOC 10057 has recommended that ATSEP training be organized in the phases as given in the *figure 2*.

ATSEP will go through training at different points in their career. Typically, ATSEP will progress from the selection phase to the completion of the unit training phase. Then, they will go through the continuation training phase to maintain competency.

In addition, ATSEP will require training when

1. There is a change within a system on which the ATSEP is already working. This is addressed through continuation training.
2. The ATSEP changes domains (e.g. from navigation to surveillance). This is addressed through either initial training or unit training.
3. A change of activities and associated competencies (e.g. change from maintenance operations to system implementation) is addressed through development training.
4. Any additional system to be operated by an ATSEP is addressed through unit training.

The above training progression under which ATSEP is trained and competencies are maintained is shown in the figure “ATSEP training progression”

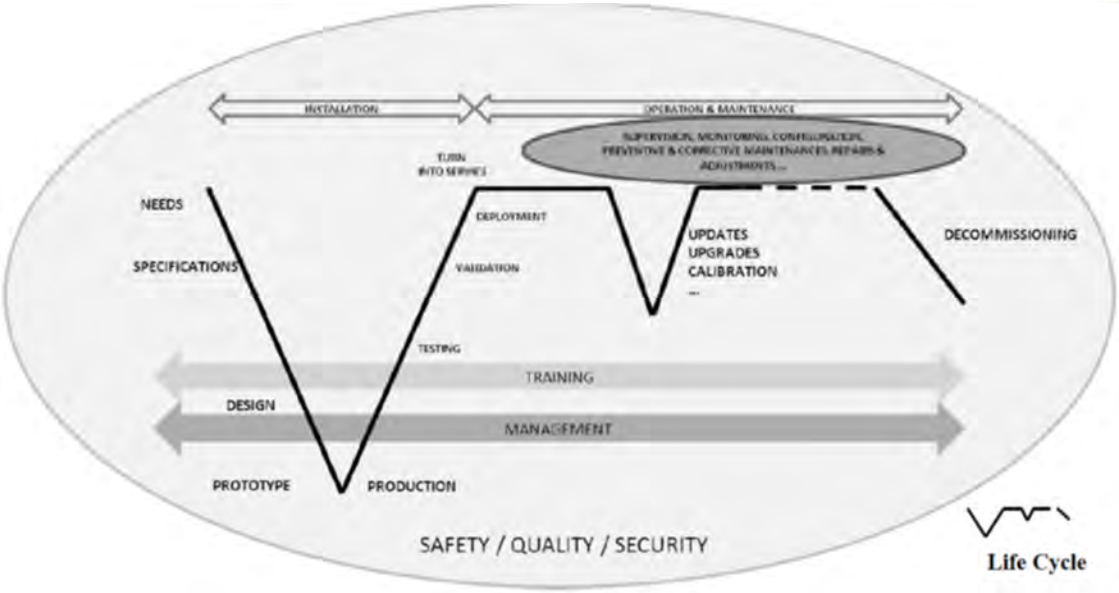

Figure 1 Scope of ATSEP activities

Figure 2 ATSEP training levels

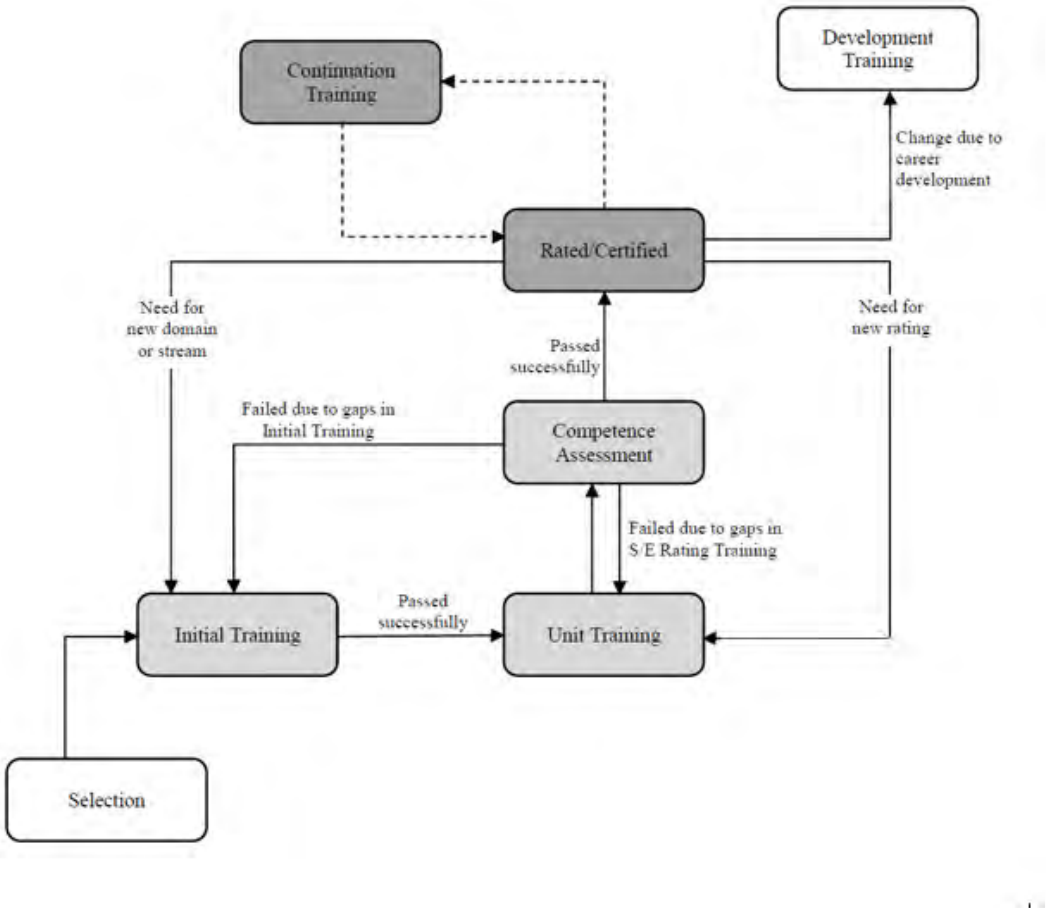

Figure 3 ATSEP training progression

1.2. People, Procedure and equipment

A typical working environment on which ATSEP performs their tasks is depicted in the figure 3. The environment includes people, procedures and equipment. ICAO SHELL model referred in DOC 9683 and which is discussed in next subtopic is well applicable and addresses the human factor issues of ATSEP.

Active participation and contribution of ATSEP are essential in all the stages of ANS ground facilities, right from the installation to operation. Addressing the human factor issues of ATSEP during these stages are very essential and issues related in the operation environment are very significant, addressing of these issues contributes directly the safety, capacity and efficiency of ANS.

Information processing for quick and correct response and decision greatly influenced by the stress and strain, work load and fatigue. Scientific means of job allocations, job rotations and job hours will reduce the negative contribution. Mechanisms to be put in place to identify the symptoms and for resolving stress.

Continuous duty hours without proper rest affect significantly the information processing and delaying the corrective action particularly in the long night shifts without any breaks.

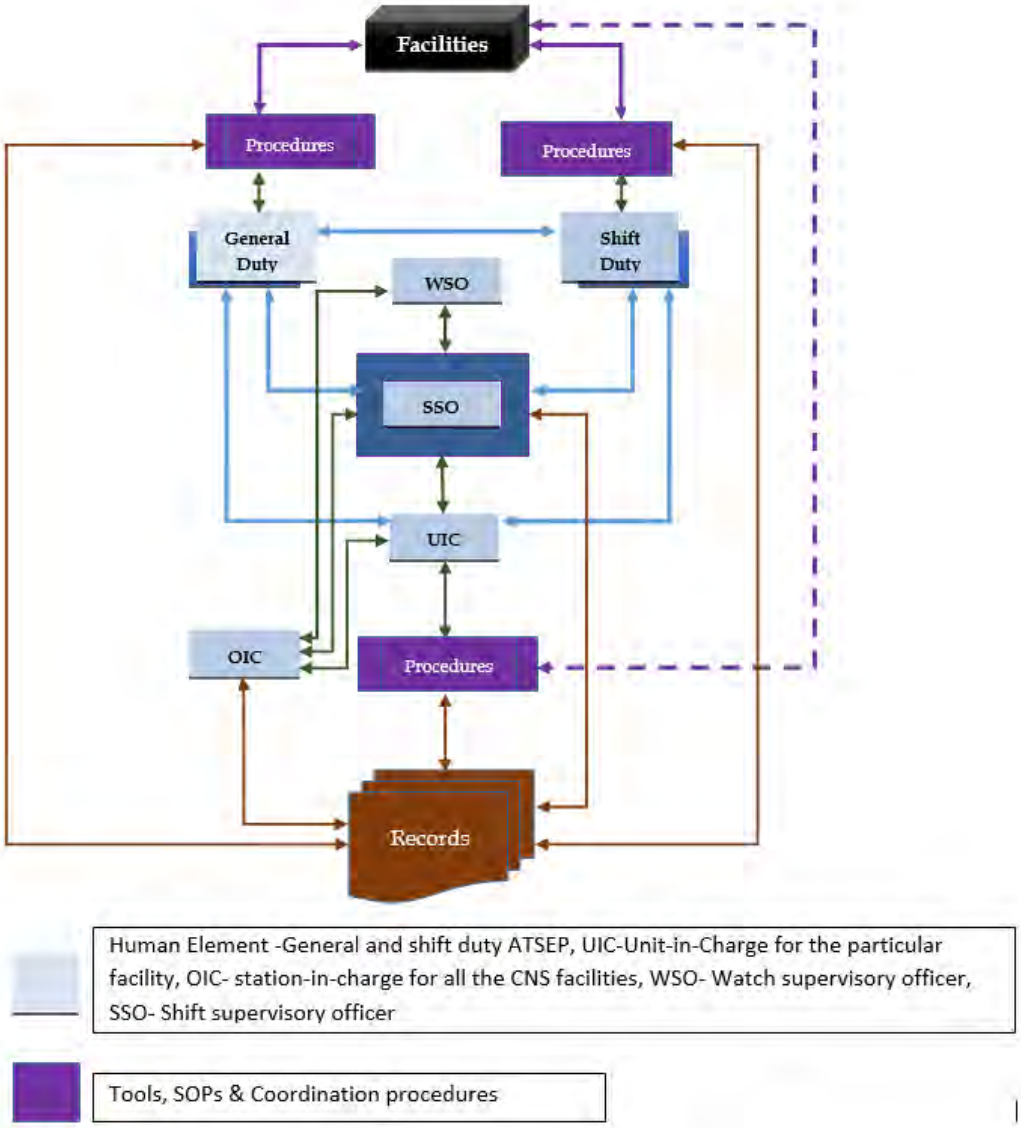

Figure 4 Working environment of ATSEP – coordination and maintenance framework

Mechanism to identify the signs of lack of physical, emotional, intellectual and social wellness of ATSEP need to be put in place for early solutions. These factors affect the team performance of ATSEP hence the safety performance of the ATSEP as a team and as system.

ATSEP are expected to perform duties with wide varying environment from high raised tower to cable trenches in the ground, very hot open place to temperature-controlled equipment room, very busy cities to very remote places of the state. Addressing the ergonomics, work place design, impact of noise and temperature in the operational area will enhance their health and contributions.

Necessary attention is required for assigning the workload as per ability. Measures in formal experience sharing among ATSEP on a regular basis improves the ability and confidence of all the ATSEP and make them suitable to be team member on a big team or even to work alone in a remote place.

The roles played by ATSEP need to be clearly defined with definite goals. This will avoid role conflicts and ambiguity on the expected performance. Communication factors to be addressed scientifically and their proficiency on writing technical reports, SOPs and specifications to be enhanced and assessed. Mechanism need to be put in place for detecting the errors and controlling the errors.

1.3. ATSEP in the safety chain

The Aviation industry requires 24-hour activities to meet the operational demands. Global growth in the industry will continue to increase these round-the-clock requirements. Air Traffic Service must be available to support 24-hour a day operation to meet these industry demands.

Programs for modernizing the air navigation infrastructure in both CNS and ATM are well underway around the globe. The implementation of new technologies will bring significant benefits to air navigation service providers and their customers. At the same time, a new set of regulations are being established for the implementation and efficient operation of future CNS/ATM systems.

Air Traffic Safety Electronics Personnel (ATSEP) are the authorized personnel who are proven competent to install, operate, maintain, release and return into operations CNS/ATM equipment. It needs to ensure they have qualified and competent ATSEP in order to install maintain and operate, at optimum performance and resilience, these globally interconnected and complex CNS/ATM systems.

ATSEP are responsible for ensuring the integrity and availability of the information used by both pilots and ATCO. Services performed by ATSEP have been proven throughout the years as critical to ensuring safety and efficiency in the civil aviation.

ATSEP are responsible for the provision of required communication, navigation and surveillance performance, which are critical enablers to ensure Performance-Based Navigation (PBN) in any given airspace as stipulated by ICAO. High availability, accuracy, continuity and resilience of this services are very important factors in the aviation business. Unreliable CNS services lead to delays and increased pilot and controller workload.

Thus, the availability and continuity of ATM/CNS services impacts efficiency and increases user costs. Similarly, an ATM system failure can have major consequences. Traffic patterns of an entire flight information region can be affected with significant impact on flight schedules, increased fuel burn, and a more complex air traffic control environment.

It is worth noting that after the sabotage in 2015 in Chicago ATC Center, ATSEP have expedited the replacement of the central communications network to restore service for ATC.

Civil aviation is based on a worldwide interoperable system involving air and ground infrastructure, procedures, and regulations to ensure safe, efficient and effective operations. These interconnected systems pose cybersecurity challenges in the area of ATM. ATSEP are in the forefront of addressing cybersecurity issues as soon as they arise in them.

ATSEP are responsible for ensuring the integrity and availability of the information used by both pilots and ATCO. Services performed by ATSEP have been proven throughout the years as critical to ensuring safety and efficiency in the civil aviation.

ATSEP must ensure the resilience of the whole system in a standardized manner. New cybersecurity challenges in the area of CNS/ATM (e.g. Remote Towers) ATSEP are in the forefront of addressing cybersecurity issues and threats equally in the networked ATM systems, at remote CNS facilities or for the 'signal in space'. These professionals need to be trusted, competent and responsible. Identifying a technical failure from a cybersecurity breach is a significant responsibility for ATSEP.

The ATM system is evolving towards a globally integrated and collaborative system. Air traffic safety electronics personnel (ATSEP) involved in the installation, operation and maintenance of the CNS/ATM system must have a shared understanding of what is expected of them in terms of performance wherever they may work in order to support a globally interoperable system and to achieve optimum capacity within acceptable safety limits. This shared understanding becomes critical when considering the increasing traffic and the growing complexity and interconnectedness of the systems involved.

As controller-pilot and system-to-system interfaces evolve, the ATSEP installing, operating and managing the CNS/ATM system need to share a common reference to ensure seamless operations.

- Operational activities.

Supervision, monitoring, control and reporting in real time of technical services, supported by electronic systems and/or equipment for CNS/ATM.

- Maintenance activities.

Preventive maintenance, corrective maintenance and/or modification and updates of supporting electronic systems and/or equipment for CNS/ATM.

- Installation activities.

Project management, specification, conception, validation, integration, test and acceptance, safety assessment, calibration, certification, optimization and upgrade of supporting electronic systems and/or equipment for CNS/ATM, engineering activities.

In addition to technical activities, others may be added related to management, teaching or assessment, safety management, security management (e.g. networks) and quality management.

1.4. Unique characteristics of ATSEP working environment

Operational environments, such as the flight deck or the ATC room, pilot or the controller will see the effects of the error before the aircraft completes its flight. It does not always apply to aircraft maintenance error. In contrast to the "real-time" nature of error in ATC and the flight deck, aircraft maintenance errors are often not identified at the time the error is made.

Where as in case of ATSEP working environment, the error caused during the operation of the system will be known immediately to ATC as well as to ATSEP as they always work in the live system. At the same time any error caused during the installation, testing and commissioning stages won't be known immediately when the error is made.

ATSEP are expected to attend the degraded system live and always under pressure to make the system available in fullest capabilities. Unless otherwise there is a total breakdown, ATSEP carry their preventive and corrective maintenance works when the systems are working either in full capable mode or in degraded mode of operation. This makes their working environment very unique among the safety chain stake holders

1.5. International federation of Air Traffic Safety Electronics Association (IFATSEA)

IFATSEA is recognized as an observer by ICAO. Working Together with Eurocontrol, IFATSA developed the ATSEP training manual adopted as ICAO document 7192.

IFATSEA contributes to the work of the SESAR Joint Undertaking, defining the future technology platform for the Single European Sky. IFATSEA is participating to the EASA rulemaking activities related to ATSEP and their competency.

IFATSEA maintains working relationships with the ATM staff trade union organizations European Transport Workers' Federation (ETF) and International Transport Workers' Federation (ITF). IFATSEA also collaborates with the global federations for other Aviation Professional Staff – IFATCA and IFALPA.

IFATSEA is governed by an Executive Board. Elections are conducted every two years at the Annual General Assembly, at each occasion half of the board membership is available for election.

Elected Officers serve a **four-year** term and are eligible for re-election. The officers of IFATSEA are President, Executive Secretary, Treasurer, Vice-President along with four Regional Board members, also known as Regional Directors.

The Regional Directors co-ordinate matters which are of interest to affiliates on a regional basis, affiliates are organised into the regional groups of Africa, Americas, Asia Pacific and Europe.

- The Objectives of IFATSEA

To operate as a non-political Federation of Air Traffic Safety Electronics Associations.

To promote safety, efficiency and regularity in International Air Navigation.

To assist and advise in the development of electronics systems in order to maintain the safe, orderly and expeditious flow of air traffic.

To uphold a high standard of knowledge and professional efficiency among Air Traffic Safety Electronics personnel.

To protect and safeguard the collective professional interests of Air Traffic Safety Electronics personnel.

To make mutual benefit affiliations with other professional organizations.

To strive for a worldwide Federation of Air Traffic Safety Electronics Associations

2. Human factor studies in aviation

In the early days of powered flight, the design, construction and control of aircraft predominated. The main attributes of the first pilots were courage and the mastery of a whole new set of skills in the struggle to control the new flying machines.

As the technical aspects of flight were overcome bit by bit, the role of the people associated with aircraft began to come to the fore. Pilots were supported initially with mechanisms to help them stabilize the aircraft, and later with automated systems to assist the crew with tasks such as navigation and communication. With such interventions to complement the abilities of pilots, aviation human factors were born.

Aircraft accidents such as that to the Aloha aircraft in the USA and the BAC 1-11 windscreen accident in the UK brought the need to address human factors issues in this environment into sharp focus. This does not imply that human factors issues were not present before these dates nor that human error did not contribute to other incidents; merely that it took an accident to draw attention to human factors problems and potential solutions.

Initially, ICAO's Human Factors actions have been directed towards flight crew performance, then towards the performance of air traffic controllers, and later towards the performance of aircraft maintenance personnel.

In the present technology centric air-ground CNS/ATM systems, ATSEP role in the safety chain is very important to seal all the holes in the last layer of defense. However, human factors of ATSEP are not addressed or focused as it is done on the performance of Pilots, AME, ATCOs, MET, ASO and Flight Dispatchers.

The installation, testing, commissioning, operation and maintenance of all these CNS/ATM facilities are essential for all ANSPs in meeting their global commitment of safety. These essential tasks have been entrusted with the Air Traffic Safety Electronics Personal (ATSEP) by ANSPs.

The stressful working environment that can lead to errors, lapses, latent or error-causing conditions that brings the invisible windows of opportunity for unsafe acts, or even fatal accidents. Given the unique nature of the job performance with zero tolerance for error and with the requirements of high levels of technical skills, there is a need for defining uniform standards on the roles, responsibilities, training requirements, duty time limitations and adequate human resources with regards to ATSEP who are playing vital role in the safety chain.

Investigations of various incidents Statistics of non-reportable Incidents to the operation and accidents such as Uberlingen, Korean Air in GUAM and Linate Airport have demonstrated the strong safety relationship.

The following accident report data factors Airport/ATC/Other where ATSEP are in the chain.

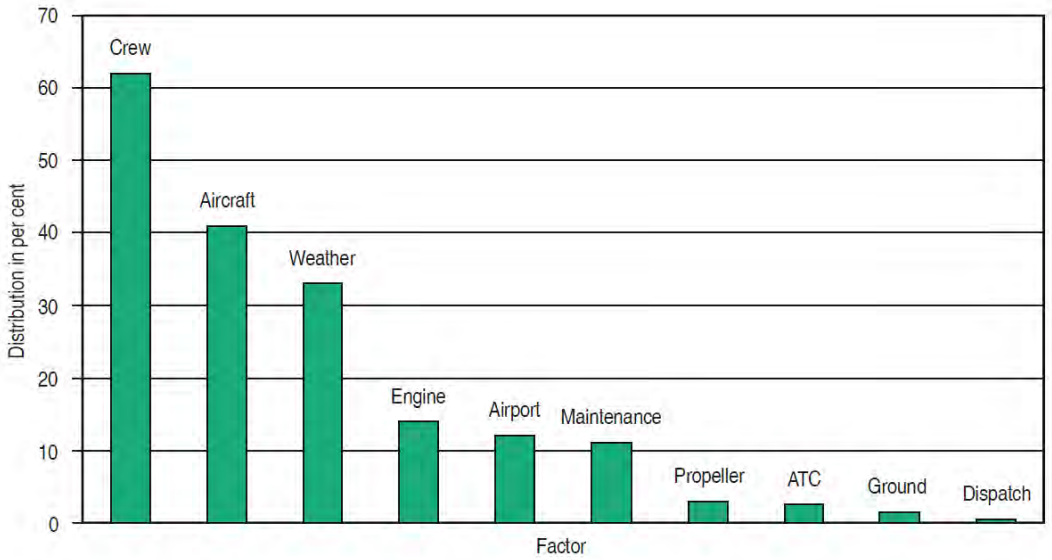

Figure 5 Accident data report factors distribution for worldwide airline operations (based on data reported to ICAO from 1970 to 2000) DOC 9824

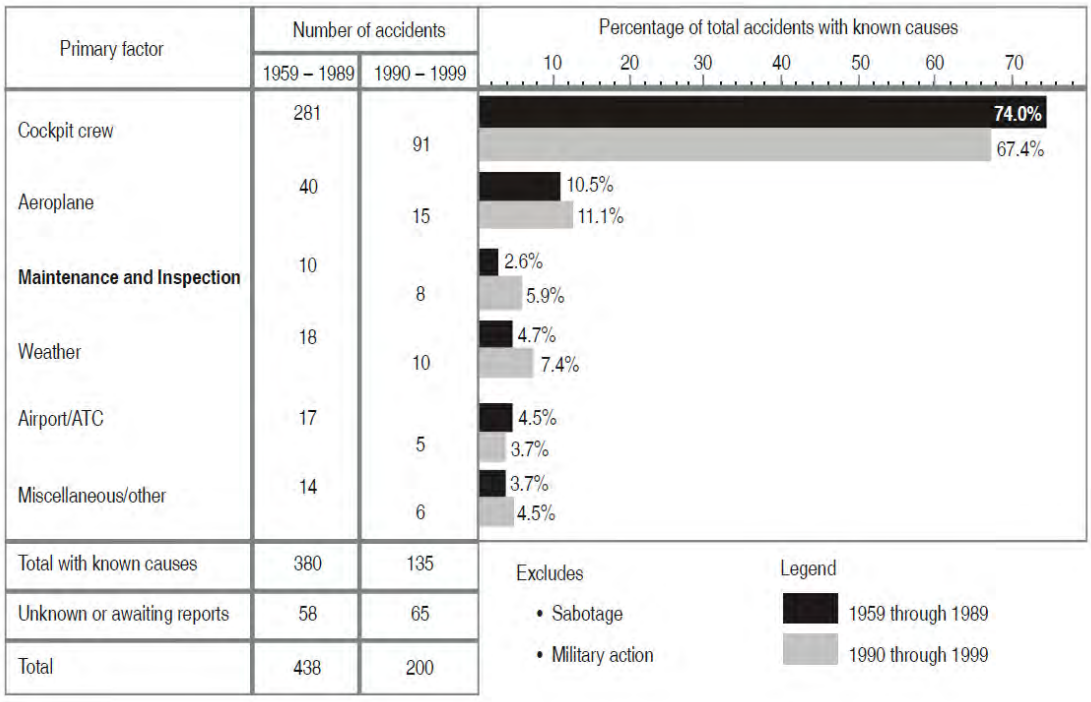

Figure 6 Maintenance error as a primary cause in hull loss accidents (DOC 9824)

2.1. Human factor studies on PILOTs

- In 1950, the Ergonomics Research Society (now the Ergonomics Society) was born. The word ergonomics was coined by Professor K.F.H. Murrell, derived from the Greek meaning, 'the science of work'. In the United States, analogous developments took place leading, in1957, to the formation of the Human Factors Society. While Human Factors continued to develop in the areas of ergonomics, pilot selection and training, it became clearer that human error and accidents in aviation were related to such processes as pilot judgement, cognition and sensory perception. While these processes all have a physiological base, they are all psychological processes. As such, Human Factors started to draw heavily on what is now commonly called 'aviation psychology'.
- Crew Resource Management.
- Boeing has addressed human factor issue by employing human factors specialists, many of whom are also pilots or mechanics, since the 1960s. Initially focused on flight deck design, this group now considers a much broader range of elements such as cognitive psychology, human performance, physiology, visual perception, ergonomics, and human-computer interface design. Applied collectively, their knowledge contributes to the design of Boeing airplanes and support products that help pilots perform to the best of their capability while compensating for their natural limitations.

2.2. Human factors studies on AMEs

- Under the auspices of the National Plan for Aviation Human Factors, the FAA has recognized the importance of the role of the human in aircraft safety, focusing research on the aircraft inspector and the aircraft maintenance technician (AMT). The classic term, "pilot error" or "human error", is attributed to accidents or incidents over 75% of the time; however, a recent study in the United States found that 18% of all accidents indicate maintenance factors as a contributing agent.
- Over the last decade various human factor studies in maintenance related issues have been initiated by agencies such as the FAA and NASA, by manufacturers and by the aircraft maintenance industry. Examples of this initiatives are the National Aging Aircraft Research Plan-NAARP, the Safer Skies initiative, the White house panel on aviation safety and NASA's aircraft maintenance programme to name a few. The object of all these studies has been to identify research issues and to promote and conduct both basic and applied research related to human factors in aircraft maintenance. The human factor approach in maintenance research considers the human factor in the centre of the system.

- Civil Aviation Authority (2002) CAP 716 Aviation Maintenance Human Factors Boeing (1993) Accident Prevention Strategies: Commercial Jet Aircraft Accidents World Wide Operations 1982-1991
- Marx, D.A. and Graeber, C. (1994) Human Error in Aircraft Maintenance; Chapter 5. In: Johnston, N., McDonald, N., Fuller, R. (Eds) (1994) Aviation Psychology in Practice. Aldershot: Avebury Aviation.
- FAA. "Reliability in Aircraft Inspection: UK and USA Perspectives". Chapter 9 of FAA/AAM Human Factors in Aviation Maintenance and Inspection Research Phase IV Progress Report. 1995.

2.3. Human factors studies on ATCOs

- V. David Hopkins, Human Factors in Air Traffic Control, Taylor & Francis, 1995
- Anne R. Isaac and Bert Ruitenberg, Air Traffic Control: Human Performance Factors, Ashgate, 1999.
- Christopher D. Wickens et al, The Future of Air Traffic Control: Human Operators and Automation, National Academy Press, 1998.

2.4. Human factors studies on ATSEP

The International Federation of Air Traffic Safety Electronics Association (IFATSEA) emphasized the importance to study the human factor issues of ATSEP on their working environment, abilities, limitations and on other characteristics for evaluating their job and safety performance CNS / SG 23 at Bangkok. As deliberated in the meeting, IFATSEA has initiated the study by involving ATSEP from different states. The progress, findings and recommendations are given further in this report.

3. Study on human factors of ATSEP

As discussed earlier, The International Federation of Air Traffic Safety Electronics Association (IFATSEA), IFATSEA has initiated the study by involving ATSEP from different states.

Though IFATSEA, had elaborated the factors that cause the human factor issues to the ATSEP and the possible impacts on safety and efficiency in airports operations and air navigation services in the paper CNS SG/23 – WP/19 Agenda Item 9, "Factors adding stress and fatigue to ATSEP and the need for a study" there was a need for a collaborated study involving ATSEP and ANSPs.

During the CNS SG/23 meeting the best practices already available on the human factors in civil aviation was pointed out by CANSO and FAA. So, it was decided to draw references from existing best practices, and correlate the human factor issues of ATSEP, including stress and fatigue, and place the outcome of the studies in the CNS/SG/24 for further discussion.

The meeting considered that establishment of a small working group would be necessary to support such study. Australia, China, Hong Kong China, India, Nepal, the Philippines, Singapore and IFATSEA volunteered to be members of the study working group.

3.1. Study objectives

- To study the human factor issues of ATSEP on their working environment
- Identify the significant factors that add stress and fatigue and affect their safety job performance.
- To understand the stress and fatigue levels of ATSEP and for resolving potential risks to ANS
- Identify the significant counter measures
- Identify the means for improving the safety culture and professional engagement.

The expected outcomes of the study are

- Significant factors will be identified and addressed through appropriate counter measures.
- By addressing the safety job performance issues of ATSEP, who in turn play a very crucial role in the safety chain, ANSPs will enhance their services with safety.
- Significant findings and standardization of ATSEP role across the globe

3.2. Initial phases planned

Due to various constraints including Covid-19 and pre-occupation on essential operational and project works the phases as per initial plan got delayed and couldn't be completed. So, went for the revised strategies and plans with different phases.

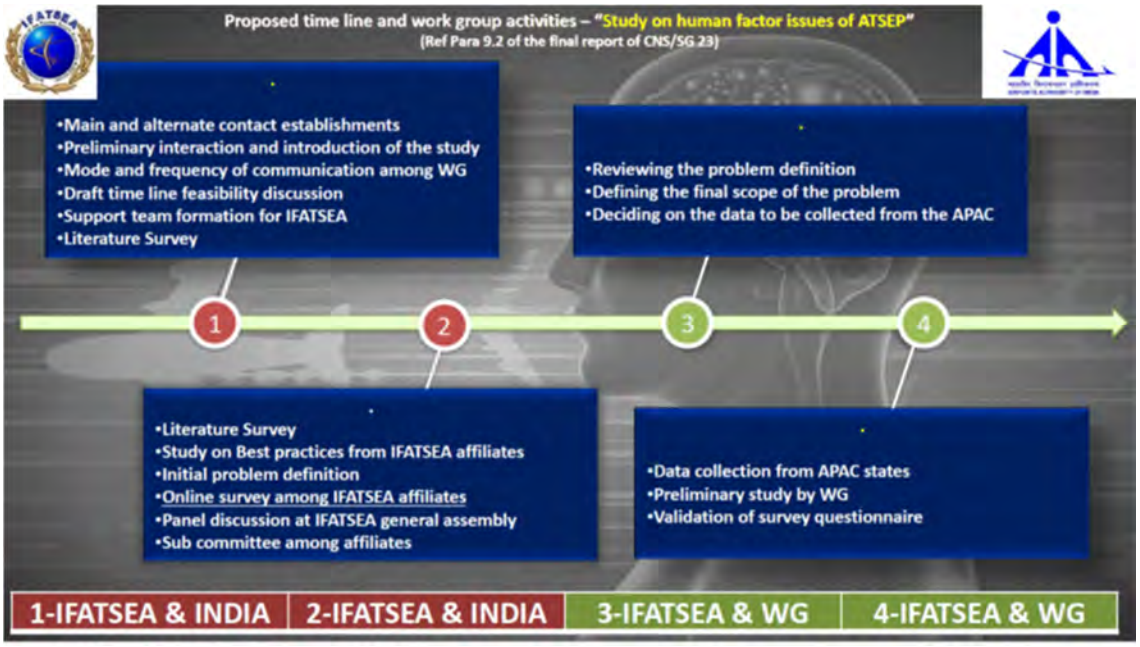

Figure 7 Initial plan and stages 1 to 4

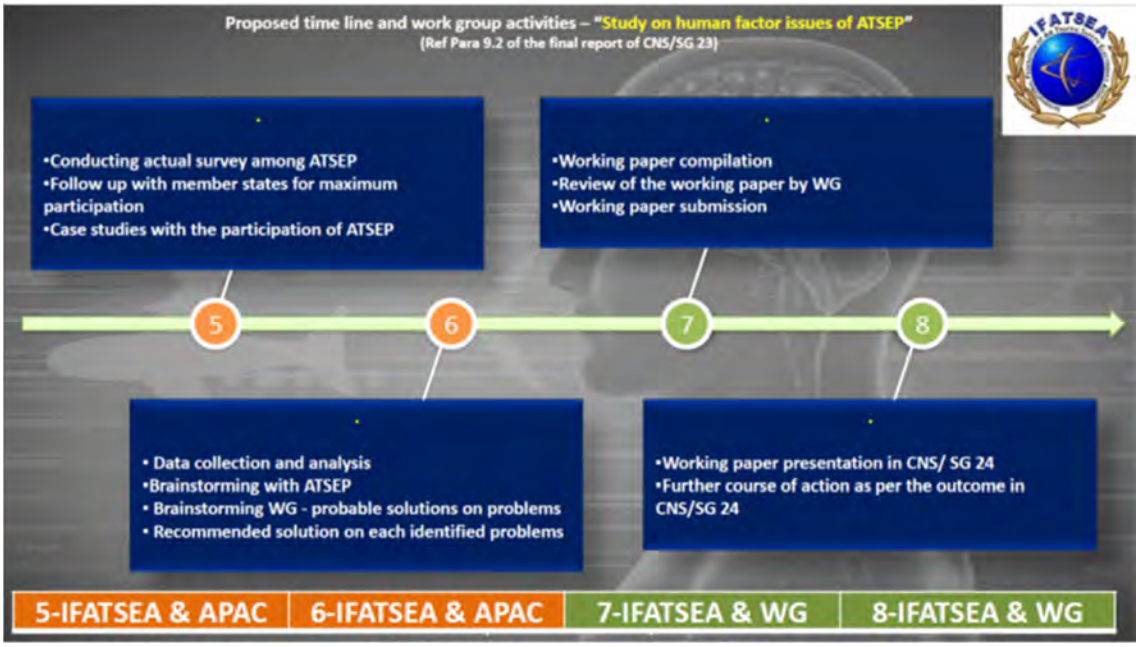

Figure 8 Initial plan and stages 5 to 8

3.3. Phases completed as per reviewed plan

Carefully reviewed and planned the study with additional phases However, all the revised phases were executed as shown and the study was conducted globally, by involving ATSEP from at least 40 states on each phase.

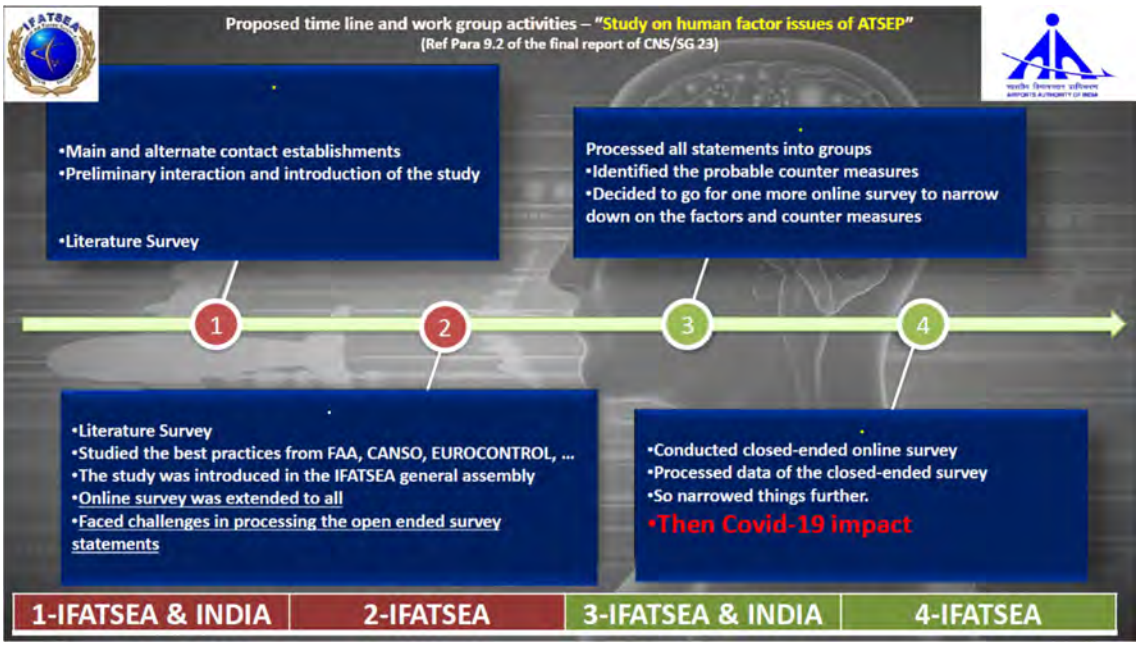

Figure 9 Revised plan and stages 1 to 4

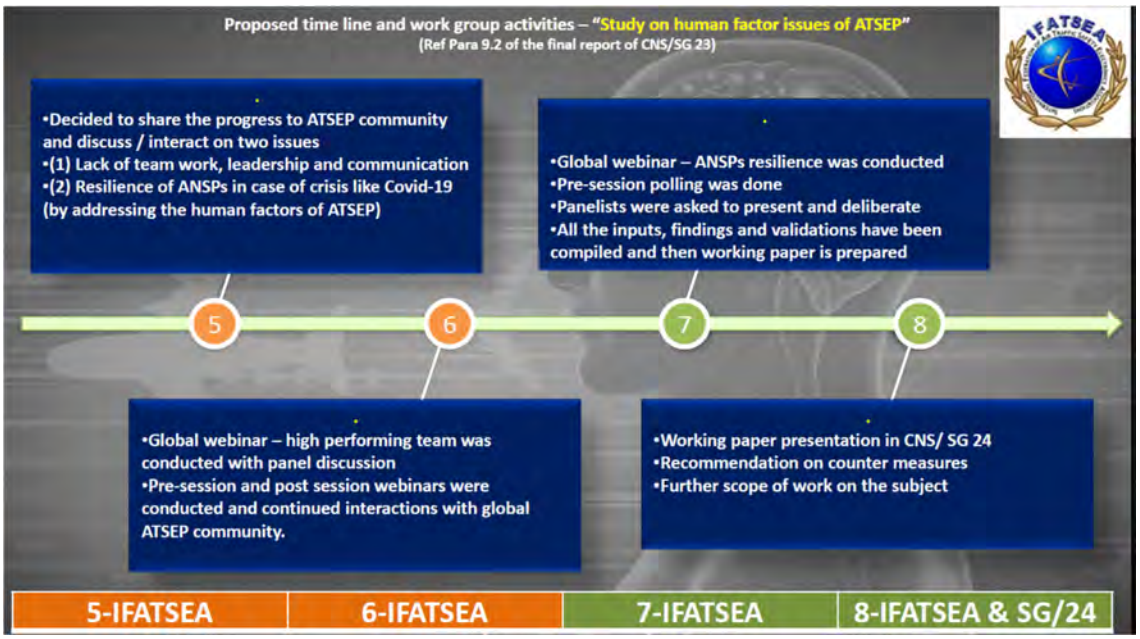

Figure 10 Revised plan and stages 5 to 8

3.4. Methodology

Methodology adopted and steps followed for the study is given below. The approach adopted was a "Learning from the bottom". So that the entire spectrum of issues from different workplaces within the states as well as from other states are captured.

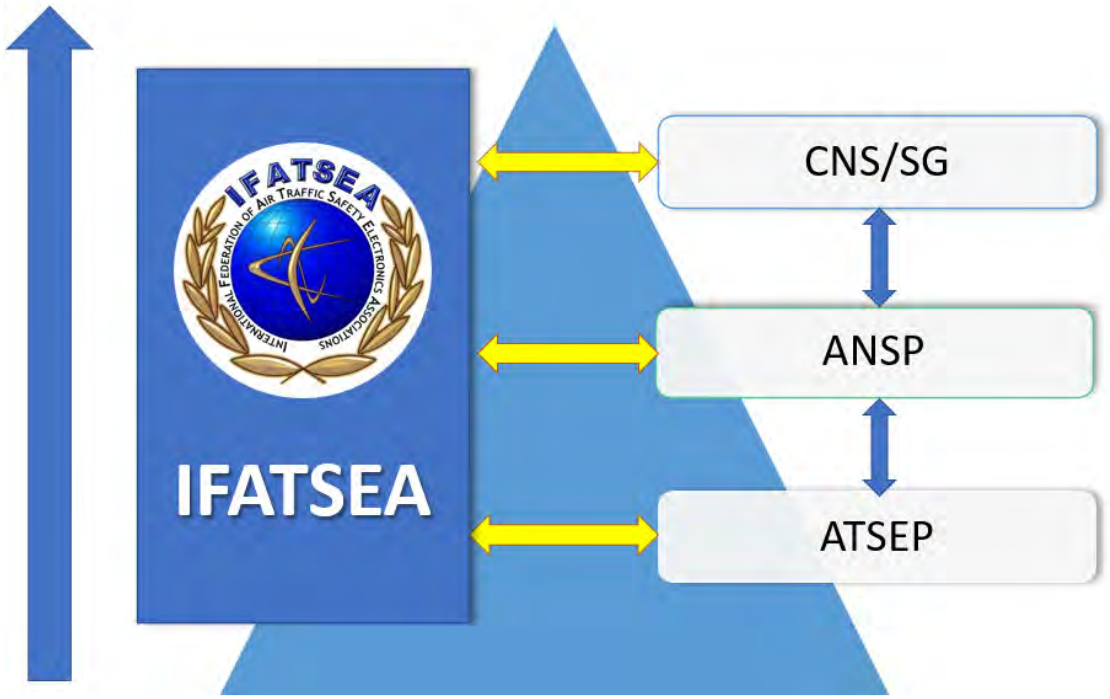

Figure 11 Methodology adopted to meet the study objective

The steps followed

a. Literature research
b. Direct interaction
c. Direct interaction data analysis
d. Open-ended survey for extending the interactions
e. Open-ended survey data analysis
f. Preliminary counter measures
g. Closed-ended survey for validating the preliminary counter measures
h. Closed-ended survey analysis
i. Validation of the preliminary counter measures identified
j. Sharing the progress of the study to the participants and involving them in focused interactions on selected areas of human factors.
k. Engaging them in the study and cross checking the validated solutions
l. Report the findings and recommendations to CNS SG/24 and WG
m. Collaborating with the WG for extending the assessment to all APAC states
n. Presenting the outcome at the future meeting of CNS SG/25

4. Literature review on human factors

ICAO's Human factors training manual is taken as a fundamental reference and SHELL model and REASON's model were taken for presenting the study to all participants. However, PEAR model and DIRTY DOZEN models were referred for further analysis of the inputs received.

As discussed in the CNS SG/23 the key references were taken from the links shared in the report of the meeting CNS SG/23 from the public domain of FAA and CANSO. In addition to these documents, documents from EASA / EUROCONTROL and other international organizations were referred.

The entire list of reference literatures is given in this chapter. However, the latest update may be found from the respective international organizations.

4.1. Reference from ICAO

Human factors training manual
ICAO, First Edition-1998, Doc no.: 9683iAN/950

Human Factors Guidelines for Aircraft Maintenance Manual
ICAO, First Edition2003, Doc 9824 AN/450

PERFORMANCE MANAGEMENT AND MEASUREMENT FOR AIR NAVIGATION SERVICES PROVIDERS, Submitted by the ICAO Secretariat, 2007

4.2. Reference from FAA

Maintenance human factors presentation system – FAA Advisory Circular, Maintainer Fatigue Risk Management FAA, AC No: 120-115, 12/2/16

Advisory Circular, Maintenance Human Factors training
FAA, AC No: 120-72A, 4/11/17

Failure to Follow Written Procedures
FAA, December 2017

Fatigue Solutions for Maintenance: From Science to Workplace Reality
FAA, December 2011

Aviation Mx HUMAN FACTORS QUARTERLY newsletters – FAA

Maintenance Human Factors – FAA Presentations

Failure to Follow Procedures: The Buck Stops with Me – FAA

Operator's Manual
Human Factors in Aviation Maintenance September 2014 - FAA

Failure to follow written procedures – FAA

FAA Human factors guide for aviation maintenance and inspection

4.3. Reference from CANSO

CANSO Standard of Excellence in Human Performance Management
CANSO, 2019 version

4.4. Reference from Eurocontrol

A Human Performance Standard of Excellence
A EUROCONTROL-FAA Action Plan 15 White Paper, December 2015

ATM Safety Framework Maturity Survey (Methodology for ANSPs)
Document No: ESP-2009-78 (Edition 1)

EASA Human Factors requirements

Human Factors Module Interpersonal Communication
EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION, HUM.ET1.ST13.1000-REP-02, Edition 1.0, 1997

Human Factors Module Stress,
EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION, HUM.ET1.ST13.2000-REP-01, Edition 1.0, 1996

EASA Module 9 Human factors AVIATION MAINTENANCE TECHNICIAN CERTIFICATION SERIES
Aircraft Technical Book Company, 2015

Guidelines for the Competence Assessment of Air Traffic Safety Electronics Personnel
EUROPEAN ORGANISATION FOR THE SAFETY OF AIR NAVIGATION, Edition 1.0, 2006

Aviation Maintenance Human Factors (EASA / JAR145 Approved Organisations) -- Guidance Material on the UK CAA Interpretation of Part-145 Human Factors and Error Management Requirements (CAP 716)
CAA 2003, Re-issued August 2006

An Introduction to Aircraft Maintenance Engineering Human Factors for JAR 66
(CAP 715) Civil Aviation Authority 2002, First Edition 22 Jan 2002

DAS/HUM
Fatigue and Sleep Management Personal strategies for decreasing the effects of fatigue in air traffic control, Eurocontrol

4.5. Other references

Safety behaviours Human factors, resource guide of engineers
Developed by Civil aviation security authority (CASA), govt of Australia 2013

Human capability to cope with unexpected events
Jean Paries, Viravanh Somvang

Swedish Radiation Safety Authority, Report number: 2017:34 ISSN: 2000-0456
Just Culture Manual for ATCO, ANSE & ATSEP behaviour after an incident and further proceedings
Brochure designed and written by SwissATCA (Swiss Air Traffic Controllers' Association)

Safety behaviours Human factors, facilitator's guide of engineers
Developed by Civil aviation security authority (CASA), govt of Australia 2013

Organizational Resilience: A summary of academic evidence, business insights and new thinking by BSI and Cranfield School of Management
BSI and Cranfield University 2017 First published 2017

Guidance on organizational resilience
BSI Standard Limited, Nov 2014, Ref no.: BS 65000:2014

5. Significant references from the recent past and current affairs

Table 1 Significant references from the recent past and current affairs

Sl No.	Date	Airports Affected	Facility Affected	Cause of Failure	Time taken to restore the facility	Impact on operation
1	30-04-2014	Los Angeles, Southern California, western Arizona, southern Nevada and part of Utah.	En Route Automation Modernization system, ERAM	Computer system failure due to shortage of memory	more than 5 hrs	Federal Aviation Administration held planes on the ground at Los Angeles International Airport, Mentioned Areas were affected by the shutdown and all flights faced several hours delay.
2	20-12-2014	Swanwick in Hampshire	National Air Traffic Services' en-route control centre (NERC)	Computer System failure	45 minutes	120 flights were cancelled and 500 flights got delayed for an average of 45 minutes
3	12-01-2017	Porto Santo	ASMGCS System	Cable cut	1 Hrs and 30 Minutes	Aerodrome operation was shut down for the duration. Tower control was not able to communicate with aircraft.

Table 2 Significant references from the recent past and current affairs Contd...

Sl No.	Date	Airports Affected	Facility Affected	Cause of Failure	Time taken to restore the facility	Impact on operation
4	03-04-2018	Brussels, Belgium	Euro control ATFM System (Flight Data Processing system lower space)	Software issues (Data Glitches)	_____	15000 flights were grounded/affected
5	08-06-2018	Reims ACC	ACC	Communication System Failure	1,088 minutes of ATFM delay;	300 +flight did not operate and 50+ route diversions as per Eurocontrol monthly network operation report June 2018
6	09-06-2018	Marseille TMA	TMA	Surveillance system failure	1,252 minutes of ATFM delay	300 +flight did not operate and 50+ route diversions as per Eurocontrol monthly network operation report June 2018
7	26-06-2018	France	Across all French ACC	FDPS Failure France	69,402 minutes of ATFM delay a	300 +flight did not operate and 50+ route diversions as per Eurocontrol monthly network operation report June 2018

Table 3 Significant references from the recent past and current affairs Contd...

Sl No.	Date	Airports Affected	Facility Affected	Cause of Failure	Time taken to restore the facility	Impact on operation
8	30-06-2018	Makedonia ACC	ACC	Communication System Failure	2,533 minutes of ATFM delay.	300 +flight did not operate and 50+ route diversions as per Eurocontrol monthly network operation report June 2018
9	10-07-2019	Gatwick Airport, London	Tower Automation	Software issues	3hrs 15 minutes	177 flights cancelled and many were diverted
10	26-07-2019	Gatwick Airport, London	RADAR issues	NA	_____	Flights were delayed and cancelled at Heathrow, Gatwick and London city airport
11	01-09-2019	Marseille, Bordeaux, Paris, Reims and Brest Airports	Common centralized computer and communication system (AMSS)	Countywide computer system failure	more than 5 hrs	Flights were delayed and cancelled at Marseille, Bordeaux, Paris, Reims and Brest Airports

Table 4 Significant references from the recent past and current affairs Contd...

Sl No.	Date	Airports Affected	Facility Affected	Cause of Failure	Time taken to restore the facility	Impact on operation
12	22-05-2020	Karachi, Pakistan	Communication between ground control and pilot	Communication system	Flight PK 8303 crashed	death of 97 people, including crew members, on board *Pakistan's CAA has decided to upgrade and overhaul its air traffic control system in view of a preliminary crash report prepared by CAA. In that report, lack of communication between the pilot of the doomed plane and the air traffic control was cited as one of the reasons behind the crash.*

These are some of the events took place in the recent past highlights the significant incidents or accidents or major traffic diversions happened due to ground CNS/ATM facilities. These incidents indicate a bigger hidden problem in the safety job performance of ATSEP.

6. Interactions with ATSEP

Interactive sessions on different slots were arranged at three major airports of India, namely Mumbai, Bengaluru and Kolkata. All ATSEP were requested to participate in the interactive sessions as per their convenience. The interactive session was taken so professionally by the management as well as the ATSEP at all the three airports. These initiatives communicated a very positive gesture on behalf of top management of Airports Authority of India, to all the ATSEP.

6.1. Objectives set for the interaction

ATSEP those who could join in the interactive sessions were called on different sessions. The key objectives set for the interactive sessions were to enable the ATSEP, to list the factors that add stress and fatigue by themselves, arrange them in the order of severity, identify whether it's an internal issue or an external issue and finally to suggest counter measure to mitigate the issues.

6.2. Methodologies followed during the interaction sessions

So, a brief presentation was given to all the participants for introducing the basic concepts behind the significance of human factors in aviation and for explaining briefly about the collaborative study and the expectations after the end of the presentation.

Based on the time availability, one or more rounds of choices were given to the participants and they were insisted to come out with a new factor that was not listed earlier by them. This enabled them to get into the subject and discuss and list different issues from different angle.

When time permitted, they have been asked to arrange the factors in the order of severity, identify whether it's an internal issue or external issue and finally to suggest counter measure to mitigate the issues as per the objectives.

Whenever a new group was called for different session, they were not shown any factors listed by the earlier group so that we could find out the common issues among groups irrespective of the airports and units they serve.

Figure 12 Interaction sessions methodology

6.3. Data collected at three international airports of India

The factors listed by different groups at different sessions without having prior knowledge on the list of factors listed by others were perfect beginning of the study to see common issues and as well as differing issues. These initial interactions have confirmed that there are issues that need to be addressed scientifically as early as possible so that safety performance can be maintained and improved before it leads to severe complications.

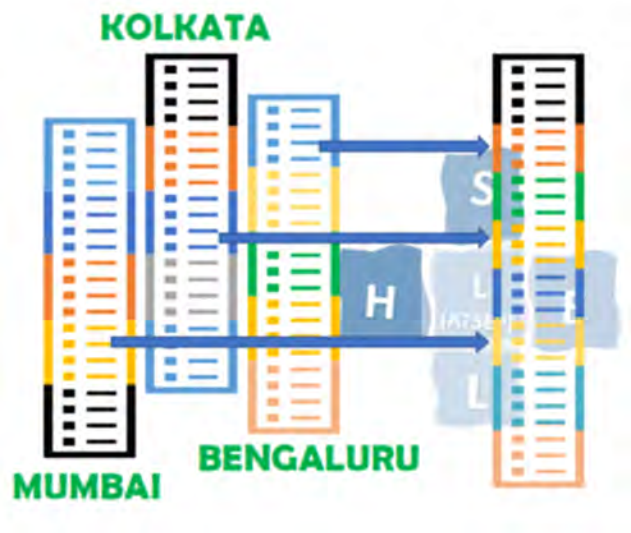

Figure 13 Common and unique factors among groups

6.4. Derived findings

After going through the total combined list of factors it is concluded that (1) There are factors that affect the safety performance of ATSEP which directly affects the safety and (2) There are scopes for improving the professional engagements and safety work culture. In addition to the factors that affect the individuals and their job performance, it is also found that there are gaps among generations in knowledge and experience sharing, mentorship issues, lack of teamwork and leadership issues.

Most important fact that was found during these efforts, all the ATSEP those who participated in the process were feeling happy to share their views and the goodwill gesture of the management was well received by them. A simple interactive session on addressing their human factor issues made lot of sense to them. They felt recognized and proud that they are performing a very sensitive safety task. These are the efforts were missing and will continue to miss if the human factors of ATSEP is not addressed practically.

7. Open-ended online survey

After seeing the response from a limited group of ATSEP from India, IFATSEA decided to extend the similar interaction to different parts of the world. The only option was to go for an online survey and extend it to all ATSEP. At the same time, it can't be without verification of credentials.

So, to meet these requirements, a website was created and asked interested ATSEP to register and validate their credentials, so that only those who have validated their credentials were enabled to access the online survey. The process has delayed the survey process but ensured the integrity of the data.

7.1. Factors considered for designing the questionnaire

The main factor that is taken care was to simulate the exact actions that were done during the personal interactive sessions. So, participants were asked to go through the video presentations before answering the questions. And they were asked to list at least three significant factors and maximum of eight factors.

So, to keep the option open and give the participants unlimited options to state their statements, the questionnaire was decided to be an open-ended i.e. free form survey.

Since the efforts taken were too high, participants were asked more information than what was asked in the interactive session for using these data for further study at a later stage. The questionnaire was too lengthy and option was given to the participant to exit after a particular section of the questionnaire. The essential parts of the questionnaire which addresses the objectives of the study were kept in the beginning.

Necessary explanations were made and FAQ were published and support videos were made and circulated and published through YouTube.

7.2. Questionnaire

The following were part of the questionnaire and it was a mix of compulsory and optional questions. All compulsory questions are shown with * in the end.

START OF QUESTIONNAIRE

Have you seen the introduction video about the survey questionnaire in YouTube channel "ATSEPism" *?

Gender *

Age *

1) Primary responsibility *

2) Seniority at the work place *

3) Approximate total number of ATSEP at your work place including all sections or units? *

4) Facilities or services for which you are accountable within the scope defined in DOC 10057?

5) Additional responsibilities other than the scope defined in DOC 10057 for ATSEP?

6) State minimum three factors in the order of severity that are adding stress to you and that lead to fatigue and affect your job performance? *

7) State any additional factors apart from the three you have quoted in 6 that are adding stress to you and that lead to fatigue and affect your job performance?

8) The gender equality in your organization is very good *

Fully agree Partially agree No idea Partially disagree Fully disagree

9) The recognition you get as ATSEP is as good as most of the other stakeholders within ANSP. *

Fully agree Partially agree No idea Partially disagree Fully disagree

10) You are assigned with the tasks only on which your competencies are developed and assessed. *

Fully agree Partially agree No idea Partially disagree Fully disagree

11) You get proper rest period after each non-scheduled maintenance works beyond general office hours *

Fully agree Partially agree No idea Partially disagree Fully disagree

12) You get proper rest period during the shift maintenance works that are performed beyond six hours. *

Fully agree Partially agree No idea Partially disagree Fully disagree

13) Your organization is very much committed in your professional development *

Fully agree Partially agree No idea Partially disagree Fully disagree

14) You have wonderful opportunities in applying your special talents and skills *

Fully agree Partially agree No idea Partially disagree Fully disagree

15) All the tasks and deadlines assigned to you are very much practical *

Fully agree Partially agree No idea Partially disagree Fully disagree

16) Your Job is well secured *

Fully agree Partially agree No idea Partially disagree Fully disagree

17)) Your job is well defined and you know exactly what is expected *

Fully agree Partially agree No idea Partially disagree Fully disagree

18) You can confidently admit your committed errors to your superior *

Fully agree Partially agree No idea Partially disagree Fully disagree

19) You are made responsible only to the extent you are accountable *

Fully agree Partially agree No idea Partially disagree Fully disagree

20) You have wonderful opportunities to learn from senior ATSEP *

Fully agree Partially agree No idea Partially disagree Fully disagree

21) You have wonderful documentation system in place, that clearly communicates about the previous faults and

corrective maintenance actions *

Fully agree Partially agree No idea Partially disagree Fully disagree

22) Your team always work towards result without compromising safety *

Fully agree Partially agree No idea Partially disagree Fully disagree

23) Please give counter measure suggestions for ANSP to the first three stress factors that you have mentioned earlier

24) Two suggestions for your ANSP towards bringing the best practices to address the human factor issues of ATSEP

25) Two suggestions for your ANSP for increasing professional engagement of ATSEP so that they won't feel boredom, monotony but motivated

26) Two suggestions for your ANSP for increasing better safety work culture of ATSEP

27) As per your knowledge and experience which state has got the best practices in addressing the stress and fatigue management of ATSEP

28) Do you want to participate in the next level of survey or discussion session of IFATSEA?

Personal Email ID

Mobile Number

END OF QUESTIONNAIRE

7.3. Outreach strategy

As the questionnaire was lengthy and there was a need for registration and validation to access the questions, constant reminders through emails were necessary. Several reminders were sent through emails. All social media were used for reaching the ATSEP.

7.4. Facts and figures

Table 5 Open ended survey - FACTs and figures

Open ended survey - FACTs and figures	
Registrations were received from	50+ States
Number of ATSEP registered	800+
Number of validated unique users	750+
Number of ATSEP participated	350
Number of ATSEP participated in the entire survey	289
The survey has started on	16-11-2019 20:53
Closed on	30-12-2019 20:59
Number of statements considered	1400+
Number of statements analysed and grouped	1300+

7.5. Data processing

Only inputs received against Q (6) Q (7) and Q (23) were taken for this study as they met the objectives of the study. 1400+ statements received from 289 participants on

Q (6) and Q (7) together. All these statements were analysed along with the response on Q (23). While processing all the statements reference materials from ICAO, FAA, CANSO and EASA were considered.

The discrete statements were combined scientifically for easy reference and for further study into eight groups of statements. While doing the grouping essential principle of human factors in maintenance were applied along with the unique working environment and the successive induction of systems and technologies.

7.6. Grouping of the factors listed by the participants

All the factors were grouped into the following eight groups as given below

1. Knowledge, Skills, Attitude, Competency and technology optimization
2. Workload management
3. Procedures, Information, Tools and Practices
4. Duty time limitation – Shift (day/night/late)
5. Stress, Fatigue, Pressure, Time pressure and deadlines
6. Lack of knowledge, communication, teamwork and leadership
7. Selection, HR and other policies
8. Workspace facilities / environment

Individual groups and factors added into the group are given below in the following tables

Table 6 Factors that affect the job performance due to the lack of KSA, Competency in coping up with the successive induction of new technologies

These factors are derived from the participants inputs. Several similar and relevant statements among 240 individual statements are merged and re-phrased for easier reference and for better focus collectively.	
1	**Preparing technical specification for a new system without knowing the local government guidelines and latest technology available.**
2	**Continued operation with the out lived or outdated and or obsolete system.**
3	**No clear job description, roles and responsibilities are varying after each movement, being deployed at non-core areas.**
4	**Lack of opportunity for developing and or retaining core competencies due to deployment in non-core areas for a long period before and after equipment training.**

5	Lack of equipment training even after years of deployment in the unit.
6	Lack of KSA and Competency to handle complex modern equipment.
7	No clear demarcation of technical and managerial responsibilities among the junior ATSEP and senior ATSEP.
8	Improper training (Training, assessing and evaluation) for the required competencies. There is a gap in the training provided and the practical work environment.
9	Too many make and models of equipment and too many competency requirements
10	Lack of skills and competencies in handling the CNS/ATM automation systems (Configuration, adaptation, replacement and upgrading the network devices, operating systems, shared storage devices, firewalls and device drivers etc..,) due to lack of OEM documentations.
11	Forced to do tasks even without qualification (attending power lines of UPS and working at heights etc..,)
12	Compromising qualities, essential OEM documentations, training and after acquisition supports on new systems against the cost (L1).
13	Procedural delays and extended file works on spare procurements.
14	Deployment of competent persons in right place after equipment training.
15	Lack of job rotation and equal opportunities.
16	Lack of knowledge in handling emergencies and disastrous situations.
17	Requirement of diversified expertise (Cyber security, Information technology, interface devices, data convertors, communication lines and links) other than core equipment for maintaining the service level.

18	**Lack of project management skills and competencies at the same time, simultaneous operation and projects tasks are given with unrealistic time lines.**
19	**Unable to resolve external interference problems and other typical problems which are not being covered in the training.**
20	**Managerial or higher responsibilities without proper training.**
21	**Lack of knowledge in handling the available scarce human resources for maximum performance due to lack of soft skills.**
22	**Lack of operational training to develop competency on the old generation equipment even after service life expansion program in place.**
23	**Lack of opportunity to develop expertise on networking, operating systems, cyber security, project management etc. due to lack of in-house expertise instructors and training infrastructure.**
24	**Lack of external training, workshops and seminars to keeping up-to-date knowledge on new technology and systems well before the systems getting inducted.**
25	**Lack of involvements of frontline experts in policies that are designed for improving the performance of frontline experts.**

Table 7 Factors that affect the job performance due to improper workload management within the available scarce competent human resources.

These factors are derived from the participants inputs. Several similar and relevant statements among 225 individual statements are merged and re-phrased for easier reference and for better focus collectively.	
1	**Less human resources for core jobs but deployment in non-core areas like terminal management, security systems, airport systems, administration works, commercial, and general stores.**
2	**Too many additional facilities added into ANSP like RADARS, CNS/ATM automation facilities, Nav-Aids at new airports and new RWYs in the last decade, without augmenting the human and other resources.**

3	**No alternate/standby operational team to share the workload even at emergency situation.**
4	**Single man shift.**
5	**Simultaneous project supervision and maintenance activities without additional manpower.**
6	**Manhours spent in Cargo, Customs clearance, without proper expertise or supporting staff instead of spending time on critical maintenance works and project works.**
7	**Innumerable, unspecified and unpredicted works being assigned to selected ATSEP preventing their attention from core maintenance tasks.**
8	**Permanent combined duties due to shortage of manpower increases workload and reduces the attention in all the combined units.**
9	**Too many unclassified additional works in smaller airports. Essential maintenance tasks are skipped.**
10	**Where there is electronics, there shall be an ATSEP – Belief of most of the in-charges.**
11	**Improper and unbalanced work distribution with undue over burden and undue over leniency.**
12	**Additional tasks assigned by regional and or corporate head quarter in addition to local airport works. (QR preparation, tender evaluation, course development, etc..,)**
13	**Acceptance of inefficient manpower by management without any punishment.**
14	**Lack of OEM documentation increases the workload in preparing the maintenance procedures in-house.**
15	**Non-utilization of technologies and machines for the installation and maintenance works and planning.**
16	**Managing the procurement tasks and maintenance tasks of multiple airports in addition to the local.**

17	**Multiple jobs of diversified nature in quick successions without notice or planning.**
18	**No clear demarcation of competencies so spending more time on KSC update on all areas without even having the access to the equipment and facilities.**
19	**Frequent failures and outages of out-lived equipment and facilities.**
20	**Sudden failures of the systems due to natural calamities and power supply issues.**
21	**Lack of training and documentation increases workload on tasks that could have been completed easier with less time with training and proper documentation.**
22	**Approval of projects without looking into the resource's requirements like human, vehicles, and other support. Workload increases on coordinating for essential supporting resources and prevents the concentration on core project activities as well as to skip the maintenance activities of ongoing operational facilities.**

Table 8 Factors that affect the job performance due to improper procedures, information, tools and practices.

These factors are derived from the participants inputs. Several similar and relevant statements among 185 individual statements are merged and re-phrased for easier reference and for better focus collectively.	
1	**Poor OEM documentation on system, diagnostic procedures, site adaptable parameters and on HMI.**
2	**Lack of readily available spare parts and poor supply chain management makes the recovery delays after emergencies and disasters.**
3	**Lack of planning before maintenance works. Not adhering to the schedules if planned.**
4	**Too much of file works for a low-cost but immediate and essential spare procurement.**

5	Huge time of already overloaded ATSEP are wasted on demanding and or waiting for resources ranging petty 5$ telephone intercom connections to vehicles to reach the remote operational sites. Even during the breakdown people can reach the site only after an hour.
6	Inaccurate procedures, lack of tested and validated SOPs leads to corrective maintenance delays.
7	Lack of document control and missing acknowledgement on new update on regulations and operational procedures.
8	Age and condition of supporting equipment like generators, electrical installations, air conditioners etc…,
9	Delayed flight calibration due to poor FIU aircraft operation and maintenance policies and contracts.
10	Delayed annual and other planned preventive and corrective maintenance due to non-availability of time for maintenance actions.
11	Non availability of calibrated working test equipment as required for the preventive as well as for the corrective maintenance.
12	Continuous changes in the scope and requirements on complex projects from the user point of view, without proper consideration from the maintenance point of view.
13	In compatible interfaces and data formats among different makes and models for integration and extending the data and voice to other ACC or APP airports.
14	Little or no-hands on training
15	Faulty equipment design and or faulty alert mechanism. Mis-leading front panel indications and irrelevant documentations. Unknown bug and or hidden deficiencies cropping up after the warranty and service agreement.
16	Frequent failures of OFC and leased lines connectivity. Non availability of near perfect cable or line diagrams for OFCs and power lines in the operational area.

17	**Improper Complaint reporting mechanism by user, that do not convey the key information required for the early rectification of the equipment.**
18	**Annual plan for ATSEP training and development in line with the operational and competency requirements.**
19	**Lack of effective coordination procedures for men material movements inside the operational areas of private operator owned airports.**
20	**Lack of effective annual spare and capital procurement plan and related budget provisions.**
21	**Lack of update in the maintenance procedures, operating procedures and maintenance philosophies in line with the technologies.**
22	**User requirements defined are not met with the supplied system**
23	**Mismatching in course development that doesn't make the ATSEP competent enough to address the practical field issues.**

Table 9 Factors that affect the job performance due to duty duration, cycles of shifts, late night calls and other late hour maintenance works without breaks and rests.

These factors are derived from the participants inputs. Several similar and relevant statements among 170 individual statements are merged and re-phrased for easier reference and for better focus collectively.	
1	**No standardized duty pattern, duration, breaks and rest periods**
2	**Extra shift duties are forced due to shortage of man power**
3	**Sleep loss due to irregular shift pattern or fast rotating shift pattern**
4	**Lack of time to family**
5	**Late hour calls and frequent calls after duty hours even during weekly OFFs**

6	Irregular duty calls without any pattern due to shortage of manpower
7	Have to report again by 0930AM even after late night breakdown calls and late-night project works.
8	No break and rest during the shift work even in the night shift.
9	Have to report on duty again by 0930AM after VVIP duties performed in the late evening / night on previous day or even during weekends.
10	No clear OFFs before shift pattern changes
11	Leave requests are not approved
12	Forced to carryout major maintenance works only during late night and need to return to duty next day by 0930AM.
13	No refreshment breaks
14	Lack of attractive compensation for extra shift works performed
15	Odd hours and on field shift duties for women ATSEP without basic rest room facilities in the operational sites.
16	Stressful 12 hours night shift without breaks and rests
17	Continuous works including weekends during the demanding situations for meeting the special maintenance and project works along with routine operational works.

Table 10 Factors that affect the job performance due to continued stress, fatigue, pressure, time pressure and deadlines on multiple tasks.

These factors are derived from the participants inputs. Several similar and relevant statements among 155 individual statements are merged and re-phrased for easier reference and for better focus collectively.	
1	24H operations with stringent regulatory compliance.
2	Mostly corrective work is done at night.

3	**Repairing critical modules of the facilities that are under NOTAM**
4	**Safety conscious in keeping the facilities available all the time.**
5	**Time line pressure from boss, management, ATCOs, and other stakeholders.**
6	**Sense of expectation on out-lived equipment failures even while carrying preventive maintenance.**
7	**Extraordinary file work delays in getting approvals for proceeding to next stages.**
8	**Telephones / communication facilities failures, link failure or poor signal coverage during the major breakdown, which prevents coordination from remote operational sites to main operation complex.**
9	**Travelling a lot between units and main air traffic services complex. Especially while working in A-SMGCS, Nav-aids and multiple Radar sites.**
10	**Long waiting for vehicles and completing the formalities for getting men and material access to remote work places.**
11	**Peer pressure due to evaluation and comments from colleagues who are not accountable**
12	**Poor workload distribution makes few carry stress, pressure, fatigue and timeline pressure throughout without any relief.**
13	**Being helpless in rectifying the unit after knowing inherent flaws in the design of the equipment and its unreliability**
14	**Project deadlines without freezing the scopes and augmenting with necessary resources often time line is set.**
15	**Trouble shooting in busy working environment on live interconnected systems.**
16	**Always under pressure to give back the facilities within the EST of NOTAM**

17	**Expectations on making quick decision, in less reactive time with zero error tolerance and on fixing the system immediately.**
18	**Constant mind switchover between old and new technologies, procedures, tools etc.., within the same service facilities. Different aged, make and model of equipment within a single service facility like VHF, Nav-Aids and surveillance.**
19	**Unrealistic timelines due to poor planning and coordination with ATCOs before making maintenance activities.**
20	**Lack of knowledge and expert support while trying to fix an unfamiliar technical glitch.**

Table 11 Factors that affect the job performance due to poor leadership, lack of knowledge sharing, lack of communication, and lack of teamwork.

These factors are derived from the participants inputs. Several similar and relevant statements among 125 individual statements are merged and re-phrased for easier reference and for better focus collectively.	
1	**Lack of mutual performance assessment as per the roles and responsibilities assigned.**
2	**Lack of leadership in building relationships and establishing communication or coordination frameworks with internal as well as external stakeholders.**
3	**Frontline ATSEP views are ignored and they are not recognized as experts.**
4	**Lack of professional communication or poor communication on technical terms to approving authority, who is mostly a non-ATSEP.**
5	**Lack of mutual respect and common values among internal stakeholders. (ATCOs, ATSEP, Engineers)**
6	**Lack of leadership in ensuring the safety conscious among sub-ordinate, instead of being reactive and blaming.**
7	**Impact of changes are not well communicated and individuals are reluctant to adopt.**

8	Frequent changes in the team members or team lead prevents better team work and communications.
9	Lack of leadership in managing conflicts and ensuring team goals and safety objectives over individuals interests and goals.
10	Lack of brainstorming on handling unfamiliar situation and regular interactions for knowledge sharing.
11	Lack of leadership in handling professional disagreement with internal and external stakeholders and pass it to frontline ATSEP.
12	Lack of knowledge sharing on latest developments in local airport level and in ANSP level to frontline ATSEP.
13	Lack of delegation or poor overlapping delegation and preferences towards frontline tasks not on managerial or leadership tasks.
14	Lack of mutual respect and mentorship for knowledge and experience sharing among the generations.
15	Lack of self-learning tools
16	Lack of corrective measure in addressing the commitment levels and contributions of ATSEP.
17	Lack of guidance, information exchange, and non-participation in the discussion make the freshers isolated.
18	Lack of knowledge on critical maintenance aspects of the equipment outsourced.
19	Lack of team work, more dependency on individuals and collective inputs are not taken by team lead for decision.
20	Lack of leadership in communicating the priorities to sub-ordinates.
21	Inhibition of valuable suggestions and ideas due to the overload of works.

22	**Lack of well-established practices of human relations and knowledge on human factors.**

Table 12 Factors that affect the job performance due to poor selection, human resource management policies and other organizational policies affect the motivation levels.

These factors are derived from the participants inputs. Several similar and relevant statements among 125 individual statements are merged and re-phrased for easier reference and for better focus collectively.	
1	**Lack of framework for career progression based on competency.**
2	**Payment delays.**
3	**Lack of opportunities for higher level needs.**
4	**Lack of fresh recruitments, but more retirements and induction of new equipment.**
5	**Uncertainty on future roles and responsibilities.**
6	**Sense of being unheard by management**
7	**Lack of competitive colleagues. People with poor knowledge and skills are getting selected.**
8	**Lack of career growth. Too many youngsters are selected at a time and get stagnated later.**
9	**Lack of motivating compensations for extra manhours spent in general maintenance, VVIP movements, project works, additional works and additional shifts.**
10	**Lack of opportunity and fund provisions for innovation and carry station level smaller projects.**
11	**Selection criteria for inducting different levels of ATSEP for ensuring more competent people are recruited in the higher levels.**
12	**Lack of regulatory requirements for complying standardized trainings and licencing to ATSEP**

13	**Lack of pride as not being recognized as expert in particular field and transferred anywhere without considering the competencies acquired.**
14	**Salary and allowances not at par with the industry standards for the level of stress and workload.**
15	**Lack of scientific annual performance assessment and rewarding scheme considering the unique working environment and expected level of performance of ATSEP.**
16	**Lack of job rotation**
17	**Lack of involvements in the discussion sessions and feedback sessions on major policy decisions.**
18	**Mandatory transfers**
19	**Lack policies and practices towards the human factors of ATSEP**
20	**Behind the curtain profession**
21	**Gender bias and equal field works are not assigned to women ATSEP.**

Table 13 Factors that affect the job performance due to poor selection, human resource management policies and other organizational policies that affect the motivation levels.

These factors are derived from the participants inputs. Several similar and relevant statements among 105 individual statements are merged and re-phrased for easier reference and for better focus collectively.	
1	**Lack of basic workplace facilities like parking, canteen, fixtures, rest rooms, vending machines, common transport for pickup and drop from employee quarters to workplace, etc..,**
2	**Lack of specific workplace facilities for women like identified rest rooms in the operational areas, Creche, child care leave, etc…,**
3	**Lack of protection and guidelines while attending equipment during heavy lightning and abnormal weather conditions.**

4	**Poor or uncomfortable employee quarters at faraway places with huge deduction of salary instead of provisions of comfortable nearby quarters with reasonable deductions in salary.**
5	**Travelling long distance from home to workplace as most of the airports are situated at outer part of the cities.**
6	**Lack of guidelines and provisions of PPE to ATSEP for protecting them while working at highly polluted with noise and dust, heights, closer to high power radiating radars, X-rays, etc..,**
7	**Travelling a lot in hot days to remote sites without proper vehicles.**
8	**Frequent exposure of high outside remote site temperature and less inside equipment room temperature in a shift.**
9	**Narrow space around equipment racks filled with too many wires and connections, making difficulties in accessing and replacing the modules.**
10	**Congested or no desk / table. Too many items are placed in the control and monitoring room. No space for keeping important manuals, procedures, SOPs in most visible and accessible manner.**
11	**Installations at very remote places, and high mountains preventing regular visits due to resources.**
12	**Difficulties in trouble shooting behind the ATC consoles in general and in particular at late night hours due to poor lighting at the behind the console.**

7.7. Derived findings

Having taken a wide range of input and categorized into eight groups, the following could be concluded.

ATSEP human factor issues are universal in nature. Irrespective of the maturity levels of ANSPs in the human performance management w.r.t to the ATCOs, the maturity levels of human performance management system w.r.t ATSEP were low and mostly it is in the initiating stage only. So, it was decided to assess this assumption in the further levels of the study.

At the end of this stage of study, not only we could see there are issues all across the world and they are common too. In this level, the PEAR and Dirty Dozen model were more meaningful and easier to apply. So further analysis was done based on PEAR model and for error issues Dirty Dozen was also applied.

After applying the above models and analysis, broadly, the following issues were visible clearly

1. Over workload and old maintenance philosophies and out-lived equipment.
2. Lack of competencies against too many competencies requirements.
3. Cumbersome procedures for corrective maintenance actions.
4. Lack of knowledge sharing, accurate procedures and time pressure.
5. Less scope of developing and retaining the core - competencies.
6. Lack of soft skills and leadership skills among seniors.
7. Low motivation, pride and less engagements.
8. Too many distractions and less attentions.

7.8. Counter measures

Most of the stress can be managed through improving the knowledge, skills, and core competencies, because most of the stress factors are pertaining to their action in the given working environment.

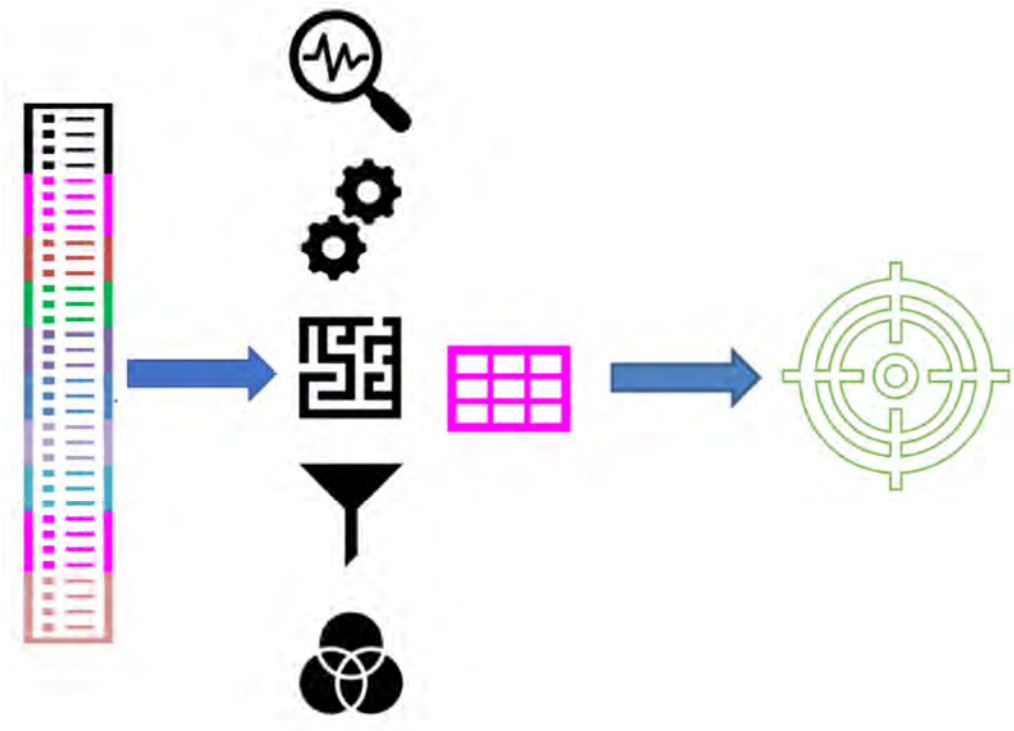

Figure 14 Counter measures assumptions

Having addressed the competencies, the next significant issues are arising due to lack of resources while doing the job. These resources can be procedures, tools, spares and human resources.

Once they are competent and supported with enough resources, how long they can work in a single shift, how long they can perform the same monotonous work in the same unit. Likewise, each significant factor was analysed in various angles and probable counter measures were identified.

However, these probable counter measures need to be discussed with more people, especially the people those who were not involved in the study. So, it was decided to go for a closed-ended survey with all counter measures into the questionnaire and reach once again all ATSEP for participating in the online survey.

8. Closed-ended online survey

In the closed-ended survey, ATSEP are provided with options from which they choose a response. Most of the questions were based on the significant factors and their counter measures.

8.1. Factors considered for designing the questionnaire

It was decided to measure the safety culture and the human performance management maturity levels through the closed-ended survey. Also, it was decided to find out the competency development framework within the organization. Since the questionnaire was long, the options were given for the participants to answer part by part whenever they find time.

8.2. Questionnaire

The following were part of the questionnaire. All were compulsory questions.

START OF QUESTIONNAIRE

SECTION 1: Do you agree

(Fully agree, partially agree, Neither agree nor disagree, Partially disagree, Fully disagree)

1. Do you agree that shift duty pattern adopted in your ANSP, addresses the health issues like sleep disorder in a best possible way?
2. Do you agree that odd hour break down calls (work beyond duty hours without rest) is well compensated in your ANSP?
3. Do you agree that safe travelling to and from office, during odd hours for breakdown maintenance is well taken care of in your ANSP?
4. Do you feel that shortage of man power, which leads to work load due to multiple assignments, adds stress and causing fatigue to you?
5. Do you agree that your competency trainings included handling sudden total shutdown of critical systems, demonstrated in a simulated working environment?
6. Do you agree that your corrective maintenance will be more effective if the OEM support is available (Proper documentation and spare)?
7. Do you agree that your safety performance will improve if your role is clearly defined with responsibilities and authorities?
8. Do you agree that your expertise will improve if your work profile is limited to any one allied stream? (Instead of entire CNS/ATM only C & N or C & S or C & ATM)?
9. Do you agree that the stress of restoring facilities in short time, will reduce significantly, if you are given optimum number of tested SOPs?
10. Do you agree that the stress of unexpected failures of the system will reduce significantly, if the fault history of the facilities is updated scientifically and made easily accessible?

11. Do you agree that the stress of managing the outlived equipment will reduce significantly, with pro-active procurement and replacement policies?
12. Do you agree that procurement policies like regulations, manuals, circulars involving mandatory financial compliance requirements are a significant hindrance in local spare management?
13. Do you agree that the pre-planned major preventive maintenance activities are re-scheduled even after taking NOTAM, thereby becoming corrective maintenance and causing stressful situation?
14. Do you agree that the concentration on the safety critical performance of CNS/ATM will improve if your roles are restricted within the scope defined in DOC 10057?
15. Do you agree that there are scopes for reviewing the maintenance philosophies and thereby reducing the paper works, physical visits, and manhours?
16. Do you agree that you are clearly told to understand the single point of failure on the system that you are dealing with?

SECTION 2: Do you agree

PART 1: (1 to 5) Best practices

PART 2: (6 to 10) Engagement of duty ATSEP

PART 3: (11 to 15) Safety work culture

How much you would agree that the following practices qualifies as best practices for an ANSP.

1. Having procurement policies that facilitates buying quality products.
2. Having HR policies that encourages recognition, appreciation and suitable allowances.
3. Providing working environment, with due consideration to human factor issues of ATSEP.
4. Conducting seminar on best practices being adopted at different airports within ANSP
5. Assessing optimum manpower requirement, recruit competent people, train, deploy and promote accordingly.

How much you would agree that the following measure increase the engagement of duty ATSEP

6. Assign dedicated small assignments based on the specific talents and skills.
7. Encourage innovation on routine tasks.
8. Online based self-learning tools.
9. Rewards and promotion based on contribution and effort.
10. Promote research groups within the ANSP.

How much you would agree that the following measure increase the safety work culture

11. Just culture by practice and better relations with ATCOs
12. No blame culture but finding root cause of the safety incidents
13. Role of ATSEP in ATM service delivery should be part of initial training.
14. Rewards safe performance
15. Review safety incidents with the perspective of how human factors played a role in the situation.

SECTION 3: Yes or no and choose the best option

Yes

No

Please state yes or no

1. Have you been trained scientifically on writing technical report, logs, system degradation reports, specification, and system manager report?
2. Have you been trained scientifically professional communication with non-ATSEP?
3. Have you been trained scientifically to interpret needs and translate into specifications?
4. Have you been trained scientifically to apply project management approaches?
5. Have you been trained scientifically to comply user requirements/system requirements/test results traceability?
6. Have you undergone human factors training as given in DOC 10057?
7. Have you undergone disaster recovery training for restoring the CNS/ATM systems after natural calamities (Floods, Tsunami, Earthquake, major fire and storm)?
8. Whether your competency training includes the allied interface devices, operating system and coordination procedures with the media service provider (Telecom company)
9. Have you undergone the qualification training course on infrastructure as given in DOC 10057?
10. Whether your initial training includes the concepts about the impact to ATM if the facilities or services fail?

Choose the most suitable one

11. Select the one which affects you in getting expertise

a. Compulsory movements within the nation during service life.
b. Different make and model for each facility / system.
c. Expected competencies in all domains of CNS/ATM systems.
d. Deployment in non-core activities for longer duration

12. If you are a manager and asked to choose a training program for enhancing your safety job performance, which one of the following you would select?

a. Contract management
b. Project management
c. Stress and fatigue management
d. Planning (for replacement of obsolete system) and procurement.

13. The response time for corrective maintenance is most affected by
a. Non availability of vehicle to reach the remote site
b. short of ideas, being alone
c. Fear on consequences of failure while trouble shooting in live system
d. Inadequate first-hand information given by user

14. Which factor affects you the most in reducing your attention during the duty
a. Monotonous monitoring for a long time
b. Working in lower temperature in equipment room
c. Combined project and operational tasks
d. Diversified tasks during duty

15. Which factor that affects your health during duty
a. Working under severe dust pollution during the project work
b. Working under noise pollution in the airfield
c. Frequent (change of) exposure to too low temperature in the server or equipment room and to high outside temperature
d. No access of fresh air and sunlight for long duration

END OF QUESTIONNAIRE

8.3. Outreach strategy

To engage more ATSEP for validating the counter measures, the questionnaire was translated into Arabic, French, Japanese and Persian languages in addition to English version. Since we wanted more than those who have participated in the open-ended survey, constant reminders through emails were necessary. Several reminders were sent through emails. All social media were used for reaching the ATSEP.

8.4. Facts and figures

Table 14 Closed ended survey - FACTs and figures

Closed ended survey - FACTs and figures	
Registrations were received from	55+ States
Number of ATSEP registered	1261
Number of validated unique users	1000+
Number of ATSEP participated	517
Number of ATSEP participated in the entire survey	409

The survey has started on	13-01-2020
Closed on	08-03-2020
Number of statements considered for section 1	517
Number of statements considered for section 2	409
Number of statements considered for section 3	410

8.5. Data processing

The data processing was much easier as it was closed-ended survey. Almost all the counter measures were validated by ATSEP response. The processed closed-ended survey data of all the three sections are given in the following tables

Table 15 Processed data of closed-ended survey of Section 1

		Fully agree	Partially agree	Neither agree nor disagree	Partially disagree	Fully disagree	
		5	4	3	2	1	
1	Do you agree that you are clearly told to understand the single point of failure on the system that you are dealing with?	179	193	51	65	29	3.8
2	Do you agree that your competency trainings included handling sudden total shutdown of critical systems, demonstrated in a simulated working environment?	95	156	42	110	114	3.0
3	Do you agree that shift duty pattern adopted in your ANSP, addresses the health issues like sleep disorder in a best possible way?	149	148	41	71	108	3.3

4	**Do you agree that safe travelling to and from office, during odd hours for breakdown maintenance is well taken care of in your ANSP?**	**96**	**112**	**51**	**101**	**157**	**2.8**
5	**Do you agree that odd hour break down calls (work beyond duty hours without rest) is well compensated in your ANSP?**	**79**	**133**	**33**	**107**	**165**	**2.7**

Table 16 Processed data of closed-ended survey of Section 1 Contd...

		Fully agree	Partially agree	Neither agree nor disagree	Partially disagree	Fully disagree	
		5	4	3	2	1	
1	Do you agree that there are scopes for reviewing the maintenance philosophies and thereby reducing the paper works, physical visits, and manhours?	229	207	48	22	11	4.2
2	Do you agree that the concentration on the safety critical performance of CNS/ATM will improve if your roles are restricted within the scope defined in DOC 10057?	248	185	68	15	1	4.3

3	Do you agree that if planned major preventive maintenance works are re-scheduled (postponed) even after issuing NOTAM, the result can be a stressful situation of becoming corrective maintenance?	230	198	65	10	14	4.2
4	Do you agree that procurement policies like regulations, manuals, circulars involving mandatory financial compliance requirements are a significant hindrance in local spare management?	265	172	48	26	6	4.3
5	Do you agree that the stress of managing the outlived equipment will reduce significantly, with pro-active procurement and replacement policies?	396	106	8	7	0	4.7
6	Do you agree that the stress of unexpected failures of the system will reduce significantly, if the fault history of the facilities is updated scientifically and made easily accessible?	394	112	7	4	0	4.7

7	Do you agree that the stress of restoring facilities in short time, will reduce significantly, if you are given optimum number of tested SOPs (STANDARD OPERATING PROCEDURES)?	344	147	19	5	2	4.6
8	Do you agree that your expertise will improve if your work profile is limited to any one allied stream? (Instead of entire CNS/ATM only C & N or C & S or C & ATM)?	268	161	31	43	14	4.2
9	Do you agree that your safety performance will improve if your role is clearly defined with responsibilities and authorities?	422	80	12	3	0	4.8
10	Do you agree that your corrective maintenance will be more effective if the OEM (ORIGINAL EQUIPMENT MANUFATURER) support is available (Proper documentation and spare)?	387	98	13	14	5	4.6
11	Do you feel that shortage of man power, which leads to work load due to multiple assignments, adds stress and causing fatigue to you?	359	100	24	21	13	4.5

Table 17 Processed data of closed-ended survey of Section 2

A	How much you would agree that the following measure increase the safety work culture	
1	Role of ATSEP in ATM service delivery should be part of initial training.	4.8
2	Review safety incidents with the perspective of how human factors played a role in the situation.	4.8
3	Rewards safe performance	4.7
4	No blame culture but finding root cause of the safety incidents	4.7
5	Just culture by practice and better relations with ATCOs	4.4
B	How much you would agree that the following measure increase the engagement of duty ATSEP	
1	Encourage innovation on routine tasks.	4.6
2	Promote research groups within the ANSP.	4.6
3	Rewards and promotion based on contribution and effort.	4.5
4	Assign dedicated small assignments based on the specific talents and skills.	4.5
5	Online based self-learning tools.	4.4
C	How much you would agree that the following practices qualifies as best practices for an ANSP	
1	Assessing optimum manpower requirement, recruit competent people, train, deploy and promote accordingly.	4.5
2	Having procurement policies that facilitates buying quality products.	4.5
3	Providing working environment, with due consideration to human factor issues of ATSEP.	4.4
4	Conducting seminar on best practices being adopted at different airports within ANSP	4.4
5	Having HR policies that encourages recognition, appreciation and suitable allowances.	4.3
5	Fully agree	5
4	Partially agree	4
3	Neither agree nor disagree	3
2	Partially disagree	2
1	Fully disagree	1

Table 18 Processed data of closed-ended survey of Section 3

Which factor that affects your health during duty	
a. Working under severe dust pollution during the project work	**51**
b. Working under noise pollution in the airfield	**40**
c. Frequent (change of) exposure to too low temperature in the server or equipment room and to high outside temperature	**200**
d. No access of fresh air and sunlight for long duration	**119**
Which factor affects you the most in reducing your attention during the duty	
a. Monotonous monitoring for a long time	**86**
b. Working in lower temperature in equipment room	**48**
c. Combined project and operational tasks	**85**
d. Diversified tasks during duty	**191**
The response time for corrective maintenance is most affected by	
a. Non availability of vehicle to reach the remote site	**87**
b. short of ideas, being alone	**57**
c. Fear on consequences of failure while trouble shooting in live system	**136**
d. Inadequate first-hand information given by user	**130**
If you are a manager and asked to choose a training program for enhancing your safety job performance, which one of the following you would select?	
a. Contract management	**11**
b. Project management	**102**
c. Stress and fatigue management	**135**
d. Planning (for replacement of obsolete system) and procurement.	**162**
Select the one which affects you in getting expertise	
a. Compulsory movements within the nation during service life.	**70**
b. Different make and model for each facility / system.	**102**
c. Expected competencies in all domains of CNS/ATM systems.	**144**
d. Deployment in non-core activities for longer duration	**94**

Table 19 Processed data of closed-ended survey of Section 3 Contd...

Have you undergone disaster recovery training for restoring the CNS/ATM systems after natural calamities (Floods, Tsunami, Earthquake, major fire and storm)?	
Yes	**36**
No	**374**
Have you been trained scientifically professional communication with non-ATSEP?	
Yes	**78**
No	**332**
Have you been trained scientifically to apply project management approaches?	
Yes	**88**
No	**322**
Have you been trained scientifically to interpret needs and translate identified needs into specifications?	
Yes	**89**
No	**321**
Have you undergone human factors training as given in DOC 10057?	
Yes	**100**
No	**310**
Have you been trained scientifically on writing technical report, logs, system degradation reports, specification, and system manager report?	
Yes	**106**
No	**304**
Whether your competency training includes the allied interface devices, operating system and coordination procedures with the media service provider (Telecom company)	
Yes	**112**
No	**298**
Have you undergone the qualification training course on infrastructure as given in DOC 10057?	
Yes	**129**
No	**281**
Have you been trained scientifically to comply user requirements/system requirements/test results traceability?	
Yes	**131**
No	**279**

8.6. Derived findings

One of the most significant derived findings from this survey indicates that most of the ANSPs are yet to consider and apply human factors principles in ATSEP working environment. For example, Section 2 C 3, and section 3 6 (Have you undergone human factors training as given in DOC 10057?) expectations of best practices and the existing practices can be easily derived.

8.7. Validated counter measures

Most of the initial counter measures have been validated by ATSEP. At the end of this stage almost all the significant stress factors and their counter measures were matched and validated. So, these findings are reported in the recommendation chapter.

9. Global webinars on human factors of ATSEP

9.1. Transforming our team into a high performing team

9.1.1. Objectives and outcome of the webinar

During the human factors study interactions with ATSEP, we have come across various stress factors as expressed by ATSEP. Some of these stress factors can be addressed by ATSEP through role play within the team.

The key session of the webinar was spent on discussing on those roles play by panellists those who are leading important positions.

In the end of the webinar we were able to list out the attributes of a high performing team, as listed below.

- Leadership plays major role
- Everyone values each other
- Roles and accountabilities are well defined
- Teams capability is seen over individual's
- Very good communication among the team members
- Continuous knowledge and experience sharing
- Attitude transfer through inspiration
- Stress levels are very low in a high performing team

9.2. Taking off into the perfect storm – Seeing positive in negative

9.2.1. Objectives and outcome of the webinar

The webinar discussions were made on how to transform our ANSPs into resilient organization through developing competencies of ATSEP and through addressing the human factor issues. Three resilience levels were discussed namely

- Preventative control
- Mindful action
- Performance optimization

On each resilience levels, how ANSPs can achieve the reliance through ATSEP were deliberated and polling was conducted.

9.2.2. Polling

A short polling was conducted on various measures that ANSPs can consider for achieving the required resilience in each level. Prior to the polling, YouTube webcasting was also done. Details of the polling is given in the next para,

9.2.3. Polling outcome

Table 20 PREVENTATIVE CONTROL

ANSP RESILIENCE THROUGH ATSEP	Most significant – gap	Number of 5	Number of 4	Number of 3	Number of 2	Number of 1	Least significant - gap	Blank	Avg
TOTAL 94		5	4	3	2	1		Blank	Avg
PREVENTATIVE CONTROL									
Training on emergency – training on sudden total shutdown or major failures in a simulated environment and with mock or simulator CNS/ATM systems.		48	21	13	3	0		9	**4.3**
Knowledge sharing on known problems and proven technique – Scientific knowledge sharing on the problems experienced and solutions arrived elsewhere within the organization		29	33	16	4	2		10	**4.0**
Competency – All the skills and competency requirements at this level need to be developed and assessed for the field engineer level ATSEP. Principles and guidelines given in DOC 9868 and DOC 10057 need to be followed.		35	19	22	8	1		9	**3.9**
Ability to respond quickly – Required resources like manpower, vehicle, test equipment etc.., need to match with the expected response.		33	26	11	10	5		9	**3.8**
Supply Chain management – For getting the required spares in time to ensure the down time is reduced		23	37	13	11	1		9	**3.8**
Manuals, circulars and other guidance materials for maintaining the CNS/ATM systems and for carrying out the repairing of the failed system – Should be clear, practical and suitable for the field engineer level ATSEP		24	27	18	12	4		9	**3.6**

Table 21 MINDFUL ACTION

ANSP RESILIENCE THROUGH ATSEP	Most significant – gap	Number of 5	Number of 4	Number of 3	Number of 2	Number of 1	Least significant - gap	Blank	Avg
TOTAL 94		5	4	3	2	1		Blank	Avg
MINDFUL ACTION									
Development of specialized knowledge, skills and attitude of filed engineer level ATSEP to enhance the resilience – Offer international certification training (PMI, CCNA etc..,) to selected experts for exercising judgement, discretion, and imagination while handling unfamiliar events.		29	27	19	6	1		12	**3.9**
Building the high reliability organization culture among ATSEP - remain sensitive to all possible threats, challenge the assumptions with specialized knowledge skills and attitude		28	29	22	3	2		10	**3.9**
Encouraging the diversity of opinion among managers and field engineers – Recognizing the field engineer level ATSEP as experts and managers help them in finding and fixing the critical issues		23	30	25	5	1		10	**3.8**
Support of expert team for resolving major breakdowns – Identified expert team that can be formed, developed, activated, combined, and recombined in emergency situations, as challenges arise.		21	42	9	8	4		10	**3.8**
ATSEP capacity to investigate, to learn, and to act, without knowing in advance – All the skills and competency requirements at this level need to be developed and assessed for the field engineer level ATSEP. Principles and guidelines given in DOC 9868 and DOC 10057 need to be followed.		22	27	28	4	2		11	**3.8**

Table 22 PERFORMANCE OPTIMIZATION

ANSP RESILIENCE THROUGH ATSEP	Most significant – gap	Number of 5	Number of 4	Number of 3	Number of 2	Number of 1	Least significant - gap	Blank	Avg
TOTAL 94		5	4	3	2	1		Blank	Avg
PERFORMANCE OPTIMIZATION									
ANS procurement process improvement – Benchmarking the entire process with key performance indicators, evaluating the vendors supply relations during the entire period of service life of the equipment, specialized training on user requirements compilation including defining the training requirements that suits the maintenance philosophies of ANSPs.		36	27	14	7	1		9	**4.1**
Maintenance procedures – Complex system fails complex way. New maintenance philosophies and procedures to suit the present technologies so that ATSEP do have sufficient scope for devoting time on mindful action and performance improvements.		34	30	17	5	1		7	**4.0**
Leaderships skill for managers so that they leave the shoes of experts and assume the critical leadership roles – Developing leadership skills through well defined training (Human factors training – DOC 10057), workshops and online training provisions.		26	34	15	8	2		9	**3.9**
Capabilities of ANS system installation, verification, validation, acceptance and commissioning - Developing necessary skills and competencies well defined training (Engineering – DOC 10057), for both the field engineer level as well as manager level.		25	33	21	6	2		7	**3.8**
Capability for continually improving, refining, and extending existing competencies. Learning to do existing things better – Opportunities to work on limited domain for a considerable work experience, with specialized knowledge, skills and competency development.		18	34	26	8	0		8	**3.7**

10. Recommendations

Since last CNS /SG 23 meeting lots of efforts were made on studying the factors adding stress and fatigue of ATSEP and reducing their safety job performance. The study was wide open and reached over 50 states during the first and second survey. Also, ATSEP from 40 states have participated in both the global webinar, where again the human factor issues were deliberated.

Second closed-ended survey was mainly focused on validation of counter measures and the same was validated (517 to 409) by a greater number of ATSEP than those (289) who have participated in the first survey. So the global findings on factors and their counter measures are recommended for the ANSPs to consider and to adopt.

10.1. Significant factors and counter measures

1. ***Reviewing maintenance philosophies and bringing technologies to supervise technologies for reducing paper works, physical visits and saving manhours.***

2. ***Improving the safety job performance of ATSEP by restricting their deployment within the scope defined in DOC 10057***

3. ***Pre-planning the pre-monsoon, annual and other time-consuming preventive maintenance tasks well in advance and carrying out the tasks as planned. So that sudden total failures and long corrective maintenance works are prevented.***

4. ***Road blocks on procurement process can be reduced by training selected ATSEP on government compliance requirements by experts having background on the financial regulation. ATSEP those who are involved in the major or repeated procurement process can be permitted to have consultants on these areas.***

5. ***Pro-active procurement and replacement policies in managing the out-lived equipment will reduce the stress of the entire ANSP on their safety commitment.***

6. ***ANSP level scientific knowledge management on fault histories will reduce the stress significantly as ATSEP are continuously learning the new problems and solutions and be ready with the proven techniques.***

7. ***By providing only optimum number of verified and validated SOPs without redundancy, the stress of restoring facilities in short time, will reduce significantly.***

8. ***By limiting their stream of competency among CNS/ATM facilities, expertise and competency levels can be developed and retained.***

9. *By defining the roles and responsibilities clearly along with accountabilities, individual job performance of ATSEP will increase and in-turn over all safety performance of ANSP will also increase.*

10. *With the proper OEM documentation and support on spare overall effectiveness of corrective maintenance will improve.*

11. *With regular optimum augmentation of human resource based on the existing tasks, expected retirements and expected additional facilities, the stress and fatigue levels of ATSEP can be brought to a minimum and safety goals can be assured.*

12. *To ensure the fullest commitment of all the ATSEP on safety tasks, ANSPs must encourage the safety work culture in the working environment of ATSEP to make sure that no ATSEP is not left out. ANSPs can improve safety work culture by taking the following measures*
    a. *Sensitizing the role of ATSEP in ATM service delivery and contributions to safety*
    b. *Imparting human factors training and explaining the safety impacts from the perspective of human factors*
    c. *Rewarding the safety performance*
    d. *Encouraging them to voluntarily disclose the errors committed before major shutdown to find the root causes.*

13. *To prevent the ATSEP to be complacent and getting bored on repeated tasks, ANSPs must try to engage them during shift duties constructively so that they remain engaged and remain alert to handle the unexpected. ANSPs can improve the engagement of duty ATSEP by taking the following measures*
    a. *Encourage innovation on routine tasks.*
    b. *Promote research groups within the ANSP.*
    c. *Rewards and promotion based on contribution and effort.*
    d. *Assign dedicated small assignments based on the specific talents and skills.*
    e. *Online based self-learning tools.*

14. *To keep the motivation level of ATSEP to progress continuously upward, ANSPs need to adopt the best practices in their work environment. It's a human nature to benchmark their organization and work environment with that of others. So ANSPs need to keep adopting the best practices into the working environment. Some of the best practices that can be adopted*
    a. *Assessing optimum manpower requirement, recruit competent people, train, deploy and promote accordingly.*
    b. *Having procurement policies that facilitates buying quality products.*

c. *Providing working environment, with due consideration to human factor issues of ATSEP.*
d. *Conducting seminar on best practices being adopted at different airports within ANSP*
e. *Having HR policies that encourages recognition, appreciation and suitable compensations.*

15. *Knowledge, skills, attitude and competencies of ATSEP are very essential for their safety job performance. ATSEP job performance is essential for meeting the safety goals of any ANSPs. The following are among the essential competency developments on which ANSPs can focus in developing on their ATSEP*
    a. *Human factor training as per DOC 10057*
    b. *Engineering training as per DOC 10057*
    c. *Preparing complex CNS/ATM systems' specifications for tenders*
    d. *Communication skills in communicating with Non-ATSEP*
    e. *Preparing technical reports*
    f. *Training on analysing the external interference, interfaces and communication links associated with CNS/ATM facilities*
    g. *Training on infrastructure as per DOC 10057*
    h. *Training on acceptance of major systems be verifying the compliance of user requirements.*

16. *Factors that affects the health of ATSEP while performing duties are given in the order of most significant in the top*
    a. *Frequent (change of) exposure to too low temperature in the server or equipment room and too high outside temperature.*
    b. *No access of fresh air and sunlight for long duration.*
    c. *Working under severe dust pollution during the project work.*
    d. *Working under noise pollution in the airfield.*

17. *Factors that affects the attention of ATSEP while performing duties are given in the order of most significant in the top*
    a. *Diversified tasks during duty.*
    b. *Monotonous monitoring for a long time.*
    c. *Combined project and operational tasks.*
    d. *Working in lower temperature in equipment room.*

18. *Factors that affects the response time of ATSEP while performing corrective maintenance are given in the order of most significant in the top*
    a. *Fear on consequences of failure while trouble shooting in live system.*
    b. *Inadequate first-hand information given by user.*
    c. *Non availability of vehicle to reach the remote site.*
    d. *short of ideas, being alone.*

19. *The training that are most preferred by manager level ATSEP from ANSPs for addressing their competency gaps are given below in the order of most preferred one in the top*
    a. *Planning (for replacement of obsolete system) and procurement.*
    b. *Stress and fatigue management.*
    c. *Project management.*
    d. *Contract management.*

20. *Most significant road block that prevent ATSEP in developing their competencies and expertise are given in the order of most significant one in the top*
    a. *Expected competencies in all domains of CNS/ATM systems.*
    b. *Different make and model for each facility / system.*
    c. *Deployment in non-core activities for longer duration.*
    d. *Compulsory movements within the nation during service live*

10.2. Benefits for ANSPs on addressing the human factors of ATSEP

1. *On a defensive perspective an ANSP need to have the lowest level of resilience maturity i.e. Preventative control. In this level ANSP focuses mainly on continued operations and regulatory compliance. Ensuring mechanism at this level is through monitoring and complying. Consistency is achieved through system, procedures and ATSEP at field level. To have such resilience at this level to handle known problem with proven techniques. ANSPs may consider filling the following gaps if exists w.r.t ATSEP, those who are working directly with the equipment:*
    a. *Training on emergency – training on sudden total shutdown or major failures in a simulated environment and with mock or simulator CNS/ATM systems.*
    b. *Knowledge sharing on known problems and proven technique – Scientific knowledge sharing on the problems experienced and solutions arrived elsewhere within the organization.*
    c. *Competency – All the skills and competency requirements at this level need to be developed and assessed for the field engineer level ATSEP. Principles and guidelines given in DOC 9868 and DOC 10057 need to be followed.*
    d. *Ability to respond quickly – Required resources like manpower, vehicle, test equipment etc.., need to match with the expected response.*
    e. *Supply Chain management – For getting the required spares in time to ensure the down time is reduced*
    f. *Manuals, circulars and other guidance materials for maintaining the CNS/ATM systems and for carrying out the repairing of the failed system – Should be clear, practical and suitable for the field engineer level ATSEP.*

2. *On the next level of defensive perspective focused on loss avoidance and value preservation ANSPs need to have next level of resilience i.e. Mindful action. Ensuring mechanism is through noticing and responding and this the flexibility in noticing and responding unknown problems is achieved mainly through ATSEP in the field level. ANSPs can achieve this resilience by developing the overall capability of ATSEP to investigate, to learn, and to act, without knowing in advance what one will be called to act upon. ANSPs may consider filling the following gaps if exists w.r.t ATSEP, those who are working directly with the equipment and considered as field experts*
    a. *Development of specialized knowledge, skills and attitude of filed engineer level ATSEP to enhance the resilience – Offer international certification training (PMI, CCNA etc..,) to selected experts for exercising judgement, discretion, and imagination while handling unfamiliar events.*
    b. *Building the high reliability organization culture among ATSEP - remain sensitive to all possible threats, challenge the assumptions with specialized knowledge skills and attitude.*
    c. *Encouraging the diversity of opinion among managers and field engineers – Recognizing the field engineer level ATSEP as experts and managers help them in finding and fixing the critical issues.*
    d. *Support of expert team for resolving major breakdowns – Identified expert team that can be formed, developed, activated, combined, and recombined in emergency situations, as challenges arise.*
    e. *ATSEP capacity to investigate, to learn, and to act, without knowing in advance – All the skills and competency requirements at this level need to be developed and assessed for the field engineer level ATSEP. Principles and guidelines given in DOC 9868 and DOC 10057 need to be followed.*

3. *Next level of organizational resilience maturity is performance optimization. It is a progressive perspective that is focused on continuous improvement. Progressive consistency is achieved through leadership qualities of ATSEP at manager levels through field level ATSEP. ANSP resilience is to handle changes in the stakeholders demand due to globalization. Performance optimization involves learning to do existing things better, delivering goals and meeting the needs of the stakeholders. Typically, optimizing involves process enhancement, including the refinement, extension and exploitation of existing assets and competencies, technologies, and standards. Optimization often involves formalized structures for authority and decision-making. In this stage Leadership is a critical aspect of optimization. ANSPs may consider filling the following gaps if exists w.r.t ATSEP, those who are in the lower and middle level management.*

a. *ANS procurement process improvement – Benchmarking the entire process with key performance indicators, evaluating the vendors supply relations during the entire period of service life of the equipment, specialized training on user requirements compilation including defining the training requirements that suits the maintenance philosophies of ANSPs.*
b. *Maintenance procedures – Complex system fails complex way. New maintenance philosophies and procedures to suit the present technologies so that ATSEP do have sufficient scope for devoting time on mindful action and performance improvements.*
c. *Leaderships skill for managers so that they leave the shoes of experts and assume the critical leadership roles – Developing leadership skills through well-defined training (Human factors training – DOC 10057), workshops and online training provisions.*
d. *Capabilities of ANS system installation, verification, validation, acceptance and commissioning - Developing necessary skills and competencies well defined training (Engineering – DOC 10057), for both the field engineer level as well as manager level.*
e. *Capability for continually improving, refining, and extending existing competencies. Learning to do existing things better – Opportunities to work on limited domain for a considerable work experience, with specialized knowledge, skills and competency development.*

11. Further scope of work

With the extensive research works already available for the stakeholders, courtesy FAA, CANSO, Eurocontrol and other international organizations, the results and best practices can be directly taken and applied by the respective ANSPs to fill the gaps.

For finding out the gaps, factors listed in the chapter 7 of this report and corrective measures listed in the chapter 10 of this report may be utilized as a ready reference.

However, WG and CNS /SG 24 meeting may decide whether to extend the study to all APAC states or to review and enhance the chapter 7 and chapter 10 collectively in the coming days. Then we can proceed for a voluntary check in the APAC states on finding the maturity levels. IFATSEA is willing to contribute either way.

- IFATSEA proposes to make a detailed human factor regional guidance material for the self-evaluation by states w.r.t ATSEP job profile and working environment. This regional guidance material shall enable the states to bench mark themselves and attain higher level of maturity in assuring the human performance.
- Though there are several manuals and guidance materials available, IFATSEA, APAC would like to prepare a human factor training material for ATSEP, for the benefit of the regional ATSEP and ANSPs.

12. Conclusion

Though best practices and guidelines are available for decades, this study proves a point that ANSPs are yet to address the human performance issues of ATSEP and manage it in an integrated manner within the organization.

The recent past events listed in the chapter 5 of this study report, hints several growing bigger hidden problems at different parts of the world. So, it's high time for ANSPs to start practicing the human performance management of ATSEP in an integrated manner as it is done with the controllers' performance and attain high level of maturity gradually.

As stated, there are several measures to be taken, listed in chapter 10 of this study report, the following measures need to be taken by ANSPs on top priority.

- Clear job description, roles, responsibilities and deployment as per DOC 10057 so that core competency is developed and retained and safety performance is assured. Defining accountabilities as per seniority with clear demarcation on technical as well as managerial aspects to avoid ambiguities.
- Rationalizing existing human resources to carry the existing safety tasks and for developing necessary KSA and competency with job rotation. Regular recruitment in phased manner to supplement retirement and also for augmenting the new additional facilities.
- Scientific resource allocations as per the number of complex systems and number of simultaneous tasks assigned to particular team. Structured workload distribution with reward and punishment mechanism for safe and non-safe performance, so that undue overload of work is prevented.
- Implementation of all the phases of CBT/A as per DOC 9868 and DOC 10057 based on the roles and responsibilities of ATSEP and competency requirements. Augmentation of training infrastructures for required KSA and competency development in line with the successive induction of technologies.
- Scientific shift duty duration and pattern with breaks in shifts and weekly clear OFFs for managing the fatigue and sleep management. Flexible working hours to general maintenance and project teams, after long work hours without break at remote sites either due to late hour calls, breakdown maintenance, VVIP movements and on installation activities.
- Procurement policies by keeping long term safety objectives above cost of acquisition, for suiting the quick induction of the best available latest technologies and for best contract support after the acquisition. Service life expansion of old and obsolete equipment based on spare support contract and on the availability of optimum number of competent ATSEP on old technology.